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# DENTAL

# SECRETS

FOURTH EDITION

Q&A FORMAT ■ EXPERT CONTRIBUTORS ■ EXAM REVIEW

STEPHEN T. SONIS

ELSEVIER

# DENTAL

SECRETS

FOURTH EDITION

EDITOR IN CHIEF

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*In memory of my father, H. Richard Sonis, DDS,  
with admiration and gratitude*

# PREFACE TO THE 4<sup>TH</sup> EDITION

It has been some time since the last edition of *Dental Secrets*. Despite the availability of many terrific online resources, student enthusiasm for the Q & A short answer format found in this book indicated that it was time for an update. Readers of older editions will note some changes in contributors. We've been fortunate to recruit new authors and co-authors for a number of chapters, which assures a fresh look at content. The science and practice of dentistry continues to evolve. No matter how much we try, it's almost impossible to be totally up-to-date. "Life-long learning" is not just a catchy phrase. Hopefully, this book will help. Once again, *Dental Secrets* is written for those who like to learn by those who love to teach.

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# PATIENT MANAGEMENT: THE DENTIST-PATIENT RELATIONSHIP

*Elliot V. Feldbau and Kathy Kommit*

## CASE EXAMPLES

**After you seat the patient, a 42-year-old woman, she turns to you and says glibly, “I don’t like dentists.” How should you respond?**

**Tip:** The patient presents with a gross negative generalization. Distortions and deletions of information need to be explored. Not liking you, the dentist, whom she has never met before, is not an accurate representation of what she is trying to say. Start the interview with curiosity in your voice as you cause her to reflect by repeating her phrasing—“You don’t like dentists?”—with the expectation that she will elaborate. Probably she has had a bad experience, and your interest gives her an opportunity to elaborate on that and to understand what she needs from you better. It is important to do active listening and allow the patient who comes to the office with some negative expectations based on past situations to express her thoughts and feelings. Therefore, you can show that perhaps you are different from a previous dentist with whom she had a negative experience, and you can communicate that you want this to be a more positive dental visit. The previous dentist might not have developed listening skills and left the patient with a negative view of all dentists. The goals in a situation in which someone enters the office with an already formed negative predisposition are to enhance communication, develop trust and rapport, and start a new chapter in this patient’s dental experience.

**As you prepare to do a root canal on tooth number 9, a 58-year-old man responds, “The last time I had that dam on, I couldn’t catch my breath. It was horrible.” How should you respond? What may be the significance of his statement?**

**Tip:** The comment, “I couldn’t catch my breath,” requires clarification. Did the patient have an impaired airway with past rubber dam experience, or has some long-ago experience been generalized to the present? Does the patient have a gagging problem? A therapeutic interview clarifies, validates, reassures, and allows the patient to be more compliant.

**A 55-year-old man is referred for periodontal surgery. During the medical history, he states that he had his tonsils out at age 10 years and, since then, any work on his mouth frightens him. He feels like gagging. How do you respond?**

**Tip:** A remembered traumatic event is generalized to the present situation. Although the feelings of helplessness and fear of the unknown are still experienced, a reassured patient who knows what is going to happen can be taught a new set of appropriate coping skills to enable the required dental treatment to be carried out. The interview fully explores all phases of the events surrounding the past trauma when the fears were first imprinted.

**After performing a thorough examination for the chief complaint of recurrent swelling and pain of a lower right first molar, you conclude that given the 80% bone loss and advanced subosseous furcation decay, the tooth is hopeless. You recommend extraction to prevent further infection and potential involvement of adjacent teeth. Your patient replies, “I don’t want to lose any teeth. Save it!” How do you respond?**

**Tip:** The command by the patient to save a hopeless tooth at all costs requires an understanding of the denial process, or the clinician may be doomed to perform treatments with no hope of success and face the likely consequence of a disgruntled patient. The interview should clarify the patient’s feelings, fears, or interpretations regarding tooth loss. It may be a fear of not knowing that a tooth may be replaced, fear of pain associated with extractions, fear of confronting disease

and its consequences, or even fear of guilt because of neglect of dental care. The interview should clarify and inform while communicating a sense of concern and compassion.

With each of these patients, the dentist should be alerted that something is not routine. Each patient expresses some concern and anxiety. This is clearly the time for the dentist to remove the gloves, lower the mask, and begin a comprehensive interview. Although responses to such situations may vary according to individual style, each clinician should proceed methodically and carefully to gather specific information based on the cues presented by the patient. By understanding each patient's comments and feelings related to earlier experiences, the dentist can help the patient see that change is possible and that coping with dental treatment is easily learned. The following questions and answers provide a framework for conducting a therapeutic interview that increases patient compliance and reduces levels of anxiety.

## PATIENT INTERVIEW

### 1. What is the basic goal of the initial patient interview?

The basic goal is to establish a therapeutic dentist-patient relationship in which accurate data are collected, presenting problems are assessed, and effective treatment is suggested. The patient should feel heard and validated, which leads to a feeling of safety and trust.

### 2. What are the major sources of clinical data derived during the interview?

The clinician should be attentive to what the patient verbalizes (i.e., the chief complaint), manner of speaking (how things are expressed), and nonverbal cues that may be related through body language (e.g., posture, gait, facial expression, or movements). While listening carefully to the patient, the dentist can observe associated gestures, fidgeting movements, excessive perspiration, or patterns of irregular breathing that might indicate underlying anxiety or emotional problems.

### 3. What are the common determinants of a patient's presenting behavior?

1. The patient's perception and interpretation of the present situation (the reality or view of the present illness)
2. The patient's past experiences or personal history
3. The patient's personality and overall view of life

Patients generally present to the dentist for help and are relieved to share personal information with a knowledgeable professional who can assist them. However, some patients also may feel insecure or emotionally vulnerable because of such disclosures.

### 4. Discuss the insecurities that patients might encounter while relating their personal histories.

Patients may feel the fear of rejection, criticism, shame, or even humiliation from the dentist because of their neglect of dental care. Confidential disclosures may threaten the patient's self-esteem. Thus, patients may react to the dentist with rational and irrational comments, and their behavior may be inappropriate and even puzzling to the dentist. In a severely psychologically limited patient (e.g., one with psychosis or a personality disorder), their behaviors may approach extremes. Furthermore, patients who perceive the dentist as judgmental or too evaluative are likely to become defensive, uncommunicative, or even hostile. Anxious patients are more observant of any signs of displeasure or negative reactions by the dentist. The role of effective communication is extremely important with such patients.

### 5. How can one effectively deal with the patient's insecurities?

Communication founded on the basic concepts of empathy and respect gives the most support to patients. Understanding their point of view (empathy) and recognition of their right to their own opinions and feelings (respect), even if different from the dentist's personal views, help deal with and avert potential conflicts.

### 6. Why is it important for dentists to be aware of their own feelings when dealing with patients?

Although the dentist tries to maintain an attitude that is attentive, friendly, and even sympathetic toward a patient, he or she needs an appropriate degree of objectivity in relation to patients and their problems. Dentists who find that they are not listening with some degree

of emotional neutrality to the patient's information should be aware of any personal feelings of anxiety, sadness, indifference, resentment, or even hostility that may be aroused by the patient. Recognition of any aspects of the patient's behavior that arouse such emotions helps dentists understand their own behavior and prevent possible conflicts in clinical judgment and treatment plan suggestions. It is important to strive to be as neutral and nonjudgmental as possible so that the patient can feel safe and trusting.

#### 7. List two strategies for the initial patient interview.

1. During the verbal exchange with the patient, all the elements of the medical and dental history relevant to treating the patient's dental needs should be elicited.
2. In the nonverbal exchange between the patient and dentist, the dentist gathers cues from the patient's mannerisms while conveying an empathetic attitude.

#### 8. What are the major elements of the empathetic attitude that a dentist tries to relate to the patient during the interview?

- Attentiveness and concern for the patient
- Acceptance of the patient and his or her problems
- Support for the patient
- Involvement with the intent to help

#### 9. How are empathetic feelings conveyed to the patient?

Giving full attention while listening demonstrates to the patient that you are physically present and comprehend what the patient relates. Appropriate *physical attending skills* enhance this process. Careful analysis of what a patient tells you allows you to respond to each statement with clarification and interpretation of the issues presented. The patient hopefully gains some insight into his or her problem, and rapport is further enhanced.

#### 10. What useful physical attending skills comprise the nonverbal component of communication?

The adept use of face, voice, and body facilitates the classic "bedside manner," including the following:

**Eye contact.** Looking at the patient without overt staring establishes rapport.

**Facial expression.** A smile or nod of the head in affirmation shows warmth, concern, and interest.

**Vocal characteristics.** The voice is modulated to create a calm tone, emphasize meaning, and help the patient understand important issues.

**Body orientation.** Facing patients as you stand or sit signals attentiveness. Turning away may seem like rejection.

**Forward lean and proximity.** Leaning forward tells a patient that you are interested and want to hear more, thus making it easier for the patient to comment. Proximity infers intimacy, whereas distance signals less attentiveness. In general, 4 to 6 feet is considered to be a social consultative zone.

A verbal message of low empathetic value may be altered favorably by maintaining eye contact, leaning forward with the trunk, and having appropriate distance and body orientation. However, even a verbal message of high empathetic content may be reduced to a lower value when the speaker does not have eye contact, turns away with a backward lean, or maintains too far a distance. For example, do not tell the patient that you are concerned while washing your hands with your back to the dental chair.

#### 11. During the interview, what cues alert the dentist to search for more information about a statement made by the patient?

Most people express information that they do not fully understand by using generalizations, deletions, and distortions in their phrasing. For example, the comment, "I am a horrible patient," does not give much insight into the patient's intent. By probing further, the dentist may discover specific fears or behaviors that the patient has deleted from the opening generalization. As a matter of routine, the dentist should be alert to such cues and use the interview to clarify and work through the patient's comments. As the interview proceeds, trust and rapport are built as a mutual understanding develops and the patient's level of fear decreases.

## 12. Why is open-ended questioning useful as an interviewing format?

Questions that do not have specific yes or no answers give patients more latitude to express themselves. More information allows the dentist to have a better understanding of patients and their problems. The dentist is basically saying, “Tell me more about that.” Throughout the interview, the clinician listens for any cues that indicate the need to pursue further questioning and obtain more information about expressed fears or concerns. Typical questions in the open-ended format include the following:

- “What brings you here today?”
- “Are you having any problems?”
- “Please tell me more about it.”

## 13. How can the dentist help the patient relate more information or talk about a certain issue in greater depth?

A communication technique called *facilitation by reflection* is helpful. One simply repeats the last word or phrase that was spoken in a questioning tone of voice. Thus, when a patient says, “I am petrified of dentists,” the dentist responds, “Petrified of dentists?” The patient usually elaborates. The goal is to go from a generalization to the specific fear to the origin of the fear. This process is therapeutic and allows fears to be reduced or diminished as patients gain insight into their feelings.

## 14. How should one construct suggestions that help patients alter their behavior or that influence the outcome of a command?

Negatives should be avoided in commands. Positive commands are more easily experienced, and compliance is usually greater. To experience a negation, the patient first creates the positive image and then somehow negates it. While experiencing something, only positive situations can be realized; language forms negation. For example, to experience the command “Do not run!,” one may visualize oneself sitting, standing, or walking slowly. A more direct command is “Stop!” or “Walk!” Moreover, a negative command may create more resistance to compliance, whether voluntary or not. If you ask someone not to see elephants, he or she tends to see elephants first. Therefore, it may be best to ask patients to keep their mouth open widely rather than say, “Don’t close,” or perhaps suggest, “Rest open widely, please.”

A permissive approach and indirect commands also create less resistance and enhance compliance. One may say, “If you stay open widely, I can do my procedure faster and better,” or “By flossing daily, you will experience a fresher breath and a healthier smile.” This style of suggestion is usually better received than a direct command.

A linking phrase—for example, “as,” “while,” or “when”—to join a suggestion with something that is happening in the patient’s immediate experience provides an easier pathway for a patient to follow and further enhances compliance. For example, “As you lie in the chair, allow your mouth to rest open. While you take another deep breath, allow your body to relax further.” In each of these, the patient easily identifies with the first experience and thus complies with the additional suggestion more readily.

Providing pathways to achieve a desired end may help patients accomplish something that they do not know how to do on their own. Patients may not know how to relax on command; it may be more helpful to suggest that while they take in each breath slowly and see a drop of rain rolling off a leaf, they can let their whole body become loose and at ease. Indirect suggestions, positive images, linking pathways, and guided visualizations play a powerful role in helping patients achieve desired goals.

## 15. How do the senses influence communication style?

Most people record experience in the auditory, visual, or kinesthetic mode. They hear, they see, or they feel. Some people use a dominant mode to process information. Language can be chosen to match the modality that best fits the patient. If patients relate their problem in terms of feelings, responses related to how they feel may enhance communication. Similarly, a patient may say, “Doctor, that sounds like a good treatment plan,” or “I see that this disorder is relatively common. Things look less frightening now.” These comments suggest an auditory mode and a visual mode, respectively. Matching your response to the patient’s dominant mode can enhance communication.

## 16. When is reassurance most valuable in the clinical session?

Positive supportive statements to the patient that he or she is going to do well or be all right are an important part of treatment. At some point, everyone may have doubts or fears about

the outcome. Reassurance given too early, such as before a thorough examination of the presenting symptoms, may be interpreted by some patients as insincerity or as trivializing their problem. The best time for reassurance is after the examination, when a tentative diagnosis is reached. The support is best received by the patient at this point.

### 17. What type of language or phrasing is best avoided in patient communications?

Certain words or descriptions that are routine in the technical terminology of dentistry may be offensive or frightening to patients. The words *cutting*, *drilling*, *bleeding*, *injecting*, or *clamping* may be anxiety-provoking terms to some patients. Furthermore, being too technical in conversations with patients may result in poor communication and provoke rather than reduce anxiety. It is beneficial to choose terms that are neutral yet informative. One may prepare a tooth rather than cut it or dry the area rather than suction all the blood. This approach may be especially important during a teaching session when procedural and technical instructions are given as the patient lies helpless, listening to conversation that seems to exclude his or her presence as a person.

## DENTAL FEAR AND ANXIETY

### 18. How common is dental-related anxiety?

It is estimated that about 75% to 80% of individuals in the United States have some anxiety about dental treatment. Approximately 5% to 10% of U.S. adults are considered to experience dental phobia to such a degree that complete avoidance of care ensues unless there is an emergency toothache or abscess. Then it can be extremely stressful to the patient and provider. Women tend to be more phobic than men and younger individuals more than mature adults. Unless this cycle of avoidance is treated by a knowledgeable and caring dentist, a patient may never seek anything but beyond emergent care, with a resultant progression toward edentulism.

### 19. What common dental-related fears do patients experience?

- Pain
- Drills (e.g., slipping, noise, smell)
- Needles (deep penetration, tissue injury, numbness)
- Loss of teeth
- Surgery

### 20. List four elements common to all fears.

- |                            |   |
|----------------------------|---|
| 1. Fear of the unknown     | 3. Fear of physical harm or bodily injury |
| 2. Fear of loss of control | 4. Fear of helplessness and dependency    |

Understanding these elements of fear allows effective planning for the treatment of fearful and anxious patients.

### 21. During the clinical interview, how may one address such fears?

According to the maxim that “fear dissolves in a trusting relationship,” establishing good rapport with patients is especially important. Second, preparatory explanations may deal effectively with fear of the unknown and thus give the patient a sense of control. Allowing patients to signal when they wish to pause or speak further alleviates their fear of loss of control. Finally, well-executed dental technique and clinical practices minimize unpleasantness.

### 22. How are dental fears learned?

Usually, dental-related fears are learned directly from a traumatic experience in a dental or medical setting. The experience may be real or perceived by the patient as a threat, but a single event may lead to a lifetime of fear when any element of the traumatic situation is reexperienced. The situation may have occurred many years before, but the intensity of the recalled fear may persist. Associated with the incident is the behavior of the doctor in the past. Thus, for defusing learned fear, the behavior of the present doctor is paramount.

Fears also may be learned indirectly as a vicarious experience from family members, friends, or even the media. Cartoons and movies often portray the pain and fear of the dental setting. How many times have dentists seen the negative reaction of patients to the term *root canal*, even though they may not have had one?

Past fearful experiences often occur during childhood, when perceptions are out of proportion to events, but memories and feelings persist into adulthood, with the same distortions. Feelings of helplessness, dependency, and fear of the unknown are coupled with pain and a possible uncaring attitude on the part of the dentist creates a conditioned response of fear when any element of the past event is reexperienced. Such events may not even be available to conscious awareness.

### 23. How are the terms *generalization* and *modeling* related to the conditioning aspect of dental fears?

Dental fears may be seen as similar to classic Pavlovian conditioning. Such conditioning may result in **generalization**, in which the effects of the original episode spread to situations with similar elements. For example, the trauma of an injury or details of an emergency setting, such as sutures or injections, may be generalized to the dental setting. Many adults who had tonsillectomies under ether anesthesia may generalize the childhood experience to the dental setting, complaining of difficulty with breathing or airway maintenance, difficulty with gagging, or inability to tolerate oral injections. **Modeling** is vicarious learning through indirect exposure to traumatic events through parents, siblings, or any other source that affects the patient.

### 24. Why is understanding the patient's perception of the dentist so important in the control of fear and stress?

According to studies, patients perceive the dentist as both the **controller** of what the patient perceives as dangerous and as the **protector** from that danger. Thus, the dentist's behavior and communications assume increased significance. The patient's ability to tolerate stress and cope with fears depends on her or his ability to develop and maintain a high level of trust and confidence in the dentist. To achieve this goal, patients must express all the issues that they perceive as threatening, and the dentist must explain what he or she can do to address patients' concerns and protect them from the perceived dangers. This is the purpose of the clinical interview. The result of this exchange should be increased trust and rapport and a subsequent decline in fear and anxiety.

### 25. How do emotions evolve? What constructs are important to understanding dental fears?

Psychological theorists have suggested that events and situations are evaluated by using interpretations that are personality-dependent (i.e., based on individual history and experience). Emotions evolve from this history. Positive or negative coping abilities mediate the interpretative process—people who believe that they are capable of dealing with a situation experience a different emotion during the initial event than those with less coping ability. The resulting emotional experience may be influenced by vicarious learning experiences (e.g., watching others react to an event), direct learning experiences (e.g., having one's own experience with the event), or social persuasion (e.g., expressions by others of what the event means).

A person's belief about his or her coping ability, or *self-efficacy*, in dealing with an appraisal of an event for its threatening content is highly variable, based on the multiplicity of personal life experiences. Belief that one has the ability to cope with a difficult situation reduces the likelihood that an event will be appraised as threatening, and a lower level of anxiety will result. A history of failure to cope with difficult events or the perception that coping is not a personal accomplishment (e.g., reliance on external aids, drugs) often reduces self-efficacy expectations, and interpretations of the event can result in higher anxiety.

### 26. How can learned fears be eliminated or unlearned?

Because fears of dental treatment are learned, relearning or unlearning is possible. A comfortable experience without the associated fearful and painful elements may eliminate the conditioned fear response and replace it with an adaptive and more comfortable coping response. Through the interview process, the secret is to uncover which elements have resulted in the maladaptation and subsequent response of fear, eliminate them from the present dental experience by reinterpreting them for the adult patient, and create a more caring and protected experience. During the interview, the exchange of information and insight gained by the patient decrease levels of fear, increase rapport, and establish trust in the doctor-patient relationship. The clinician only needs to apply an expert operative technique to treat the vast majority of fearful patients.

**27. What remarks may be given to a patient before beginning a procedure that the patient perceives as threatening?**

Opening comments by the dentist to inform the patient about what to expect during a procedure—for example, pressure, noise, pain—may reduce the patient’s fear of the unknown and sense of helplessness. Control through knowing is increased with these preparatory communications.

**28. How may the dentist further address the issue of loss of control?**

A simple instruction that allows patients to signal by raising a hand if they wish to stop or speak returns a sense of control. Also, patients can be given the choice of whether to lie back or sit up.

**29. What is denial? How may it affect a patient’s behavior and dental treatment planning decisions?**

*Denial* is a psychological term for the defense mechanism that people use to block out the experience of information with which they cannot emotionally cope. They may not be able to accept the reality or consequences of the information or experience with which they will have to cope; therefore, they distort that information or completely avoid the issue. Often, the underlying experience of the information is a threat to self-esteem or liable to provoke anxiety. These feelings are often unconsciously expressed by unreasonable requests of treatment.

For the dentist, patients who refuse to accept the reality of their dental disease, such as the hopeless condition of a tooth, may lead to a path of treatment that is doomed to fail. The subsequent disappointment of the patient may result in litigation issues.

**30. Define dental phobia.**

A phobia is an irrational fear of a situation or object. The reaction to the stimulus is often greatly exaggerated in relation to the reality of the threat. The fears are beyond voluntary control, and avoidance is the primary coping mechanism. Phobias may be so intense that severe physiologic reactions interfere with daily functioning. In the dental setting, acute syncopal episodes may result.

Almost all phobias are learned. The process of dealing with true dental phobia may require a long period of individual psychotherapy and adjunctive pharmacologic sedation. However, relearning is possible, and establishing a good doctor-patient relationship is paramount.

**31. What is PTSD and what are the symptoms?**

Post-traumatic stress disorder (PTSD) is an anxiety disorder that develops subsequent to a traumatic event, such as sexual or physical abuse, serious accident, assault, war combat, or natural disaster. Symptoms include intrusive memories, avoidance behaviors, mood disorders, and high levels of physiologic arousal.

**32. How do traumatic events create behaviors later in life?**

Past traumatic events, whether remembered or suppressed in the subconscious, may trigger behavioral responses that occur when similar or even vicarious events occur in the present. These events may be through direct experience, such as an accident, combat wound, or sexual abuse, or associated with observation of such events. The triggered behavior in the patient may be generalized fear and anxiety, and even extreme panic.

**33. Why is it important for dental providers to be sensitive to this issue?**

Patients with PTSD who come for dental treatment may feel very vulnerable and can sometimes find the experience retraumatizing. This is because the patient is often alone with the dentist, is placed in a horizontal position, is being touched by the dentist, who is hierarchically more powerful (and often male), is having objects placed in the mouth, is unable to swallow, and is anticipating or feeling pain. Many PTSD sufferers avoid going to the dentist, often cancel or reschedule appointments, have stress-related dental issues, and experience heightened distress while undergoing procedures.

**34. How might a dentist know if a patient suffers from PTSD?**

Often these patients are reluctant to admit this, so it is a good idea to ask during the diagnostic interview, “Have you ever suffered from post-traumatic stress disorder?”

**35. What are some special considerations when treating patients with PTSD?**

Similar to treating other anxious patients, dentists want to practice active listening, show compassion, and try to give the patient as much control in the situation as possible. You might offer an initial appointment just to talk, place the chair in an upright position, keep the door open, have an assistant present, check in frequently to see how the patient is doing, offer reassurance, and explain the procedures as you proceed.

Also, you can offer soothing music, blanket, or body covering (e.g., an x-ray cover). Make sure that the patient has been instructed to stop you whenever their anxiety level is getting too high. Premedication may be helpful.

**36. When should you refer a patient with PTSD for a psychological consultation?**

If the patient is unable to tolerate being in the dental chair because her or his anxiety is uncontrollably high, you might want to refer this patient to a professional who specializes in the treatment of anxiety disorders. Counseling and anti-anxiety medications can be helpful in the treatment of PTSD and, in some cases, may be a prerequisite to dental work being carried out.

**37. What strategies may be used with the patient who gags at the slightest provocation?**

The gag reflex is a basic physiologic protective mechanism that occurs when the posterior oropharynx is stimulated by a foreign object; normal swallowing does not trigger the reflex. When overlying anxiety is present, especially if anxiety is related to the fear of being unable to breathe, the gag reflex may be exaggerated. A conceptual model is the analogy to being tickled. Most people can stroke themselves on the sole of the foot or under their arm without a reaction, but when the same stimulus is done by someone else, the usual results are laughter and withdrawal. Hence, if patients can eat properly, put a spoon in their mouth, or suck on their own finger, they are usually considered physiologically normal and may be taught to accept dental treatment and even dentures with appropriate behavioral therapy.

In dealing with these patients, desensitization involves the process of relearning. A review of the history to discover episodes of impaired or threatened breathing is important. Childhood general anesthesia, near-drowning, choking, or asphyxiation may have been the initiating event that created increased anxiety about being touched in the oral cavity. Patients may fear the inability to breathe, and the gag becomes part of their protective coping mechanism. Thus, reduction of anxiety is the first step; an initial strategy is to give information that allows patients to understand their own response better.

Instruction in nasal breathing may offer confidence in the ability to maintain a constant and uninterrupted air flow, even with oral manipulation. Also, diaphragmatic breathing, which involves inflating the lower part of the abdomen, can be helpful. Eye fixation on a single object may help dissociate and distract the patient's attention away from the oral cavity. This technique may be especially helpful for taking radiographs and for brief oral examinations. For severe gaggers, hypnosis and nitrous oxide may be helpful; others may find the use of a rubber dam reassuring. For some patients, longer term behavioral therapy may be necessary.

**38. What is meant by the term *anxiety*? How is it related to fear?**

**Anxiety** is a subjective state commonly defined as an unpleasant feeling of apprehension or impending danger in the presence of a real or perceived stimulus that the person has learned to associate with a threat to well-being. The feelings may be out of proportion to the real threat, and the response may be grossly exaggerated. Such feelings may be present before the encounter with the feared situation and may linger long after the event. Associated somatic feelings include sweating, tremors, palpitations, nausea, difficulty with swallowing, and hyperventilation.

**Fear** is usually considered an appropriate defensive response to a real or active threat. Unlike anxiety, the response is brief, the danger is external and readily definable, and the unpleasant somatic feelings pass as the danger passes. Fear is the classic fight-or-flight response and may serve as an overall protective mechanism by sharpening the senses and ability to respond to the danger. The fear response does not usually rely on unhealthy actions for resolution, but the state of anxiety often relies on noncoping and avoidance behaviors to deal with the threat.



### 39. How is stress related to pain and anxiety? What are the major parameters of the stress response?

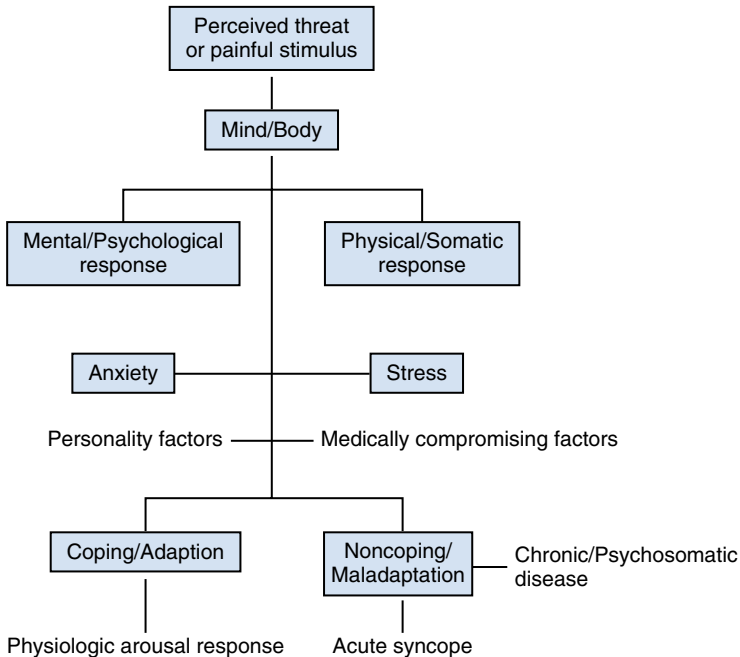
When a person is stimulated by pain or anxiety, the result is a series of physiologic responses dominated by the autonomic nervous system, skeletal muscles, and endocrine system. These physiologic responses define stress. In what is termed an *adaptive response*, the sympathetic responses dominate—increases in pulse rate, blood pressure, respiratory rate, peripheral vasoconstriction, skeletal muscle tone, and blood sugar; decreases in sweating, gut motility, and salivation. In an acute maladaptive response, the parasympathetic responses dominate, and a syncopal episode may result—decreases in pulse rate, blood pressure, respiratory rate, and muscle tone; increases in salivation, sweating, gut motility, and peripheral vasodilation, with overall confusion and agitation. In chronic maladaptive situations, psychosomatic disorders may evolve. *Figure 1-1* illustrates the relationships of fear, pain, and stress. It is important to control anxiety and stress during dental treatment. The medically compromised patient requires appropriate control to avoid potentially life-threatening situations.

### 40. What is the relationship between pain and anxiety?

Many studies have shown the close relationship between pain and anxiety. The greater the person's anxiety, the more likely it is that he or she will interpret the response to a stimulus as painful. In addition, the pain threshold is lowered with increasing anxiety. People who are debilitated, fatigued, or depressed respond to threats with a higher degree of undifferentiated anxiety and thus are more reactive to pain.

### 41. List four guidelines for the proper management of pain, anxiety, and stress.

1. Make a careful assessment of the patient's anxiety and stress levels by a thoughtful interview. Uncontrolled anxiety and stress may lead to maladaptive situations that could become life-threatening in medically compromised patients. Prevention is the most important strategy.



**Figure 1-1.** Relationships of pain, anxiety, stress, and reactions. (From Gregg JM: *Psychosedation. Part 1*. In McCarthy FM, editor: *Emergencies in dental practice*, ed 3, Philadelphia, WB Saunders, 1979, p 230.)

2. From all information gathered, medical and personal, determine the correct methods for controlling the pain and anxiety. This assessment is critical to appropriate management. Monitoring the patient's responses to the chosen method is essential.
3. Use medications as adjuncts for positive reinforcement, not as methods of control. Drugs circumvent fear; they do not resolve conflicts. The need for good rapport and communication is always essential.
4. Adapt control techniques to fit the patient's needs. The use of a single modality for all patients may lead to failure; for example, the use of nitrous oxide sedation to moderate severe emotional problems may not be helpful for all patients.

#### 42. Construct a model for the therapeutic interview of a self-identified fearful patient.

1. Recognize a patient's anxiety by acknowledging what the patient says or observing the patient's demeanor. Recognition, which is verbal and nonverbal, may be as simple as saying, "Are you nervous about being here?" This indicates the dentist's concern, acceptance, supportiveness, and intent to help.
2. Facilitate patients' cues as they tell their story. Help them go from generalizations to specifics, especially to past origins, if possible. Listen for generalizations, distortions, and deletions of information or misinterpretation of events as the patient talks.
3. Allow patients to speak freely. Their anxiety decreases as they tell their story, describing the nature of their fear and the attitude of previous doctors. Trust and rapport between doctor and patient also increase as the patient is allowed to speak to someone who cares and listens.
4. Give feedback to the patient. Interpretation of the information helps patients learn new strategies for coping with their feelings and adopting new behaviors by confronting past fears. Thus, a new set of feelings and behaviors may replace maladaptive coping mechanisms.
5. Finally, the dentist makes a commitment to protect the patient—a commitment that the patient may have perceived as absent in past dental experiences. Strategies include allowing the patient to stop a procedure by raising a hand or simply assuring a patient that you are ready to listen at any time.

#### 43. Discuss behavioral methods that may help patients cope with dental fears and related anxiety.

1. The first step for the dentist is to get to know the patient and his or her presenting needs. Interviewing skills cannot be overemphasized. A trusting relationship is essential. As the clinical interview proceeds, fears are usually reduced to coping levels.
2. Because a patient cannot be anxious and relaxed at the same moment, teaching methods of relaxation may be helpful. Systematic relaxation allows the patient to cope with the dental situation. Guided visualizations may be helpful to achieve relaxation. Paced breathing also may be an aid to keeping patients relaxed. Guiding the rate of inspiration and expiration allows a hyperventilating patient to resume normal breathing, thus decreasing the anxiety level. A sample relaxation script is presented in [Box 1-1](#).
3. Hypnosis, a useful tool with myriad benefits, induces an altered state of awareness, with heightened suggestibility for changes in behavior and physiologic responses. It is easily taught, and the benefits can be highly beneficial in the dental setting.
4. Informing patients of what they may experience during a procedure addresses the specific fears of the unknown and loss of control. Sensory information—that is, what physical sensations may be expected—as well as procedural information is appropriate. Knowledge enhances a patient's coping skills.
5. Modeling, or observing a peer undergo successful dental treatment, may be beneficial. Videotapes are available for a variety of dental scenarios.
6. Methods of distraction may also improve coping responses. Audio or video programs have been reported to be useful for some patients.

#### 44. What are common avoidance behaviors associated with anxious patients?

Generally, putting off making appointments, followed by cancellations and failing to appear, are routine events for anxious patients. The avoidance of care can be of such magnitude that personal suffering is endured from tooth ailments, with emergency consequences. A mutilated dentition often results.

**BOX 1-1. Relaxation Script**

*The following example should be read in a slow, rhythmic, and paced manner while carefully observing the patient's responses. Backing up and repeating parts are beneficial if you find that the patient is not responding at any time. Feel free to change and incorporate your own stylistic suggestions.*

Allow yourself to become comfortable . . . and as you listen to the sound of my voice, I shall guide you along a pathway of deepening relaxation. Often we start out at some high level of excitement, and as we slide, down lower, we can become aware of our descent and enjoy the ride. Let us begin with some attention to your breathing . . . taking some regular, slow . . . easy . . . breaths. Let the air flow in . . . and out . . . air in . . . air out . . . until you become very aware of each inspiration . . . and . . . expiration . . . [pause] Very good. Now as you feel your chest rise with each intake and fall with each outflow, notice how different you now feel from a few moments ago as you comfortably resettle yourself in the chair, adjusting your arms and legs just enough to make you feel more comfortable.

Now with regularly paced, slow, and easy breathing, I would like to ask that you become aware of your arms and hands as they rest [describe where you see them—e.g., “on your lap”] . . . Move them slightly. [pause] Next become aware of your legs and feel the chair's support under them . . . they may also move slightly. We shall begin our total body relaxation in just this way . . . becoming aware of a part and then allowing it to become at ease . . . resting, floating, lying peacefully. Start at your eyelids and, if they are not already closed, allow them to become free and rest them downward . . . your eyes may gaze and float upward. Now focus on your forehead . . . letting the subtle folds become smoother and smoother with each breath. Now let this peacefulness of eyelids and forehead start a gentle warm flow of relaxing energy down over your cheeks and face, around and under your chin, and slowly down your neck. You may find that you have to swallow . . . allow this to happen, naturally. Now continue this as a stream flowing over your shoulders and upper chest and over and across to each arm . . . [pause] . . . and when you feel this warmth in your fingertips you may feel them move ever so slightly . . . [pause for any movement] Very good.

Next, allow the same continuous flow to start down to your lower body and over your waist and hips . . . reaching each leg. You may notice that they are heavy or light, and that they move ever so slightly as you feel the chair supporting them with each breath and each swallow that you take. You are resting easily, breathing comfortably and effortlessly.

You may now become aware of just how much at ease you are, in such a short time, from a moment ago, when you entered the room. Very good, be at ease.

**45. Whom do dentists often consider their most “difficult” patient?**

Surveys have repeatedly shown that dentists often view the anxious patient as their most difficult challenge. Almost 80% of dentists report that they themselves become anxious with an anxious patient. The ability to assess a patient's emotional needs carefully helps the clinician improve his or her ability to deal effectively with an anxious patient. Furthermore, because anxious patients require more chair time for procedures, are more reactive to stimuli, and associate more sensations with pain, effective anxiety management yields more effective practice management.

**46. What are the major practical considerations in scheduling identified anxious dental patients?**

Autonomic arousal increases in proportion to the length of time before a stressful event. A patient left to anticipate the event with negative self-statements and perhaps frightening images for a whole day or for a long time in the waiting area is less likely to have an easy experience. Thus, it is considered prudent to schedule patients earlier in the day and keep the waiting period after the patient's arrival as short as possible. In addition, the dentist's energy is usually optimal earlier in the day for dealing with more demanding situations.

**47. What do patients describe as qualities and behaviors of a dentist who makes them feel relaxed and lowers their anxiety?**

- Explains procedures before starting
- Gives specific information during procedures
- Instructs the patient to be calm
- Verbally supports the patient: gives reassurance
- Helps the patient redefine the experience to minimize threat
- Gives the patient some control over procedures and pain
- Attempts to teach the patient to cope with distress
- Provides distraction and tension relief
- Attempts to build trust in the dentist
- Shows personal warmth to the patient

#### 48. What qualities do patients describe as making them feel satisfied with their dentist and dental experience?

- Assured me that he or she would prevent pain
- Was friendly
- Worked quickly, but did not rush
- Had a calm manner
- Gave me moral support
- Reassured me that she or he would alleviate pain
- Asked if I was concerned or nervous
- Made sure that I was numb before starting

### HEALTH INFORMATION AND IMPROVEMENT

#### 49. What is the opportune time to teach new health information to patients?

Patients are most receptive to learning new health behaviors when there is an immediate need for the new skill or behavior. A patient with gingival bleeding at a furcation site wants to know how to resolve the problem and is most receptive to learning how to use a proxy brush.

#### 50. What is a strong motivational tool to use for communicating health improvement issues?

Positive feedback while instructing often yields the greatest acceptance and minimizes patient resistance to compliance. Fear of tooth loss, for example, may not weigh as much in communicating the consequences of not brushing as creating a desire for a healthy smile and teeth that last a lifetime.

#### 51. In introducing new ideas about oral hygiene, what considerations help maximize compliance?

People learn best when information is presented in the context of their own personal experience. In talking to an avid woodworker, for example, the dentist may speak about “planing down” plaque and debris to create a smooth surface that will stay clean and healthy. Similarly, a gardener may “keep plaque weeds suppressed” to allow healthy tissues to grow. In each case, context-specific phrasing communicates ideas most effectively.

#### 52. Does self-esteem play a role in adopting new behaviors such as flossing and regular brushing?

It absolutely plays a role. Most adults want to learn concepts that enhance or maintain their self-esteem. Enhancing their physical appearance is directly related to the acceptance of new health behaviors.

#### 53. List four important elements in maximizing the long-term retention of information given by the dental team to patients.

1. **Repetition** of key ideas enhances patient learning and compliance. A patient may recall only one third of a conversation after 24 hours and even less after 30 days. By artfully repeating ideas and concepts at the initial presentation, recall is maximized.
2. **Interest and direct relevance** of information to the patient’s specific needs yield the greatest learning experience. A patient with a loose tooth is concerned about why the problem occurred and how to prevent tooth loss. This concern may outweigh issues related to the general concepts of periodontal disease and the outcome of needing full dentures.
3. **Context** of the information presented should be within the personal experience of the patient to maximize acceptance and understanding.
4. **Emotion** relates the patient’s feeling about dental issues. Understanding relevant emotional history enhances doctor-patient rapport and the patient’s trust and acceptance of the suggestions made by the dental team.

### CLINICAL FINDINGS

#### 54. What are four common styles that a dentist may use to communicate clinical findings and discuss treatment plans to the patient?

Because of the unique listening and learning styles of individuals, dentists should be adept at varying their style of communication to suit the needs of their patients best.

1. A classic style is the **paternalistic model**. This is a manner of communication in which the dentist assumes the role of the parent and relates to the patient as an immature, inexperienced individual. The patient becomes acquiescent to the directives of the dentist, who has the clinical information and knows what is the best treatment. In this style, the dentist uses his or her clinical knowledge and values in the decision process, giving the patient little or no autonomy. In essence, the dentist becomes the patient's guardian. Although not considered appropriate in most situations, there are patients who do require very careful guidance because they may be totally overwhelmed by making any decisions for themselves. "Doctor, please do whatever you think is best for me" may be their request.
2. The **informative model** assumes that the patient is very inquisitive, perhaps even scientific in their thoughtful analysis of presented information. The objective of the dentist is to provide all the relevant clinical findings and treatment choices to the patient. The patient then is able to make the decision about what dental treatment he or she wishes to receive. This model gives the patient autonomy to choose based on her or his values. The dentist only presents the factual objective information and does not include personal values in the decision process. The patient relies on the dentist's clinical knowledge and technical expertise to execute the desired therapy.
3. The **interpretive model** creates a cooperative interaction between the dentist and patient in which the patient's values are elucidated and then the appropriate treatment choices are developed that meet the patient's desires. The dentist does not dictate the patient's values, but tries to help the patient articulate and understand them. The dentist becomes a counselor, helping create patient autonomy through self-understanding by the patient.
4. The **deliberative model** creates a dentist's role as teacher and partner by helping the patient choose the best health-related values that can be realized for the patient's health. After presenting the clinical findings, the dentist explains the values related to the treatment options, and expresses his or her opinions about why some choices are more worthwhile to overall health. The dentist's expression of these values is presented here, but only to help patients in developing their own self-awareness of their choices about health-related issues. It is a dialogue that becomes the goal, with mutual respect preserved.

#### 55. What are some of the factors that might contribute to bruxism?

Mental disorders, anxiety, stress, and adverse psychosocial factors can all be related to tooth grinding during sleep. It has been found that almost 70% of bruxism occurs as a behavioral symptom resulting from stress and anxiety. Job-related stress has been found to be the most significant stressor associated with bruxism.

#### 56. What are some treatment considerations for the dentist, in addition to dental appliance therapy?

As with other patients presenting with some variant of anxiety, the dentist wants to be sure to conduct a thorough and sensitive interview. It is important to ask the bruxer, "Have you been under any stress in your life lately?" and to explain how this could be a contributing factor. There are some behavioral approaches that can be useful. Patients can be educated about how postural habits such as chin thrusting and/or chewing on pencils can contribute to straining the jaw muscles. Biofeedback is an effective treatment modality in which patients can learn how to become aware of the tension in their jaw muscles and then practice alternative behaviors.

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# TREATMENT PLANNING AND ORAL DIAGNOSIS

*Stephen T. Sonis and Nathaniel Treister*

## TREATMENT PLANNING

### 1. What are the objectives of pretreatment evaluation of a patient?

1. Establishment of a diagnosis
2. Determination of underlying medical conditions that may modify the oral condition or patient's ability to tolerate treatment
3. Discovery of concomitant illnesses
4. Prevention of medical emergencies associated with dental treatment
5. Establishment of rapport with the patient

### 2. What are the essential elements of a patient history?

1. Chief complaint
2. History of the present illness (HPI)
3. Past medical history
4. Social history
5. Family history
6. Review of systems
7. Dental history

### 3. Define the chief complaint.

The chief complaint is the reason that the patient seeks care, as described in the patient's own words.

### 4. What is the history of the present illness?

The HPI is a chronologic description of the patient's symptoms and should include information about duration, location, character, and previous treatment.

### 5. What elements need to be included in the medical history?

- Current status of the patient's general health
- Medications
- Hospitalizations and surgeries
- Allergies

### 6. What areas are routinely investigated in the social history?

- Present and past occupations
- Smoking, alcohol or drug use
- Occupational hazards
- Marital status and relevant sexual history

### 7. Why is the family history of interest to the dentist?

The family history often provides information about diseases of genetic origin or diseases that have a familial tendency. Examples include clotting disorders, atherosclerotic heart disease, psychiatric diseases, and diabetes mellitus.

### 8. How is the medical history usually obtained?

The medical history is obtained with a written questionnaire supplemented by a verbal history. The verbal history is imperative because patients may leave out or misinterpret questions on the written form. For example, some patients may take daily aspirin and yet not consider it a "true" medication. Surprisingly, patients who are treated with an annual infusion of bisphosphonates for osteoporosis may not consider this a medication. The verbal history also allows the clinician to pursue positive answers on the written form and, in doing so, establish rapport with the patient.

### 9. What techniques are used for physical examination of the patient? How are they used in dentistry?

Inspection, the most commonly used technique, is based on visual evaluation of the patient. Palpation, which involves touching and feeling the patient, is used to determine the

consistency and shape of masses in the mouth or neck. Percussion, which involves differences in sound transmission of structures, has little application to the head and neck. Auscultation, the technique of listening to differences in the transmission of sound, is usually accomplished with a stethoscope. In dentistry, it is generally used to listen to changes in sounds emanating from the temporomandibular joint and to take a patient's blood pressure.

#### 10. What are the patient's vital signs?

- Blood pressure
- Respiratory rate
- Pulse
- Temperature

#### 11. What are the normal values for the vital signs?

- Blood pressure: 120 mm Hg/80 mm Hg
- Respiratory rate: 16 to 20 respirations per minute
- Pulse: 72 beats per minute
- Temperature: 98.6° F or 37° C

#### 12. What is a complete blood count (CBC)?

A CBC consists of a determination of the patient's hemoglobin, hematocrit, white blood cell count, differential white blood cell count, and platelet count.

#### 13. What are the normal ranges of a CBC?

Hemoglobin:	Men, 14-18 g/dL Women, 12-16 g/dL	Differential white blood count: Neutrophils, 50%-70%
Hematocrit:	Men, 40%-54% Women, 37%-47%	Lymphocytes, 30%-40%
White blood count:	4,000-10,000 cells/mm <sup>3</sup>	Monocytes, 3%-7%
Platelet count:	150,000-400,000 cells/mm <sup>3</sup>	Eosinophils, 0%-5% Basophils, 0%-1%

#### 14. What is the most effective blood test to screen for diabetes mellitus?

The most effective screen for diabetes mellitus is fasting blood glucose. The glycosylated hemoglobin test (HbA1c, usually just called A1c) can be ordered without fasting and effectively assesses glucose levels over a 90 day period. A1c is typically used to monitor patients, rather than for diagnostic screening.

## ORAL DIAGNOSIS

#### 15. What is the technique of choice for the diagnosis of a soft tissue lesion in the mouth?

With a few exceptions, a biopsy is the diagnostic technique of choice for almost all soft tissue lesions of the mouth.

#### 16. Is there any alternative diagnostic technique to biopsy for the evaluation of suspected malignancies of the mouth?

Exfoliative cytology has been used in the past for the diagnosis of oral lesions. Because of its high false-negative rate, it has never been particularly effective. Recently, the technique has been modified to include the use of a brush to obtain a cell sample and then a specific processing and evaluation procedure that increases the sensitivity of the assay. Biopsy remains the most reliable way to make a diagnosis.

#### 17. When is immunofluorescence of value in oral diagnosis?

Immunofluorescent techniques are of value in the diagnosis of autoimmune vesiculobullous diseases that affect the mouth, including pemphigus vulgaris and mucous membrane pemphigoid. Immunofluorescence can also be used in the diagnosis and typing of herpes simplex virus (HSV) infection.

#### 18. What elements should be included in the dental history?

1. Past dental visits, including frequency, reasons, previous treatment, and complications
2. Oral hygiene practices
3. Oral symptoms other than those associated with the chief complaint, including tooth pain or sensitivity, gingival bleeding or pain, tooth mobility, halitosis, and abscess formation



4. Past dental or maxillofacial trauma
5. Habits related to oral disease, such as bruxing, clenching, and nail biting
6. Dietary history

### 19. When is it appropriate to use microbiologic culturing in oral diagnosis?

1. **Bacterial infection.** Because the overwhelming majority of oral infections are sensitive to treatment with penicillin, routine bacteriologic culture of primary dental infections is not generally indicated. However, cultures are indicated for patients who are immunocompromised or myelosuppressed for two reasons: (1) they are at significant risk for sepsis; and (2) the oral flora often change in these patients. Cultures should be obtained for infections that are refractory to the initial course of antibiotics before changing antibiotics.
2. **Viral infection.** Immunocompromised patients who present with mucosal ulcerations may be manifesting signs of a herpes simplex infection. A viral culture is warranted. Routine culturing for typical secondary herpes infections (herpes labialis) is not warranted for healthy patients. Once a specimen is obtained, it should be kept on ice and transported to the laboratory as quickly as possible because viral cultures are temperature-sensitive.
3. **Fungal infection.** Candidiasis is the most common fungal infection affecting the oral mucosa. Because its appearance is often varied, especially in immunocompromised patients, fungal cultures may be of value. In addition, because a candidal infection is a frequent cause of a burning mouth, culture is often indicated for immunocompromised patients, even in the absence of visible lesions. Of note, however, a positive culture does not confirm infection, but only the presence of candida organisms.

### 20. How do you obtain access to a clinical laboratory?

It is easy to obtain laboratory tests for your patients, even if you do not practice in a hospital. Community hospitals provide almost all laboratory services that your patients may require. Usually, the laboratory provides order slips and culture tubes. Simply indicate the test needed, and send the patient to the laboratory. Patients who need a test at night or on a weekend can generally be accommodated through the hospital's emergency department. Commercial laboratories also may be used, and they also supply order forms. If you practice in a medical building with other physicians, find out which laboratory they use. If they use a commercial laboratory, a pick-up service for specimens may be provided. The most important issue is to ensure the quality of the laboratory. Adherence to the standards of the American College of Clinical Pathologists is a good indicator of laboratory quality.

### 21. What is the approximate cost of a complete blood count (CBC)?

The Medicare allowable rate is \$10.95.

### 22. Which laboratory tests should be used to assess a patient who may be at risk for a deficiency in hemostasis?

The basic laboratory tests for a possible coagulopathy should include assessments of platelet number and clotting factors of the internal and external pathways. The three essential tests are a CBC, which includes platelet number, prothrombin time (typically expressed as the international normalized ratio, or INR), and partial thromboplastin time.

### 23. What positive responses in the medical history should suggest to you that a patient may have a problem with hemostasis?

- Family history of a bleeding problem, such as hemophilia
- Taking medications that can cause thrombocytopenia, such as cancer chemotherapy
- History of a disease that may cause thrombocytopenia
- Taking medications known to cause prolonged bleeding, such as aspirin, warfarin, or vitamin E
- History of liver disease

### 24. What are the causes of halitosis?

Halitosis may be caused by local factors in the mouth and by extraoral or systemic factors. Local factors include food retention, periodontal infection, caries, acute necrotizing gingivitis, and mucosal infection. Extraoral and systemic causes of halitosis include smoking, alcohol ingestion, pulmonary or bronchial disease, metabolic defects, diabetes mellitus, sinusitis, and tonsillitis.

**25. Which bacteria are associated with halitosis?**

Gram-negative anaerobes are associated with halitosis.

**26. Which gases are associated with halitosis?**

Volatile sulfur compounds—in particular, hydrogen sulfide, methyl mercaptan, and dimethyl sulfide—are associated with halitosis.

**27. What are the most commonly abused drugs in the United States?**

- Alcohol
- Marijuana
- Cocaine
- Phencyclidine (PCP)
- Heroin
- Methamphetamines
- Prescription medications
  - Narcotic analgesics
  - Tricyclic antidepressants
  - Sedative-hypnotics
  - Stimulants
  - Anxiolytic agents
  - Diet aids

**28. What are the common causes of lymphadenopathy?**

1. Infectious and inflammatory diseases of all types—oral conditions that can cause lymphadenopathy include herpes infections, dental infection, pericoronitis, aphthous or traumatic ulceration, and acute necrotizing ulcerative gingivitis
2. Immunologic diseases, such as rheumatoid arthritis, systemic lupus erythematosus, and drug reactions
3. Malignant disease, such as Hodgkin disease, non-Hodgkin lymphoma, leukemia, and metastatic disease from solid tumors
4. Hyperthyroidism
5. Lipid storage diseases, such as Gaucher disease and Niemann-Pick disease
6. Other conditions, including sarcoidosis, amyloidosis, and granulomatosis

**29. How can one differentiate between lymphadenopathy associated with an inflammatory process and lymphadenopathy associated with tumor?**

1. Onset and duration. Inflammatory nodes tend to have a more acute onset and course than nodes associated with malignancy.
2. Identification of an associated infected site. An identifiable site of infection associated with an enlarged lymph node is probably the source of the lymphadenopathy. Effective treatment of the site should result in resolution of the lymphadenopathy.
3. Symptoms. Enlarged lymph nodes associated with an inflammatory process are usually tender to palpation. Nodes associated with cancer are not.
4. Progression. Continuous enlargement over time is associated with cancer.
5. Fixation. Inflammatory nodes are usually freely movable, whereas nodes associated with tumor are hard and fixed.
6. Lack of response to antibiotic therapy. Continued nodal enlargement in the face of appropriate antibiotic therapy should be viewed as suspicious.
7. Distribution. Unilateral nodal enlargement is a common presentation for malignant disease. In contrast, bilateral enlargement is often associated with systemic processes.

**30. What is the most appropriate technique for lymph node diagnosis?**

The most appropriate technique for lymph node diagnosis is biopsy or needle aspiration. Needle aspiration is preferred, but is technique-sensitive.

**31. What are the most frequent causes of intraoral swelling?**

The most frequent causes of intraoral swelling are infection and tumor (benign or malignant).

**32. Why does Polly get parotitis?**

Polly gets it from too many crackers.

**33. Why do humans get parotitis?**

A viral or bacterial infection is the most common cause of parotitis in humans. Viruses causing parotitis are mumps, coxsackie, and influenza. *Staphylococcus aureus*, the most common bacterial cause of parotitis, results in the production of pus within the gland. Other bacteria, such as *Actinomyces*, streptococci, and gram-negative bacilli, may also cause suppurative parotitis.

**34. What are common causes of xerostomia?**

- Advanced age
- Certain medications
- Radiation therapy
- Sjögren syndrome

**35. What is the presentation of a patient with a tumor of the parotid gland? How is the diagnosis made?**

The typical patient with a parotid gland tumor presents with a firm, fixed mass in the region of the gland. Involvement of the facial nerve is common and results in facial palsy. Fine-needle biopsy is a commonly used technique for diagnosis. However, the small sample obtained by this technique may be limiting. Computed tomography (CT) and magnetic resonance imaging (MRI) are also often helpful for evaluating suspected tumors.

**36. What are the major risk factors for oral cancer?**

Tobacco and alcohol use are the major risk factors for the development of oral cancer. Human papilloma virus (HPV) subtypes 16 and 18 are associated with oropharyngeal cancers, with the primary risk factor being the number of lifetime sexual partners.

**37. What is the most common location of cancers of the tongue?**

The most common location is the lateral or ventral edge of the posterior tongue.

**38. Summarize the impact of early detection of mouth cancers on survival.**

Although the 5-year survival rate for advanced tongue cancers is only 20%, it is 65% for more localized tumors. For tumors of the floor of the mouth, the difference in survival rates between treatment of early tumors and treatment of advanced cancers is 60%. Patients with early floor mouth tumors have a 5-year survival rate of 78%, but this rate plummets to only 18% for advanced cancers.

**39. How is oral cancer staged?**

Tumor staging is a system whereby cancers are clinically defined based on the parameters of tumor size, involvement of local nodes, and metastases (TNM).

**40. What is the possible role of toluidine blue stain in oral diagnosis?**

Because toluidine blue is a metachromatic nuclear stain, it has been reported to be preferentially absorbed by dysplastic and cancerous epithelium. Consequently, it has been used as a technique to screen oral lesions. The technique has a reported false-positive rate of 9% and a false-negative rate of 5%.

**41. What are the two most common clinical presentations of oral cancers?**

The two most common clinical presentations of oral cancer are a nonhealing ulcer or an area of leukoplakia, often accompanied by erythema.

**42. What percentage of keratotic white lesions in the mouth are dysplastic or cancerous?**

Keratotic white lesions are generally regarded as leukoplakia. The term has had inconsistent interpretations, but is now considered simply to be a nonscrapable, keratotic plaque. The risk of such lesions being dysplastic or cancerous is between 5% and 15%. The risk is higher in smokers.

**43. What is a simple way to differentiate clinically between necrotic and keratotic white lesions of the oral mucosa?**

Necrotic lesions of the mucosa, such as those caused by burns or candidal infections, scrape off when gently rubbed with a moist tongue blade. Conversely, because keratotic lesions result from epithelial changes, scraping fails to dislodge them.

**44. How long should one wait before obtaining a biopsy of an oral ulcer?**

Almost all ulcers caused by trauma or aphthous stomatitis heal within 14 days of presentation. Consequently, any ulcer that is present for 2 weeks or longer should be biopsied.

**45. What is the differential diagnosis of ulcers of the oral mucosa?**

- Traumatic ulcer
- Aphthous stomatitis
- Cancer
- Tuberculosis
- Recrudescant HSV infection
- Chancre of syphilis
- Noma
- Necrotizing sialometaplasia
- Deep fungal infection

**46. Why is it a good idea to aspirate a pigmented lesion before obtaining a biopsy?**

Because pigmented lesions may be vascular in nature, prebiopsy aspiration is prudent to prevent hemorrhage.

**47. What are the major causes of pigmented oral and perioral lesions?**

Pigmented lesions are caused by endogenous or exogenous sources. **Endogenous sources** include melanoma, endocrine-related pigmentation (e.g., as in Addison disease), and perioral pigmentation associated with intestinal polyposis or Peutz-Jeghers syndrome. **Exogenous sources** of pigmentation include heavy metal poisoning (e.g., lead), amalgam tattoos, and changes caused by chemicals or medications. A common example of medication-related changes is black hairy tongue associated with antibiotics, particularly tetracycline, or bismuth-containing compounds, such as Pepto-Bismol.

**48. Do any diseases of the oral cavity also present with lesions of the skin?**

Numerous diseases can cause simultaneous lesions of the mouth and skin. Among the most common are lichen planus, erythema multiforme, lupus erythematosus, bullous pemphigoid, and pemphigus vulgaris.

**49. What is the appearance of the skin lesion associated with erythema multiforme?**

The skin lesion of erythema multiforme looks like an archery target, with a central erythematous bull's eye and a circular peripheral area. Hence, the lesions are called bull's-eye or target lesions.

**50. A 25-year-old woman presents with a chief complaint of spontaneously bleeding gingiva. She also notes malaise. On oral examination, you find that her hygiene is excellent. Would you suspect a local or systemic basis for her symptoms? What tests might you order to make a diagnosis?**

Spontaneous bleeding, especially in the presence of good oral hygiene, is most likely of systemic origin. Gingival bleeding is among the most common presenting signs of acute leukemia, which should be high on the differential diagnosis. A CBC and platelet count should provide data to help establish a preliminary diagnosis. Definitive diagnosis most likely requires a bone marrow biopsy.

**51. A 45-year-old, overweight man presents with suppurative periodontitis. As you review his history, he tells you that he is always hungry, drinks water almost every hour, and awakens four times each night to urinate. Which systemic disease is most likely a cofactor in his periodontal disease? What test(s) might you order to help you with a diagnosis?**

The combination of polyuria, polyphagia, polydipsia, and suppurative periodontal disease should raise a strong suspicion of undiagnosed or poorly controlled diabetes mellitus. A fasting blood glucose test is the most efficacious screen.

**52. A 60-year-old woman presents with a complaint of numbness of the left side of her mandible. Four years ago, she had a mastectomy for treatment of breast cancer. What is the likely diagnosis? What is the first step that you take to confirm it?**

The mandible is not an infrequent site for metastatic breast cancer. As the metastatic lesion grows, it puts pressure on the inferior alveolar nerve and causes paresthesia. Radiographic evaluation of the jaw is a reasonable first step to make a diagnosis. Positron emission tomography (PET)/CT imaging by the oncologist may also help demonstrate malignancy.

- 53. Which endocrine disease may present with pigmented lesions of the oral mucosa?**  
Pigmented lesions of the oral mucosa may suggest Addison disease.
- 54. What drugs cause gingival hyperplasia?**
- Phenytoin
  - Cyclosporine
  - Nifedipine
- 55. What is the most typical presentation of the oral lesions of tuberculosis? How do you make a diagnosis?**  
The oral lesions of tuberculosis are thought to result from organisms brought into contact with the oral mucosa by sputum originating at the site of infection in the lung. A nonhealing ulcer, which is impossible to differentiate clinically from carcinoma, is the most common presentation in the mouth. Ulcers are typically located on the lateral borders of the tongue and may have a purulent center. Lymphadenopathy also may be present. Diagnosis is made by histologic examination and demonstration of organisms in the tissue.
- 56. What are the typical oral manifestations of a patient with pernicious anemia?**  
Pernicious anemia is caused by a vitamin B<sub>12</sub> deficiency caused by a lack of intestinal absorption. The most common target site in the mouth is the tongue, which presents with a smooth, dorsal surface denuded of papillae that may be associated with sensitivity and burning. Angular cheilitis is a frequent accompanying finding.
- 57. What is angular cheilitis? What is its cause?**  
Angular cheilitis, or cheilosis, is fissuring or cracking at the corners of the mouth. The condition typically occurs because of a localized mixed infection of bacteria and fungi. Cheilitis usually results from a change in the local environment caused by excessive saliva because of loss of the vertical dimension between the maxilla and mandible. In addition, a number of systemic conditions, such as deficiency anemias and long-term immunosuppression, predispose to the condition.
- 58. What is the classic oral manifestation of Crohn disease?**  
Mucosal lesions with a cobblestone appearance are associated with Crohn disease. Oral manifestations of Crohn disease may also include aphthous-like lesions, orofacial granulomatosis, and angular cheilitis.
- 59. List the oral changes that may occur in a patient receiving radiation therapy for treatment of a tumor on the base of the tongue.**
- Xerostomia
  - Cervical and incisal edge caries
  - Osteoradionecrosis
  - Mucositis
- 60. A patient presents for extraction of a carious tooth. In taking the history, you learn that the patient is undergoing chemotherapy for treatment of a breast carcinoma. What information is critical before proceeding with the extraction?**  
Because cancer chemotherapy nonspecifically affects the bone marrow, the patient is likely to be myelosuppressed after treatment. Therefore, you need to know the patient's white blood cell count and platelet count before initiating treatment. Because bisphosphonates may constitute part of the treatment regimen (e.g., zoledronic acid), the patient might be at risk for osteonecrosis of the jaw.
- 61. What oral findings have been associated with use of the diuretic hydrochlorothiazide?**  
Lichen planus has been associated with hydrochlorothiazide.
- 62. Some patients believe that topical application of an aspirin to the mucosa next to a tooth will help odontogenic pain. How may you detect this form of therapy by looking in the patient's mouth?**  
Because of its acidity, topical application of aspirin to the mucosa frequently causes a chemical burn, which appears as a white necrotic lesion in the area corresponding to aspirin placement.

**63. What are the possible causes of burning mouth symptoms?**

1. Dry mouth
2. Nutritional deficiencies
3. Diabetes mellitus
4. Psychogenic factors
5. Medications
6. Acid reflux from the stomach
7. Hormonal imbalances
8. Allergy
9. Chronic infections (especially fungal)
10. Blood dyscrasias
11. Anemia
12. Iatrogenic factors
13. Inflammatory conditions such as lichen planus

**64. What is the most important goal in the evaluation of a taste disorder?**

The most important goal in evaluating a taste disorder is the elimination of any underlying neurologic, olfactory, or systemic disorder as a cause of the condition.

**65. What drugs often prescribed by dentists may affect taste or smell?**

1. Metronidazole
2. Benzocaine
3. Ampicillin
4. Tetracycline
5. Sodium lauryl sulfate toothpaste
6. Codeine

**66. What systemic conditions may affect smell and/or taste?**

1. Bell's palsy
2. Multiple sclerosis
3. Head trauma
4. Cancer
5. Chronic renal failure
6. Cirrhosis
7. Niacin deficiency
8. Adrenal insufficiency
9. Cushing syndrome
10. Diabetes mellitus
11. Sjögren syndrome
12. Radiation therapy to the head and neck
13. Viral infections
14. Hypertension

**67. What is burning mouth syndrome?**

Burning mouth syndrome, also referred to as glossodynia or stomatodynia, is characterized by unprovoked oral burning that typically affects the tongue, anterior aspects of the lips, and anterior hard palate. It is a diagnosis of exclusion in which the mucosa appears normal and is not associated with any underlying disease. Other frequently associated symptoms include xerostomia and dysgeusia. Treatments vary; they often include topical or systemic clonazepam. Clinical trials demonstrate a high placebo response among patients suffering with the condition.

**68. What questions should a clinician consider before ordering a diagnostic test to supplement a clinical examination?**

1. What is the likelihood that the disease is present, given the history, clinical findings, and known risk factors?
2. How serious is the condition? What are the consequences of a delay in diagnosis?
3. Is an appropriate diagnostic test available? How sensitive and accurate is it?
4. Are the costs, risks, and ease of administering the test worth the effort?

**69. Distinguish among the accuracy, sensitivity, and specificity of a particular diagnostic test.**

The **accuracy** is a measure of the overall agreement between the test and a gold standard. The more accurate the test, the fewer false-negative or false-positive results. In contrast, the **sensitivity** of the test measures its ability to show a positive result when the disease is present. The more sensitive the test, the fewer false-negatives. For example, one problem with a cytologic evaluation of cancerous keratotic oral lesions is that 15 of 100 patients with cancer will test as negative (unacceptable false-negative rate). Consequently, cytology for this diagnosis is not highly sensitive. The **specificity** of the test measures the ability to show a negative finding in people who do not have the condition (false-positives).

**70. What is meant by FNA? When is it used?**

No, FNA is not an abbreviation for the Finnish Naval Association. It refers to a diagnostic technique termed *fine-needle aspiration*, in which a 22-gauge needle on a syringe is used to aspirate cells from a suspicious lesion for pathologic analysis. Many otolaryngologists use the technique to aid in the diagnosis of cancers of the head and neck. It can be particularly

valuable for the diagnosis of submucosal tumors, such as lymphoma, salivary gland tumors, and parapharyngeal masses that are not accessible to routine surgical biopsy. Like many techniques, the efficacy of FNA depends on the skill of the operator and experience of the cytopathologist reading the slide.

### 71. Which systemic diseases have been associated with alterations in salivary gland function?

1. Cystic fibrosis
2. Human immunodeficiency virus (HIV) infection
3. Diabetes mellitus
4. Affective disorder
5. Metabolic disturbances (e.g., malnutrition, dehydration, vitamin deficiency)
6. Renal disease
7. Cirrhosis
8. Thyroid disease
9. Autoimmune disease (e.g., Sjögren syndrome, myasthenia gravis, graft-versus-host disease)
10. Sarcoidosis
11. Autonomic dysfunction
12. Alzheimer's disease
13. Cancer

### 72. What is PCR? Why may it become an important technique in oral diagnosis?

Polymerase chain reaction (PCR) is a technique developed by researchers in molecular biology for the enzymatic amplification of selected DNA sequences. Because of its exquisite sensitivity, PCR appears to have marked clinical potential for the diagnosis of viral diseases of the head and neck. PCR tests for the diagnosis of HSV are available, but are not typically used for detection of oral disease.

### 73. What conditions and diseases may cause blistering (vesiculobullous lesions) in the mouth?

1. Viral disease
2. Lichen planus
3. Pemphigoid
4. Pemphigus vulgaris
5. Erythema multiforme

### 74. What are the most common sites of intraoral cancer?

The posterior lateral and ventral surfaces of the tongue are the most common sites of intraoral cancer.

### 75. What is staging for cancer? What are the criteria for staging cancers of the mouth?

Staging is a method of defining the clinical status of a lesion; it is closely related to its future clinical behavior. Thus, it is related to prognosis and is helpful for providing a basis for treatment planning. The staging system used for oral cancers is called the TNM system. It is based on three parameters: T = size of the tumor on a scale from 0 (no evidence of primary tumor) to 3 (tumor > 4 cm in greatest diameter); N = involvement of regional lymph nodes on a scale from 0 (no clinically palpable cervical nodes) to 3 (clinically palpable lymph nodes that are fixed; metastases suspected); and M = presence of distant metastases on a scale from 0 (no distant metastases) to 1 (clinical or radiographic evidence of metastases to nodes other than those in the cervical chain).

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# MANAGEMENT OF MEDICALLY COMPROMISED PATIENTS

Joseph W. Costa, Jr.

## A SHORT HISTORY OF MEDICINE

2000 BC "Here, eat this root."

1000 BC "That root is heathen. Say this prayer."

1850 AD "That prayer is superstition. Drink this potion."

1940 AD "That potion is snake oil. Swallow this pill."

1985 AD "That pill is ineffective. Take this antibiotic."

2000 AD "That antibiotic is artificial. Here, eat this root."

—Authors Unknown

## DISORDERS OF HEMOSTASIS

### 1. What questions should be asked to screen a patient for potential bleeding problems?

The best screening procedure for a bleeding disorder is a good medical history. If the review of the medical history indicates a bleeding problem, a more detailed history is needed. The following questions are basic:

1. Is there a family history of bleeding problems?
2. Is there excessive bleeding after tooth extractions or other surgeries?
3. Has there been excessive bleeding after trauma, such as minor cuts and falls?
4. Is the patient taking any medications that affect bleeding, such as aspirin, commonly prescribed anticoagulants (e.g., warfarin [Coumadin], enoxaparin [Lovenox], heparin), herbal medications, or antibiotics?
5. Does the patient have any known illnesses that are associated with bleeding (e.g., hemophilia, leukemia, renal disease, liver diseases, cardiac diseases)?
6. Has the patient ever had spontaneous episodes of bleeding from anywhere in the body?

### 2. What laboratory tests should be ordered if a bleeding problem is suspected?

- Platelet count: normal values = 150,000-400,000/ $\mu$ L
- Prothrombin time (PT): normal value = 10-13.5 seconds
- International normalized ratio (INR): normal value = 1-2 (only useful for those patients on known anticoagulant medications)
- Partial thromboplastin time (PTT): normal value = 25-36 seconds
- Thrombin time (TT): normal value = 9-13 seconds
- Bleeding time: normal value  $\leq$  9 minutes (bleeding time is a nonspecific predictor of platelet function)

Normal values may vary from one laboratory to another. It is important to check the normal values for the laboratory that you use. If any of the tests are abnormal, the patient should be referred to a hematologist for evaluation before treatment is performed.

### 3. What are the clinical indications for use of 1-deamino-8-D-arginine vasopressin (DDAVP) in dental patients?

DDAVP (desmopressin) is a synthetic antidiuretic hormone that controls bleeding in patients with type I von Willebrand's disease, platelet defects secondary to uremia related to

renal dialysis, and immunogenic thrombocytopenic purpura (ITP). The dosage is 0.3  $\mu\text{g}/\text{kg}$ . DDAVP should not be used in patients younger than 2 years; caution is necessary in older patients and patients receiving intravenous fluids. In consultation with a patient's hematologist, it can be used to reduce the risk of excessive bleeding after surgical procedures.

#### 4. What is hemophilia A?

Hemophilia A is a congenital bleeding disorder characterized by a deficiency of clotting factor VIII.

#### 5. What is hemophilia B?

Hemophilia B is a congenital bleeding disorder characterized by a deficiency of clotting factor IX.

#### 6. How are the hemophilias managed?

In general, hemophilia A and hemophilia B are managed with appropriate concentrates of the deficient factor—factor VIII for hemophilia A and factor IX for hemophilia B. Adjunctive treatment with  $\epsilon$ -aminocaproic acid (Amicar) and tranexamic acid is also appropriate.

#### 7. How does bleeding typically manifest in a patient with thrombocytopenia compared with a patient with hemophilia?

Patients with severe thrombocytopenia typically present with mucosal bleeds. Patients with hemophilia typically present with deep hemorrhage in weight-bearing joints.

#### 8. When do you use $\epsilon$ -aminocaproic acid or tranexamic acid?

$\epsilon$ -Aminocaproic acid (Amicar) and tranexamic acid are antifibrinolytic agents that inhibit the activation of plasminogen. They are used to prevent clot lysis in patients with hereditary clotting disorders. For epsilon aminocaproic acid, the dose is 75 to 100 mg/kg every 6 hours; for tranexamic acid, it is 25 mg/kg every 6 hours. Tranexamic acid also comes in a mouth rinse formulation (4.8%), which can be used as a local hemostatic agent. The mouth rinse regimen is 10 mL, four times daily. The mouth rinse is not currently available for use in the United States.

#### 9. What is the minimal acceptable platelet count for an oral surgical procedure?

The normal platelet count is 150,000 to 450,000/ $\mu\text{L}$ . In general, the minimal count for an oral surgical procedure is 50,000 platelets. However, emergency procedures may be done with as few as 30,000 platelets if the dentist is working closely with the patient's hematologist and uses excellent techniques of tissue management.

#### 10. For a patient taking warfarin (Coumadin), a dental surgical procedure can be done without undue risk of bleeding if the PT is below what value?

Warfarin affects clotting factors II, VII, IX, and X by impairing the conversion of vitamin K to its active form. The normal PT for a healthy patient is 10.0 to 13.5 seconds. The normal INR is 1 to 2. Oral procedures with a risk of bleeding should not be attempted if the PT is more than 1.5 times normal ( $>18$  seconds). Caution must be taken when the INR is greater than 2. Patients taking warfarin usually have a normal therapeutic INR in the 2 to 3 range, and simple dental prophylaxis can usually be accomplished with an INR in this range. Simple extractions or other minor surgical procedures can also usually be accomplished in the 2 to 3 range, using careful surgical technique. When the INR is 3 or above, surgery should be deferred, and the patient's physician should be consulted. Consider tapering the dose of warfarin to bring the patient into the 2 to 3 range.

#### 11. Is the bleeding time a good indicator of perisurgical and postsurgical bleeding?

The bleeding time is used to test for platelet function. However, studies have shown no correlation between blood loss during cardiac or general surgery and prolonged bleeding time. The best indicator of a bleeding problem in the dental patient is a thorough medical history. The bleeding time should be used in patients with no known platelet disorder to help predict the potential for bleeding.

#### 12. Should oral surgical procedures be postponed in patients taking aspirin?

Non-elective oral surgical procedures in the absence of a positive medical history for bleeding should not be postponed because of aspirin therapy, but the surgeon should be aware that bleeding may be exacerbated in a patient with mild platelet defect. However, elective

procedures should be postponed in the patient taking aspirin, if possible. Aspirin irreversibly acetylates cyclooxygenase, an enzyme that assists platelet aggregation. The effect is not dose-dependent and lasts for the 7- to 10-day life span of the platelet.

**13. Are patients taking nonsteroidal medications likely to bleed from oral surgical procedures?**

Nonsteroidal anti-inflammatory drugs (NSAIDs) produce a transient inhibition of platelet aggregation that is reversed when the drug is cleared from the body. Patients with a preexisting platelet defect may have increased bleeding.

**14. If a patient presents with spontaneous gingival bleeding, which diagnostic tests should be ordered?**

A patient who presents with spontaneous gingival bleeding without a history of trauma, tooth brushing, flossing, or eating should be assessed for a systemic cause. The causes of gingival bleeding include inflammation secondary to localized periodontitis, platelet defect, factor deficiency, hematologic malignancy, and metabolic disorder. A thorough medical history should be obtained, and the following laboratory tests should be ordered: (1) PT/INR, (2) PTT, and (3) complete blood count (CBC).

## INDICATIONS FOR PROPHYLACTIC ANTIBIOTICS

**15. For what cardiac conditions is prophylaxis for endocarditis recommended in patients receiving dental care?**

High-risk category

- Prosthetic cardiac valves, including bioprosthetic and homograft valves
- Previous bacterial endocarditis
- Complex cyanotic congenital heart disease (e.g., single-ventricle states, transposition of the great arteries, tetralogy of Fallot)
- Surgically constructed systemic pulmonary shunts or conduits

Moderate-risk category

- Most congenital cardiac malformations other than above and below (see next question)
- Acquired valvular dysfunction (e.g., rheumatic heart disease)
- Hypertrophic cardiomyopathy
- Mitral valve prolapse with valvular regurgitation and/or thickened leaflets

**16. What cardiac conditions do *not* require endocarditis prophylaxis?**

Negligible-risk category (no higher than the general population)

- Isolated secundum atrial septal defect
- Surgical repair of atrial septal defect, ventricular septal defect, or patent ductus arteriosus (without residua beyond 6 months)
- Previous coronary artery bypass graft surgery
- Mitral valve prolapse without valvular regurgitation
- Physiologic, functional, or innocent heart murmurs
- Previous Kawasaki disease without valvular regurgitation
- Previous rheumatic fever without valvular regurgitation
- Cardiac pacemakers (intravascular and epicardial) and implanted defibrillators

**17. What are the antibiotics and dosages recommended by the American Heart Association (AHA) for the prevention of endocarditis from dental procedures?**

The AHA updates its recommendations every few years to reflect new findings. The dentist has an obligation to be aware of the latest recommendations. The patient's well-being is the dentist's responsibility. Even if a physician recommends an alternative prophylactic regimen, the dentist is liable if the patient develops endocarditis and the latest AHA recommendations were not followed.

Standard regimen:

Amoxicillin, 2.0 g orally 1 hour before procedure

*For patients allergic to amoxicillin and penicillin:*

Clindamycin, 600 mg orally 1 hour before procedure

*or*

Cephalexin or cefadroxil,\* 2.0 g orally 1 hour before procedure

or

Azithromycin or clarithromycin, 500 mg orally 1 hour before procedure

Patients unable to take oral medications:

Ampicillin, intravenous (IV) or intramuscular (IM) administration of 2 g 30 minutes before procedure

For patients allergic to ampicillin, amoxicillin, and penicillin:

Clindamycin, IV administration of 600 mg 30 minutes before procedure

or

Cefazolin,\* IV or IM administration of 1.0 g within 30 minutes before procedure

**18. For which dental procedures is antibiotic premedication recommended in patients identified as being at risk for endocarditis?**

- Dental extractions
- Periodontal procedures including surgery, scaling and root planing, probing, and recall maintenance
- Dental implant placement and reimplantation of avulsed teeth
- Endodontic (root canal) instrumentation or surgery only beyond the apex
- Subgingival placement of antibiotic fibers or strips
- Initial placement of orthodontic bands but not brackets
- Intraligamentary local anesthetic injections
- Prophylactic cleaning of teeth or implants if bleeding is anticipated

**19. For what dental procedures is antibiotic premedication *not* recommended for patients identified as being at risk for endocarditis?**

- Restorative dentistry (including restoration of carious teeth and prosthodontic replacement of teeth), with or without retraction cord (clinical judgment may indicate antibiotic use in selected circumstances that may create significant bleeding)
- Local anesthetic injections (non-intraligamentary)
- Intracanal endodontic treatment (after placement and buildup)
- Placement of rubber dams
- Postoperative suture removal
- Placement of removable prosthodontic or orthodontic appliances
- Making of impressions
- Fluoride treatments
- Intraoral radiographs
- Orthodontic appliance adjustment
- Shedding of primary teeth

**20. Should a patient who has had a coronary bypass operation be placed on prophylactic antibiotics before dental treatment?**

No evidence indicates that coronary artery bypass graft surgery introduces a risk for endocarditis. Therefore, antibiotic prophylaxis is not needed.

**21. What precautions should you take when treating a patient with a central line devices such as a Hickman peripherally inserted central catheter (PICC) or Port-a-Cath (manufacturer: Smiths Medical, Dublin, OH)?**

Current research recommends treating these patients as follows:

- Antibiotic prophylaxis is not routinely recommended after device placement for patients who undergo dental, respiratory, gastrointestinal or genitourinary procedures.
- It is recommended for patients with these devices if they undergo incision and drainage of infection at other sites (e.g., abscess) or replacement of an infected device.

**22. Should a patient with a prosthetic joint be placed on prophylactic antibiotics before dental treatment?**

The newest guidelines concerning the use of prophylactic antibiotics before dental treatment in patients with prosthetic joints are evidence-based. They were developed as a result of a

\*Cephalosporins should not be used in patients with immediate-type hypersensitivity reaction (e.g., urticaria, angioedema, anaphylaxis) to penicillins.

combined research effort by the American Academy of Orthopaedic Surgeons and American Dental Association, the results of which were published in 2012.

The guidelines state that there is insufficient evidence to recommend routine antibiotic prophylaxis for dental procedures in patients with joint replacements. The summary of recommendations is as follows:

1. The practitioner might consider discontinuing the practice of routinely prescribing prophylactic antibiotics for patients with hip and knee prosthetic joint implants undergoing dental procedures.

**Strength of Recommendation: Limited**

A Limited Recommendation means that the quality of the supporting evidence is unconvincing, or that well-conducted studies show little clear advantage to one approach versus another.

Practitioners should be cautious in deciding whether to follow a recommendation classified as Limited and should exercise judgment and be alert to emerging publications that report evidence. Patient preference should have a substantial influencing role.

2. We are unable to recommend for or against the use of topical oral antimicrobials in patients with prosthetic joint implants or other orthopedic implants who are undergoing dental procedures.

**Strength of Recommendation: Inconclusive**

An Inconclusive Recommendation means that there is a lack of compelling evidence, resulting in an unclear balance between benefits and potential harm.

Practitioners should feel little constraint in deciding whether to follow a recommendation labeled as Inconclusive and should exercise judgment and be alert to future studies that clarify existing evidence for determining the balance of benefits versus potential harm. Patient preference should have a substantial influencing role.

3. In the absence of reliable evidence linking poor oral health to prosthetic joint infection, it is the opinion of the work group that patients with prosthetic joint implants or other orthopedic implants maintain appropriate oral hygiene.

**Strength of Recommendation: Consensus**

A Consensus Recommendation means that expert opinion supports the guideline recommendation, even though there is no available empirical evidence that meets the inclusion criteria.

Practitioners should be flexible in deciding whether to follow a recommendation classified as Consensus, although they may set boundaries on alternatives. Patient preference should have a substantial influencing role.

### 23. Is it necessary to prescribe prophylactic antibiotics for a patient on renal dialysis?

Patients with arteriovenous (AV) shunts do not require antibiotic prophylaxis because the shunt is derived from native vessels. Patients with synthetic grafts or indwelling catheters should receive antibiotic prophylaxis, using the following regimens:

Standard regimen:

Amoxicillin, 2.0 g orally 1 hour before procedure

*For patients allergic to amoxicillin and penicillin:*

Clindamycin, 600 mg orally 1 hour before procedure

or

Cephalexin\* or cefadroxil,\* 2.0 g orally 1 hour before procedure

or

Azithromycin or clarithromycin, 500 mg orally 1 hour before procedure

Patients unable to take oral medications:

Ampicillin, IV or IM administration, 2.0 g within 30 minutes before procedure

*For patients allergic to ampicillin, amoxicillin, and penicillin:*

Clindamycin, IV administration of 600 mg within 30 minutes before procedure or

Cefazolin,\* IV or IM administration of 1.0 g within 30 minutes before procedure

\*Cephalosporins should not be used in patients with immediate-type hypersensitivity reaction (urticaria, angioedema, or anaphylaxis) to penicillins.

## TREATMENT OF HIV-POSITIVE PATIENTS

### 24. What do ART and HAART stand for as they relate to HIV (human immunodeficiency virus) treatment?

ART stands for **antiretroviral treatment**. HAART stands for **highly active antiretroviral treatment** and typically consists of a “cocktail” of at least three active antiretroviral medications. The primary goals of treatment are to reduce the HIV viral load to below the level of assay detection for a prolonged period and reduce the virus mutation rates, which lead to drug resistance.

### 25. What are the common oral manifestations of HIV infection?

Over the years, there has been a significant drop in the incidence of oral lesions associated with HIV, mostly because of the potent antiretroviral treatment regimens. However, the most common HIV-associated conditions include the following:

- Xerostomia
- Candidiasis
- Oral hairy leukoplakia
- Linear gingival erythema
- Necrotizing ulcerative gingivitis
- Kaposi’s sarcoma
- Human papilloma virus (HPV)-associated warts
- Herpes (herpes simplex virus [HSV]) lesions
- Recurrent aphthous ulcers
- Neutropenic ulcers

### 26. What are the classifications of the most commonly used drugs to treat HIV infection?

- Non-nucleoside reverse transcriptase inhibitors (NNRTIs). NNRTIs disable a protein needed by HIV to make copies of itself. Examples include efavirenz (Sustiva), etravirine (Intelence), and nevirapine (Viramune).
- Nucleoside reverse transcriptase inhibitors (NRTIs). NRTIs incorporate into the DNA of the HIV virus and stop transcription. Examples include abacavir (Ziagen), and the combination drugs emtricitabine plus tenofovir (Truvada), and lamivudine plus zidovudine (Combivir).
- Protease inhibitors (PIs). PIs block the activity of the protease enzyme, which is a protein that HIV needs to make copies of itself. Examples include atazanavir (Reyataz), darunavir (Prezista), fosamprenavir (Lexiva), and ritonavir (Norvir).
- Entry or fusion inhibitors. Fusion inhibitors block the entry of HIV into CD4 cells. Examples include enfuvirtide (Fuzeon) and maraviroc (Selzentry).
- Integrase inhibitors. Integrase inhibitors disable the integrase protein that HIV uses to insert its genetic material into CD4 cells. An example is raltegravir (Isentress).

### 27. What are the drugs that typically comprise the initial HAART regimen used to treat HIV infection?

This question is very difficult to answer because the HAART drug regimens are continually changing according to the latest research. Efavirenz is a NNRTI that has proven to be very successful in reducing HIV viral loads. Currently, this drug is used to initiate many HAART regimens. An example a currently preferred regimen for the initiation of treatment is: efavirenz plus tenofovir (a nucleotide) plus emtricitabine (an NRTI). However, there are several possible drug combinations that have proven to be effective at reducing viral load and virus mutation rates.

### 28. A patient with HIV infection requires an oral surgical procedure to remove teeth after severe bone loss caused by HIV-related localized periodontitis. What precautions should be taken?

It is estimated that 10% to 15% of patients with HIV develop immunogenic thrombocytopenic purpura (ITP). The antiplatelet antibodies appear to be found more frequently in those in an advanced stage of disease. Affected patients should have a CBC done before any oral surgical procedure. If the platelets are low ( $<150,000/\mu\text{L}$ ), the procedure should be done only after consultation with the patient’s physician and with the knowledge that bleeding may be increased. The patient may require platelet transfusions to control postoperative bleeding.

In the absence of any coagulopathy caused by thrombocytopenia or hemophilia, an otherwise healthy HIV-positive patient who presents for an extraction typically may undergo an extraction. However, the practitioner must proceed with caution. A careful medical history must be taken, and consultation with the patient's physician should be completed, as needed. If no underlying blood dyscrasia is present, the patient may safely undergo extractions without further precautions.

### 29. Are there any contraindications to restorative dentistry procedures in patients with HIV infection?

If the patient is not neutropenic or thrombocytopenic, there are no contraindications to preventive and restorative dental care. Patients should receive aggressive dental care to reduce the oral cavity as a source of infection. They should be placed on a 3- to 6-month recall to maintain optimal oral health and followed closely for opportunistic infections and HIV-related oral conditions.

### 30. What is a normal CD4 count? At what level is a patient at risk for infections? When should a patient begin antiretroviral treatment?

A normal CD4 count is from 500 to 1000 cells/mm<sup>3</sup>. When the CD4 count is less than 350 cells/mm<sup>3</sup>, the patient is considered to be at risk for acquiring an opportunistic infection. A CD4 count of less than 200 cells/mm<sup>3</sup> is one of the criteria for a diagnosis of acquired immunodeficiency syndrome (AIDS).

The World Health Organization (WHO) issued a statement in 2013 regarding the appropriate time to begin ART in HIV-positive patients. Here is an excerpt from of their statement for the treatment of HIV-positive patients adults and adolescents:

- As a priority, ART should be initiated in all individuals with severe or advanced HIV clinical disease (WHO clinical stage 3 or 4) and individuals with a CD4 count of 350 cells/mm<sup>3</sup> or lower (*strong recommendation, moderate-quality evidence*).
- ART should be initiated in all individuals with HIV with a CD4 count of 350 to 500 cells/mm<sup>3</sup>, regardless of the WHO clinical stage (*strong recommendation, moderate-quality evidence*).
- ART should be initiated in all individuals with HIV, regardless of WHO clinical stage or CD4 cell count, in the following situations:
  - Individuals with HIV and active tuberculosis (TB) (*strong recommendation, low-quality evidence*)
  - Individuals co-infected with HIV and HBV with evidence of severe chronic liver disease (*strong recommendation, low-quality evidence*)
  - Partners with HIV in serodiscordant couples should be offered ART to reduce HIV transmission to uninfected partners (*strong recommendation, high-quality evidence*).

## CARDIOVASCULAR DISEASE

### 31. What is the appropriate response if a patient with a history of cardiac disease develops chest pain during a dental procedure?

1. Discontinue treatment immediately.
2. Take and record vital signs (blood pressure, pulse, respiration), and question the patient about the pain. Chest pain from ischemia may be substernal or more diffused. Patients often describe the pain as crushing, pressure, or heavy; it may radiate to the shoulders, arms, neck, or back.
3. If the patient has a history of angina and takes nitroglycerin, give the patient his or her own nitroglycerin or a tablet from your emergency cart. Continue to monitor the patient's vital signs. If the pain does not stop after 3 minutes, give the patient a second dose. If after three doses in a 10-minute period the pain does not subside, contact the medical emergency service and have the patient transported to an emergency department to rule out a myocardial infarction.
4. If the patient does not have a history of heart disease but has persistent chest pain for longer than 2 minutes, the medical emergency service should be contacted and the patient transported to a hospital emergency department for evaluation.
5. If the patient is not allergic to aspirin, administer one tablet of aspirin (325 mg) orally. The aspirin acts as an antithrombotic agent.

**32. At what blood pressure should elective dental care be postponed?**

Elective dental care should be postponed if the systolic blood pressure is  $\geq 180$  mm Hg or higher and/or the diastolic pressure is 110 mm Hg or higher. Refer the patient to a physician for follow-up. If the patient is also symptomatic, refer to the emergency room for immediate care.

**33. Can or should emergency dental treatment be administered to a patient with uncontrolled hypertension?**

Emergency dental treatment can be used to treat problems such as pain, infection, or bleeding. The dentist must compare the benefit of such treatment with the risks. The patient must be managed in consultation with a physician and be carefully monitored with intraoperative blood pressure readings, at a minimum. Other measures such as electrocardiographic monitoring, IV lines, and nitrous oxide sedation can also be used. In addition to treatment of the dental emergency, great care must be taken to reduce the patient's stress and anxiety.

**34. What are the dental treatment considerations for patients with unstable angina or a history of myocardial infarction (MI) within the past 30 days?**

Elective dental treatment should be avoided in a patient with unstable angina or who has had an MI within the past 30 days. If care is absolutely necessary, the patient's physician should be consulted to help develop a plan. Care should be limited to management of pain, infection, and/or bleeding. If possible, refer the patient to a hospital dental clinic.

**35. Can a patient with stable (mild) angina and a past history of MI be treated safely in the dental office?**

This patient is at intermediate risk for having perioperative complications from dental procedures. Dental treatment can be completed with some treatment modifications, such as short morning appointments, comfortable chair position, recording of pretreatment vital signs, having nitroglycerin readily available, use of oral sedation as needed, use of nitrous oxide-oxygen sedation if needed, excellent local anesthesia (limiting the amount of epinephrine to no more than two cartridges containing 1:100,000 epinephrine), and excellent postoperative pain management.

**36. Can nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen be administered safely to patients who have had a history of MI?**

A recent study has shown that the use of NSAIDs in patients with a history of MI increases the risk for another MI. This is true even if it is a relatively short course (e.g., 7 days) of NSAID treatment. Therefore, NSAIDs should be used with caution in patients who have had a previous MI, if at all, and perhaps limited to less than 7 days of use.

**37. How do you differentiate between stable and unstable angina?**

Unstable angina is characterized by a change in the pattern of pain. The pain occurs with less exertion or at rest, lasts longer, and is less responsive to medication. Dental care for such patients must be postponed and the patient referred to his or her physician immediately for care. Patients are at increased risk for MI. If emergency dental care is necessary before the patient is stable, it should be attempted only with cardiac monitoring and sedation.

**38. Should a retraction cord that contains epinephrine be used in a patient with cardiovascular disease?**

The concentration of epinephrine in an impregnated cord is high, and systemic absorption occurs. An impregnated cord should not be used in patients with cardiac disease, hypertension, or hyperthyroidism. It has been argued that an epinephrine-containing retraction cord should not be used in dental practice.

**39. Should vasoconstrictors be avoided in any patients with cardiovascular disease?**

In a patient at major risk of developing perioperative cardiovascular complications, vasoconstrictors should be used only in consultation with the patient's physician. The result of this consultation may dictate that vasoconstrictors be avoided. This high-risk category includes the following conditions: acute or recent MI (between 7 to 30 days prior); decompensated heart failure; and significant arrhythmias (e.g., AV block, ventricular-related arrhythmia). Some studies have shown that very modest quantities of a vasoconstrictor are safe in these high-risk patients when accompanied by oxygen, sedation, nitroglycerin, and adequate pain control.



#### 40. Is it safe to treat a patient who has undergone heart transplantation in an outpatient dental office?

During the first 3 months after heart transplantation, elective dental treatment should be avoided. Various systemic complications and infections are common during this period because the patient is receiving an intensive course of immunosuppressive medications. Emergency dental treatment can be provided in consultation with the patient's physician. If treatment is required during these first 3 months, antibiotic prophylaxis should be administered. Emergency dental treatment should be completed only after consultation with the patient's cardiologist.

In the stable post-transplantation period (usually after 3 months, but the timing is determined in consultation with the physician), heart transplant patients can receive elective dental treatment. The use of prophylactic antibiotics during this period is determined on an individual basis based on the patient's level of immunosuppression, whether he or she has shown evidence of rejection, and other factors.

### METABOLIC DISORDERS

#### 41. What precautions do you need to take in treating a patient with insulin-dependent diabetes mellitus (IDDM)?

The major concern for the dental practitioner treating the patient with IDDM is hypoglycemia. It is important to question the patient about changes in insulin dosage, diet, and exercise routine before undertaking any outpatient dental treatment. A decrease in dietary intake or increase in the normal insulin dosage or exercise may place the patient at risk for hypoglycemia.

#### 42. What are the symptoms of hypoglycemia?

- |                 |                  |
|-----------------|------------------|
| 1. Tachycardia  | 4. Tremulousness |
| 2. Palpitations | 5. Nausea        |
| 3. Sweating     | 6. Hunger        |

The symptoms may progress to coma and convulsions without intervention.

#### 43. What should the dentist be prepared to do for the patient who has a hypoglycemic reaction?

The dental practitioner should have some form of sugar readily available, such as packets of table sugar, candy, or orange juice. Also available are 4- to 5-gram tablets of glucose. It is recommended that a hypoglycemic patient take 15 grams of fast-acting carbohydrates (glucose), which is approximately 3 to 4 tablets. If a patient develops symptoms of hypoglycemia, the dental procedure should be discontinued immediately; if conscious, the patient should be given some form of oral glucose.

If the patient is unconscious, the emergency medical service should be contacted. Glucagon, 1 mg, can be injected IM, or 50 mL of 50% glucose solution can be given by rapid IV infusion. The glucagon injection should restore the patient to a conscious state within 15 minutes, and then some form of oral sugar can be given.

#### 44. Is the diabetic patient at greater risk for infection after an oral surgical procedure?

It is important to minimize the risk of infection in diabetic patients. They should have aggressive treatment of dental caries and periodontal disease and be placed on frequent recall examinations and oral prophylaxis.

After oral surgical procedures, endodontic procedures, and treatment of suppurative periodontitis, diabetic patients should be placed on antibiotics to prevent infection secondary to delayed healing. Antibiotics of choice are amoxicillin, 500 mg 3 times daily, or clindamycin, 300 mg 3 times daily for 7 to 10 days.

#### 45. When is it necessary to increase the dose of corticosteroids in dental patients who have primary or secondary adrenal insufficiency?

Guidelines on the use of supplemental corticosteroids state that only those patients who have primary adrenal insufficiency and who are undergoing surgical procedures require supplementation with additional corticosteroids. They do not require supplementation for routine dental procedures.

Patients who have secondary adrenal insufficiency only require their usual dose of corticosteroid on the morning of the procedure.

If supplementation is needed for those patients with primary adrenal insufficiency, the following guidelines apply:

<i>Procedure</i>	<i>Target Dose</i>
Routine dentistry	None
Minor surgery	25 mg hydrocortisone preoperatively on day of surgery
Moderate surgical stress	50-75 mg hydrocortisone on day of surgery and up to 1 day after
Major surgical stress	100-150 mg/day of hydrocortisone, given for 2 to 3 days

**46. What are the clinical symptoms of hypothyroidism? What dental care can be safely provided?**

The clinical symptoms of hypothyroidism are weakness, fatigue, intolerance to cold, changes in weight, constipation, headache, menorrhagia, and dryness of the skin. Dental care should be deferred until after a medical consultation in a patient with or without a history of thyroid disease who experiences a combination of these signs and symptoms. If the patient is myxedematous, he or she should be treated as a medical emergency and referred immediately for medical care. It is important not to prescribe opiates for the palliative treatment of the myxedematous patient, who may be unusually sensitive and die after being given a normal dose of an opiate.

## ALLERGIC REACTIONS

**47. What would you prescribe for the patient who develops a mild soft tissue swelling of the lips under the latex rubber dam?**

The patient probably has had a contact allergic reaction from the latex. If the reaction is mild (slight swelling, with no extension into the oral cavity) and self-limiting, the patient should be given 50 mg of oral diphenhydramine and observed for at least 2 hours for a possible delayed reaction. If the reaction is moderate to severe, the patient should be given 50 mg of diphenhydramine IM or IV and closely monitored. Emergency services should be contacted to transport the patient to the emergency department for treatment and observation. Allergic patients should be instructed to inform their health care providers of their latex allergy and referred to an allergist. Dentists are encouraged to use nonlatex rubber dams and gloves whenever possible.

**48. What should you do if a patient for whom you prescribed the prophylactic antibiotic amoxicillin approximately 1 hour previously reports urticaria, erythema, and pruritus (itching)?**

If the reaction is delayed (>1 hour) and limited to the skin, the patient should be given 50 mg of diphenhydramine IM or IV and then observed for 1 to 2 hours before being released. If no further reaction occurs, the patient should be given a prescription for 25 to 50 mg of diphenhydramine to be taken every 6 hours until symptoms are gone.

If the reaction is immediate (<1 hour) and limited to the skin, 50 mg of diphenhydramine should be given immediately IM or IV. The patient should be monitored and emergency services contacted to transport the patient to the emergency department. If other symptoms of allergic reaction occur, such as conjunctivitis, rhinitis, bronchial constriction, or angioedema, 0.3 mL of aqueous 1:1000 epinephrine should be given by subcutaneous (SC) or IM injection. The patient should be monitored until emergency services arrive. If the patient becomes hypotensive, an IV line should be started with Ringer's lactate or 5% dextrose in water.

**49. What are the signs and symptoms of anaphylaxis? How should it be managed in the dental office?**

Anaphylaxis is characterized by bronchospasm, hypotension or shock, and urticaria or angioedema. It is a medical emergency in which death may result from respiratory obstruction, circulatory failure, or both. With the first indication of anaphylaxis, 0.3 to 0.5 mL of 1:1000 aqueous epinephrine should be injected SC or IM, and emergency services should be

contacted. The injection of epinephrine may be repeated every 20 to 30 minutes, if necessary, for as many as three doses. Oxygen at a rate of 4 L/min must be delivered with a face mask. The patient must be continuously monitored, and an IV line containing Ringer's lactate or normal saline should be infused at 100 mL/hr. If the patient becomes hypotensive, the IV infusion should be increased. If airway obstruction occurs because of edema of the larynx or hypopharynx, a cricothyrotomy must be performed. If the airway obstruction is caused by bronchospasm, an albuterol or terbutaline nebulizer should be used or IV aminophylline, 6 mg/kg, infused over 20 to 30 minutes.

## HEMATOLOGY AND ONCOLOGY

### 50. What are the normal values for a CBC?

<b>White blood cell count</b>		<b>Hemoglobin (Hgb)</b>	
≥18 years	4,000-10,000/mL	≥18 years	
12-17 years	4,500-13,000/mL	Male	13.5-18.0 g/dL
6 months-11 years	4,500-13,500/mL	Female	11.5-16.4 g/dL
<b>Red blood cell count</b>		12-17 years	12.0-16.0 g/dL
≥18 years		6 months-11 years	10.5-14.0 g/dL
Male	4.5-6.4 M/mL		
Female	3.9-6.0 M/mL	<b>Platelet count (PLT)</b>	
12-17 years	4.1-5.3 M/mL	8 days and older	150,000-450,000/mL
6 months-11 years	3.7-5.3 M/mL	Up to 7 days	150,000-350,000/mL
<b>Hematocrit (Hct)</b>			
≥18 years			
Male	40%-54%		
Female	36%-48%		
12-17 years	36%-39%		
6 months-11 years	34%-45%		

### 51. What precautions should be taken when providing dental care to a patient with sickle cell anemia?

1. Patients with sickle cell disease should not receive dental treatment during a crisis, except for the relief of dental pain and treatment of acute dental infections. Dental infections should be treated aggressively; if facial cellulitis develops, the patient should be admitted to the hospital for treatment.
2. The patient's physician should be consulted about the patient's cardiovascular status. Myocardial damage secondary to infarctions and iron deposits is common.
3. Patients with sickle cell anemia are at increased risk for bacterial infections when surgical procedures are performed. Although there is no evidence to support their use, prophylactic antibiotics are often administered before any dental surgical procedure to prevent the possibility of wound infection and/or osteomyelitis. It is not recommended for routine, nonsurgical procedures. The same prophylactic antibiotic regimen used for the prevention of endocarditis should be followed. After a surgical procedure, antibiotics (amoxicillin, 500 mg three times daily, or clindamycin, 300 mg three times daily) should be considered for 7 to 10 days postoperatively.

### 52. What hematologic disorders are characterized by a so-called hair-on-end appearance of bone on radiographic surveys?

Thalassemia major and sickle cell anemia are characterized in this way.

### 53. Can local anesthetic with a vasoconstrictor be used for a patient with sickle cell disease?

Because of the possibility of impairing local circulation, the use of vasoconstrictors in patients with sickle cell disease is controversial. It is recommended that the planned dental procedure dictate the choice of local anesthetic. If the planned procedure is a short routine procedure that can be performed without discomfort by using an anesthetic without a

vasoconstrictor, the vasoconstrictor should not be used. However, if the procedure requires long profound anesthesia, 2% lidocaine with 1:100,000 epinephrine is the anesthetic of choice.

**54. Can nitrous oxide be used to help manage anxiety in patients with sickle cell anemia?**

Nitrous oxide can be safely used in patients with sickle cell anemia as long as the concentration of oxygen is greater than 50%, the flow rate is high, and the patient can ventilate adequately.

**55. Can a dental infection cause a crisis in a patient with sickle cell anemia?**

Preventive dental care—routine scaling and root planing, topical fluorides, sealants, and treatment of dental caries—is important in patients with sickle cell anemia. Studies have reported some cases of a sickle cell crisis precipitated by a periodontal infection.

**56. What are the oral symptoms of acute leukemia?**

More than 65% of patients with acute leukemia have oral symptoms. The symptoms result from myelosuppression caused by the overwhelming numbers of malignant cells in the bone marrow and/or large numbers of circulating immature cells (blasts).

1. Symptoms from thrombocytopenia—gingival oozing, petechiae, hematoma, and ecchymosis
2. Symptoms from neutropenia—recurrent or unrelenting bacterial infections, lymphadenopathy, oral ulcerations, pharyngitis, and gingival infection
3. Symptoms from circulating immature cells (blasts)—gingival hyperplasia from blast infiltration

Patients with these signs or symptoms should be evaluated to rule out a hematologic malignancy. The dentist should consider carefully whether the symptoms can be explained by local factors or are disproportionate to these factors. If a hematologic malignancy is suspected, a CBC with a differential white cell count should be ordered.

**57. Which leukemia is typically referred to as the leukemia of childhood?**

Acute lymphocytic leukemia almost always occurs in children. The condition can be successfully treated, with a 50% to 70% 5-year survival.

**58. Is it safe to extract a tooth in a patient who is receiving chemotherapy?**

The major organ system affected by cytotoxic chemotherapy is the hematopoietic system. When a patient receives chemotherapy, the white cell count and platelets may be expected to decrease in about 7 to 10 days. If the patient's absolute neutrophil count (calculated by multiplying the white cell count by the number of neutrophils in the differential count and dividing by 100) drops below 500 neutrophils, the patient is considered neutropenic and at risk for infection. If the platelet count drops below 50,000/ $\mu\text{L}$ , the patient is at risk for bleeding.

If possible, dental procedures should be scheduled 2 weeks before planned chemotherapy or after the counts begin to recover, usually 14 days for white cells and 21 days for platelets. Dental treatment should be attempted only after consultation and in coordination with the patient's physician and after the patient has had a CBC.

**59. Which precautions should be taken in treating a patient who has undergone bone marrow transplantation for a hematologic malignancy?**

Dental care should be done only in consultation with the patient's physician. As a rule, elective dental treatment should be postponed for 6 months after transplantation. However, emergency dental treatment can be carried out. If dental care must be done before the recommended postponement, a CBC should be checked, and if the results are acceptable (platelets > 50,000/ $\mu\text{L}$  and neutrophils > 500), the patient should be premedicated using the same regimen as for the prevention of endocarditis.

**60. What should be done if a patient has enlarged lymph nodes?**

Lymphadenopathy may be secondary to a sore throat, upper respiratory infection, or the initial presentation of a malignancy. A thorough history and clinical examination help determine the cause of the lymphadenopathy. Patients with lymphadenopathy and an identifiable inflammatory process should be reexamined in 2 weeks to determine whether the lymphadenopathy has responded to treatment.

If no inflammatory process can be identified or the lymphadenopathy does not resolve after treatment, the patient should be referred to a physician for further evaluation and possible biopsy (Table 3-1).

## KIDNEY DISEASE

### 61. Which precautions should be taken before beginning treatment of a patient on dialysis?

Patients typically receive dialysis three times/week, usually on a Monday, Wednesday, Friday schedule or Tuesday, Thursday, Saturday schedule. Dental treatment for a patient on dialysis should be done on the day between dialysis appointments to avoid bleeding difficulties (patients receive the anticoagulant, heparin, on dialysis days). Patients with grafts or indwelling catheters should be premedicated to prevent infection of the graft or catheter. Patients with an AV shunt do not need to be premedicated.

### 62. Which adjustments in the dosage of oral antibiotics should you make for a patient on renal dialysis who has a dental infection?

Penicillin	500 mg orally every 6 hours; dose after hemodialysis
Amoxicillin	500 mg orally every 24 hours; dose after hemodialysis
Ampicillin	250 mg to 1 g orally every 12-24 hours; dose after hemodialysis
Erythromycin	250 mg orally every 6 hours; not necessary to dose after hemodialysis
Clindamycin	300 mg every 6 hours; not necessary to dose after hemodialysis

### 63. Which regional lymph nodes are most commonly involved in the presentation of early Hodgkin's disease?

Hodgkin's disease typically presents with cervical, subclavicular, axillary, or mediastinal lymph node involvement and, less commonly, with inguinal and abdominal lymph node involvement.

### 64. Which pain medications can be safely prescribed for patients on dialysis?

Codine is safe to use in dialysis but may produce more profound sedation. The dose should be titrated, beginning with 50% of the normal dose for patients on dialysis and 50% to 75% of the normal dose for patients with severely decreased renal function.

Acetaminophen is nephrotoxic in overdoses. However, it may be prescribed in patients on dialysis at a dose of 650 mg every 8 hours. For patients with decreased renal function, the regimen should be 650 mg every 6 hours.

Aspirin should be avoided in patients with severe renal failure and patients on renal dialysis because of the possibility of potentiating hemorrhagic diathesis.

Meperidine (Demerol) should not be prescribed for patients on renal dialysis. The active metabolite, normeperidine, accumulates and may cause seizures.

**Table 3-1.** Clinical Presentations of Lymphadenopathy

PARAMETER	INFLAMMATORY PROCESS	GRANULOMATOUS DISEASE OR NEOPLASIA
Onset	Acute	Progressive enlargement
Pain on palpation	Tender	Neoplasia, asymptomatic
		Granulomatous, painful
Symmetry	Bilateral for systemic infections	Usually unilateral
	Unilateral for localized infections	
Consistency	Firm, movable	Firm, non-movable

From Sonis ST, Fazio RC, Fang LS: *Principles and practice of oral medicine*, ed 2, Philadelphia, 1995, WB Saunders, pp 269-271.

**65. Which changes do you expect to see in the dental radiographs of a patient on renal dialysis?**

The most common changes are decreased bone density with a ground glass appearance, increased bone density in the mandibular molar area compatible with osteosclerosis, loss of lamina aura, subperiosteal cortical bone resorption in the maxillary sinus and mandibular canal, and brown tumor.

**66. What is uremic stomatitis?**

Uremic stomatitis is an ulcerative condition of the oral mucosa that develops in patients with chronic renal failure. It is thought to be caused by ammonia metabolites.

**67. What is a common oral complication of renal transplant patients who are on chronic doses of cyclosporine?**

Gingival hyperplasia is a common oral complication.

**68. Which other medications are known to cause gingival hyperplasia?**

Phenytoin (Dilantin), verapamil, nifedipine (Procardia), and amlodipine (Norvasc) are known to cause gingival hyperplasia. Phenytoin is an anticonvulsant. Verapamil, nifedipine, and amlodipine are calcium channel blockers.

**69. What precautions should be taken when treating a patient after renal transplantation?**

After renal transplantation, patients receive immunosuppressive drugs and have an increased susceptibility to infection. Dental infections should be treated aggressively. As with other post-transplantation patients, elective dental treatment should be deferred during the first 3 months after renal transplantation. If emergency dental treatment is needed during the first 3 months, prophylactic antibiotics should be administered but should only be given thereafter on an individual case basis in consultation with the patient's physician. Erythromycin should not be prescribed for any patient taking cyclosporine.

**70. Which antibiotic should be avoided in a patient taking cyclosporine?**

Cyclosporine is used to prevent organ rejection in renal, cardiac, and hepatic transplantation and to prevent graft-versus-host disease in patients who have received a bone marrow transplant. Erythromycin should not be prescribed for patients taking cyclosporine. Erythromycin increases the levels of cyclosporine by decreasing its metabolism.

**PULMONARY DISEASE****71. What precautions should be taken in treating a patient with chronic obstructive pulmonary disease (COPD)?**

Caution must be taken in prescribing drugs with antiplatelet activity (aspirin and NSAIDs) to patients with COPD and a history of hemoptysis. Hemoptysis has been reported after the use of aspirin in patients with COPD.

**72. Which antibiotic should not be prescribed for patients with COPD who take theophylline?**

Erythromycin should not be prescribed for patients taking theophylline because it decreases the metabolism of theophylline and may cause toxicity.

**73. Which intervention is appropriate for a dental patient who has had an asthma attack in the office?**

The medical history should provide an indication of the severity of the asthma and the medications that the patient takes for an asthma attack. The symptoms of an acute asthma attack are shortness of breath, wheezing, dyspnea, anxiety, and, with severe attacks, cyanosis. As with all medical emergencies, the first two steps are to discontinue treatment and remain calm and not increase the patient's anxiety. Patients should be allowed to position themselves for optimal comfort and then placed on oxygen, 2 to 4 L/min. If patients have their own nebulizer, they should be allowed to use it. If the patient does not have a nebulizer, he or she should be given a metaproterenol or albuterol nebulizer from the emergency cart or case and take two inhalations.

If the symptoms do not subside or increase in severity, emergency services should be contacted. The patient must be closely monitored and given 0.3 to 0.5 mL of a 1:1000 solution

of epinephrine SC or IV aminophylline, 5.6 mg/kg, in 150 mL of 5% dextrose in half-normal saline or normal saline infused over 30 minutes. (To calculate the patient's weight in kilograms, divide the patient's weight in pounds by 2.2.) The dose of epinephrine may be repeated every 30 minutes for as many as three doses. Epinephrine should not be used in patients with severe hypertension, severe tachycardia, or cardiac arrhythmias. Aminophylline should not be used in patients who have had theophylline in the past 24 hours.

#### 74. Can nitrous oxide be used safely to sedate a patient with COPD?

Sedation with nitrous oxide should be avoided in patients with COPD. The high flow of oxygen may depress the respiratory drive. Low-flow oxygen via a nasal cannula may be safely used, without risk of respiratory depression.

## LIVER DISEASE

#### 75. Which laboratory blood tests should be ordered for a patient with alcoholic hepatitis?

Alcoholic hepatitis is the most common cause of cirrhosis, which is one of the most common causes of death in the United States. There are a number of concerns in treating the patient with alcoholic hepatitis:

1. Increased risk of perioperative and postoperative bleeding, secondary to a decrease in vitamin K-dependent coagulation factors
  2. Qualitative and quantitative effects of alcohol on platelets
  3. Anemia secondary to dietary deficiencies and/or hemorrhage
- Before attempting a surgical procedure, the minimal laboratory tests that should be ordered are PT/INR, PTT, CBC, and bleeding time.

#### 76. What precautions should be taken with patients on anticonvulsant medications?

It is important to obtain a detailed history of the seizure disorder to determine whether the patient is at risk for seizures during dental treatment. Important information includes the type and frequency of seizures, date of the last seizure, prescribed medications, last blood test to determine therapeutic ranges, and activities that tend to provoke seizures. For patients taking valproic acid or carbamazepine, periodic tests for liver function should be performed. Blood counts for patients taking carbamazepine and ethosuximide should be done by the patient's physician. Liver function test results and blood counts should be checked before any oral surgical procedure is planned (Table 3-2).

#### 77. Which emergency procedures should be taken for a patient having a seizure?

It is important to determine whether the patient has a history of seizure disorders. Any patient who has a seizure in the dental office without a history of seizures must be treated as a medical emergency. The emergency medical service should be contacted as the dentist proceeds with management. There are two stages of a seizure, the ictal phase and postictal phase. The management of each is described here.

1. Place the patient in a supine position, away from hard or sharp objects to prevent injury; a carpeted floor is ideal. If the patient is in the dental chair, it is important to protect the patient by moving equipment out of the way as far as possible.
2. The airway must be maintained and vital signs monitored during the tonic stage. If suctioning equipment is available, it should be ready with a plastic tip for suctioning secretions to maintain the airway. The patient may experience periods of apnea and develop cyanosis. The head should be extended to establish a patent airway, and oxygen should be administered. Vital signs, pulse, respiration, and blood pressure must be monitored throughout the seizure.
3. If the ictal phase of the seizure lasts more than 5 minutes, emergency services should be called. Tonic-clonic status epilepticus is a medical emergency. If the dentist is trained to do so, an IV line should be initiated, and a dose of 25 g (50 mL) of 50% dextrose should be given immediately in case the seizure is caused by hypoglycemia. If there is no response, the patient should be given 10 mg of diazepam IV over a 2-minute period.
4. Once the seizure activity has stopped and the patient enters the postictal phase, it is important to continue to monitor the vital signs and, if necessary, to provide basic life support. If respiratory depression is significant, emergency services should be called, the

**Table 3-2.** Seizure Medications and Precautions for the Dental Practitioner

MEDICATION	ADVERSE REACTIONS	INTERACTIONS
Valproic acid (Depakote), Heparin	Prolonged bleeding time, leukopenia, thrombocytopenia	Increased risk of bleeding with aspirin and NSAIDs or warfarin; additive depression of central nervous system (CNS) with other depressants, including narcotic analgesics and sedative-hypnotics
Carbamazepine (Tegretol)	Aplastic anemia, agranulocytosis, thrombocytopenia, leukopenia, leukocytosis	Erythromycin increases levels of carbamazepine, may cause toxicity
Phenytoin (Dilantin)	Aplastic anemia, agranulocytosis, leukopenia, thrombocytopenia sedative-hypnotics	Additive depression of CNS with other depressants, including narcotics and sedative-hypnotics
Phenobarbital		Additive depression of CNS with other depressants, including narcotics and sedative-hypnotics; may increase risk of hepatic toxicity of acetaminophen
Primidone	Blood dyscrasias, orthostatic hypotension	Additive depression of CNS with other depressants, including narcotics and sedative-hypnotics
Ethosuximide	Aplastic anemia, granulocytosis, leukopenia	Additive depression of CNS with other depressants
Clonazepam	Anemia, thrombocytosis, leukopenia	Additive depression of CNS with other depressants

airway maintained, and respiration supported. Blood pressure may be initially depressed but should recover gradually.

- If the patient recovers from the postictal phase without basic life support or other complications, the patient's physician should be contacted and the patient, if stable, should be discharged from the dental office, accompanied by a responsible adult.

### 78. Which dental considerations must be considered in treating patients with seizure disorders?

Patients taking phenytoin are at risk for gingival hyperplasia. Tissue irritation from orthodontic bands, defective restorations, fractured teeth, plaque, and calculus accelerate the hyperplasia.

The dental practitioner should consider the patient's seizure status. A rubber dam with dental floss tied to the clamp should be used for all restorative dental procedures to enable the rapid removal of materials and instruments from the patient's oral cavity. Fixed prosthetics, when indicated, should be fabricated, rather than removable prosthetics. If removable prosthetics are indicated, they should be fabricated with metal for all major connectors. Acrylic partial dentures should be avoided because of the risk of breaking and aspiration during seizure activities. Unilateral partial dentures are contraindicated. Temporary crowns and bridges should be laboratory-cured for strength.

### 79. Is general anesthesia contraindicated for patients with a seizure disorder?

No, it is not contraindicated. However, general anesthesia lowers the seizure threshold, and precautions must be taken to ensure that serum levels of the antiseizure drug are within therapeutic range.



**80. What are the common causes of unconsciousness in dental patients?**

The most common cause of loss of consciousness in the dental office is syncope. The signs and symptoms are diaphoresis, pallor, and loss of consciousness. Place the patient in the supine position with the feet elevated, monitor vital signs, and administer oxygen, 3 to 4 L/min via a nasal cannula.

**RADIATION THERAPY****81. What are the risk factors for the development of osteoradionecrosis?**

Bone exposed to high radiation therapy is hypovascular, hypocellular, and hypoxic tissue. Osteoradionecrosis develops because the radiated tissue is unable to repair itself. The risk for osteoradionecrosis increases as the dose of radiation increases from 5000 rad to over 8000 rad. Tissues receiving less than 5000 rad are at low risk for necrosis. In addition, the risk increases with poor oral health. Oral surgical procedures after radiation therapy place the patient at high risk for developing osteoradionecrosis. Soft tissue trauma from dentures and oral infections from periodontal disease and dental caries also put the patient at risk.

**82. How should the dentist prepare the patient for radiation therapy of the head and neck?**

The dentist should consult with the radiotherapist to determine which oral structures will be in the field of radiation, as well as the maximal radiation dose. If teeth are in the field and the dose is greater than 5000 rad, periodontally involved teeth and teeth with periapical lucencies should be extracted at least 2 weeks before radiation therapy begins. The patient should receive antibiotic prophylaxis prior to the extractions and should continue with a 1-week regimen of antibiotics four times daily after the extractions. The dentist should prepare the patient for postradiation xerostomia—provide custom fluoride trays and prescribe 0.4% stannous fluoride gel to be used for 3 to 5 minutes twice daily. The patient must be placed on a 2- to 3-month recall schedule. On recall, the teeth must be carefully examined for root caries, and instruction in oral hygiene should be reviewed.

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## DEVELOPMENTAL CONDITIONS

### TOOTH-RELATED PROBLEMS

1. **True or false: Dental fluorosis increases pitting and porosity of the enamel and therefore increases the risk of dental caries.**

It is true that fluorosis causes increased pitting and porosity because fluoride increases retention of amelogenin, which results in hypomineralization of the enamel. This causes an unesthetic chalky white or even brown discoloration of the enamel, which may be pitted and fissured. However, because this enamel is more caries-resistant, the risk of dental caries is lower.

2. **Name the three main forms of amelogenesis imperfecta.**

1. **Hypoplastic form:** inadequate deposition of enamel matrix. Whatever is deposited calcifies normally. The teeth have thin enamel that may be pitted.
2. **Hypomaturation form:** adequate deposition of enamel, but the enamel crystal does not mature normally. The result is soft pigmented enamel that chips easily.
3. **Hypocalcified form:** inadequate mineralization. The result is enamel that gets lost a few years after eruption.

3. **Describe the different types of dentinogenesis imperfecta.**

Dentinogenesis imperfecta (DI) is a condition caused by abnormal dentin formation and several types exist. The classic type lead to opalescent teeth in the primary and permanent dentition. The teeth are bluish-brown and translucent. Enamel is lost early, and the exposed dentine undergoes rapid attrition.

Osteogenesis imperfecta with opalescent teeth  
Dentinogenesis imperfect

Dentin dysplasia Type I  
Dentin dysplasia Type II

4. **Describe the two main types of dentin dysplasia.**

**Type I, radicular type.** The roots are poorly formed, short, and distorted or even absent, with poorly formed crescent-shaped pulp chambers and absent pulp canals. Periapical lucencies develop early and teeth exfoliate prematurely.

**Type II, coronal type.** The crowns contain large pulp chambers that are thistle- or flame-shaped, that extend into the root. Pulp stones often develop. Primary teeth look like those of dentinogenesis imperfect with early obliteration of the pulp.

5. **What is the difference between fusion and concrescence? Between twinning and gemination?**

Fusion is a more complete process than concrescence and involves fusion of the entire length of two teeth (enamel, dentin, and cementum) to form one large tooth, with one less tooth in the arch, or fusion of the root only (dentin and cementum), with the maintenance of two clinical crowns. Concrescence involves fusion of cementum only.

Twinning is more complete than gemination and results in the formation of two separate teeth from one tooth bud (one extra tooth in the arch). In gemination, separation is attempted, but the two teeth share the same root canal.

6. **What is a Turner tooth?**

A Turner tooth is a solitary, usually permanent tooth with signs of enamel hypoplasia or hypocalcification. This phenomenon is caused by trauma or infection in the overlying deciduous tooth that damages the ameloblasts of the underlying tooth bud and thus leads to localized enamel hypoplasia or hypocalcification.

**7. What are “bull teeth”?**

Bull teeth, also known as taurodonts, have long anatomic crowns, large pulp chambers, and short roots, resembling teeth found in bulls. They are most dramatic in permanent molars but may affect teeth in either dentition. They occur more frequently in certain syndromes, such as Klinefelter syndrome.

**8. What is the difference between dens evaginatus and dens invaginatus?**

Dens evaginatus occurs primarily in the Chinese population (also named Leong premolar) and affects the premolars. **Evagination** of the layers of the tooth germ results in the formation of a tubercle that arises from the occlusal surface and consists of enamel, dentin, and pulp tissue. This tubercle tends to break when it occludes with the opposing dentition and may result in pulp exposure and subsequent pulp necrosis. Dens invaginatus occurs mainly in maxillary lateral incisors and ranges in severity from an accentuated lingual pit to what is known as a *dens in dente*. This phenomenon is caused by **invagination** of the layers of the tooth germ. Food becomes trapped in the pit, and caries begin early.

**9. What are the causes of generalized intrinsic discoloration of teeth?**

- Amelogenesis imperfecta
- Dentinogenesis imperfecta
- Tetracycline staining
- Fluorosis
- Rh incompatibility
- Congenital porphyria
- Biliary atresia

**10. Why do teeth discolor from ingestion of tetracycline during odontogenesis?**

Tetracycline binds with the calcium component of bones and teeth and is deposited at sites of active mineralization, causing a yellow-brown endogenous pigmentation of the hard tissues. Because teeth do not turn over the way bone does, this stain becomes a permanent label that fluoresces under ultraviolet light.

**11. Which teeth are most commonly missing congenitally?**

Third molars, maxillary lateral incisors, and second premolars are the most common.

**12. What conditions are associated with multiple supernumerary teeth?**

Gardner's syndrome and cleidocranial dysplasia are two important conditions.

**13. What are the most common sites for supernumerary teeth?**

Midline of the maxilla (mesiodens), posterior maxilla (fourth molar or paramolar), and mandibular bicuspid areas.

**INTRABONY LESIONS****14. A 40-year-old black woman presents with multiple periapical radiolucencies and radiopacities. What is the diagnosis?**

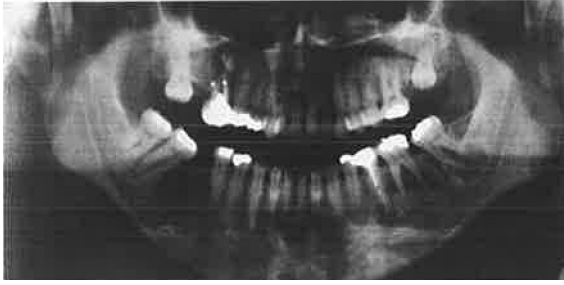
The U.S. black population is prone to developing benign fibro-osseous lesions of various types. They range from localized lesions, such as focal cemento-osseous dysplasia, usually involving the apex of a mandibular molar, to periapical cemento-osseous dysplasia, usually involving the mandibular anterior teeth, to florid (multi-focal) cemento-osseous dysplasia, involving all four quadrants. The term *cemento-osseous* is preferred to *cemental* because a combination of cementum droplets and woven bone are usually present (Fig. 4-1).

**15. Are fibrous dysplasias of bone premalignant lesions?**

Fibrous dysplasia, a malformation of bone, is of unknown cause and is not premalignant, although a gene (GNAS) has been identified for this condition. The monostotic form often affects the maxilla unilaterally. The polyostotic form is associated with various other abnormalities, such as skin pigmentations and endocrine dysfunction (Albright and Jaffe-Lichtenstein syndromes). Cherubism, which used to be termed *familial fibrous dysplasia*, is probably not a form of fibrous dysplasia and is associated with a different gene mutation (SH3BP2). In the past, fibrous dysplasia was treated with radiation, which sometimes caused the development of osteosarcoma. The best way to treat cherubism is by recontouring the bone after the teenage growth spurt and when lesions become quiescent.

**16. True or false: The globulomaxillary cyst is a fissural cyst.**

False. Historically, the globulomaxillary cyst was classified as a nonodontogenic or fissural cyst thought to result from the entrapment of epithelial rests along the line of fusion between the lateral maxillary and nasomedial processes. Current thinking puts it into



**Figure 4-1.** Florid cement-osseous dysplasia affecting at least three quadrants.

the category of odontogenic cysts of a) developmental origin, and possibly related to the development of the lateral incisor or canine (if the teeth are vital), or of b) inflammatory origin (radicular cyst) if the teeth are nonvital. The two embryonic processes mentioned do not fuse. The fold between them fills in and becomes erased by mesodermal invasion so that there is no opportunity for trapping of epithelial rests. This cyst occurs between the roots of the maxillary lateral incisor and cuspid.

**17. True or false: The median palatal cyst is a true fissural cyst.**

True. The epithelium of this intrabony cyst arises from proliferation of entrapped epithelium when the right and left palatal shelves fuse in the midline. This should be distinguished from a nasopalatine duct cyst, which arises from remnants of the duct in the area of the nasopalatine foramen. The soft tissue counterpart, which also occurs in the midline of the palate and is known as the palatal cyst of the newborn (Epstein pearl), is congenital and exteriorizes on its own.

**18. A neonate presents with a few white nodules on the mandibular alveolar ridge. What are they?**

They are most likely dental lamina cysts of the newborn (Bohn nodules). The epithelium of these cysts arises from remnants of dental lamina on the alveolar ridge after odontogenesis. Sometimes they appear at the junction of the hard and soft palate. Dental lamina cysts of the newborn tend to involute and do not require treatment.

**19. A boy presents to the dental clinic with multiple jaw cysts and a history of jaw cysts in other family members. What syndrome does he most likely have?**

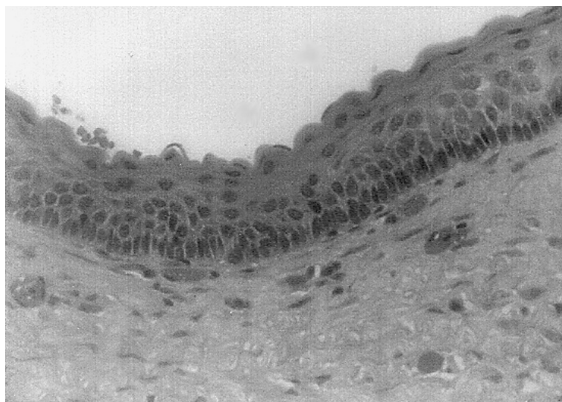
The boy most likely has the bifid rib–basal cell nevus syndrome, which is inherited as an autosomal dominant trait. The cysts are odontogenic keratocysts, which have a higher incidence of recurrence than other odontogenic cysts. The new name for keratocyst is keratocystic odontogenic tumor because they are now considered to be cystic neoplasms. Other findings include palmar pitting, palmar and plantar keratosis, calcification of the falx cerebri, hypertelorism, ovarian tumors, and neurologic manifestations, such as mental retardation and medulloblastomas. Mutation in the *PTCH* gene is responsible for this condition.

**20. Are all jaw cysts that produce keratin considered odontogenic keratocysts?**

No. The odontogenic keratocyst–keratocystic odontogenic tumor is a specific histologic entity. There is some controversy as to whether this is a cyst or cystic tumor, with the new terminology favoring the latter. The epithelial lining exhibits corrugated **parakeratosis**, uniform thinness (unless altered by inflammation), and palisading of the basal cell nuclei. The recurrence rate is high, and the condition is associated with the basal cell carcinoma–bifid rib (Gorlin-Goltz) syndrome. Odontogenic cysts that produce **orthokeratin** do not show the basal cell nuclei changes, do not have the same tendency to recur, and are not associated with the syndrome. These cysts are referred to as orthokeratinized odontogenic cyst. The histologic distinctions are important because they have clinical and prognostic implications.

**21. What neoplasms may arise in a dentigerous cyst?**

Ameloblastoma, mucoepidermoid carcinoma and, least commonly, squamous cell carcinoma may arise in a dentigerous cyst. Odontogenic tumors that may arise in a dentigerous relationship, although not within a dentigerous cyst, include adenomatoid odontogenic



**Figure 4-2.** Odontogenic keratocyst—keratocystic odontogenic tumor.

tumor, calcifying cystic odontogenic tumor (Gorlin cyst) and calcifying epithelial odontogenic tumor (Pindborg tumor). The odontogenic keratocyst or keratocystic odontogenic tumor, formerly classified as a cyst and now as a cystic neoplasm, are often seen in a dentigerous relationship with an impacted tooth (Fig. 4-2).

**22. What is the difference between a lateral radicular cyst and a lateral periodontal cyst?**

A lateral radicular cyst is an **inflammatory** cyst in which the epithelium is derived from rests of Malassez (like a periapical or apical radicular cyst). It is in a lateral rather than an apical location because the inflammatory stimulus is emanating from a lateral accessory canal. The associated tooth is always nonvital. The lateral periodontal cyst is a **developmental** cyst in which the epithelium probably is derived from rests of dental lamina. It is usually located between the mandibular premolars, which are vital.

**23. What is the incidence of cleft lip and/or cleft palate?**

Cleft lip and cleft palate should be considered as two entities, (1) cleft palate alone and (2) cleft lip, with or without cleft palate. The former is more common in females and the latter in males. The incidence of cleft palate alone is 1 in 2000 to 3000 births, whereas the incidence of cleft lip with or without cleft palate is 1 in 700 to 1000 births (highest in Asians and Native Americans). Of all cases, 25% are cleft palate alone and 75% are cleft lip with or without cleft palate.

**SOFT TISSUE CONDITIONS**

**24. Name some conditions in the mouth that may appear yellow.**

Sebaceous material—Fordyce granules

Fat—lipoma or other fatty tumors

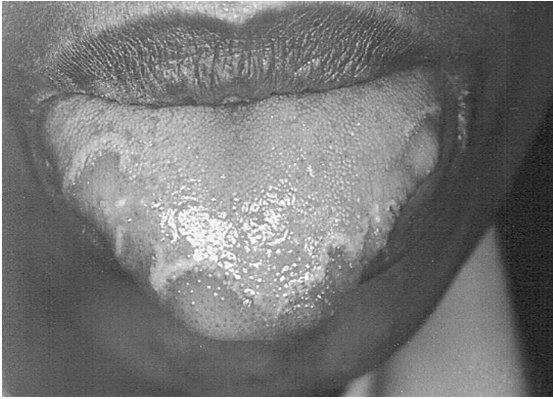
Keratin—oral lymphoepithelial cyst (yellow nodules on the base of the tongue, floor of the mouth, or tonsils), epidermoid cyst, dermoid cyst

**25. Is benign migratory glossitis (“geographic tongue”) associated with any systemic conditions?**

Most cases of benign migratory glossitis are associated with atopy (history of hay fever, asthma, and eczema) and some human leukocyte antigen (HLA) types. Some cases have been associated with fissured tongue and patients with psoriasis, especially generalized pustular psoriasis, have a higher incidence of benign migratory glossitis. (Fig. 4-3).

**26. What predisposes to the formation of a coated or hairy tongue?**

Hairy tongue is not a developmental lesion but a benign reactive condition. It is caused by reduced shedding and increased buildup of the keratin of the filiform papillae of the



**Figure 4-3.** Benign migratory glossitis.

tongue. Factors that predispose to this include dehydration, smoking, and reduced intake of coarse foods, fresh foods, and vegetables. Most patients have a history of a recent illness and have been on antibiotics, systemic steroids, and oxygenating mouth rinses. The papillae are putatively colonized by chromogenic bacteria, so the tongue may appear black, brown, or even green. It does not represent candidiasis.

## INFECTIONS

### FUNGAL INFECTIONS

#### 27. Discuss the main clinical forms of candidiasis.

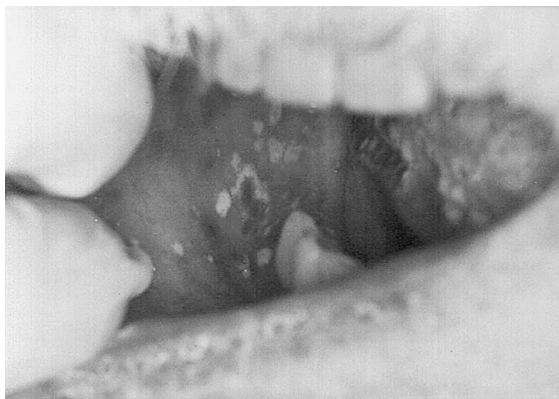
- Pseudomembranous candidiasis (the typical type, with curdy white patches, also known as *thrush*, tends to have an acute onset)
- Atrophic or erythematous candidiasis often seen under dentures (referred to as denture sore mouth or denture stomatitis); usually present for a long time because the denture often acts as a fomite; may be acute or chronic
- Angular cheilitis presenting as cracked, weepy red areas at the corners of the mouth; tends to be chronic and recurrent
- Median rhomboid glossitis presenting as a red plaque in the midline of the posterior tongue, just anterior of the circumvallate papillae
- Chronic hyperplastic candidiasis presenting as leukoplakia-like patches that do not wipe off easily
- Chronic mucocutaneous candidiasis (associated with skin candidiasis and an underlying systemic condition such as an endocrinopathy; Fig. 4-4)

#### 28. What factors predispose to candidal infection?

Predisposing factors include the following: (1) poor immune function, which may be related to age (very young and very old), malignancies, immunomodulating medications (topical or systemic), endocrine dysfunction, or human immunodeficiency virus (HIV) infection; (2) malnutrition; (3) antibiotics that upset the normal balance of flora; (4) dental prostheses, especially dentures that act as fomites; and (5) alteration in saliva flow and constituents.

#### 29. A culture performed on an oral ulcer grows *Candida* spp. Does this mean that the patient has candidiasis?

No. Approximately one-quarter to one-third of the adult population harbors *Candida* spp. in the mouth. Swabs from patients who are carriers for candida who do not have candidiasis, will grow candida.



**Figure 4-4.** Acute pseudomembranous candidiasis.

### 30. How do you make a diagnosis of candidiasis?

1. **Good clinical judgment.** Pseudomembranous plaques of candidiasis usually wipe off with difficulty, leaving a raw, bleeding surface.
2. **Potassium hydroxide (KOH) preparation.** The plaque is scraped, and the scrapings are put onto a glass microscopic slide. A few drops of KOH are added, the slide is warmed over an alcohol flame for a few seconds, and a coverslip is placed over the slide. The candidal organisms, if present, can be seen with a microscope. Alternatively, the scraping can be placed on a glass slide, fixed in alcohol, and sent to a cytology or pathology laboratory for staining and identification of the organism by light microscopy.
3. **Biopsy.** This shows hyphae penetrating the tissues (too invasive for routine use).
4. **Cultures.** Although cultures are not the ideal way to diagnose candidiasis, the quantity of candidal organisms that grow on culture correlates somewhat with clinical candidiasis. Cultures are particularly important for recalcitrant candidiasis to identify drug-resistant species.

### 31. What are common antifungal agents for treating oral candidiasis?

- Polyenes: nystatin (topical), amphotericin (topical, systemic)
- Imidazoles: clotrimazole, ketoconazole
- Triazoles: fluconazole, itraconazole, voriconazole

### 32. True or false: Actinomycosis represents a fungal infection.

False. *Actinomyces* is a gram-positive bacteria. Do not be fooled by the suffix *-mycosis*.

### 33. What are sulfur granules?

These yellowish granules (hence the name) are seen within the pus of lesions of actinomycosis. They represent aggregates of *Actinomyces* (usually *A. israelii*), which are invariably surrounded by neutrophils.

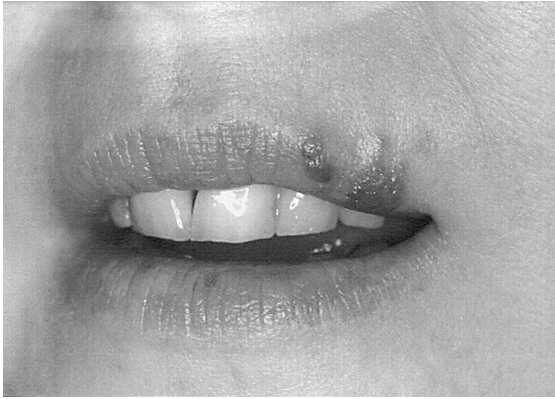
### 34. Name two opportunistic fungal diseases that often present in the orofacial region.

Aspergillosis and zygomycosis tend to infect immunocompromised hosts; the latter causes rhinocerebral infections in patients with diabetes mellitus.

### 35. Name the deep fungal infections that are endemic in North America.

Histoplasmosis (caused by *Histoplasma capsulatum*) is endemic in the Ohio-Mississippi basin, coccidioidomycosis (caused by *Coccidioides immitis*) is endemic in the San Joaquin Valley in California, and blastomycosis (caused by *Blastomyces*) dermatitidis is endemic from the Great Lakes basin to the Mississippi valley.





**Figure 4-5.** Recurrent herpes labialis (cold sores or fever blisters).

## VIRAL INFECTIONS

- 36. Name the six most common viruses of the Herpesviridae family that often present in the orofacial area.**

Herpes simplex virus types 1 and 2 (HSV-1 and -2)	Varicella zoster virus (VZV)
Cytomegalovirus (CMV)	Epstein-Barr virus (EBV)
Human herpesvirus 8	

- 37. True or false: Antibodies against HSV-1 protect against further outbreaks of the disease.**

False. The herpes viruses are unique in that they exhibit latency. Once a person has been infected by HSV-1, the virus remains latent within the sensory ganglia (e.g., trigeminal ganglion) for life. When conditions are favorable (for the virus, not the patient), HSV travels along nerve fibers and causes a mucocutaneous lesion at a peripheral site, such as a cold sore on the lip. A positive antibody titer (immunoglobulin G [IgG]) indicates that the patient has been previously exposed, and at the time of reactivation the titer may rise. Hypersensitivity to recurrent HSV infections may lead to an ulcerative condition called *erythema multiforme*.

- 38. How do you differentiate between recurrent aphthous ulcers and recurrent herpetic ulcers?**

Clinically, recurrent aphthous ulcers (minor) occur only on the nonkeratinized mucosae of the labial mucosa, buccal mucosa, sulci, ventral tongue, soft palate, and faucial pillars. Recurrent herpetic ulcers occur on the vermilion border of the lips (cold sores or fever blisters) and on the keratinized mucosae of the palate and attached gingiva in immunocompetent individuals. A culture confirms the presence of virus. In immunocompromised hosts, however, recurrent herpetic lesions may occur on the keratinized and nonkeratinized mucosae and may mimic aphthous ulcers (Fig. 4-5).

- 39. An older patient with long-standing rheumatoid arthritis presents with a history of upper respiratory tract infection, ulcers of the right hard palate, right facial weakness, and vertigo. What does this patient have?**

The patient has herpes zoster infection, which typically is unilateral. The patient also has Ramsay-Hunt syndrome, which is caused by infection of cranial nerves VII and VIII with herpes zoster, leading to facial paralysis, tinnitus, deafness, and vertigo.

- 40. What lesions associated with the Epstein-Barr virus may present in the orofacial region?**

- Infectious mononucleosis
- Burkitt lymphoma (African type)
- Hodgkin lymphoma
- Nasopharyngeal carcinoma
- Hairy leukoplakia

**41. How does infectious mononucleosis present in the mouth?**

Infectious mononucleosis usually presents as multiple, painful, punctate ulcers of the posterior hard palate and soft palate in young adults or adolescents. It is often associated with regional lymphadenopathy and constitutional signs of a viral illness, such as fever and malaise.

**42. What oral lesions have been associated with infection by human papillomavirus (HPV)?**

- Focal epithelial hyperplasia (Heck disease)
- Squamous papilloma
- Oral condylomas
- Carcinoma of the tonsil
- Verruca vulgaris
- Oral carcinoma and leukoplakia

The benign conditions are usually associated with HPV-6 and -11; the malignant ones are usually associated with HPV-16 and -18. Heck's disease is associated with HPV-13 and HPV-32.

**43. What oral conditions does coxsackievirus cause?**

Herpangina and hand-foot-and-mouth disease are caused by the type A coxsackievirus and generally affect children, who then develop oral ulcers associated with an upper respiratory tract viral prodrome. Lymphonodular pharyngitis is also caused by coxsackievirus.

**44. What are Koplik spots?**

Koplik spots are early manifestations of measles or rubeola (hence they also are called *herald spots*). They are 1- to 2-mm, yellow-white ulcers with surrounding erythema that occur on the buccal mucosa, usually a few days before the body rash of measles is seen. Koplik spots are not usually seen in German measles.

**OTHER INFECTIONS****45. What are the organisms responsible for noma?**

Noma, which is a gangrenous stomatitis resulting in severe destruction of the orofacial tissues, is usually encountered in areas in which malnutrition is rampant. The bacteria are similar to those associated with acute necrotizing ulcerative gingivitis—namely, spirochetes, fusiform bacteria, and others. It is sometimes seen in patients with AIDS.

**46. What are the oral findings in syphilis?**

Primary: oral chancre

Secondary: mucous patches, condyloma lata

Tertiary: gumma (ulcerated nodules), glossitis

Congenital: enamel hypoplasia, mulberry molars, notched incisors

**47. What is a granuloma?**

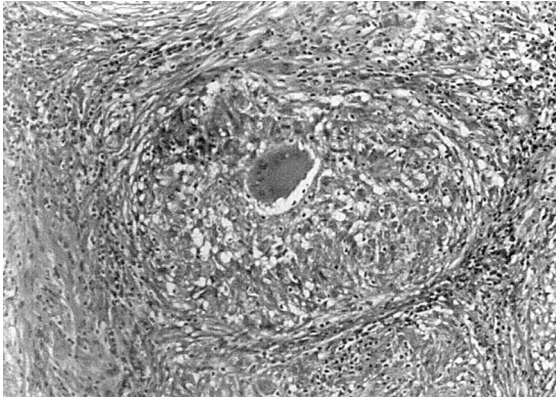
Strictly speaking, a granuloma is a collection of epithelioid histiocytes that is often associated with multinucleated giant cells such as the Langhans-type giant cells seen in granulomas of tuberculosis (caused by *Mycobacterium tuberculosis*). Many infectious agents, including fungi (e.g., *Histoplasma* spp.) and those causing tertiary syphilis (*Treponema pallidum*) and cat scratch disease (*Bartonella henselae*), can produce granulomatous reactions. Foreign body reactions are often granulomatous. Orofacial granulomatosis may be related to hypersensitivity to foods, flavorings, and preservatives. Crohn's disease and sarcoidosis are granulomatous diseases of unclear etiology (Fig. 4-6).

**48. What are Langhans cells?**

Langhans cells are multinucleated giant cells seen in granulomas, usually those caused by *M. tuberculosis*. Their nuclei have a characteristic horseshoe distribution. Do not confuse them with Langerhans cells, which are antigen-processing cells.

**REACTIVE, HYPERSENSITIVITY, AND AUTOIMMUNE CONDITIONS****INTRABONY AND DENTAL TISSUES****49. True or false: The periapical granuloma is composed of a collection of histiocytes—that is, a true granuloma.**

False. The periapical granuloma is a tumor-like (-oma) proliferation of granulation tissue found around the apex of a nonvital tooth. It is associated with chronic inflammation from



**Figure 4-6.** Tuberculous granuloma with Langhans giant cell.



**Figure 4-7.** Apical radicular cyst.

pulp devitalization. The inflammation can stimulate proliferation of the epithelial rests of Malassez to form an apical radicular or periapical cyst (Fig. 4-7).

#### 50. What is condensing osteitis?

Condensing osteitis, a relatively common condition, manifests as an area of radiopacity in the bone, usually adjacent to a tooth that has a large restoration or endodontic therapy, although occasionally it may lie adjacent to what appears to be a sound tooth. It is asymptomatic. Histologically, condensing osteitis consists of dense bone, with little or no inflammation. It probably arises as a bony reaction to a low-grade inflammatory stimulus from the adjacent tooth. *Idiopathic osteosclerosis*, *bone scar* and *dense bone island* are terms used for similar bone lesions unassociated with teeth.

**51. What are the different causative factors between the wearing down of teeth caused by attrition, abrasion, erosion, and abfraction?**

**Attrition:** tooth to tooth contact

**Abrasion:** a foreign object to tooth contact (e.g., toothbrush bristles, bobby pins, nails)

**Erosion:** a chemical agent to tooth contact (e.g., lemon juice, gastric juices)

**Abfraction:** occlusal stress leading to excessive tensile forces, which cause damage to enamel at cervical areas of the teeth

**SOFT TISSUE CONDITIONS**

**52. Name some systemic conditions associated with aphthous-like ulcers.**

- Iron, folate, or vitamin B<sub>12</sub> deficiency
- Inflammatory bowel disease
- Behçet disease
- Hypersensitivity to food or medications
- HIV infection
- Conditions predisposing to neutropenia

**53. True or false: An aphthous ulcer is the same as a traumatic ulcer.**

False, but with reservations. A traumatic ulcer is the most common form of oral ulcer and, as its name suggests, occurs at the site of trauma, such as the buccal mucosa, lateral tongue, lower labial mucosa, or sulci. It follows a history of trauma, such as mastication or toothbrush injury. An aphthous ulcer may occur at the same sites, but often with no history of trauma. However, patients prone to developing aphthae tend to do so after episodes of minor trauma (Fig. 4-8).

**54. A child returns after a visit to the dentist at which several amalgam restorations were placed. The child now has ulcers of the lateral tongue and buccal mucosa on the same side as the amalgams. What is your diagnosis?**

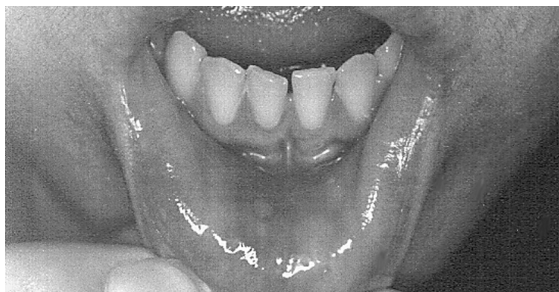
This is a factitial injury. Children may inadvertently chew their tongues and buccal mucosae while tissues are numb from local anesthesia because the tissues feel strange to the child. Children and parents should be advised to be alert for such behavior.

**55. Is the mucocele a true cyst?**

It depends. The term *mucocele* refers loosely to a cystlike lesion that contains mucus and usually occurs on the lower lip, ventral tongue, or floor of the mouth. However, it may occur wherever mucous glands are present. In most cases, it is not a true cyst because it is not lined by epithelium. It is caused by escape of mucus into the connective tissue when an excretory salivary duct is traumatized. Therefore, the mucocele is lined by fibrous and granulation tissue. In a few cases, it is caused by distention of the excretory duct because of a distal obstruction or the presence of a sialolith; the preferred term is *salivary duct cyst*.

**56. What is the cause of necrotizing sialometaplasia?**

This painless ulcer usually develops on the hard palate but may occur wherever salivary glands are present. It represents vascular compromise and subsequent infarction of the salivary gland tissue, with reactive squamous metaplasia of the salivary duct epithelium that may mimic squamous cell carcinoma. The lesion resolves on its own.



**Figure 4-8.** Recurrent aphthous ulcer (minor) of lower labial mucosa.

**57. Name the major denture-related findings in the oral cavity.**

- Chronic atrophic candidiasis, especially of the palate (denture sore mouth)
- Papillary hyperplasia of the palatal mucosa
- Fibrous hyperplasia of the sulcus where the denture flange impinges (epulis fissuratum)
- Traumatic ulcers from overextension of flanges
- Angular cheilitis (candidiasis) from overclosure
- Denture base hypersensitivity reactions (very uncommon; resembles chronic atrophic candidiasis)

**58. A patient is suspected of having an allergy to denture materials. What do you recommend?**

The first thing is to rule out chronic atrophic candidiasis (denture stomatitis or denture sore mouth) because this is much more common. The patient should be treated with fluconazole (much more effective than nystatin or clotrimazole) or Mycostatin–triamcinolone cream applied directly to the denture to be worn by the patient; the denture must also be soaked in an antifungal agent overnight because it is a fomite. If these measures are taken and there is no response, the patient should be patch-tested by an allergist or dermatologist to a panel of denture base materials, which include metals and acrylic polymerization products. Usually, the lesions resolve with topical steroids.

**59. What is a gum boil (parulis)?**

A gum boil is an erythematous nodule usually located on the attached gingiva or even the alveolar mucosa. It may have a yellowish center that drains pus, and it may be asymptomatic. The nodule consists of granulation tissue and a sinus tract that usually can be traced to the root of the underlying tooth, with a thin gutta percha point. It indicates an infection of pulpal or periodontal origin (Fig. 4-9).

**60. What is plasma cell gingivitis?**

Plasma cell gingivitis, first reported in the 1970s, presented as an intensely erythematous gingivitis and was likely caused by an allergic reaction to a component of chewing gum or other allergen. It is a form of contact stomatitis and still occurs sporadically.

**61. Some patients have a reaction to tartar control toothpaste. What is the offending ingredient?**

The offending ingredient is cinnamic aldehyde. Susceptible patients develop burning of the mucosa and sometimes bright red gingivitis, similar to plasma cell gingivitis, after using the product. They also often have a reaction to chewing gum that contains cinnamon.

**62. What is the differential diagnosis for desquamative gingivitis? What special handling procedures are necessary if you obtain a biopsy?**

Desquamative gingivitis, which usually affects middle-aged women, is characterized by painful, red, eroded, and denuded areas of the gingiva. Definitive diagnosis requires direct



**Figure 4-9.** Two parulides. The one on the left is about to drain.

immunofluorescence studies of the gingiva to look for autoantibodies. To preserve the integrity of immune reactants, the biopsy specimen should be split; half should be submitted in formalin for routine histopathology and the other half in Michel solution or fresh in saline. Alternately, two specimens can be harvested.

Immunofluorescence patterns show that most cases (80% to 90%) represent lichenoid reactions, lichen planus and mucous membrane pemphigoid, or nonspecific immunoreactivity that may represent hypersensitivity reactions. Approximately 10% are pemphigus vulgaris, or other autoimmune condition, such as lupus erythematosus, linear IgA disease, and epidermolysis bullosa acquisita (Fig. 4-10).

### 63. How does classic lichen planus present?

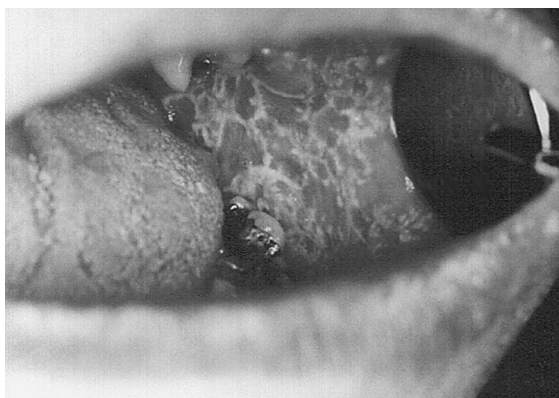
Classic lichen planus presents with white, lacey lesions (Wickham striae), often with erythema and sometimes ulcers, usually in a bilaterally symmetric fashion on the buccal mucosa, ventral tongue, and gingiva, although any site may be affected.

### 64. What medications can give a lichen planus-like (lichenoid) mucosal reaction (Fig. 4-11)?

- Drugs for treating hypertension, such as hydrochlorothiazide, angiotensin-converting enzyme (ACE) inhibitors, and beta blockers
- Hypoglycemic agents in the sulfonylureas group
- Antiarthritic agents, such as penicillamine



**Figure 4-10.** Desquamative gingivitis.



**Figure 4-11.** Lichenoid stomatitis associated with hydrochlorothiazide.

- Antigout agents, such as allopurinol
- Medications for treating inflammatory bowel disease, such as sulfasalazine
- Nonsteroidal anti-inflammatory drugs (NSAIDs)
- New biologic agents

**65. Name the medications that can be used to treat symptomatic lichen planus.**

Most of the medications involved are immunomodulating agents. The most commonly used are corticosteroids (e.g., fluocinonide or clobetasol gels) applied topically, injected intralesionally, or taken systemically or tacrolimus applied topically. Hydroxychloroquine, azathioprine, cyclosporine A, and retinoids have been used with some success.

**66. True or false: Dental restorations may cause lichen planus-like reactions.**

True. In some people, amalgam and composite restorations have been shown to cause a lichenoid reaction in the mucosa in contact with the restoration. Replacement of the restoration leads to resolution.

**67. What are the typical skin lesions of erythema multiforme called?**

They are called *target*, *iris*, or *bull's-eye lesions*. Erythema multiforme is an acute mucocutaneous inflammatory process that may recur periodically in chronic form. It often leads to ulcers and erythema of the oral mucosa. It is no longer considered a variant of Stevens-Johnson syndrome.

**68. Name the most common factors responsible for recurrent erythema multiforme.**

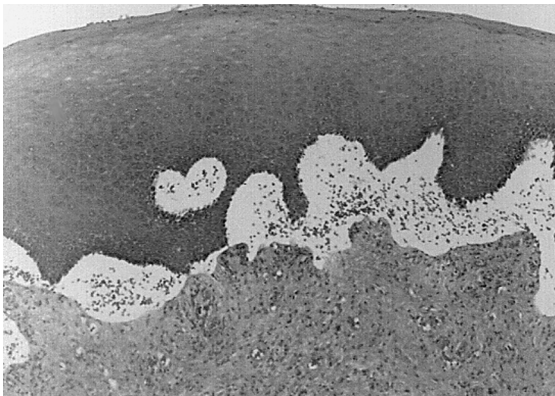
These are herpes simplex virus reactivation and, less frequently, hypersensitivity to some medications. Do not expect to be able to culture herpes simplex virus from the lesions of recurrent erythema multiforme, which is a hypersensitivity reaction to some component of the virus. Usually, the viral infection precedes the lesions of erythema multiforme.

**69. What is Stevens-Johnson syndrome?**

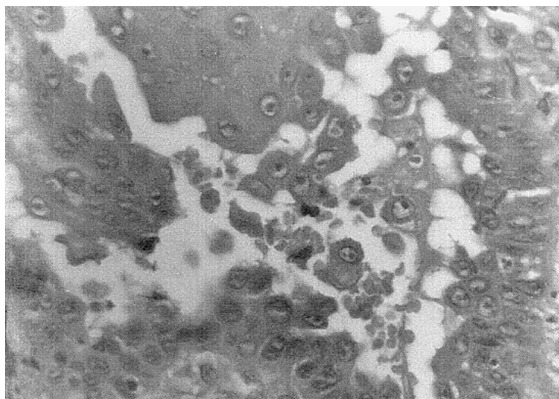
Stevens-Johnson syndrome is a condition leading to blistering and necrosis of the epidermis; the more severe form is called *toxic epidermal necrolysis*, a potentially fatal disorder. It is usually caused by hypersensitivity to medications. The condition is characterized by extensive involvement of the mucous membranes of the oral cavity, eyes, genitalia, and occasionally the upper gastrointestinal and respiratory tracts. Desquamation and ulceration of the lips, with crusting, is usually dramatic. Atypical target lesions may be seen on the skin.

**70. What is the difference between pemphigus and pemphigoid?**

Both are autoimmune vesiculobullous diseases. In pemphigus (usually vulgaris when in the mouth), autoantibodies attack desmosomal plaques of the epithelial cells, leading to acantholysis and formation of an intraepithelial bulla. In pemphigoid (usually mucous membrane), autoantibodies attack the junction between the epithelium and connective tissue, leading to the formation of a subepithelial bulla (Fig. 4-12).



**Figure 4-12.** Subepithelial bulla formation in mucous membrane pemphigoid.



**Figure 4-13.** Tzanck (acantholytic) cells of pemphigus vulgaris.

**71. What two forms of pemphigoid involve the oral cavity?**

The two forms are mucous membrane pemphigoid and bullous pemphigoid. These autoimmune vesiculobullous diseases have antigens located in the lamina lucida of the basement membrane. Mucous membrane pemphigoid presents primarily with oral mucosal and ocular lesions and occasionally with skin lesions, whereas bullous pemphigoid presents primarily with skin lesions and occasionally with mucosal lesions. IgG, IgA, and/or C3 localize at the basement membrane zone.

**72. Differentiate between a Tzanck test and Tzanck cell.**

The **Tzanck test** involves direct examination of cells that may indicate a herpes simplex virus infection. The test is done by scraping the lesion (which may be a vesicle, ulcer, or crust) and smearing the debris on a slide. The slide is then stained and examined with a microscope for virally infected cells, which show multinucleation and ground glass nuclei. **Tzanck cells** are acantholytic cells seen within the bulla of pemphigus vulgaris (Fig. 4-13).

**73. What is the difference between systemic lupus erythematosus (SLE) and discoid lupus erythematosus (DLE)?**

SLE is the prototypical multisystem autoimmune disease characterized by circulating antinuclear antibodies; the principal sites of injury are skin, joints, and kidneys. The oral mucosa is often involved, and the lesions may appear lichenoid, with white striae, erythema, or ulcers. DLE is the limited form of the disease; most manifestations are localized to the skin and mucous membranes, with no systemic involvement. DLE does not usually progress to SLE, although certain phases of SLE are clinically indistinguishable from DLE. The oral findings are similar in both.

**74. Define midline lethal granuloma midline destructive disease.**

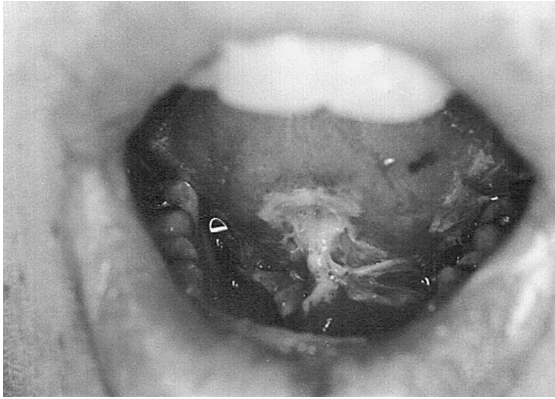
These terms describe a destructive ulcerative process, usually located in the midline of the hard palate, that may lead to palatal perforation. Conditions that may cause this clinical entity include deep fungal infections, syphilitic gummas, anti-neutrophilic cytoplasmic antibody-associated (Wegener) granulomatosis, chronic cocaine use, and malignant neoplasms, such as sinonasal lymphomas, salivary gland malignancy, or squamous cell carcinoma.

## CHEMOTHERAPY AND HUMAN IMMUNODEFICIENCY VIRUS INFECTION

**75. What are the common oral side-effects of chemotherapy?**

Chemotherapy is often directly toxic to the oral mucosa. The mucosa becomes atrophic and ulcerates. The chemotherapeutic agents also act on other rapidly dividing cells in the





**Figure 4-14.** Chemotherapy-associated oral ulcerative mucositis.

body, such as hematopoietic tissues. The results are neutropenia (low neutrophil count), anemia, and thrombocytopenia (low platelet count). Neutropenia may have an indirect stomatotoxic effect by allowing oral bacteria to colonize the ulcers. Usually, these ulcers develop during the period of profound neutropenia and resolve when neutrophils reappear in the blood circulation. In addition, patients are at increased risk for developing oral candidiasis, oral herpetic lesions, and deep fungal infections. Thrombocytopenia may cause oral petechiae, ecchymoses, and hematomas, especially at sites of trauma (Fig. 4-14).

**76. A patient who has undergone cancer chemotherapy now has recurrent intraoral herpetic lesions but no history of cold sores or fever blisters. Is this likely?**

Yes. Many people have been exposed to HSV without their knowledge and are completely asymptomatic. The virus becomes latent in the sensory ganglia and reactivates to give rise to recurrent or recrudescent herpetic lesions. The prevalence of those who have been exposed to HSV increases with age.

**77. What are the complications of leukemia in the oral cavity, aside from those associated with chemotherapy?**

Leukemic infiltration of the bone marrow leads to reduced production of functional components of the marrow. Neutropenia results in more frequent and more aggressive odontogenic infections; thrombocytopenia results in petechiae, ecchymoses, and hematomas in the oral cavity, which is subject to trauma from functional activities. The patient may have a more than adequate white cell count, but many of the white cells are malignant and do not necessarily function like normal white cells. As such, patients often develop odontogenic and soft tissue infections (including viral infections). In addition, some leukemias, especially acute monocytic leukemia, have a propensity to infiltrate the gingiva, causing localized or diffuse gingival enlargement.

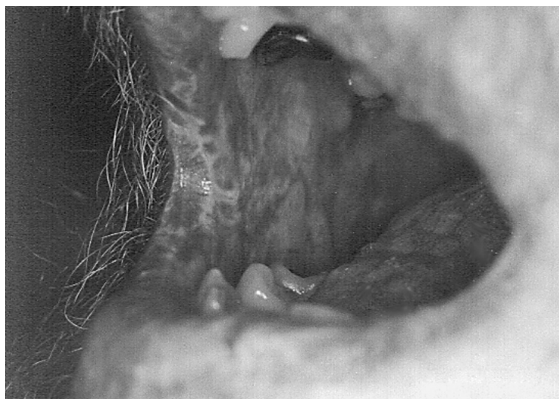
**78. A patient has undergone a matched allogeneic bone marrow transplantation for the treatment of leukemia. Three months later, he has erosive and lichenoid lesions in his mouth. What is your diagnosis?**

The likely diagnosis is chronic oral graft-versus-host disease. The allogeneic bone marrow transplant or graft contains immunocompetent cells that recognize the host cells as foreign and attack them. The oral lesions of chronic graft-versus-host disease resemble the lesions of lichen planus (Fig. 4-15).

**79. What are the effects of radiation on the oral cavity?**

**Short-term:** oral erythema and ulcers, candidiasis, dysgeusia, parotitis, acute sialadenitis, hyposalivation, loss of taste

**Long-term:** hyposalivation, erythema and ulcers, dental caries, osteoradionecrosis, epithelial atrophy and fibrosis (leading to trismus), loss of taste



**Figure 4-15.** Chronic oral graft-versus-host disease of buccal mucosa.

**80. What factors predispose to osteoradionecrosis?**

This necrotic process affects bone that has been in the radiation field. Predisposing factors include a high total dose of radiation (especially if >6500 cGy), presence of odontogenic infection (e.g., periapical pathosis, periodontal disease), trauma (e.g., extractions), and site (the mandible is less vascular and more susceptible than the maxilla).

**81. What is the basic cause of osteoradionecrosis?**

The breakdown of hypocellular, hypovascular, and hypoxic tissue results in a chronic, nonhealing wound containing sequestra that can be secondarily infected.

**82. Other than radiation, what other situations may lead to osteonecrosis?**

- Medications: antiosteoclastic agents such as bisphosphonates and denosumab; antiangiogenic agents such as bevacizumab and sunitinib
- Trauma (especially of the lingual plate in the area of the molars)
- Odontogenic infection—osteomyelitis leading to sequestrum formation; aggravated by primary sclerotic bone disease (e.g., cemento-osseous dysplasia)
- Viral infection (e.g., oral shingles)

**83. True or false: A patient can only be said to have bisphosphonate-related osteonecrosis of the jaws if she or he has exposed dead bone.**

False. Patients can have stage 0 (nonexposed) osteonecrosis if there are signs and symptoms that the clinician thinks are not related to odontogenic pathology. These include pain and sinus tracts not related to odontogenic infection, and poorly defined radiolucencies with sequestrum.

**84. What are the common oral manifestations of HIV infection?**

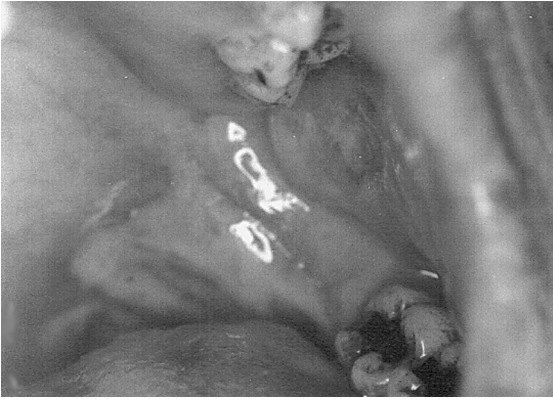
**Soft tissue:** candidiasis, recurrent herpetic infections, deep fungal infections, aphthous-like ulcers, hairy leukoplakia, viral warts, acute necrotizing stomatitis

**Periodontium:** nonspecific gingivitis, acute necrotizing ulcerative gingivitis, severe and rapidly destructive periodontal disease, often with unusual pathogens

**Tumors:** Kaposi sarcoma, B-cell lymphoma, squamous cell carcinoma

**85. A patient who tested positive for HIV antibodies presents with a CD4 count of 150/μl but has never had an opportunistic infection or been symptomatic. Does he have AIDS?**

Yes. By the CDC definition (December 2008), patients with CD4 counts below 200 are considered to have Stage 3 AIDS. Patients with Stage 1 and Stage 2 disease have CD4 counts of >500 cells/ul and 200-499 cells/ul respectively.



**Figure 4-16.** HIV-associated aphthous ulcers of the soft palate and oropharynx.

**86. True or false: Like other leukoplakias, hairy leukoplakia has a tendency to progress to malignancy.**

False. Hairy leukoplakia is associated with EBV infection and usually a superimposed candidiasis, with no malignant potential. However, patients infected with HIV are more susceptible to oral cancer in general. The word “leukoplakia” used in this context is misleading.

**87. Are HIV-associated aphthous ulcers similar to recurrent major aphthae?**

Yes. They tend to be larger than 1 cm, persist for long periods (weeks to months), and are difficult to treat. They may be associated with neutropenia (Fig. 4-16).

**88. Should HIV-associated aphthous ulcers be routinely cultured?**

Yes. Often the culture is positive for HSV or even CMV, and the patient needs to be treated appropriately. A biopsy is often necessary to rule out CMV or deep fungal infection.

**89. You have a patient with HIV-AIDS whom you have been treating with fluconazole. More recently, his candidiasis has been recalcitrant, even with double the dose of fluconazole. What should you do?**

Culture the scrapings of candidiasis and specifically ask the laboratory to check for resistance to fluconazole. Fluconazole occurs not uncommonly in patients who have been treated for a long time with fluconazole. Other medications are voriconazole and itraconazole.

## BENIGN NEOPLASMS AND TUMORS

### ODONTOGENIC TUMORS

**90. Name the benign odontogenic tumors that are purely epithelial.**

- Ameloblastoma
- Calcifying epithelial odontogenic tumor (Pindborg tumor)
- Adenomatoid odontogenic tumor
- Squamous odontogenic tumor
- Ameloblastic carcinoma (or primary intraosseous carcinoma)
- Clear cell odontogenic carcinoma

**91. Which odontogenic tumor is associated with amyloid production? With ghost cells?**

Calcifying epithelial odontogenic tumor (Pindborg tumor) is associated with amyloid production; calcifying cystic odontogenic tumor (Gorlin cyst) is associated with ghost cells.

**92. Which two lesions, one in the long bones and one in the cranium, resemble the ameloblastoma?**

In the long bones, it is adamantinoma; in the cranium, it is craniopharyngioma.

**93. True or false: All forms of ameloblastoma behave aggressively and tend to recur.**

False. One form of ameloblastoma, which occurs in adolescents and young adults, behaves less aggressively and has a lower tendency to recur. It is called *unicystic ameloblastoma*. Peripheral (extraosseous) ameloblastomas also behave in a benign fashion and do not recur.

**94. True or false: Because ameloblastoma is so aggressive, it can be considered a malignancy.**

False. Ameloblastoma is a locally destructive lesion that has no tendency to metastasize. However, it has two malignant counterparts, ameloblastic carcinoma and malignant ameloblastoma.

**95. To which teeth are cementoblastomas usually attached?**

They are usually attached to the mandibular permanent molars.

**96. Name the two most common odontogenic tumors that produce primarily mesenchymal tissues.**

These are odontogenic fibroma and odontogenic myxoma.

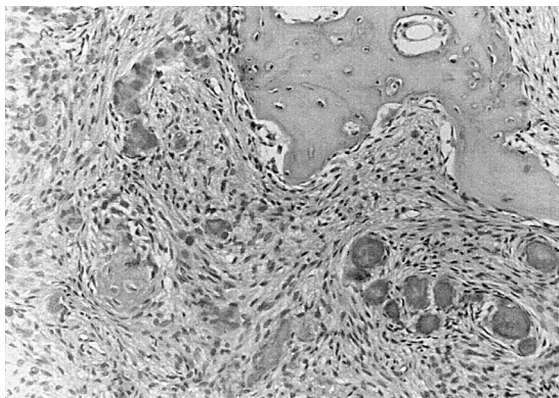
**97. An adolescent presents with a mandibular radiolucency with areas that histologically resemble ameloblastoma and dental papilla. What is your diagnosis?**

The diagnosis is ameloblastic fibroma, one of the rare odontogenic tumors that has both neoplastic epithelial and mesenchymal components.

### FIBRO-OSSEOUS TUMORS

**98. True or false: Ossifying fibromas arise from bone-producing cells, and cementifying fibromas are odontogenic in origin.**

In real life and real pathology, the line of demarcation between the two is not so clear. They are clinically indistinguishable. Histologically, although pure ossifying and pure cementifying fibromas exist, it is much more common to see a mixture of bone-osteoid and cementum in any given lesion, with either predominating or in equal proportions. Many pathologists use the term *cemento-ossifying fibroma* as a unifying concept. The cell of origin is likely to be a mesenchymal cell in the periodontal ligament that is capable of producing bone or cementum, therefore duplicating the two anchoring sites for Sharpey fibers (Fig. 4-17).



**Figure 4-17.** Central cement-ossifying fibroma with round globules of cementum and trabeculae of osteoid.

**99. Is it possible to distinguish histologically between fibrous dysplasia and central ossifying fibroma?**

Sometimes yes, often no. The clinical and radiographic findings are the most important for differentiating between the two. Fibrous dysplasia tends to occur in the maxilla of younger individuals and presents as a poorly defined radiolucent or radiopaque area that is nonencapsulated. The radiographic appearance has been described as resembling ground glass. The central ossifying fibroma is a well-demarcated radiolucency, often with a distinct border, and may contain areas of radiopacity within the lesion. It is more common in the mandible.

**SOFT TISSUE TUMORS**

**100. True or false: Fibroma of the oral cavity is a true neoplasm.**

False. As its name suggests, fibroma of the oral cavity is a tumor (-oma) composed of fibrous tissue. It tends to occur as a result of trauma and therefore usually presents on the buccal mucosa, lower labial mucosa, and lateral tongue. It is nonencapsulated and may enlarge with continued local trauma/irritation. Neoplasm has been defined as new growth; the growth, once established, continues excessively, even after cessation of the stimulus (or stimuli) that first evoked the change. Therefore, it is not a true neoplasm but just a tumor of fibrous scar tissue. Some pathologists prefer the term *fibrous hyperplasia* or *fibroepithelial polyp* instead of *fibroma* because it more accurately reflects its nature. The pathogenesis is similar to that of fibrous hyperplasias caused by poorly fitting dentures (Fig. 4-18).

**101. What are Verocay bodies?**

Verocay bodies consist of amorphous-looking, eosinophilic material that forms between parallel groups of nuclei in the schwannoma, a nerve sheath tumor. They actually represent duplicated basement membrane produced by Schwann cells and are an important component of Antoni A tissue.

**102. What is the most common tumor that contains neural structures?**

Traumatic neuroma is the most common. This is caused by trauma and severance of nerves. When the nerves twigs try to regrow (Wallerian regeneration), they form a tangled mass of nerve fibers of varying sizes admixed with scar tissue. They are particularly common under denture flanges close to the mental foramen.

**104. What are venous lakes?**

Venous lakes or varices are purplish-blue nodules or papules, often present on the lips of older people, that represent dilated venules.

**105. What is the most common benign salivary gland tumor?**

Pleomorphic adenoma is the most common.



**Figure 4-18.** Fibroma of the tongue.

**106. Why is pleomorphic adenoma sometimes called a *benign mixed tumor*?**

Pleomorphic adenoma is called a *mixed tumor* because histologically it has a mixture of epithelial and connective tissue components. The tumor arises from a progenitor cell that is capable of producing ducts, myoepithelial cells, and stroma, which may contain cartilage and bone.

**107. What is a brown tumor?**

A brown tumor is histologically a central giant cell granuloma associated with hyperparathyroidism. It appears brown when excised because it is a highly vascular lesion. Most conventional central giant cell granulomas occur in children and young adults in the absence of hyperparathyroidism.

**MALIGNANT NEOPLASMS****108. What percentage of the population has leukoplakia? What percentage of leukoplakias have dysplasia or carcinoma when first biopsied as compared with erythroplakias?**

Leukoplakia occurs in 1% to 3% of the population, and 15% to 40% of leukoplakias have dysplasia or carcinoma at the time of biopsy, whereas 90% of erythroplakias show such changes at the time of biopsy (Fig. 4-19).

**109. What is leukoplakia and which forms of leukoplakia have a higher association with dysplasia?**

Leukoplakia is a white plaque, usually well-demarcated, that is the most common premalignant mucosal lesion. Those that have verrucous, nodular, or red components have a higher chance of harboring dysplasia.

**110. What is proliferative verrucous leukoplakia?**

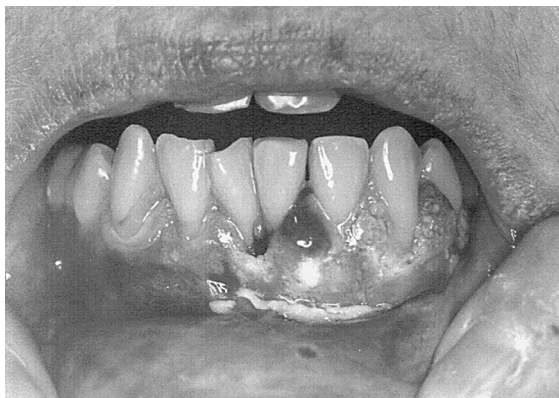
It is a clinically progressive and multifocal form of leukoplakia with a high rate of malignant transformation (up to 70%) compared to localized leukoplakias.

**111. What is the prevalence of oral cancer in the United States? Which country has the highest prevalence of oral cancer?**

Oral cancer accounts for 3% of all cancers in the United States if oropharyngeal lesions are included. India has the highest prevalence of oral cancer; it is the most common cancer there and is related to the use of areca nut and tobacco products.

**112. What are the risk factors for oral cancer?**

- Tobacco products
- Alcohol (especially in conjunction with smoking)
- Areca nut products and submucous fibrosis (especially in East Indians and some South-east Asian cultures)



**Figure 4-19.** Squamous cell carcinoma presenting as leukoplakia with erythematous and verrucous areas.

- Sunlight (especially for cancer of the lip in men)
- Immunosuppression
- History of oral cancer or other cancer
- Family history of cancer
- Age
- Plummer-Vinson syndrome

**113. True or false: Patients with HPV-associated tonsillar carcinoma have a better prognosis than those with tobacco-associated tonsillar carcinoma.**  
This is true.

**114. What is the difference in prognosis between a squamous cell carcinoma and verrucous carcinoma?**

Approximately 50% of squamous cell carcinomas have metastasized at the time of diagnosis. The larger they are, the more likely that metastases will develop. Verrucous carcinomas do not tend to metastasize despite the rather large size of some lesions; they are locally aggressive lesions.

**115. What is a so-called “rodent ulcer”?**

A “rodent ulcer” refers to a basal cell carcinoma of the skin that despite its low tendency to metastasize, erodes through adjacent tissues like the gnawing of a rodent; through persistence, it may cause destruction of the facial structures.

**116. What are the three most common intraoral malignant salivary gland tumors?**

These are mucoepidermoid carcinoma, polymorphous low-grade adenocarcinoma, and adenoid cystic carcinoma.

**117. Which two salivary gland tumors often show perineural invasion (neurotropism)?**

These are adenoid cystic carcinoma and polymorphous low-grade adenocarcinoma. However, any malignancy (particularly carcinomas) can show perineural invasion.

**118. True or false: Lymphoepithelial sialadenitis (formerly known as myoepithelial sialadenitis and benign lymphoepithelial lesion) of Sjögren syndrome is an innocuous autoimmune sialadenitis.**

False. The “benign” lymphoepithelial lesion is not so benign. Patients with this condition have a higher incidence of lymphoma (up to 44 times more) than the general population.

**119. A patient with Sjögren syndrome is referred for a labial salivary gland biopsy to identify a lymphoepithelial sialadenitis. Does this sound right?**

No. The lymphoepithelial sialadenitis of Sjögren syndrome is found in the major glands, mainly the parotid, especially if parotid enlargement is present. A labial salivary gland biopsy will show an autoimmune sialadenitis characterized by lymphocytic infiltrates that form “foci” which are collections of at least 50 lymphocytes around a duct. The more “foci,” the more likely the diagnosis of an autoimmune sialadenitis.

**120. Do lymphomas of the oral cavity occur outside Waldeyer ring?**

Yes. Oral lymphomas are most common in Waldeyer ring, but they may occur in the palatal mucosa, buccal mucosa, tongue, floor of the mouth, and retromolar areas. Primary bone lymphomas also occur in the jawbones.

**121. What does monoclonal plasma cell proliferation mean?**

Plasma cells produce immunoglobulin that contains heavy and light chains. Each plasma cell and its progeny produce either kappa or lambda light chains and never both. A group of plasma cells that produces only kappa or lambda light chains is most likely caused by proliferation of a single malignant clone of plasma cells, such as a plasmacytoma or multiple myeloma. The presence of both light chains in a plasma cell proliferation is more likely to be polyclonal proliferation, which characterizes inflammatory lesions.

**122. Name the different epidemiologic forms of Kaposi sarcoma.**

1. Classic or European form: usually Eastern European men (often Jewish); multiple red papules on the lower extremities, with rare visceral involvement and a more indolent course

2. Endemic or African form: young men or children in equatorial Africa; frequent visceral involvement that may be fulminant
3. Epidemic form: HIV-associated; may be widely disseminated to mucocutaneous and visceral sites; variable course
4. Organ transplantation-associated form: patients who have undergone organ (especially renal) transplantation, with immunosuppressive therapy

**123. A patient has a suspected metastatic tumor to the mandible. What are the likely primary tumors?**

- Lung
- Breast
- Prostate
- Kidney
- Gastrointestinal tract
- Thyroid
- Skin

**124. True or false: Osteosarcoma of the jaws occurs in younger patients more often than osteosarcoma of the long bones.**

False. Patients with osteosarcoma of the jaws are 1 to 2 decades older than patients with osteosarcoma of the long bones.

**125. Which conditions predispose to osteosarcoma?**

Many cases of osteosarcoma in young adults occur *de novo*. However, there are well-documented cases of osteosarcoma in association with Paget disease, chronic osteomyelitis, history of retinoblastoma, and prior radiation to the bone for fibrous dysplasia.

## NONVASCULAR PIGMENTED LESIONS

**126. What medications can cause mucosal melanosis?**

- Oral contraceptives
- Antimalarial agents (e.g., hydroxychloroquine)
- Tetracycline and minocycline
- Imatinib

**127. Why does heavy metal poisoning primarily cause staining of the gingiva?**

Heavy metals such as lead, bismuth, and silver may cause a grayish-black line to appear on the gingival margins, especially in patients with poor oral hygiene. Plaque bacteria can produce hydrogen sulfide; this combines with the heavy metals to form heavy metal sulfides, which are usually black.

**128. What can cause mucosal melanosis?**

**Benign:** physiologic pigmentation, postinflammatory hyperpigmentation (especially in dark-skinned people), oral melanotic macule, smoking (may be post-inflammatory), mucosal melanocytic nevus, melanoacanthosis

**Malignant:** melanoma

**Systemic conditions:** Peutz-Jegher syndrome, Albright syndrome, Addison disease, neurofibromatosis

**129. What are the different forms of oral melanocytic nevi?**

**Intramucosal nevus:** tends to be elevated, papular, or nodular

**Junctional nevus:** tends to be macular

**Compound nevus:** tends to be papular or nodular

**Blue nevus:** tends to be macular

**130. What is the most common site for oral melanoma?**

It is the hard palatal mucosa.

**131. What is the difference between a melanocyte and melanophage?**

A melanocyte is a neuroectodermally derived dendritic cell that contains the intracellular apparatus to manufacture melanin. A melanophage is a macrophage (scavenger cell) that has phagocytosed melanin pigment and therefore can resemble a melanocyte because it contains melanin. However, it lacks the enzymes to produce melanin.



## METABOLIC LESIONS ASSOCIATED WITH SYSTEMIC DISEASE

### 132. What are the three presentations of Langerhans cell histiocytosis?

**Localized (unifocal) disease:** eosinophilic granuloma; in children or adults; often occurs in the bones (such as mandible) or lungs.

**Multifocal (multisystem) disease:** limited to a few organ systems in adults:

- Hand-Schuller-Christian disease is a well-recognized form, characterized by exophthalmos, diabetes insipidus and bony lesions, sometimes with skin and visceral involvement
- Letterer-Siwe disease in children; widespread and fulminant involvement of multiple organ systems, especially skin; does not usually affect bones

**Congenital disease:** macular-papular rash either at birth or shortly thereafter; milder course and some cases spontaneously regress.

### 133. What are Birbeck granules?

Birbeck granules are racket-shaped cytoplasmic inclusions seen in Langerhans cells of histiocytosis X (Fig. 4-20).

### 134. What are two common oral changes associated with pregnancy?

These are gingivitis and pyogenic granuloma (epulis gravidarum).

### 135. An older man complains that his jaw seems to be getting too big for his dentures and that his hat does not fit him anymore. What do you suspect?

This could be Paget disease of bone (osteitis deformans), a metabolic bone disease in which initial bone resorption is followed by haphazard bone repair, with resulting marked sclerosis. This condition may lead to narrowing of the skull base foramina and neurologic deficits. The maxilla is often affected; a cotton wool appearance has been described on radiographs.

### 136. What oral lesions are associated with gastrointestinal disease?

The most common gastrointestinal disease associated with oral signs is inflammatory bowel disease, especially Crohn disease. Patients may manifest with swelling of the lips, cobblestoning of the mucosa, papulous growths, and linear aphthous-like ulcers. Biopsy shows non-necrotizing granulomas. Patients may also develop glossitis associated with vitamin B<sub>12</sub> deficiency if part of the ileum has been resected for the disease. Those with gluten-sensitive enteropathies such as celiac disease may also present with aphthous-like ulcers. Patients with ulcerative colitis may also develop pyostomatitis vegetans.

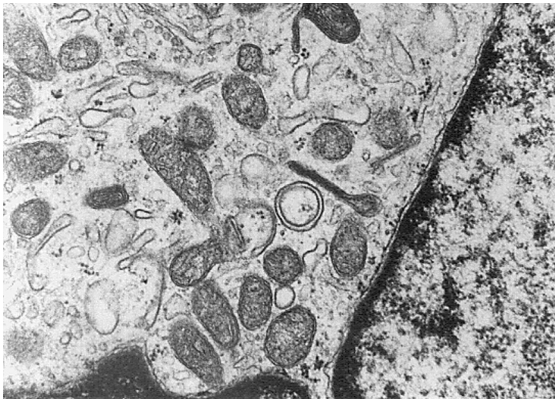


Figure 4-20. Racket-shaped Birbeck granule of Langerhans cell histiocytosis.

**137. What are primary and secondary Sjögren syndrome?**

Primary Sjögren syndrome consists of dry eyes (keratoconjunctivitis sicca) and dry mouth (hyposalivation) in the absence of other systemic conditions. Secondary Sjögren syndrome consists of primary Sjögren syndrome plus a connective tissue disorder such as rheumatoid arthritis, systemic lupus erythematosus, or progressive systemic sclerosis. Most patients with Sjögren's syndrome have circulating autoantibodies (antinuclear antibodies).

**138. What is the dental significance of the Sturge-Weber syndrome?**

This syndrome is characterized by vascular malformations of the leptomeninges, facial skin innervated by the fifth nerve (nevus flammeus), and corresponding ipsilateral areas in the oral mucosa and bone. Bleeding is therefore an important consideration in dental treatment. Patients may also exhibit mental retardation and seizure disorders. Treatment may include phenytoin.

**DIFFERENTIAL DIAGNOSES AND GENERAL CONSIDERATIONS****INTRABONY LESIONS****139. Name three pseudocysts of the jaw bones.**

- Traumatic (simple) bone cyst: radiolucency scallops between tooth roots; empty at surgery
- Aneurysmal bone cyst: giant cells lining blood-filled spaces
- Static bone cyst (Stafne bone cavity): salivary gland depression beneath the inferior alveolar canal

**140. What is the differential diagnosis for a multiloculated radiolucency?**

- Dentigerous cyst
- Odontogenic keratocyst (also known as a keratocystic odontogenic tumor)
- Ameloblastoma
- Vascular malformations
- Odontogenic myxoma
- Intraosseous salivary gland tumors
- Lesions that contain giant cells (e.g., aneurysmal bone cyst, central giant cell granuloma, cherubism)

**SOFT TISSUE LESIONS****141. What is the differential diagnosis for a solitary upper lip nodule?**

**Salivary gland lesion:** sialolith, benign salivary gland tumor (especially pleomorphic adenoma and canalicular adenoma), malignant salivary gland tumor

**Vascular lesion:** pyogenic granuloma

**Neural lesion:** neurofibroma, schwannoma, neuroma

**Skin appendage tumors**

**142. What may cause diffuse swelling of the lips?**

- Vascular malformations
- Angioedema
- Hypersensitivity reactions
- Cheilitis glandularis
- Orofacial granulomatosis (e.g., Melkersson-Rosenthal syndrome)
- Crohn disease

**143. What is the differential diagnosis for a solitary gingival nodule?**

The most common diagnoses are fibroma or fibrous hyperplasia, pyogenic granuloma (especially in a pregnant patient), peripheral giant cell granuloma, and peripheral ossifying fibroma (essentially a fibrous hyperplasia with metaplastic bone formation). Other less common conditions include gingival cyst of the adult, benign extraosseous odontogenic tumors, and malignant tumors, including metastatic tumors.

**144. What may cause generalized overgrowth of gingival tissues?**

Common causes include plaque accumulation, medications such as phenytoin, cyclosporine A, sodium valproate, diltiazem, and nifedipine (the last two are calcium channel

blockers), hormonal factors (puberty and pregnancy), anti-neutrophilic cytoplasmic antibody-associated (Wegener) granulomatosis, orofacial granulomatosis, fibromatosis gingivae, and leukemic infiltrate.

**145. A labial salivary gland biopsy is useful for diagnosis of certain systemic conditions. What are they?**

- Sjögren syndrome
- Autoimmune sialadenitis associated with connective tissue disease
- Amyloidosis
- Sarcoidosis

**146. What may cause chronic hyposalivation?**

Common causes include ingestion of anticholinergic or multiple medications, aging (although many experts believe this to be drug-related), insufficient oral intake of fluids, excessive consumption of caffeinated products, and chronic anxiety. Less common conditions include autoimmune sialadenitis (such as Sjögren syndrome and graft-versus-host disease), and radiation to the gland.

**147. Name possible causes of bilateral parotid swelling.**

Mumps	Malnutrition	Lymphoepithelial cysts in HIV
Sjögren syndrome	Alcoholism	infection
Radiation-induced acute parotitis	Bulimia	
Diabetes mellitus	Warthin tumor	

**148. What may cause depapillation of the tongue?**

Vitamin B, iron, and/or folate deficiency	Median rhomboid glossitis (focally)
Benign migratory glossitis (focally)	Syphilis
Plummer-Vinson syndrome	Lichen planus
Chronic hyposalivation	

**149. What may cause diffuse enlargement of the tongue?**

Congenital macroglossia	Angioedema
Lymphangioma (with vesicles)	Acromegaly
Hemangioma	Trisomy 21
Neurofibromatosis	Amyloidosis
Hyperpituitarism	Hypothyroidism

**150. What is the differential diagnosis of midline swellings of the floor of the mouth?**

Ranula (mucocele, usually to one side)	Dermoid cyst
Epidermoid cyst	

**151. What may cause diffuse white plaques in the buccal mucosa?**

Cannon white sponge nevus	Pachyonychia congenita
Candidiasis	Dyskeratosis congenita
Hereditary benign intraepithelial dyskeratosis	Extensive leukoplakia (especially proliferative verrucous leukoplakia)
Chronic bite keratosis (Morsicatio mucosae oris)	Contact desquamation from strong dentifrices

**152. Name the conditions that may give rise to papillary lesions of the oral cavity.**

These are papilloma, verruca vulgaris, condyloma, papillary hyperplasia of the palatal mucosa (denture injury), verrucous carcinoma, papillary squamous cell carcinoma, and verruciform xanthoma.

**153. What lesions may occur in the oral cavity of neonates?**

Lesions in the oral cavity of neonates include neuroectodermal tumor of infancy, congenital granular cell tumor of the newborn, gingival cyst of the newborn, palatal cyst of the newborn (Bohn nodules, Epstein pearls), lymphangiomas of the alveolar ridge, and natal teeth.

**154. What may cause burning symptoms of the tongue?**

Patients may report burning symptoms of the tongue secondary to mucosal disease such as atrophic glossitis, candidiasis, lichen planus, and migratory glossitis. However, this syndrome may also occur in the absence of any organic mucosal disease. In these cases, it is referred to as primary burning mouth syndrome, a neuropathic pain disorder with a strong association with anxiety, depression, and other somatoform symptoms.

**155. What may cause oral paresthesia?**

Oral paresthesia may be caused by manipulation or inflammation of a nerve or tissues around a nerve, direct damage to a nerve or tissues around a nerve, tumor impinging on or invading a nerve, primary neural tumor, and central nervous system disorder or tumor.

**156. Why do lesions appear white in the oral cavity?**

Lesions appear white because of the following:

- Thickened keratin or keratin where none was present before
- Edema of the epithelium cells
- Thickened epithelium
- Altered epithelium from dyskeratotic syndromes (often genetic) or from dysplasia (leukoplakia)
- Scarring of the connective tissue

**157. Why do lesions appear red in the oral cavity?**

- Loss of the usual keratin layer
- Erosion or atrophy of the epithelium
- Increased or dilated vasculature (e.g., in inflammation)
- Change in the intrinsic nature of the epithelial cell, such as epithelial dysplasia (erythroplakia).

**158. Distinguish among macules, papules, and plaque.**

A macule is a localized lesion that is not raised and is better seen than felt. The term is often used to describe localized pigmented lesions, such as amalgam tattoos and melanotic macules. Papules and plaque are broad-based, raised lesions; the papule is smaller than 5 mm, and the plaque is larger than 5 mm.

**159. What is the difference between a bulla and a vesicle?**

Both are fluid-filled. A bulla is usually larger than 5 mm; a vesicle is smaller than 5 mm.

**160. Differentiate between a hamartoma and a choristoma.**

A **hamartoma** is a tumor-like growth consisting of an overgrowth of tissues that histologically appears mature and is native to the area (e.g., hemangioma, odontoma). A **choristoma** is a tumor-like growth consisting of an overgrowth of tissues that histologically appears mature but is not native to the area (e.g., cartilaginous choristoma, bony choristoma of the tongue). A hamartoma of the skin and mucosa is sometimes called a *nevus* (e.g., vascular, epidermal, or melanocytic nevus).

**161. What are oncocytes?**

Oncocytes are eosinophilic swollen cells found in many salivary gland tumors, such as oncocytomas and Warthin tumor, and in oncocytic metaplasia of salivary ducts. They are swollen because they contain many mitochondria.

**162. What are Russell bodies?**

Russell bodies are round eosinophilic bodies found in reactive lesions; they represent globules of immunoglobulin in plasma cells.

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## RADIATION PHYSICS AND BIOLOGY

1. Since the last edition of *Dental Secrets* was published, in 2003, there have been two major changes in oral radiology. Name them.

The two changes that stand out are digital radiography and cone beam computed tomography (CBCT). Although both modalities were in existence when the previous edition was published, they have since then made significant inroads into dentistry. These changes are reflected in this edition. There are few references to film-based radiography. A number of questions on or related to CBCT have been added.

2. How are x-rays produced?

X-rays are produced by “boiling off” electrons from a filament (the cathode) and accelerating the electrons to the target at the anode. The accelerated x-rays are decelerated by the target material, resulting in bremsstrahlung (German for “braking radiation”). Characteristic x-rays are produced when the incoming electrons knock out an inner K- or L-shell electron in the target and an electron from the L- or M-shell falls in to fill the void.

3. At the energies typically used in dental radiography, what interactions do the x-rays undergo with tissues?

X-rays undergo three interactions with tissue—elastic scatter, Compton scatter (also known as inelastic or incoherent scatter), and photoelectric absorption. Pair production occurs at much higher energy values (1.02 megaelectron volts [MeV]) than those used in dentistry.

4. Which of the interactions is primarily responsible for patient dose?

In the photoelectric process, the incoming x-ray transfers all its energy to the tissue. Photoelectric absorption, therefore, contributes the most to patient dose.

5. What is resolution and how is it measured?

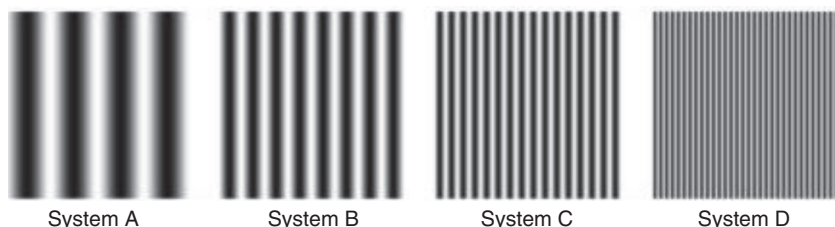
Resolution, more accurately termed *spatial resolution*, is a measure of how well a radiographic system can distinguish fine line detail. Stated differently, resolution quantifies how close lines can be to each other and still be seen as separate. In analog systems, such as film-based radiography, resolution is measured using a line-pair resolution phantom and is expressed in line pairs per millimeter (lp/mm). An example of how resolution applies to clinical practice is the ability to see the lamina dura and periodontal ligament space, both small structures that are adjacent to one another. A system with good resolution (a periapical image) allows one to distinguish between the lamina dura and periodontal ligament space, whereas a system with poorer resolution (a panoramic image) may not allow this to be done.

If a line-pair resolution phantom is used to evaluate a digital system, the resulting resolution can also be expressed in lp/mm. With digital systems, however, spatial resolution is more complicated. For example, it may be different in the row (horizontal) and column (vertical) directions. In digital systems, spatial resolution in effect refers to the number of independent pixel values per unit length and is limited by the minimum pixel size. Resolution of digital systems is measured by the modulation transfer function (MTF), which incorporates a number of variables. A full discussion of MTF is beyond the scope of this text (Fig. 5-1).

6. How do each of the digital systems, CCD and CMOS detectors,\* and storage phosphor plates work to produce an image?

Each pixel of a charge-coupled device (CCD) and complementary metal–oxide–semiconductor (CMOS) sensor acts as an analog device. When x-rays strike the pixel, the energy

\*The words detector and sensor are used interchangeably in this text.



**Figure 5-1.** Line pairs/mm (lp/mm) is how spatial resolution is measured in analog systems. In the systems shown, system A has the lowest and system D has the highest resolution.

deposited is stored as a small electrical charge. The charges are converted to a voltage one pixel at a time as they are read from the chip. Further circuitry then converts the voltage into digital information that can be displayed on a monitor.

With storage phosphor plates, the energy deposited by x-ray photons is stored within the phosphor. This energy is released when the phosphor is stimulated with a visible wavelength laser light.

**7. Which radiosensitive organs are in the field of typical dental x-ray examinations?**

The thyroid is an extremely radiosensitive organ, along with lymphoid tissue and bone marrow in the exposed areas.

**8. What evidence suggests a risk of carcinogenesis from exposures to low levels of ionizing radiation such as those in dentistry?**

No single study has proven the association between carcinogenesis and exposure to x-rays at the low levels used in dentistry. Many studies that follow patients exposed to higher levels, however, provide evidence of a link. Populations that have been studied include atomic bomb survivors in Nagasaki and Hiroshima, radium watch dial painters, and patients exposed to multiple fluoroscopies for tuberculosis.

**9. What units are used to describe radiation exposure and dose? What do they measure?**

1. The roentgen (R) is the basic unit of radiation exposure for x-rays and gamma radiation.

It is defined in terms of the number of ionizations produced in air. It is a measure of the amount of radiation to which a person has been exposed, but does not measure how much radiation was absorbed.

2. The rad (roentgen-absorbed dose) is a measure of the amount of energy absorbed by an organ or tissue. Different organs or tissues absorb a different amount of energy when exposed to the same amount of radiation or roentgens.

3. The rem (roentgen equivalent, man or mammal) is a measure of the degree of damage caused to different organs or tissues. Different organs or tissues show differing amounts of damage even when they have absorbed the same amounts of rads.

The International System of Units (SIs) are the coulomb/kilogram (C/kg), gray (Gy), and sievert (Sv) for the roentgen, rad, and rem, respectively.

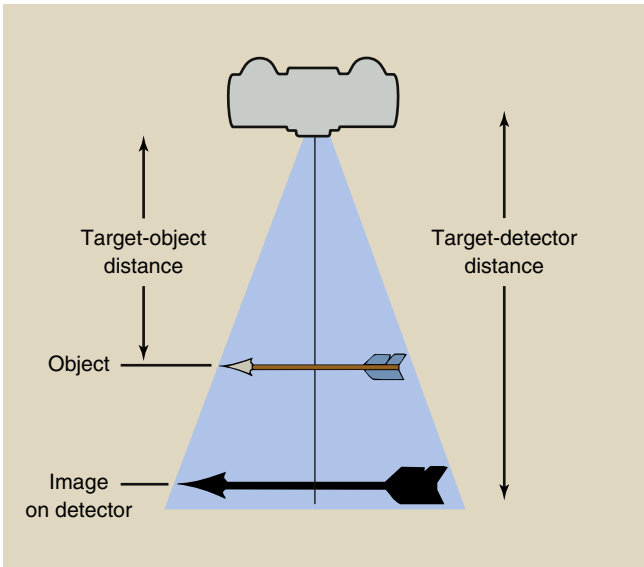
**10. What is the difference between density and contrast?**

Density refers to the overall degree of blackening of a film. Contrast refers to the differences in densities between adjacent areas of film.

**11. Which technique factors control film density?**

The longer a sensor is exposed, the darker it will be; hence, time of exposure controls density. The milliamperage (mA) determines how hot the filament gets and how many electrons are boiled off. The higher the filament current, the hotter the filament and the more electrons are boiled off to reach the anode and produce x-rays; hence, mA also controls density. As a result of the kilovolt peak (kVp), which is the potential voltage difference between the cathode (filament) and anode, electrons that are boiled off are accelerated to the anode. The greater the potential difference between the cathode and anode, the greater the acceleration of the electrons toward the anode. Electrons that hit the anode at higher





**Figure 5-2.** Magnification is the ratio of the image size to the object size. (From Bushong SC: *Radiologic science for technologists*, ed 10, St. Louis, 2013, Mosby.)

speed result in x-rays with higher energies. X-rays with higher energies are more likely to reach the sensor and darken it. Thus, kVp also controls sensor density. The distance from the source to the sensor also has a great effect on sensor density (see question 16).

**12. Which technique factors control film contrast? How do they affect contrast?**

Contrast is controlled by the kVp only. The higher the kVp, the lower the contrast, and vice versa. Time, mA, and distance affect only density and not contrast.

**13. What is cone beam CT (CBCT), and how does it differ from medical or conventional CT in acquiring the images?**

CBCT is a relatively new (c. 2000) computed tomographic imaging modality that is able to provide three-dimensional images of anatomic structures. Unlike medical CT, in which the data are acquired axially by a thin, fan-shaped beam, the beam in CBCT is shaped like a cone. The medical CT scanner acquires individual image slices, which are then stacked to obtain the field of view (FOV). CBCT, with its large cone-shaped beam, acquires all the data in a single rotation. Thus, whereas in medical CT the x-rays are parallel to one another, in CBCT the x-rays are divergent.

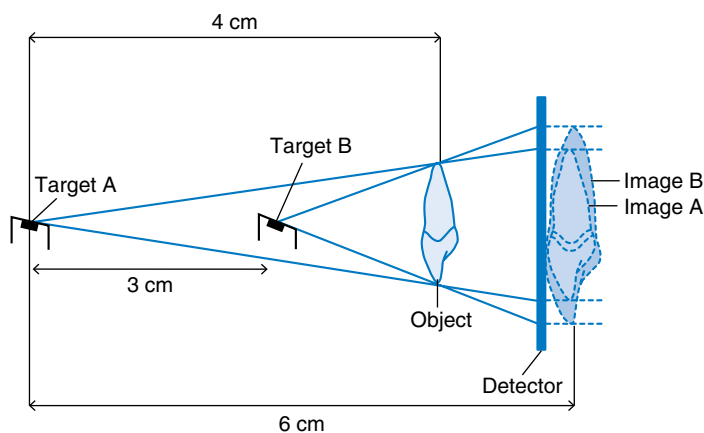
**14. How is magnification defined? How do the target-detector and object-detector distances affect magnification?**

Magnification is the ratio of the image size to the object size. It is, for example, the ratio of the length of the actual tooth as compared to the length of the tooth as measured on the monitor. In real life, it is rarely possible to measure the size—for example, whether it is length or width—of an object because the object is in the patient and is not visible at all (e.g. an impacted tooth, osseous landmarks on a lateral cephalogram) or is only partly visible (e.g. an erupted tooth). Thus, we use the formula

$$\text{Magnification} = (\text{target-detector distance}) / (\text{target-object distance})$$

to calculate magnification (Fig. 5-2).

Figure 5-3 shows how to calculate magnification and how the target-detector and object-detector distances affect magnification. When the target (the target on the anode in the x-ray tube) is in position A, the target-detector distance is 6 cm and the target-object distance is 4 cm. Thus, the magnification is 6/4, or 1.5. If we move the target to position



**Figure 5-3.** Changing the target-detector distance changes magnification. (From Frommer HH, Stabulas-Savage JJ: *Radiology for the dental professional*, ed 9, St. Louis, 2011, Mosby.)

B, the target-detector distance is now 3 cm and the target-object distance is 1 cm. This shows how the target-detector distance affects magnification. All other factors remaining unchanged, the longer the target-detector distance, the less the magnification. This is the rationale behind using the long cone technique for intraoral imaging and the long distance in cephalometric radiography. Using the formula and Figure 5-3 as an example, you should now be able to determine how the object-detector distance affects magnification.

**15. What is the ideal geometric setup to get the most accurate image in intraoral radiography?**

The central x-ray should be perpendicular to the long axis of the object (e.g., tooth, head) and the long axis of the detector. To accomplish this, the long axis of the detector must be parallel to the long axis of the object.

Large target-detector distance: The longer this distance, the less the magnification (see question 14).

Small object-detector distance: The smaller this distance, the less the magnification (see question 14).

**16. What is the inverse square law?**

The intensity or exposure rate of radiation at a given distance from the source is inversely proportional to the square of the distance. If we double the distance from the source, for example, the intensity of the radiation is reduced fourfold. This is why the tube should be close to the patient and to the sensor to ensure that the image is not underexposed. The inverse square law can also be used to our advantage. By standing further away from the x-ray source, the intensity of the x-ray beam is reduced. Although the exact number may vary from state to state, generally if one stands 6 feet away from the dental x-ray source, no additional radiation protection is needed for the operator.

**17. How do you trouble-shoot a radiographic image that is too dark (overexposed) or too light (underexposed)?**

For film-based and digital systems, check the exposure factors (kVp, mA, time) to ensure that they are appropriate for the patient. For digital systems, one of these will almost always be the cause of the problem. With film, changes in radiographic quality usually result from errors in processing. For film-based systems check the chemicals to ensure that they are at the correct temperature, have been stirred, and are fresh. If all these factors are satisfactory, evaluation of the x-ray unit, digital sensor, or batch of film may be necessary.

Another error that may cause an underexposed image is failure to depress the x-ray exposure button for the duration of the exposure. It is not possible to overexpose an image by holding the exposure button too long because there is a fail-safe mechanism that will

automatically stop the exposure after the time that was set. Placing the tube too far from the sensor will also result in an underexposed image because of the effects of the inverse square law (see question 16).

**18. What is the difference between internal and external scatter?**

When x-rays interact with material, including body tissues, a number of interactions may take place, including scatter (see question 3). Scatter may result from x-rays interacting with material outside the patient's body and undergoing a change in direction so that the scattered photons hit the patient and thus increase the dose. This type of scatter is called *external scatter*. An example is an x-ray photon that hits the wall and is scattered in the direction of the patient. The second type of scatter is called *internal scatter*. This type of scatter occurs when x-ray photons interact with tissues in the patient and are directed to other parts of the patient's body. Because these photons arise from interactions that occur in the patient's body, they are known as internal scatter. An example is x-rays that interact with an object in the mouth (e.g., tooth restoration) and are scattered toward the thyroid gland. A lead apron and thyroid will not help reduce internal scatter.

**19. How do we control scatter radiation in intraoral radiography?**

In intraoral radiography, we do not control scattered x-rays after the fact—that is, we do not control scatter that results from the interaction of x-rays within the patient. We do, however, try to minimize scatter before the fact by using a lead-lined long cone, reducing the size of the x-ray field, and using as high a kVp as possible.

**20. What is meant by the quality of an x-ray beam, and how it is measured?**

The quality of the beam refers to the penetrating power of the beam. The penetrating power is greater the higher the energy values of the photons. X-ray beams have higher energy values, and the more penetrating, the higher the kVp. The word *quality* is a term of art and refers only to the energy level of the beam. The number of x-rays in a beam is described by the beam intensity. Although kVp may affect beam quality and intensity (quantity), the two parameters are distinct and separable.

Beam quality is measured by the half-value layer (HVL). The HVL is defined as that thickness of a given substance which, when introduced in the path of a given beam of rays, will reduce its intensity by half. Different materials have different half-value layers. The half-value layer also differs for different energy (kVp) beams.

**21. What is meant by the terms *sensitivity*, *specificity*, and *predictive value* when applied to the efficacy of radiographic examinations?**

Sensitivity refers to the ability of a test, in this case a radiograph, to detect disease in patients who have disease. Thus, sensitivity is a measure of the frequency of positive (true-positive rate) and negative (false-negative rate) test results in patients with disease. Specificity refers to the ability of a test to screen out patients who do not in fact have the disease. Thus, specificity is a measure of the frequency of negative (true-negative rate) and positive (false-positive) test results in patients without disease. The predictive value of a radiograph is the probability that a patient with a positive test result actually has the disease (positive predictive value) or the probability that a patient with a negative test result actually does not have the disease (negative predictive value).

**22. What is the basic technology behind magnetic resonance imaging (MRI)?**

Nuclei of atoms that have an unpaired proton or neutron in the body act like bar magnets. In the MRI procedure, the area to be examined is subjected to an external magnetic field. The long axes of the nuclei line up with the magnetic field. Once the nuclei are aligned, they are subjected to a radiofrequency (RF) pulse. They absorb some of the radio wave's energy and lean over or tilt (the technical term is *precess*). When the RF pulse is turned off, the nuclei begin to return to their original energy state (relax) and emit the energy that they absorbed. This energy can be picked up by appropriate receivers and converted into a picture.

**23. How does an MRI image produce tissue contrast so that one can distinguish between various types of tissue?**

The operator selects the technical parameters of an MRI scan. The most important of these is the RF pulse sequence. The most basic characteristics of a pulse sequence are the repetition time (length of time between successive RF pulses) and echo time (how long after the

RF pulse is applied when the magnetic resonance signal is read). The contrast is determined by the repetition time (TR) and echo delay time (TE), as well as by the T1 and T2 times. The latter are fixed by the intrinsic characteristics of the tissue under examination. A T1-weighted image highlights differences in the T1 values of different tissues, whereas a T2-weighted image highlights differences in the T2 values of tissues.

- *T1-weighted images*: Tissues with fast T1 times appear bright (e.g. fat, subacute hemorrhage, gadolinium-enhanced brain tumor). The high signal from short T1 substances is enhanced on short TR–short TE images.
- *T2-weighted images*: Tissues with long T1 times appear dark (e.g. cerebrospinal fluid [water], mucus, late subacute hemorrhage). The high signal from long T2 substances is enhanced on long TR–long TE images.

Contrast agents may be administered to enhance image contrast. These agents, which are administered orally or intravenously, work by altering the relaxation times of atoms.

#### 24. What is the difference between stochastic and determinative effects as the terms are used in radiation biology?

*Stochastic effects* result from sublethal damage inflicted to the DNA of individual cells exposed to radiation. The greatest concern of a stochastic effect is carcinogenesis. Although mutations inherited by the offspring of the exposed individual are possible, they are much less likely.

*Determinative effects* are concerned with changes to the macromolecules of intracellular structures. These changes may result in cell death.

Other differences between stochastic and determinative effects include the following:

- Determinative effects require a threshold dose; for stochastic effects, even a single x-ray photon could cause cancer or lead to an inheritable mutation
- With determinative effects, once the threshold dose is attained, all individuals display the effect; with stochastic effects, the higher the dose, the greater the chance of having the effect
- With determinative effects, the severity of the clinical outcome is proportional to the dose; with stochastic effects, the results are an all or nothing proposition—one either experiences the effect or does not

## RADIOGRAPHIC TECHNIQUES

#### 25. From the standpoint of the detector, what types of intraoral digital radiographic systems are available today? How do they differ from one another? What are the advantages and disadvantages of each system?

There are basically three types—the CCD, CMOS, and storage phosphor (PSP). The most basic clinical differences among the systems lie in the physical nature of the detector and the manner in which images are transferred to the computer monitor. CCD and CMOS detectors are rigid, whereas PSP detectors are flexible. In the rigid detector systems, the detector is connected directly (hard-wired) to a computer, whereas with PSP systems the latent image must first be processed by putting the detector into a laser-scanning device. The latter is connected to the computer.

##### Advantages of Storage Phosphor

- Detectors are thin and flexible, more comfortable for the patient, and easier for the operator to use.
- It is less expensive, especially when multiple operatories and operators are involved.

##### Advantages of Rigid Detector Systems

- Image appears on the monitor almost instantaneously.
- Infection control is easier and quicker. The detector is merely enclosed in a protective latex sleeve.

##### Disadvantages of Storage Phosphor

- When a full-mouth series is done, multiple detectors must be used, just as with film; each detector must be wrapped before use and then unwrapped after use before placement in the scanner.
- The images appear only after the sensors have been placed in a laser reader.

- The position in which the images appear on the monitor depend on the position that each plate occupied in the laser scanner. This means that the images are jumbled when they first appear and must be digitally mounted in the correct position.
- The sensors are easily scratched, giving rise to artifacts.
- Information begins to be lost within a few minutes of exposure, so it is important to place the sensors in the laser reader as soon as possible.
- Exposure to light affects the image, so the sensors should be stored away from even ambient light until they are needed.

#### **Disadvantages of Rigid Detector Systems**

- CCD and CMOS detectors are more uncomfortable for the patient than storage phosphor plates.
- Because of their total inflexibility, obtaining images of certain regions are difficult. The most typical example is where the arch has its greatest curvature, and the sensor cannot be adapted to fit the curvature. This is seen especially in the canine area. Thus, capturing the distal aspect of the canine on a bitewing is difficult.
- The cable connecting the sensor to the computer makes it impossible for the teeth to be fully in occlusion. This results in a small open bite, which, on a bitewing, may make it difficult to assess periodontal bone height, especially if there is bone loss.
- Biting or pressure on the cable may introduce artifacts or noise into an image.
- The presence of a cable limits the distance that the computer may be from the chair.
- These are expensive compared with storage phosphor systems.

#### **26. Are wireless CCD and CMOS detectors available?**

Although a wireless sensor would have the advantage of getting rid of the problems caused by having a cable running from the sensor to the computer, and even though there are companies that advertise wireless sensors, there are not any truly wireless sensors. With traditional CCD and CMOS detectors, the cable is attached to the sensor and plugs into the computer. With so-called wireless sensors, there is still a cable. In this case, however, the cable is much shorter and plugs into a device, the wi-fi transmitter, that is attached to the dental chair. It is this wi-fi device that is wireless and that transmits the signal it receives via the cable to a computer. Although a “wireless” sensor does have the advantage of reducing the need to have the computer physically close to the patient (because, for technical reasons, there is a limit to the length of the cable), the so-called wireless sensor does not resolve the problems associated with having a cable run from inside the patient’s mouth to the outside.

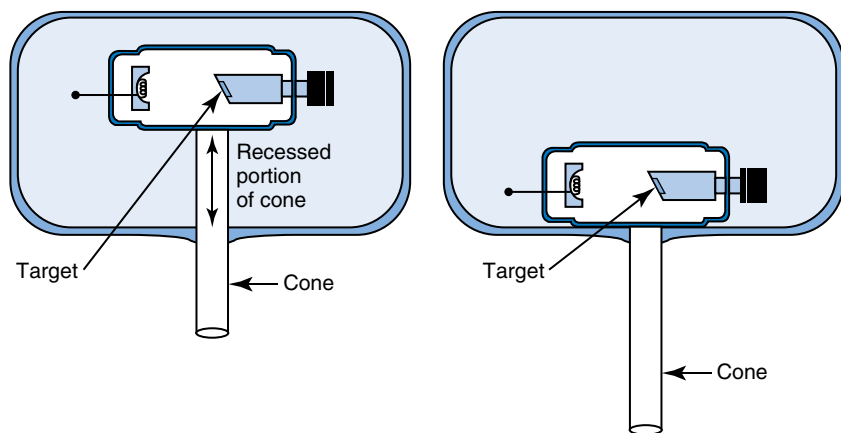
#### **27. What are the differences between a long cone and short cone? When is each one used? What is a recessed or built-in long cone, and what are its advantages ?**

Until approximately the 1970s, two types of x-ray cones were available, long and short cones. The short cone was used with the bisecting angle technique. With this technique, there is no aiming device, so that one has to “eyeball” the position of the tube in all dimensions. Obtaining the precise vertical angulation is difficult for most operators. Because it is easier to eyeball something over a shorter rather than a longer distance, a short cone was used.

When using beam-indicating devices, and eyeballing is not necessary, the lead-lined long cone is preferred. The long cone technique has two primary benefits. It reduces patient dose by reducing the field size and also increases the target-film distance, thereby reducing magnification. Because of the advantages of the long cone, it is always desirable to use it, even for the bisecting angle technique. This became feasible when Dr. Albert Richards invented the recessed or built-in long cone in the mid-1960s. The recessed cone has the advantage of a short-appearing cone, thus making it easier for the operator to execute the bisecting angle technique successfully, but with the benefits of the long cone. The recessed long cone takes up less space, which may be important in cramped quarters. The principle of the recessed cone is schematically illustrated in [Figure 5-4](#).

#### **28. Concerns about the effects of radiation on children has led to the establishment of a campaign to increase awareness about the dangers. Name that campaign.**

This campaign is Image Gently (<http://www.pedrad.org/associations/5364/ig/>), an initiative of the Society for Pediatric Radiology. It has a number of signatories, including the American Academy of Oral and Maxillofacial Radiology. The campaign strives to reduce the number of radiation exposures. On its website, clinicians can download suggested



**Figure 5-4.** The recessed long cone compared to the traditional long cone. By moving the anode and target deeper into the x-ray unit, it became possible to build part of the cone into the machine. From the outside, the recessed long cone has the appearance of a short cone.

protocols that list technical parameters (exposure factors) that, if followed, reduce patient dose. Although not as great a concern as radiation to children, the exposure of adults should also be minimized. The American College of Radiology and Radiological Society of North America formed the Joint Task Force on Adult Radiation Protection, known as Image Wisely (<http://www.imagewisely.org>) to raise awareness about this issue.

### 29. How has the use of occlusal radiography changed in recent years?

Occlusal images are used, among other reasons, to determine the buccolingual position of an impacted tooth, demonstrate the buccolingual dimensions of a lesion and the buccal and lingual cortices in the mandible, visualize the intermaxillary suture, demonstrate arch form, and replace periapical films in young children. An occlusal image also may be used when one wishes to visualize on one film a lesion that is too large to fit on a single periapical film, such as a large nasopalatine duct cyst.

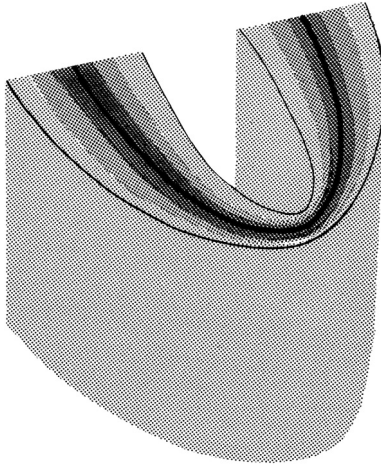
The use of occlusal imaging has declined markedly in recent years for two reasons. The first is related to digital radiography. With the introduction of digital radiography, occlusal-size sensors are not as readily available. Because of their prohibitive cost, no rigid detectors (CCD and CMOS sensors) come in an occlusal size. Very few manufacturers of storage phosphor plates make occlusal-size plates, so unless one uses storage phosphor plates from a manufacturer that makes them, one is not likely to use them. The second reason for the drop in occlusal radiography is the advent of CBCT. The dose from CBCT is relatively low compared to medical CT (but higher than from a single occlusal exposure), so CBCT has become widely used to provide information that would otherwise have been acquired from an occlusal image.

### 30. What operator error results in a foreshortened image?

Foreshortening results when the vertical angulation of the tube is too great; that is, the tube is angled too steeply. Elongation, by contrast, results from a vertical angle that is too shallow. A good way to remember cause and effect is to think of the sun and your shadow. Your shadow is shortest at noon when the sun is highest in the sky (a steep vertical angle) and longest in the late afternoon when the sun is low in the sky (a shallow vertical angle).

### 31. On a panoramic image, some structures may be clearly visible while others are not or appear blurry or out of focus. Why is this?

For structures to be visible on a panoramic image, they must be in what is termed the *focal trough*. The focal trough determines the distance between the nearest and farthest objects that appear acceptably sharp in the image. The width of the focal trough in different



**Figure 5-5.** Focal trough. Structures positioned on the black line will be in the sharpest focus. As one moves farther away from this line, the structures are less sharp, until they eventually become almost invisible. (From White SC, Pharoah MJ: *Oral Radiology: Principles and Interpretation*, ed 6. St. Louis, 2009, Mosby.)

machines varies in different parts of the jaw. It is widest in the posterior region and narrowest in the anterior. For structures to appear clearly on a panoramic image, the structures must be in the focal trough. Structures that are perfectly positioned in the focal trough will show up sharpest. As structures move farther away from the focal trough, they become blurrier, until they are no longer visible. Think of the focal trough as akin to the depth of field in photography. The manner in which the focal trough and depth of field are determined is not related, but conceptually they are similar (Fig. 5-5).

**32. Which radiographic view is considered the primary view for evaluating the alveolar bone for periodontal disease?**

The bitewing view is the primary view for evaluating radiographic changes consistent with periodontal disease, which include loss of crestal cortication, changes in the contour of the interdental bone, horizontal and angular bone loss, and furcation involvement. The bitewing film is superior to a periapical film because distortion, including elongation or foreshortening, is slight. The reason is that the vertical angle is small (approximately plus 5 to 10 degrees), and the central ray is directed at right angles to the film.

**33. Is there a generally accepted protocol for the frequency of radiographic evaluation in adult dental patients?**

Yes. The U.S. Food and Drug Administration (FDA), in cooperation with the American Dental Association and other major organizations, has developed and disseminated protocols for exposing dental patients to x-ray examinations. These protocols require a history and clinical examination before prescribing an individualized radiographic examination. For more information, go to <http://www.fda.gov/Radiation-EmittingProducts/RadiationEmittingProductsandProcedures/MedicalImaging/MedicalX-Rays/ucm116504.htm>.

**34. How should radiographic protocols be altered for pregnant dental patients?**

With the use of standard radiation protection, there should be no additional risk to the fetus from x-ray exposures commonly used in dentistry. However, because of the concerns many women have during pregnancy, it is advisable to limit x-ray exposures to the necessary minimum.

**35. Describe the use of CBCT in dentistry with regard to implants, endodontics, orthodontics, and impacted teeth, especially third molars.**

**Implants.** The use of CBCT in implant planning is well accepted and widely practiced. If there is any disagreement, it is whether CBCT should be used in all cases. This is still an open question.

**Endodontics.** CBCT is being increasingly used in endodontic therapy. This is especially true for teeth that are being retreated after failing or failed endodontic therapy. It is also used for cases in which additional canals are suspected but cannot be found clinically, and for teeth that have unusual anatomy (e.g., a dens in dente, dilated odontome) that complicates diagnosis and/or treatment. CBCT should not be used routinely in all endodontic cases. CBCT is also indicated in cases of suspected tooth fracture.

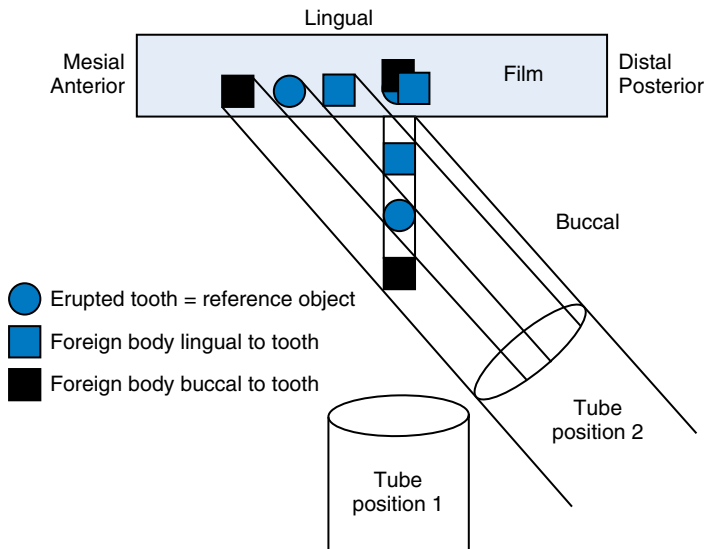
**Orthodontics.** The use of CBCT in the discipline of orthodontics is one of the most unsettled and contentious issues concerning this modality. Although CBCT is used by private practitioners and some educational institutions in all orthodontic cases, many, probably most, dentists are opposed to its routine use or at least have serious reservations about it. This is based on the young age of most orthodontic patients and the lack of evidence showing that the routine use of CBCT affects the outcome. There are some situations in which there is almost complete unanimity, so the use of CBCT is appropriate. These include localizing impacted, unerupted, or supernumerary teeth, cleft palate patients, and patients for whom orthognathic surgery is a consideration.

**Impacted teeth.** Aside from orthodontic cases, CBCT is sometimes used to locate impacted teeth, usually mandibular third molars, to assess their proximity to vital structures. CBCT should not be routinely used in such cases. Although there are as yet no guidelines for when CBCT should be used in these circumstances, the signs seen on the panoramic image should serve as a starting point.

**36. What is the buccal object rule? What do you need to apply it? How is it applied?**

The buccal object rule (the SLOB rule—**S**ame **l**ingual, **o**pposite **b**uccal) is a method for determining the relative location of objects that cannot be directly visualized. Examples include the location of an impacted tooth or additional root or canal. To apply the rule, one needs a reference object and two images taken at different angles.

The rule is applied as follows. In tube position 1, the images of the three objects are as depicted in Figure 5-6. Assume that one wants to determine the position of the circular and checkered objects. The horizontal position of the tube is changed, in this case by moving the tube distally to position 2. Another way of looking at it is to say that the tube is directed anteriorly in position 2, but most people find it easier to think simply in terms of the mesio-distal position of the tube.



**Figure 5-6.** The buccal object rule or tube shift rule (the SLOB rule).



With the tube in position 2, the images of all three objects are projected more mesially. However, their absolute position on the detector is not important. In applying the buccal object rule, we are interested only in their relative positions to one another. From Figure 5-6, it is evident with the tube in position 2 that the checkered object has moved mesially with respect to the circular object, an erupted tooth that is serving as the reference object. Now apply the SLOB rule. As the tube was moved distally, the checkered object moved mesially with respect to the erupted tooth; that is, the checked object moved in the opposite direction to the tube. Thus, the checked object is buccal (opposite buccal) to the reference. For more information, see <http://www.unc.edu/~jbl/BuccalObjectRule.html>.

Using the two periapical views shown in Figure 5-7, determine whether the crown of the impacted bicuspid is buccal or lingual to the first molar.

**37. When performing CBCT, what parameters should be taken into account? How can they be adjusted?**

Time, kVp, and mA should be taken into account. Just as with any x-ray exposure, kVp, mA, and the time of exposure are important technical parameters. Different manufacturers allow varying amount of control over these parameters. In some machines, it may not be possible to adjust these technical factors at all, which are preset and must be used for all studies. In others, the factors come preset for specific studies. For example, some machines allow one to select a patient by size, such as child, small adult, or adult. In these machines, selecting a child patient will result in certain default settings, whereas selecting an adult for the same study will cause the machine to apply different default settings. Some machines allow one to set the default settings in each group (e.g., adult, child), as opposed to the manufacturer setting them. Some manufacturers allow one to alter these default settings for a specific patient—for example, a particularly obese or small-framed patient. In this situation, if one chooses “adult” and the default kVp is 90, one may change the kVp for this one patient only. As soon as one selects another patient, the parameters revert to the default settings. It is important for the operator to understand what each machine permits and how to alter the settings so as to minimize patient dose and obtain the best-quality image.

**Resolution.** Not every study requires the highest resolution. For example, an implant CT is commonly done at a resolution of 0.4 voxel, although some may do it at 0.3 voxel. Rarely is any higher resolution required for an implant study or the evaluation of pathology. On the other hand, for endodontic studies, where one is looking for individual canals, one would generally choose the highest resolution of which the machine is capable. Remember that the smaller the number, the higher the resolution. Thus, a resolution of 0.2 voxel is greater than one of 0.4 voxel.

**Field of view.** This refers to the physical size of the x-ray field. CBCT machines come in three FOV categories—small, medium and large. One wants to select the smallest FOV that is compatible with the desired clinical information. The ability to adjust the FOV varies by manufacturer and model of machine. In some of the large FOV machines, one can adjust the height of the field, but not the anteroposterior FOV. Thus, one can image one arch



**Figure 5-7.** Is the crown of the impacted bicuspid buccal or lingual to the first molar (see question 36)? It is lingual.

(small vertical FOV), both arches (larger FOV), or the whole head (large vertical FOV), but one cannot image just part of one jaw—for example, only the right posterior mandible. Some machines have a number of preset FOVs. In this case, the operator selects the most appropriate FOV but cannot customize it further. It is up to the operator to understand the limitations and capabilities of each machine.

### 38. What factors should you consider when deciding which CBCT unit to buy?

A large number of machines are available today. An initial task should be to ascertain what can be obtained. The website <http://www.conebeam.com/cbctchart> provides a good starting point about what is on the market.

- *Small or large FOV machine.* Probably the first decision you need to make is whether to buy a small or large FOV machine. In some cases, the decision is easy. For an endodontist, only a small FOV makes sense because endodontics requires the highest possible resolution, or nearly so. For an oral surgeon, a large field of view would almost always make the most sense. For an implant dentist, the decision is more complicated. For a practitioner who usually does only smaller cases (e.g., one to three implants in a jaw), a small FOV machine may be adequate. However, for practitioners who commonly do larger cases, a large FOV machine will probably serve them better. With small FOV machines, one must take two separate views for teeth that are not close enough to be covered in a single view. These different views can be stitched together to create a single view, but having to do this on a regular basis may become tiresome.
- *Size.* What space do you have in which to place the machine? Particularly if you are not building or remodeling an office with a CBCT in mind, space may be limited. Small FOV machines take up less space than large FOV machines.
- *Cost.* Unless you have an unlimited budget, cost will be a factor. Small FOV machines cost less than large FOV ones.
- *Service.* An important consideration should be what level of service you to expect. If you purchase a machine from a manufacturer who has none or only a few machines in your area, it is not likely that trained technicians will be readily available for repairs. However, if a manufacturer wants to get a foot in the door in your neighborhood, you could use this to negotiate a better price.
- *Image quality.* Generally speaking, machines from reputable manufacturers will produce clinically adequate images. Practitioners should be sure to research less expensive machines carefully. In addition to asking knowledgeable individuals for their opinion, practitioners should also do a PubMed search. Researchers often publish studies performed on machines that enter the market.

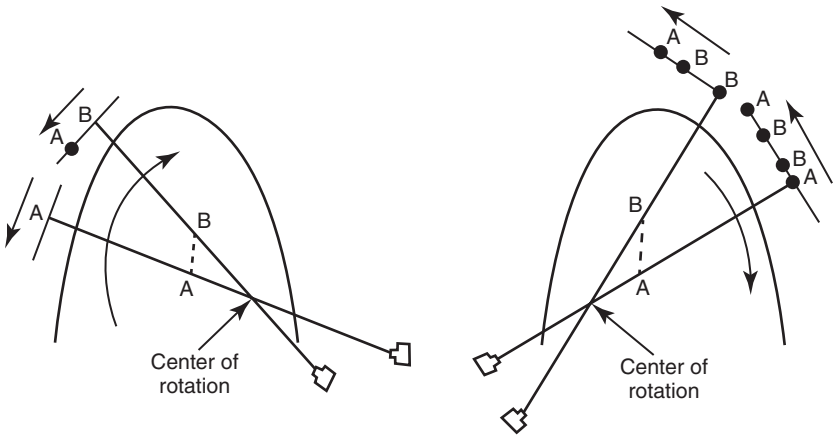
Once you have narrowed your choice down to a few machines, ask the respective manufacturers for the names of practitioners in your area who already have one of their machines. Call them and ask what their experience has been. If possible, visit each practitioner so you can see the machine in action, as well as its software interface and software capabilities.

### 39. Do panoramic images portray objects with sufficient accuracy to permit reliable measurements to be made on the image?

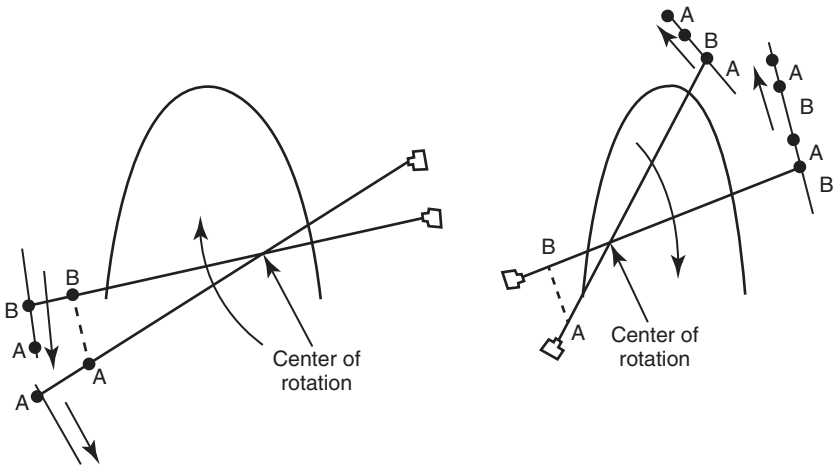
Although magnification (or minification) is generally undesirable, it is not a major impediment to obtaining accurate measurements if one knows the amount of magnification. All one needs to do is to apply a correction factor. In panoramic images, however, magnification varies from one part of the image to another. Varying magnification of different parts of the same image is termed *distortion*. If one wants to do measurements on a panoramic image, one should place an opaque object of known dimensions (ball bearings are commonly used) in the area of interest. By then measuring the size of that object's image, one can calculate a conversion factor. That measurement will be accurate only for that specific location. There is less variation in vertical magnification than in horizontal magnification on panoramic images.

### 40. In panoramic radiography, what are ghost and double images? How are they formed, and how can one tell them apart?

Panoramic radiography produce two broad categories of images, real images and ghost images. Real images can be divided into true real images and double images. True real and double images are formed by objects that are between the center of rotation and the sensor in both projections (Fig. 5-8). Ghost images occur when structures are located between the x-ray source and the rotation center (Fig. 5-9).



**Figure 5-8.** Formation of a double image. Note that for the formation of the true real image and double image, the object AB is located between the center of rotation and the detector.



**Figure 5-9.** Formation of a ghost image. Note that for the formation of the true real image, AB is located between the center of rotation and the detector, but in the formation of the second (ghost) image, object AB is located between the x-ray tube and center of rotation.

One can tell them apart by the following characteristics:

A double image:

- is reversed with respect to the true real image—that is, it is a mirror image of the true real image.
- has the same proportions as the true real image.
- has the same location, including vertical position, on the opposite side.

A ghost image:

- is more blurred compared to the true real image.
- is more blurred in the vertical than the horizontal.
- is magnified especially in the vertical runs in the same direction as the real image—that is, it is not a mirror image of the true real image.

**41. Which intraoral view is best for visualizing the greater palatine foramina?**

The greater palatine foramina cannot be visualized on any intraoral film. On some maxillary occlusal films, a foramen can be seen in the area of the second or third molars. This foramen is the nasolacrimal canal and not the greater palatine foramen.

**42. What are the names of the major salivary glands? How are they studied radiographically?**

The three major salivary glands are the parotid, submandibular, and sublingual glands. Because the salivary glands consist of soft tissue, they cannot be seen on radiographs unless special steps are taken to make them visible. In a technique called sialography, a radiopaque dye or contrast is injected through the duct openings into the gland. Iodine is the agent normally used to provide contrast. If patients are allergic to iodine, a different contrast agent must be used. Calcifications of the duct may be seen on intraoral films, especially calcifications of Wharton's duct, the submandibular gland duct. The stones or sialoliths may be seen on periapical or, more commonly, on occlusal films. If a stone is detected it is obviously present. However, if none is detected it does not mean that there is not a stone. Up to 40% of parotid sialoliths and 20% of submandibular sialoliths are not radiopaque. MRI is increasingly replacing sialography as the modality of choice for studying the salivary glands.

**43. What are the major advantages of digital radiography over conventional film-based systems?**

- With a CCD or CMOS detector, images are visible instantaneously.
- The need for a film processor and/or darkroom is eliminated.
- Archiving of images is easier, and so is retrieval.
- Digital images can be optimized—density and contrast can be changed; images can be magnified.
- Built-in digital rulers enable one to perform measurements on the image.
- Patient dose is reduced. Importantly, however, it is unclear whether the reduction in dose has any biologic benefits (e.g. reduced number of cancers, cataracts). There is much controversy in the radiation biology and radiation physics literature over this issue.

**44. What are the typical magnifications of radiographs commonly used in dentistry?**

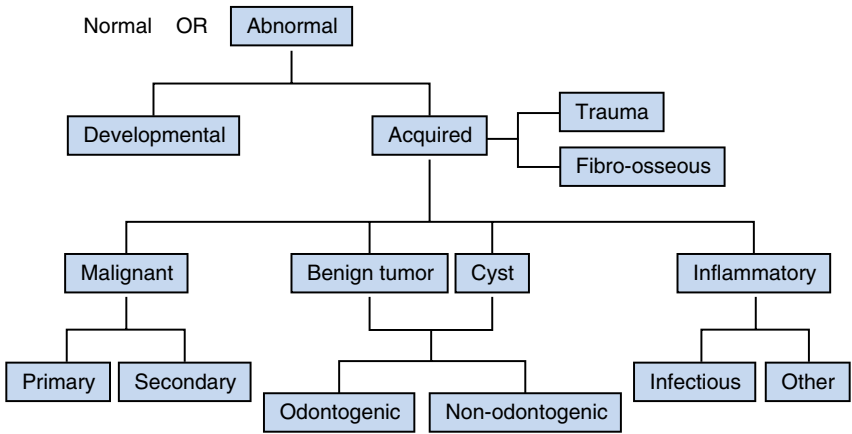
The magnification of periapical and bitewing films is about 4%, of cephalometric films, about 10%, and of panoramic films, 20% to 25%.

**45. What are the indications for the use of MRI versus CT?**

There is no simple answer to this question. In general, MRI is better for imaging soft tissue—for example, a tumor in the tongue. CT, on the other hand, provides better images of bone; thus, for an intraosseous tumor, CT is the technique of choice. Not uncommonly, one may want to use both MRI and CT. For example, when a patient has a tumor in the floor of the mouth, one may use MRI to determine its extent in the soft tissue and CT to determine whether there is any bone involvement. For temporomandibular joint (TMJ) imaging, MRI is better at depicting the soft tissue of the disk, but CT is better for almost all other TMJ studies. For most dental purposes, where the primary interest is bone and soft tissue discrimination is not a factor (e.g., implant or endodontic studies), CBCT is the modality of choice.

**BASIC RADIOLOGIC INTERPRETIVE CONCEPTS****46. What are the radiographic features of any lesion or area of interest that always should be defined and recorded?**

1. Location of the lesion as exactly as possible. This is an important feature, as many lesions have a propensity to occur in certain locations.
2. Shape. This too is an important feature. Cysts, for example, tend to be round (hydraulic). One notable exception is the odontogenic keratocyst (OKC), now renamed the keratocystic odontogenic tumor, which has a tendency to grow along the internal aspect of the jaw (in the length of the bone), thus causing minimal expansion.
3. Appearance of borders. This is a critical feature that may help distinguish between benign (usually well-defined borders) and malignant lesions (usually poorly defined borders).



**Figure 5-10.** Algorithm for arriving at a radiographic differential diagnosis.

4. Internal structure. Pay particular attention to whether the lesion is radiolucent, radiopaque, or mixed. Also note the nature of the opacity, if any. For example, determine such factors as whether it is homogeneous and the density of the bone or tooth. The internal structure may also have septations, which may show subtle differences among various septated lesions.
5. Effects of the lesion on adjacent structures. Has the lesion displaced structures (e.g., moved teeth, the canal, sinus floor)? Has it caused resorption of teeth or simply destroyed the bone around them, leaving the teeth themselves untouched? Is there any reactive response—for example, a periosteal response?
6. Localized versus generalized. When lesions are generalized, one has to consider a different differential diagnosis than if just a single lesion is present.
7. Size. Although many people describe size before any of the other features, size by itself is generally not helpful. A snapshot of a lesion does not indicate how long it has been present. Even a benign lesion will grow to a large size if left untreated.

**47. Once you have described the features of a lesion (see question 46), you need to arrive at a differential diagnosis. Describe a method or algorithm for doing this.**

Although there is no one correct way to do this, the initial step should be to determine whether the area in question is normal or abnormal. If normal, you should be able to identify the structure. If you decide that the area in question is abnormal, [Figure 5-10](#) illustrates one way to proceed.

One reason for following at least the initial steps outlined here is that patients typically want to know whether something is normal and, if it is not, whether the abnormality is benign or malignant, so it is desirable to reach that conclusion as soon as possible. After that, there is more leeway. Some clinicians, for example, may prefer to decide on the odontogenic versus nonodontogenic nature of a lesion before deciding whether it is a cyst or tumor, whereas others may reverse that step.

**48. What is the most likely interpretation of a bilaterally symmetric radiographic appearance in the jaws?**

A bilateral symmetric appearance, with extremely few exceptions, is indicative of normality. Among the few exceptions to this are cherubism and infantile cortical hyperostosis (Caffey's disease).

**49. The location of a lesion may be a clue about its origin. What single anatomic structure in the mandible is most useful for differentiating between a lesion of possible odontogenic versus nonodontogenic origin?**

The mandibular or inferior alveolar canal is extremely useful in distinguishing between a lesion of odontogenic or nonodontogenic origin. Because one does not expect to find odontogenic

tissues below the canal, it is most unlikely that lesions situated below the canal are odontogenic in origin. The lesion of odontogenic origin rarely, if ever, begins below the canal. However, any lesion, including one of odontogenic origin, may begin above the canal and extend below it.

**50. If you wish to view pathology in soft tissue, would you order a CBCT? Explain your answer.**

Although CBCT has a number of advantages over medical CT, it also has disadvantages. One of the greatest is that relative to medical CT, CBCT lacks soft tissue contrast. This means that CBCT does not discriminate well between different soft tissues, such as fat and muscle. Thus, CBCT is not the modality of choice if the primary purpose is to examine the soft tissues. Usually, an MRI is the modality of choice for viewing soft tissue, but a medical CT might be a reasonable choice, depending on the situation. If one has an intraosseous lesion and simply wants to determine whether it has broken through into the surrounding soft tissue, CBCT is useful.

**51. What broad categories of possible disease entities need to be considered when developing a differential diagnosis of any abnormality noted during a radiographic examination?**

- Trauma
- Metabolic, nutritional, and endocrinologic diseases
- Congenital anomalies and abnormalities of growth and development
- Iatrogenic lesions
- Cysts
- Neoplastic diseases (benign and malignant)
- Inflammation and infection

**52. What general radiographic features or principles permit the diagnosis of an underlying systemic cause for a particular condition or appearance?**

When a systemic cause underlies a problem, the mandible and maxilla are affected. Furthermore, the jaws are typically affected bilaterally, often symmetrically. If the condition affects the teeth, one would expect them also to be affected in a bilaterally symmetric fashion.

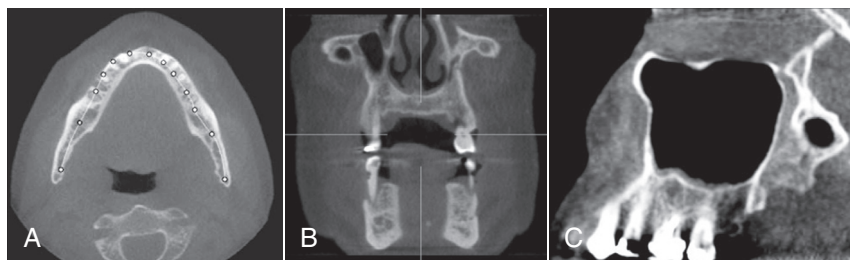
**53. What do we call the three different perspectives from which one can view images on a cone beam or medical CT scan or an MRI?**

The axial view is considered as viewing the patient from below, the coronal or frontal view is considered as viewing the patient from the front, and the sagittal view is considered as viewing the patient from the side (Fig. 5-11).

In dentistry, the coronal view through the alveolus, as depicted in Figure 5-12, is also referred to as a cross section or cross-sectional view. Also, in dentistry, a panoramic reconstruction is frequently obtained (Fig. 5-13).

**54. What are the usual radiographic signs of inflammatory disease involving the paranasal sinuses?**

- Mucous membrane thickening
- Air-fluid levels
- Opacification of a sinus cavity
- Presence of a soft tissue mass
- Changes in the cortical margins of a sinus



**Figure 5-11.** Axial (A), coronal (frontal; B), and sagittal (C) views of a CBCT scan.

**55. What common radiographic signs help distinguish among a cyst, benign neoplasm, and malignant neoplasm?**

Cysts tend to be radiolucent and round or oval in shape, with intact cortical margins. Benign neoplasms are more variable than cysts in density, shape, and definition of margins. Malignant neoplasms of the jaws tend to be aggressive, with ragged margins and poor definition of shape and borders. Malignant lesions often grow quickly, leaving roots of teeth in position and giving the appearance of teeth floating in space. Cysts and benign neoplasms are more likely than malignant neoplasms to resorb tooth roots.



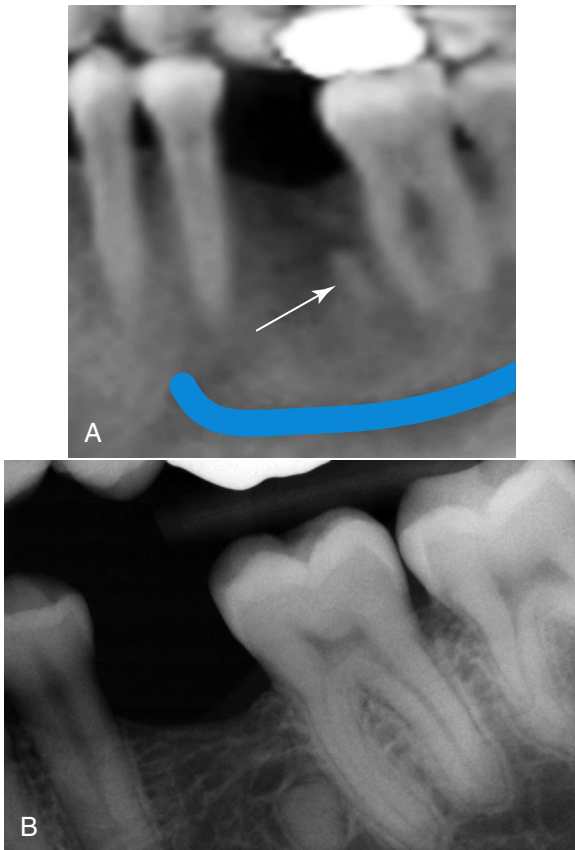
**Figure 5-12.** Coronal view, also known as a cross-sectional view, through the posterior mandible.



**Figure 5-13.** Panoramic reconstruction from a CT scan. Note that there is a differences between a panoramic reconstruction from a CT scan and a panoramic image.

**56. Which modality, CBCT, panoramic imaging, or intraoral radiography, is best for interpreting and diagnosing conditions radiographically?**

Contrary to what is commonly thought, and what purveyors of the latest products might lead one to believe, the latest and/or most expensive imaging technology is not always best for interpretation and diagnosis. What is best depends on what information is being sought. For example, CBCT is of little to no use in diagnosing caries. The scatter from metals such as amalgams, posts and cores, crowns, and, to a lesser extent, other less dense materials such as gutta percha results in so much scatter as to render CBCT scans almost useless for caries detection. Panoramic images provide a useful overview of the jaws, but may lack sufficient detail to visualize small structures. For example, in some cases, the lamina durae may not be visible on a panoramic image because this modality lacks sufficient resolution. The panoramic image does not show the buccolingual dimension so it is not useful when this information is being sought. Intraoral images, with their high resolution, provide exquisite images of small structures, but the views are limited in size. Before ordering a particular image, the dentist should think about what information is being sought and select the appropriate imaging modality accordingly (Fig. 5-14).



**Figure 5-14.** A, A cropped, full-thickness panoramic reconstruction of a CBCT scan. An opacity (*arrow*) is visible on the mesial of the apical third of the root of the second molar. Based on this and other perspectives (not shown) on the CBCT scan, the differential diagnosis includes dense bone (enostosis), condensing osteitis, and a tooth root. B, A periapical image of the area clarifies the nature of the opacity, which can be clearly seen to be surrounded by a uniform lucency (the periodontal ligament space), which is in turn surrounded by a cortical border (the lamina dura). One is therefore looking at a tooth root.



**57. Is it possible for a patient to have an asymmetry, yet for it not to be clinically evident?**

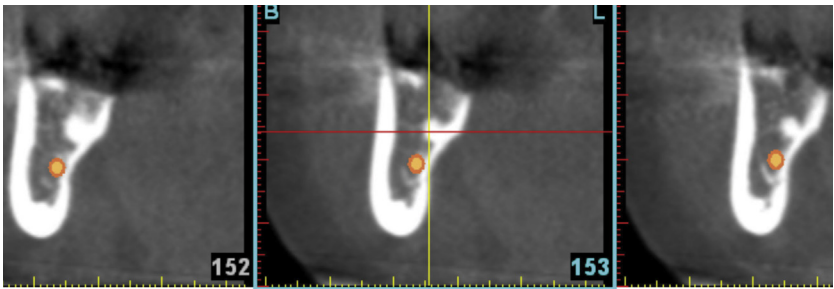
Yes, both the osseous structures and soft tissues contribute to a person's appearance. It is possible to have an osseous hypoplasia or hyperplasia, which is compensated for by soft tissue. In such a case, the asymmetry will only be noticeable with radiography. In these cases, treatment may not be necessary for aesthetic purposes. The reverse is also true; one may have a soft tissue asymmetry, but not an osseous one.

**58. How do primary teeth differ from permanent teeth radiographically? How does the difference affect the radiographic evidence of caries in primary teeth?**

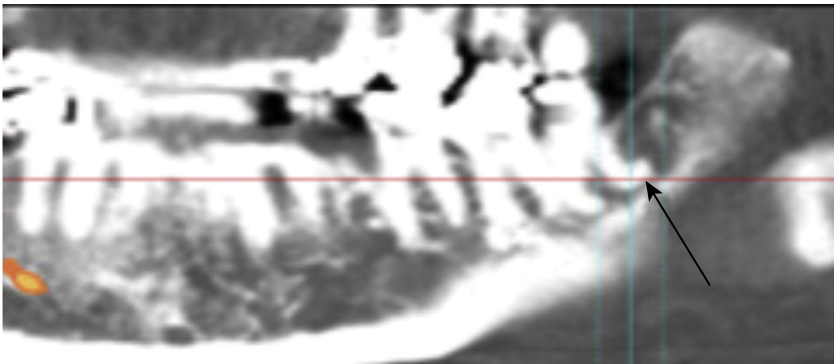
Primary teeth are smaller and have relatively larger pulp chambers, with pulp horns in closer proximity to the external surface of the crown. The enamel layer is thinner in dimension. Primary teeth are slightly less opaque on film because of a higher inorganic content. As a result, caries in primary teeth tends to progress more rapidly from initial surface demineralization to involvement of the dentin. Thus, careful interpretation is especially important when evaluating the primary dentition.

**59. Which CBCT view, axial, coronal, sagittal, or panoramic, is best for viewing pathology?**

There is no single view that is always best. It is always important to look at all three views because each one conveys different information. It is only by viewing all three perspectives that one obtains the complete picture (Figs. 5-15 and 5-16).



**Figure 5-15.** Cross-sectional views of the posterior mandible show a rounded opacity toward the lingual aspect of the alveolus. The differential diagnosis includes bone (enostosis, condensing osteitis) and tooth material. It is not possible to determine definitively which it is.



**Figure 5-16.** A view through a thin section of a panoramic reconstruction shows a dilacerated distal root (*arrow*) of the third molar. It is this dilaceration that is seen in the cross section. One can now say with certainty that the opacity noted in the cross section is a root.

**60. What is the rule of 3s for radiographic assessment of the development of permanent teeth?**

It takes approximately 3 years for a permanent tooth bud to calcify after matrix formation is complete, approximately 3 more years for the tooth to erupt after calcification is complete, and about 3 more years after initial eruption for root formation to be complete.

**61. In pathology of the maxilla, which feature seen on a periapical image is most useful in determining whether the pathology arose inside or outside the sinus?**

The floor of the sinus is the most useful feature. If the pathology arose inside the sinus, the floor is intact and in its normal position or perhaps depressed inferiorly. If the pathology arose outside the sinus, the floor of the sinus is intact and in its normal position or moved or pushed superiorly. If the sinus floor has been destroyed, it may not be possible to determine whether the pathology arose from without or within the sinus.

**62. Foramina may be superimposed over the apices of teeth, mimicking the presence of periapical disease. Which radiographic features are most useful in distinguishing between normal structures and apical pathology?**

If the lucency is caused by the superimposition of a foramen, the periodontal ligament space and the lamina aura around the tooth are intact. The exposure of a second radiograph, with the tube in a different position from the first exposure, also is frequently useful. If the lucency moves relative to the apex of the tooth, the lucency is not associated with the tooth and is not caused by periapical pathology. This exercise, however, does not rule out the possibility that the lesion is abnormal; it merely means that the lesion is not related to the tooth.

**63. What is the differential diagnosis of a radiopacity in the soft tissues in and around the jaws?**

It is easiest to answer this question if the radiopacities are classified into groups—tooth, bone, foreign body, and calcification. Although bone is a form of calcification or mineralization, it is distinctive enough to warrant a separate category. In a given case it may be difficult to distinguish even among these categories, but classification is nevertheless useful. In most cases, one can easily rule out a tooth in soft tissue, although in cases of trauma, fragments of a tooth or even a whole tooth may be found in the lips or tongue. Bone in soft tissue is rare, but choleliths and ossifying hematomas do occur. Foreign bodies tend to be metallic, but need not be. Gutta percha, endodontic cements, some composites, and contrast media are opaque but not metallic. A number of entities involve calcification. Fortunately, only a few are common, such as sialoliths, lymph node calcification (e.g., in granulomatous diseases such as tuberculosis), and tonsilloliths. Less common examples include phleboliths, calcified acne lesions, and parasitic larvae (e.g., cysticercosis). Antroliths and rhinoliths are calcifications (stones) that occur in a sinus or the nasal cavity, respectively. When an opacity is seen in a cavity, such as the sinus, fluids and soft tissue should be added as two separate groups. They are not as dense as the other opacities.

**64. Is it possible for a patient to be in acute pain as a result of a periapical abscess, yet have a completely normal periapical film?**

Yes. This finding is not unusual because 30% to 60% of mineralization must be lost before bone destruction is radiographically evident. In an acute situation, there frequently has not been sufficient time for this amount of bone destruction to occur. Thus, the radiograph lags behind the clinical picture. The same may be true in the healing phase. A patient may be improving clinically but still show radiographic signs of pathology.

**65. Is a widened periodontal ligament space at the apex of a tooth always indicative of pathology?**

No. When a radiolucency such as the mental foramen or mandibular canal is superimposed over the periodontal ligament (PDL) space, the ligament space appears to be widened. Such a widening is purely artifactual. The PDL space also may appear wider, usually at the neck of a tooth, as a normal variation, or may be widened around the entire tooth as a result of orthodontic treatment. If the lamina dura is normal in this area, the widened PDL space is probably a variant of normal. Generalized widening of the PDL space may be caused by disease, such as scleroderma.

- 66. Some serious conditions may mimic periodontal disease. Name two such conditions, and indicate how bone loss from these conditions can be differentiated from regular periodontal bone loss.**

The two conditions that usually mimic periodontal bone loss are Langerhans cell histiocytosis (LCH) and squamous cell carcinoma. One can usually determine LCH because this condition begins in the bone, whereas periodontal disease progresses from the crest down. Thus, in LCH, the alveolar crest may be intact. If the crest is destroyed, then this feature is not useful in differentiating the two conditions. Furthermore, in LCH, the lesion is centered around the midroot portion of the tooth or teeth. Another feature that may be useful is that in periodontal disease, once the bone loss extends to the apex, it does not progress, whereas in LCH, one may see bone loss well beyond the apices of the teeth. Patients with LCH may manifest a periosteal reaction.

Squamous cell carcinoma (SCCA) often begins in the overlying soft tissue, extending into the bone. When SCCA invades the bone in this fashion, it destroys the alveolar crest, so this feature is not useful to distinguish between SCCA and periodontal disease. Periodontal disease is usually generalized, so what looks like periodontal disease in a localized area should heighten one's degree of suspicion that something more sinister is occurring. A lucency caused by SCCA is unlikely to be surrounded by a sclerotic border, whereas in periodontal disease there may be a sclerotic border. As in the case of LCH, one may see bone loss well beyond the apices of the teeth in SCCA.

- 67. What are the radiographic manifestations in the jaws of patients infected with the human immunodeficiency virus (HIV)?**

There are no unique oral or maxillofacial radiographic manifestations of HIV infection, although infected patients are at a significantly higher risk for aggressive periodontal disease.

- 68. What is the efficacy of dental radiographs?**

Studies of standard dental radiography (bitewing, periapical, and panoramic views) show considerable variation in the ability to detect common dental diseases such as caries, periodontal disease, and apical periodontitis. Radiographs should not be considered to be perfect; they are most valuable when combined with a thorough history and clinical examination.

## RADIOGRAPHIC INTERPRETATION

- 69. What is the earliest radiographic sign of periapical disease of pulpal origin?**

The earliest radiographic sign is widening of the periodontal ligament space around the apex of the tooth or, in the case of primary teeth, in the furcation.

- 70. What is the next radiographic sign of periapical disease of pulpal origin?**

The next radiographic sign is loss of the lamina aura around the apex of the tooth or, in the case of primary teeth, in the furcation.

- 71. Describe the radiographic differences that allow periapical abscesses, granulomas, radicular (periapical) cysts, and apical surgical scars to be distinguished.**

One cannot distinguish among periapical abscesses, granulomas, or radicular (periapical) cysts on radiographic grounds alone. All these lesions are radiolucent, with well-defined borders. Whereas an abscess may be expected to be less well corticated than a radicular cyst, this feature is not marked or constant enough to be useful. An apical surgical scar may be radiographically distinguishable from the other three lesions if there is radiographic evidence of surgery, such as a retrograde filling. A history should elicit whether surgery has been performed.

- 72. How does the radiographic appearance of pulpal pathology that has extended to involve the bone differ in primary posterior teeth from what is commonly seen in permanent posterior teeth?**

In permanent teeth, widening of the periodontal ligament space is seen around the apex of the tooth. In primary teeth, by contrast, the infection presents as widening of the periodontal ligament space or an area of lucency in the furcation area.

**73. Radiographically, a benign neoplasm in bone may be differentiated from a malignant neoplasm by which of the following?**

1. Margins are irregular and fade imperceptibly into surrounding bone.
2. The cortex tends to remain intact but may be thinned, and the part involved may be expanded.
3. Margins are usually defined and demarcated from surrounding bone.
4. There often is a perforation of the periosteum.
5. Some structures (e.g., teeth, the canal, sinus floor) are displaced.
  - a. 1 and 2 only
  - b. 1, 2, and 4 only
  - c. 2, 3, and 5
  - d. 2, 3, and 4 only

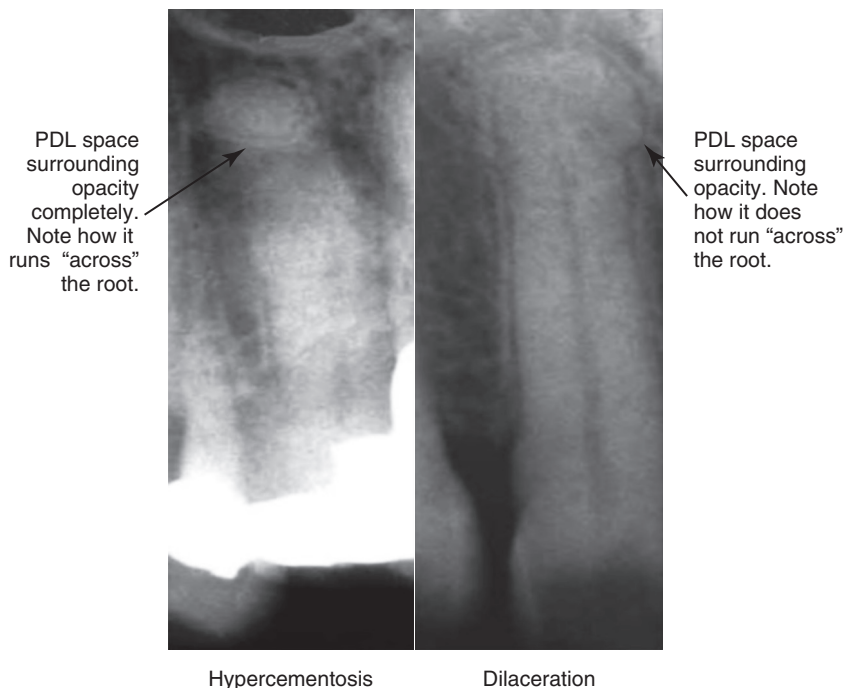
Answer: c

**74. At times, it may be difficult to distinguish between hypercementosis and a buccal or palatal dilaceration at the apex of a tooth. What radiographic feature permits a definitive diagnosis when this occurs?**

For both conditions, the periodontal ligament space is visible around the opacity; that is, the excess cementum or root is contained within the PDL space. In the case of a dilaceration, the PDL space surrounds the entire opacity, running across the root. In hypercementosis, by contrast, the PDL space does not cross the root (Fig. 5-17).

**75. What are the radiographic signs of mandibular hypoplasia (assume it is a non-syndromic patient)?**

Signs of a mandibular hypoplasia include a combination of the following. Not all need to be present in a particular case.



**Figure 5-17.** Periapical images showing an example of a dilacerated root (buccal or palatal) and of hypercementosis. Note how, in hypercementosis, the PDL space runs across the tooth.

- The condyle on the ipsilateral side, although usually normal in shape, is diminished in size.
- The condylar neck is short.
- The condylar neck and ramus have a posterior (dorsal inclination).
- The distance from the coronoid notch to the angle of the mandible is reduced.
- The occlusal plane on the affected side is higher.
- The antegonial notch on the affected side is deepened.

**76. What is the earliest radiographic sign of periodontal disease?**

The earliest radiographic sign of periodontal disease is loss of density of the crestal cortex, which is best seen in the posterior regions. In the anterior part of the mouth, the alveolar crests lose their pointed appearance and become blunted. In the posterior areas, the alveolar crests usually meet the lamina aura at right angles. In the presence of periodontal disease, these angles become rounded.

**77. What is the earliest radiographic sign of furcation involvement caused by periodontal disease?**

In periodontal disease, one may see the loss of a cortical plate, the buccal or lingual plate, on an intraoral film. The plate may be lost to such a degree that the crest now occupies a position apical to the furcation. This appearance, however, does not permit a diagnosis of furcation involvement. Widening of the periodontal ligament space in the furcation area is the earliest radiographic sign of furcation involvement.

**78. What is the radiographic differential diagnosis of a radiolucency on the root of a periodontally healthy tooth?**

Internal resorption, external resorption, and superimposition are the most common causes. Note that the question refers to a periodontally healthy tooth. If bone loss has resulted in exposure of the root, caries and abrasion, among other possibilities, enter the picture.

**79. How can you distinguish among the above radiolucencies on the root of a tooth?**

In internal resorption, the canal is widened, whereas it is unaffected in external resorption. If the resorption began below the bone level, it has to be internal resorption because, without adjacent bone, there are no osteoclasts in the area to cause external resorption. If internal or external resorption involves both the canal and other tooth structure, it is not possible to distinguish between the two conditions. A superimposed radiolucency moves relative to the root if another view is obtained with the tube in a different position. The most common of these lucencies are normal anatomy, such as foramina, sinus, mandibular canal, and accessory or nutrient foramina or canals. Artifacts such as cervical burnout may also produce a lucency on the root at the junction of the enamel and cementum.

**80. What is the radiographic differential diagnosis of a radiolucency on the crown of a tooth?**

Caries, internal resorption, restorations, abrasions, erosions, and enamel hypoplasia are among the more common possibilities. Caries typically have irregular margins; they may also have typical shapes, such as the triangular appearance of interproximal caries. Internal resorption has smooth, well-defined margins. The same is true of radiolucent restorations, which frequently can be recognized by their shape and sometimes by the presence of an opaque base, such as calcium hydroxide, lining the floor of the preparation. Abrasions, particularly at the cervical margins, often have a V-shaped appearance. Other abrasions, such as those caused by a clasp on a denture, typically have well-defined borders and straight lines, unlike most naturally occurring phenomena. Erosions also have well-defined borders, and their shape is typically round or oval. Hypoplasia usually is not a single lucency on a tooth but rather many small lucencies.

**81. One can determine a tooth that has not completed formation by which of the following?**

1. With a tooth that has completed formation, the apex is open and the walls of the canal are convergent, whereas in a tooth that has not completed formation, the apex is closed and the walls of the canal are divergent.
2. With a tooth that has completed formation, the apex is closed and the walls of the canal are divergent, whereas in a tooth that has not completed formation, the apex is open and the walls of the canal are convergent.

3. With a tooth that has completed formation, there is a blunderbuss apex.
4. With a tooth that has not completed formation, the apex is open and the walls of the canal are divergent, whereas in a tooth that has completed formation, the apex is closed and the walls of the canal are convergent.
5. With a tooth that has not completed formation, the apex is open and the walls of the canal are convergent, whereas in a tooth that has completed formation, the apex is closed and the walls of the canal are divergent.

Answer: 5

### 82. What is the differential diagnosis for an apical lucency?

The answer to this question is best begun by differentiating between vital and nonvital teeth. For nonvital teeth, the differential diagnosis includes:

- A periapical abscess
- A periapical cyst
- A periapical granuloma
- A periapical scar

For vital teeth, the differential diagnosis includes:

- The papilla of a still-developing tooth
- Cemento-osseous lesions (e.g., periapical cemental dysplasia [PCD], florid cemento-osseous dysplasia)

### 83. If endodontic therapy on a maxillary molar is failing, what is the most likely cause?

Maxillary molars were classically described as having three canals, one in the mesiobuccal (MB) root, one in the distobuccal (DB) root, and one in the palatal root. Some maxillary molars have an additional canal, which is a second canal in the MB root. The first canal in the MB root is called MB1 and the second one is MB2. With the use of microscopes in endodontics, it became evident that more maxillary molars have an MB2 than was originally thought. If MB2 cannot be located clinically, a high-resolution CBCT scan can frequently identify it.

### 84. Name two serious and even potentially fatal conditions that may be detected by dental radiographs before clinical signs or symptoms develop. What are the dental signs and symptoms of these diseases?

Gardner's syndrome and Gorlin-Goltz syndrome have radiographic signs that should alert a vigilant practitioner to the possibility of their presence. **Gardner's syndrome** is characterized by the following: multiple osteomas, which may occur on the mandible; multiple supernumerary teeth, frequently impacted; sebaceous skin cysts; and polyps of the large and occasionally small intestine. The polyps may become malignant. **Gorlin-Goltz syndrome** (multiple basal cell nevoid carcinoma syndrome, basal cells nevus syndrome, bifid rib syndrome) is characterized by the presence of odontogenic keratocysts, basal cell carcinomas, and other potential anomalies, including skin tumors and ocular and neurologic abnormalities, such as calcification of the falx cerebri.

### 85. Can one diagnose osteomyelitis radiographically? What are other radiographic signs of osteomyelitis?

Osteomyelitis may be present in the total absence of radiographic signs. To make a radiographic diagnosis of osteomyelitis, a sequestrum must be noted. A sequestrum is an area of bone that has been separated from the body of the bone. A radiographic sign that may be suggestive but is not pathognomonic of osteomyelitis is a periosteal reaction.

### 86. In radiology, what do we mean when we say that something is a central lesion?

Lesions can be central or peripheral. A central lesion is one that starts in the bone. A peripheral lesion is one that begins on the surface of the bone or in the overlying soft tissue. Most lesions are of one type or another, but some may be of either type. For example, odontogenic fibromas, the vast majority of which are of the central variety, also have a peripheral form.

### 87. What features of a periosteal reaction help differentiate between infectious periostitis and a periosteal reaction caused by malignant disease?

A periosteal reaction by itself does not permit a definitive diagnosis of an infectious or malignant origin. Although some periosteal reactions are more suggestive than others of a particular origin (e.g., the sunburst appearance of osteogenic sarcoma), none is definitive.

**88. Simple bone cysts (traumatic bone cysts) occur in two distinct age groups. What are these age groups? How are the simple bone cysts in these age groups similar or different?**

Simple bone cysts usually occur in the first 2 decades of life, with a mean age of occurrence of 17 years. In this age group, there is a male-to-female predominance of 2:1. Simple bone cysts in this age group are solitary. They are treated by curettage, which causes bleeding into the lesion and then heals.

The second group in whom simple bone cysts occur are middle-aged black women. It is in this group that cemento-osseous dysplasia is found. Simple bone cysts may be found in patients with cemento-osseous dysplasia, especially the florid variety, and there may be multiple simple bone cysts. One or more cysts form and heal, and then others may form. As opposed to solitary simple bone cysts, which occur in the younger age group, cysts that occur in the presence of cemento-osseous dysplasia are not usually treated.

**89. Explain how the lamina dura may fail to be visible on a periapical image.**

The most common cause of loss of the lamina dura is infection; the vast majority are the result of infections of endodontic origin. Once infection has been ruled out, malignancy should be considered. With infections and malignancy, the lamina is actually destroyed.

There is, however, a third condition that may render the lamina dura invisible, but it is not destroyed, as in the aforementioned conditions. In fibrous dysplasia, the lamina dura may be converted to fibrous dysplastic bone, so the contrast between the normal lamina dura and bone is lost. In osteoporosis and osteopetrosis, a similar process may result in loss of the lamina dura. If there is generalized destruction of the lamina dura, systemic conditions such as hyperparathyroidism should be considered. Finally, the lamina dura may not be visible because of radiographic technique and/or technical factors. A panoramic image, with its relatively poor resolution compared with intraoral radiographs, may not show the lamina dura. Even an intraoral image that is underexposed, overexposed, or very poor in contrast may render the lamina dura difficult or impossible to see.

**90. What are the radiographic signs of a fracture?**

The radiographic signs of a fracture include a demonstrable radiolucent fracture line, displacement of a bony fragment, disruption in the continuity of the normal bony contour, and increased density (caused by overlap of the adjacent fragments).

**91. What is the differential diagnosis for early tooth loss?**

- Extraction (e.g., for orthodontic reasons because of caries)
- Periodontal disease (may be nonspecific or may be a result of a disorder such as juvenile periodontitis or Papillon-Lefevre syndrome or of a systemic condition predisposing to periodontal disease, such as diabetes mellitus and Down syndrome)
- Trauma
- Dentinogenesis imperfecta
- Dentinal dysplasia
- Regional odontodysplasia, ghost teeth
- Hypophosphatasia
- Langerhans cell histiocytosis
- Vitamin D-resistant rickets, hypophosphatemia
- Cyclic neutropenia
- Acro-dynia (pink disease)
- Acatalasia
- Chediak-Higashi-Steinbrinck syndrome
- Vitamin C deficiency
- Cherubism (caused by curettage of a lesion)
- Neuroblastoma (<5 years of age)

**92. Match the lesion with the most common location for each one:**

1. Dentigerous cyst
2. Lateral periodontal cyst
3. "Globulomaxillary" cyst
4. Ameloblastoma
5. Adenomatoid odontogenic tumor

6. Periapical cemento-osseous dysplasia
  - a. Mandibular incisors around the apices
  - b. Maxilla between lateral and canine
  - c. Third molars
  - d. Mandible from the lateral incisor to the first premolar
  - e. Canine area in maxilla
  - f. Mandibular molar–ramus area

Answers: 1, c; 2, d; 3, b; 4, f; 5, e; 6, a

**93. What is the differential diagnosis for a large tooth, and how would you differentiate between the conditions?**

The differential diagnosis includes macrodont or megadont, a geminated tooth, and fused teeth.

A macrodont is simply a larger version of one of the normal complement of teeth. Aside from the fact that the tooth is larger, it is otherwise normal. For example, the root will be in proportion to the size of the crown. The pulp chamber and canal will be in proportion to the size of the crown and root, respectively.

As a practical matter, geminated or fused teeth have an altered shape—that is, they never completely resemble a normal tooth. On clinical examination, there may be a “cleft” running down part or all of the crown. On radiographic examination, the roots often do not appear normal.

Gemination and fusion are most easily distinguished by counting the teeth. If there is a normal complement (including the altered tooth), one is dealing with gemination. If there is one tooth less than in a normal dentition, one is dealing with fusion.

**94. To what extent do the amount and degree of calcification in a tumor indicate its benign or malignant nature?**

Calcification has no significance in predicting the benign or malignant nature of a tumor. Benign tumors (e.g., odontomas, adenomatoid odontogenic tumors, ossifying fibromas) and malignant tumors (e.g., osteogenic sarcoma) produce bone or calcifications. To determine the benign or malignant nature of a tumor, other features must be sought.

**95. Which lesions may present with a soap bubble or honeycomb appearance?**

Ameloblastoma	Giant cell lesions
Keratocyst	Hemangioma
Primordial cyst	Calcifying epithelial odontogenic tumor
Aneurysmal bone cyst	Fibrous dysplasia
Cherubism	

**96. Assume that a bone (e.g., the mandible) is enlarged or expanded. Which feature would be most helpful when making an initially broad differential diagnosis?**

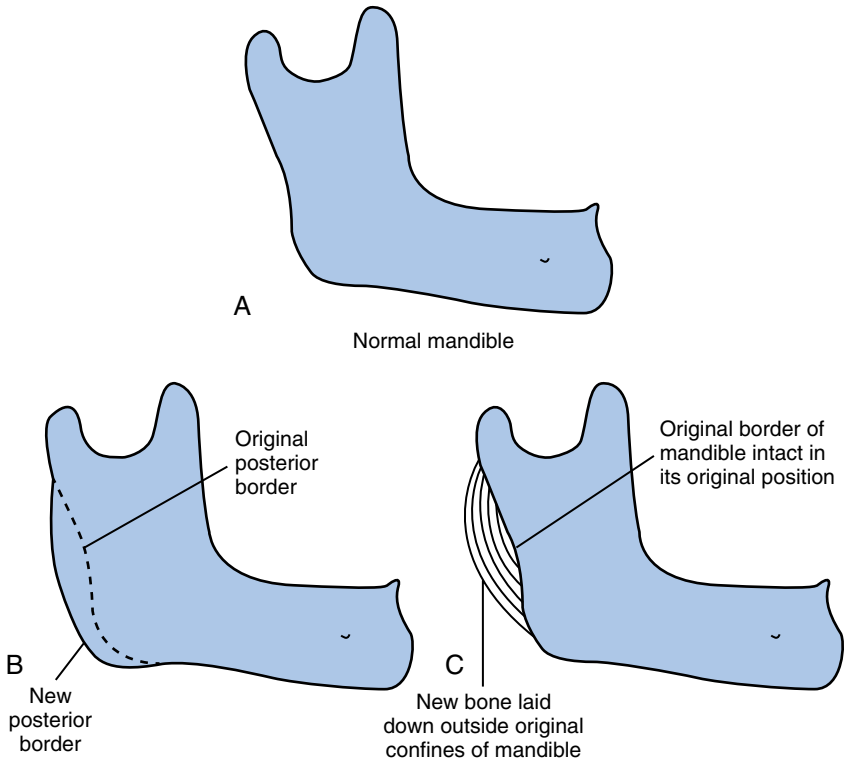
The most useful feature would be whether the disease process began inside or on the surface of the bone. If the original cortical boundary is intact and in its normal position, and the new bone has been laid down outside that bone, the new bone is of periosteal origin. With this appearance, the differential diagnosis would include conditions that result in a periosteal reaction. An infectious process would be most common. If the original cortex is on the outer surface of the expanded bone, the condition began in the bone. In that case, the differential would include diseases such as fibrous dysplasia, Paget’s disease, cemento-osseous dysplasia, and central (benign) cysts and tumors (Fig. 5-18).

**97. At times, it is very difficult to differentiate dense bone from tooth. What features should be sought to identify opacities of this nature?**

Features to look for are the following:

- The shape of the opacity—teeth typically have a certain distinctive shape. Remember that at times, one may be looking at a cross section of a tooth or part of it.
- Note the heterogeneity of the opacity. A tooth is not homogeneous, but has a denser outer surface (enamel) and a less dense bulkier portion (dentin) with a lucency, representing the chamber and/or canal in the center. If the opacity is just a root and not a whole tooth, there will be no enamel.





**Figure 5-18.** A, A normal mandible. B, Depiction of an expanded mandible in which the expansion is a result of pathology within the body of the bone. C, Representation of an expanded mandible in which the expansion is a result of new bone being laid down outside the confines of the original bone.

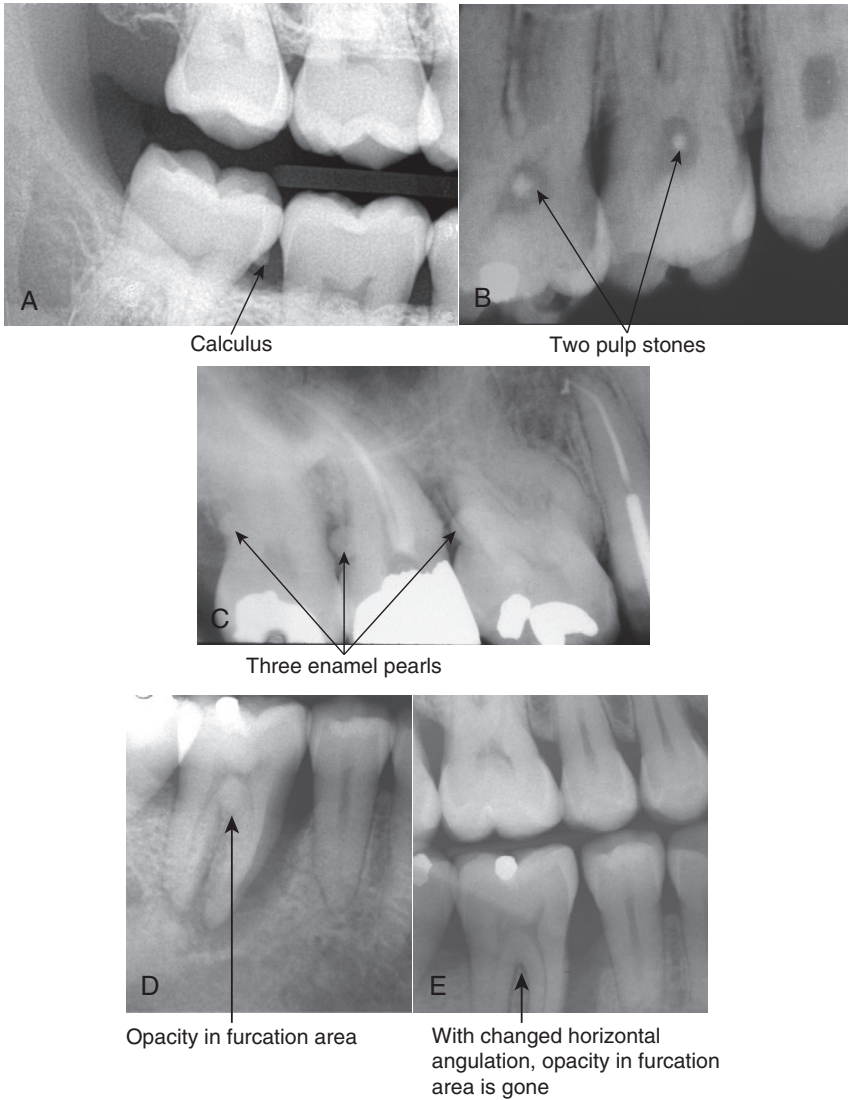
- A tooth is surrounded by a uniform radiolucency that represents the periodontal ligament space.
- In the case of a tooth, outside the periodontal ligament space will be a cortical border, the lamina dura.

**98. What common intracranial calcifications may be observed on a radiographic view of the skull, such as a cephalometric view? Which intracranial calcifications represent pathology and should be further evaluated?**

Physiologic calcifications include those of the pineal gland, choroid plexus, aura (falx cerebri, tentorium, vault), ligaments (petroclinoid, interclinoid), habenular commissure, basal ganglia, and dentate nucleus. Pathologic calcifications include calcifications in tumors (e.g., meningioma, craniopharyngioma, glioma), cysts (e.g., dermoid cyst), and infections (e.g., parasitic, as in cysticercosis; tuberculosis).

**99. What is the differential diagnosis for an opacity in or about the coronal aspect (crown) a tooth?**

The most common finding is probably calculus (Fig. 5-19A). A pulp stone and enamel pearl should be included in the differential diagnosis (see Fig. 5-19B and C). Calculus can be ruled in or out on clinical examination. It is easiest to differentiate between a pulp stone and enamel pearl by increasing the vertical angulation of the tube. If it is an enamel pearl, the opacity will move away from the pulp chamber. Finally, what appears to be an opacity may actually be an artifact. This occurs when x-rays pass obliquely through a molar,



**Figure 5-19.** A-E, Some common coronal opacities—calculus. These can usually be easily distinguished by their radiographic location and a clinical examination.

resulting in part of one root in the furcation area to be superimposed over another, causing an opacity. Another view taken at a different horizontal angle usually causes the opacity to disappear, revealing its true nature (see Fig. 5-19D and E).

**100. Certain teeth or tooth locations are more prone to anomalies than others. List the location in which anomalies of teeth are common, and describe those anomalies.**

The following teeth and locations are most commonly associated with anomalies:

- Third molars—congenital absence
- Mandibular second bicuspid—congenital absence of the tooth

Mandibular bicuspid region—supernumeraries (which may be multiple)  
 Maxillary lateral incisors—congenital absence, peg lateral, dens invaginatus  
 Maxillary midline—mesiodens, supernumerary (usually single)

**101. On a panoramic image, what are some of the signs that suggest a close association between an impacted mandibular third molar and the mandibular canal?**

Root darkening, narrowing of the tooth root, loss of the cortical boundaries of the canal, and diversion of the canal are some of the more common signs that suggest a close association between an impacted mandibular third molar and the mandibular canal. There is no agreement about which of these signs is the best predictor that exposure of the nerve or a clinical complication will occur. There does, however, appear to be general consensus that the absence of positive radiographic signs on the panoramic film is more useful than the presence of such signs. Without positive signs, the risk of injury to the nerve is considered miniscule, whereas the presence of one or more positive signs is not a good predictor of injury to the nerve.

**102. Mandibular first molar roots that have been displaced into the lingual cortex in a child is highly suggestive of what lesion?**

It likely indicates a buccal bifurcation cyst. The finding of first molar roots that have been displaced into the lingual cortex, together with the lesion being centered over the furcation, is considered to be pathognomonic; no other lesion displays these features.

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# PERIODONTOLOGY

*David Kim and Paul A. Levi, Jr.*

## FUNDAMENTALS OF THE PERIODONTIUM

- 1. Anatomically, what makes up the components of periodontium?**
  - The gingiva
  - Periodontal ligament
  - Root cementum
  - Alveolar bone
- 2. Sharpey's fibers are mainly composed of what type of collagen?**

They are mostly type I collagen.
- 3. What connective tissue fibers are normally found in the gingiva?**

Histologically, the fibers described are the dentogingival, dentoalveolar, dentoperiosteal, circular, and transseptal fibers.
- 4. What portion of the root is covered by acellular cementum? What portion of the root is covered by cellular cementum?**

Acellular cementum is located in the coronal and middle portion of the root. Cellular cementum is located in the apical third of the root.
- 5. Which blood vessels supply the gingiva?**

Supraperiosteal blood vessels from the sublingual, mental, buccal, facial, greater palatine, infraorbital, and posterior superior dental arteries supply the gingiva.
- 6. What are the components of the organic matrix of alveolar bone?**

They are mainly type I collagen (90%), with small amounts of noncollagenous proteins.
- 7. How is the width of attached gingiva determined?**

It is determined by subtracting the probing depth from the coronal width of the gingiva.
- 8. The gingiva is what type of mucosal tissue?**

The masticatory mucosa.
- 9. What is the principle cell type of the gingival epithelium?**

The keratinocyte.
- 10. What are the different cell types present in the connective tissue of gingiva?**
  - Fibroblasts
  - Mast cells
  - Macrophages
  - Inflammatory cells
- 11. What are the four layers of oral epithelium?**
  - Stratum basale
  - Stratum spinosum
  - Stratum granulosum
  - Stratum corneum

## CLASSIFICATION AND CAUSES OF PERIODONTAL DISEASES

- 12. What is the primary causative agent in periodontal disease?**

The primary cause of gingivitis and periodontitis is bacterial plaque, specifically gram-negative bacteria.

**13. How does the presence of gram-negative bacteria predispose the patient to periodontal disease?**

The toxins from bacteria may directly cause tissue destruction and stimulate and modulate the host response.

**14. Name the predominant bacterial species associated with periodontal disease.**

- *Porphyromonas gingivalis*
- *Aggregatibacter actinomycetemcomitans*
- *Tannerella forsythia*
- *Fusobacterium nucleatum*
- *Prevotella intermedia*
- *Campylobacter rectus*
- *Peptostreptococcus micros*
- *Eikenella corrodens*

**15. Which bacteria are associated with periodontal health?**

They are gram-positive facultative species and some members of *Streptococcus* and *Actinomyces* spp. (e.g., *Streptococcus sanguis*, *Streptococcus mitis*, *Actinomyces viscosus*, and *Actinomyces naeslundii*).

**16. What is the primary composition of plaque?**

Bacteria in the matrix of salivary glycoproteins and extracellular polysaccharides primarily compose plaque.

**17. What is the major difference between materia alba and plaque?**

Materia alba does not have the same organized structure as plaque, so it can be easily displaced.

**18. Why is the tooth a likely place for plaque accumulation?**

The tooth surface is nonshedding.

**19. What are the basic types of plaque? How do they differ in composition?**

The basic types of plaque are supragingival and subgingival. Supragingival plaque consists mostly of aerobes and facultative bacteria (mostly gram-positive), whereas subgingival plaque consists mostly of anaerobic bacteria (frequently gram-negative).

**20. What type of plaque is associated with caries?**

Supragingival plaque is associated with caries, predominantly gram-positive cocci and rods (e.g. *Streptococcus mutans*, lactobacilli).

**21. What role does the salivary pellicle play in plaque retention?**

Salivary pellicle attaches the tooth and allows for bacterial adhesion.

**22. Where is subgingival plaque located?**

It is found on hard tissue (enamel, cementum, dentin), soft tissue (adheres to the epithelial cells), and loose in sulcus.

**23. What are the two major factors determining the difference in composition between supragingival and subgingival plaque?**

They are the presence or absence of oxygen and availability of blood products.

**24. Do gram-positive cariogenic bacteria promote colonization by periodontal pathogens?**

No. The cariogenic bacteria tend to inhibit the gram-negative rods associated with periodontal disease by producing bacteriocins and other substances that inhibit gram-negative bacterial growth.

**25. Why is subgingival calculus generally darker than supragingival calculus?**

Inflammation leads to ulceration of epithelium, which then leads to subgingival bleeding, and blood pigment permeates the calculus.

**26. What terms are used to describe healthy gingiva?**

Healthy gingiva has scalloped, knife-like margins and a firm stippled texture. With an absence of melanin pigmentation, its color is uniform and has varying shades of pink.

**27. What terms are used to describe inflamed gingiva?**

The key word is inflammation; the cardinal signs of inflammation are calor, rubor, tumor, and dolor. All may apply to inflamed gingiva. The signs of inflammation in gingiva may be marginal or diffuse, depending on the location of the inflammation. The margins are described as rolled and, interproximally, it is often bulbous. The gingiva will be erythematous and edematous. The gingiva is frequently described as boggy because of edema, and stippling is lost in those areas.

**28. Anatomically, what are the two parts of gingiva?**

They are free gingiva (marginal gingiva) and attached gingiva.

**29. What is gingivitis?**

Gingivitis is an inflammation of the gingiva that is not causing a migration of the attachment apparatus apically.

**30. Which bacterial groups are generally associated with gingivitis?**

They are spirochetes, *Actinomyces* spp. (gram-positive filament), and *Eikenella* spp. (gram-negative rod).

**31. What other terms are used in the clinical description of gingival inflammation?**

Other terms describe severity (mild, moderate, severe), location (marginal or diffuse), and presence or absence of ulceration, suppuration, and hemorrhage. Other terms describing the architecture also may apply, such as blunting papilla and clefting.

**32. How should the gingiva be described in this diabetic patient?**

There is severe marginal erythema, evidence of edema, bulbousness, and rolling margin, and absence of marginal stippling (Fig. 6-1).

**33. Which viral infection is associated with linear gingival erythema?**

Linear gingival erythema (LGE) is frequently seen in HIV gingivitis. The gingival margin shows significant erythematous and hemorrhages easily.

**34. Does all gingivitis become periodontitis?**

No, gingivitis may persist for long periods without advancing to periodontitis.

**35. Does attachment loss occur without gingivitis?**

Yes, attachment loss can be induced by trauma (e.g., physical trauma) rather than bacteria.

**36. What causes gingivitis to become periodontitis?**

It is caused by microbial shift from gram-positive to gram-negative, from cocci to rods, from nonmotile to motile, and from facultative anaerobe to obligate aerobes.



**Figure 6-1.** The gingiva on this diabetic patient shows severe marginal erythema, evidence of edema, bulbousness, and rolling margin, and an absence of marginal stippling.

**37. What are the histologic characteristics of the initial lesion (stage I gingivitis)?**

Basically the vasculitis of the blood vessels is accompanied by an increase of gingival exudate from the sulcus. PMNs (polymorphonuclear leukocytes) migrate into the sulcus and junctional epithelium. The most coronal portion of the junctional epithelium is altered, and some perivascular collagen is lost.

**38. What are the histologic characteristics of the early lesion (stage II gingivitis)?**

Many of the changes are a continuation of the initial lesion. PMNs continue to migrate into the epithelium, and other lymphocytes follow. The collagen network continues to break down, and the junctional epithelial cells proliferate. Ulceration of the gingival sulcus is also noted.

**39. What are the histologic characteristics of the established lesion (stage III gingivitis)?**

A key component of the established lesion is the predominance of plasma cells in the connective tissue, with the production of antibodies, continued loss of connective tissue substance, and proliferation of junctional epithelium, with or without apical migration.

**40. What are the histologic characteristics of the advanced lesion (stage IV gingivitis)?**

Many of the features are similar to those of the established lesion. The advanced lesion extends to the periodontal ligament and alveolar bone with pocket formation and goes through periods of exacerbation and remission. There are more extensive cellular changes because of inflammation.

**41. A patient presents with heavy plaque and calculus without attachment loss. What is the periodontal diagnosis?**

It is dental plaque-induced gingival disease (Fig. 6-2).

**42. What are the clinical signs of necrotizing ulcerative gingivitis (NUG)?**

NUG is an acute recurring infection of the gingiva characterized by necrosis of the papilla (leading to blunting), spontaneous bleeding, pain, and fetor oris.

**43. Which bacteria are associated with NUG?**

The bacteria associated with NUG are a fusospirochetal complex—fusiform bacteria and spirochetes.

**44. How is necrotizing ulcerative periodontitis (NUP) different NUG?**

There is loss of clinical attachment and alveolar bone in NUP.

**45. Which bacteria are associated with gingivitis of pregnancy? Why?**

Bacteria associated with gingivitis of pregnancy are the black-pigmenting *Bacteroides* spp., which use steroid hormones for their own metabolism. Therefore, pregnancy essentially selects for these bacteria. Patients who use birth control pills or receive steroid therapy (for chronic autoimmune disease) are also at risk.



**Figure 6-2.** Patient with plaque-induced gingival disease. Note the heavy plaque and calculus. No attachment loss was present.

46. A pregnant patient presents with gingival swelling on the palatal of the #12/13 area. She presents with minimal plaque buildup, without radiographic evidence of bone loss. What is the ideal initial periodontal treatment (Fig. 6-3)?

The patient is diagnosed with pregnancy-associated gingivitis. The treatment will review plaque control technique and initiation of scaling. Following the initial treatment, gingival swelling has been reduced (Fig. 6-4).

47. What is the American Dental Association's periodontal diseases classification?

Type I	Gingivitis
Type II	Mild periodontitis
Type III	Moderate periodontitis
Type IV	Severe or advanced periodontitis

These categories are based on clinical and radiographic criteria, such as the amount of bone loss, pocket depth, and mobility.

48. How is chronic periodontitis further subclassified and characterized?

- Localized form: <30% of sites involved
- Generalized form: >30% of sites involved



Figure 6-3. Patient with pregnancy-associated gingivitis.



Figure 6-4. After treatment, the gingival swelling of patient seen in Figure 6-3 was reduced.



- Slight: 1 to 2 mm of clinical attachment loss
- Moderate: 3 to 4 mm of clinical attachment loss
- Severe:  $\geq 5$  mm of clinical attachment loss

**49. What are the clinical features of localized aggressive periodontitis (LAP)?**

- Clinical signs of inflammation and amount of local factors less than what would be expected for the severity of destruction
- Circumpubertal onset of disease
- Localized first molar or incisor disease with proximal attachment loss on at least two permanent teeth, one of which is a first molar
- Robust serum antibody response to infecting agents

**50. Initial radiograph shows no bone loss on #13. However, radiographs are taken 3 and 6 years later showed extensive progressive bone loss. What is the most appropriate diagnosis for this patient?**

It would be localized aggressive periodontitis (Fig. 6-5).

**51. What are the clinical features of generalized aggressive periodontitis (GAP)?**

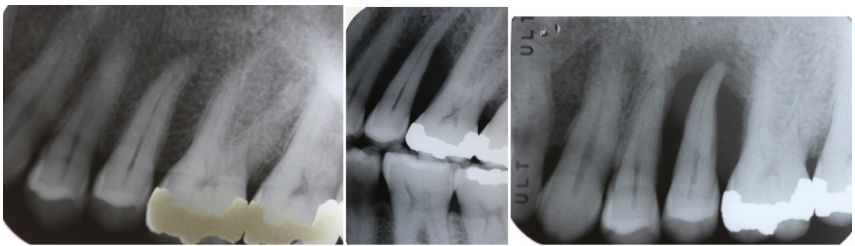
- Usually affecting persons younger than 30 (but may be older)
- Generalized proximal attachment loss affecting at least three teeth other than first molars and incisors
- Pronounced episodic nature of periodontal destruction
- Poor serum antibody response to infecting agents

**52. This patient presented with significant bone and clinical attachment loss, but minimal local factors. What is the most likely classification of this patient's periodontal disease?**

It would be generalized aggressive periodontitis (Fig. 6-6).

**53. What bacteria is commonly associated with aggressive periodontitis?**

It is *Aggregatibacter actinomycetemcomitans*.



**Figure 6-5.** Initial radiograph (left) and radiographs 3 (middle) and 6 years (right) after the initial radiograph of a patient with localized aggressive periodontitis. Extensive progressive bone loss is shown.



**Figure 6-6.** Clinical (left) and panoramic (right) views of a patient with generalized aggressive periodontitis. Significant bone loss and clinical attachment loss are present.

**54. What is the first cellular line of defense of the body against the periodontal pathogens?**

Other than the epithelial cell barrier, the first line of defense is the PMN.

**55. What is meant by a “burnout lesion” in a patient with LAP?**

At one point, the patient with LAP had an infection with periodontal lesions in which the chief infectious agent was *A. actinomycetemcomitans*. The body responds with an immunologic response and controls the infection, but the bony defect remains. The deep pocketing now becomes inhabited with bacterial flora, which is more characteristic of chronic periodontal lesions.

**56. Patients with deep periodontal pockets and heavy deposits of plaque and calculus may develop an acute periodontal abscess after scaling. Why?**

This is the result of incomplete removal of causative agents.

**57. What is a perio-endo (periodontal-endodontic) abscess?**

A perio-endo abscess is a combined lesion in which periodontal and endodontic problems occur simultaneously. The lesion can be initiated by extensive periodontitis or by pulpal pathology.

**58. What treatment is frequently used for a periodontal abscess?**

Initial treatment may consist of the establishment of drainage and removal of the causative agents (incision and drainage through the sulcus, along with scaling, root planing, and irrigation), followed first by a course of antibiotic therapy and then by surgical treatment, when needed.

**59. When is it safe to treat a pregnant woman’s nonacute periodontal problem?**

In general, the second trimester is the window of treatment for most dental procedures. If antibiotics or other medications are indicated, consult with the obstetrician.

**60. Which periodontal disease almost fulfills Koch’s postulates?**

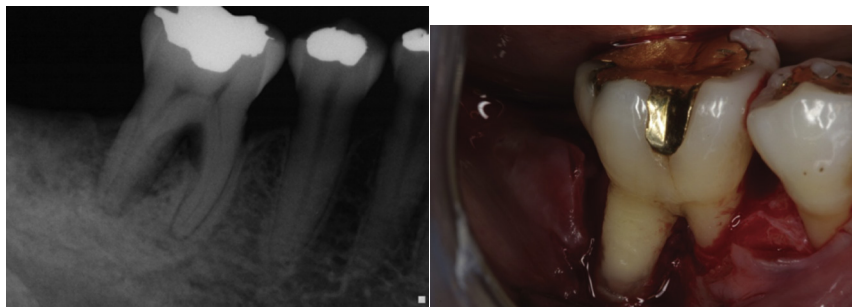
Koch’s postulates state that a pathogenic bacterium causes a disease, the disease is transmissible through the bacteria, and if you eliminate or control the bacteria, you eliminate the infection. *A. actinomycetemcomitans* (localized aggressive periodontitis) and *P. gingivalis* almost fulfill Koch’s postulates.

**61. Which bacterial group is associated with root caries?**

Root caries may be a problem for patients with gingival recession and xerostomia (whether induced by drugs, radiation, or some other agent). The bacteria associated with root caries are gram-positive rods and filaments, particularly *Actinomyces viscosus*.

**62. This patient presented with deep pocket depth and severe bone loss on #30. What is the most noticeable contributing factor that can be seen from the surgical exposure of the site?**

It is enamel projection (Fig. 6-7).



**Figure 6-7.** Radiographic (left) and clinical (right) views of severe bone loss and deep pocket depth on tooth #30. Note the significant enamel projection.

## CONCEPT OF DISEASE ACTIVITY

### 63. What is meant by active periodontitis?

It refers to periodontal inflammation causing an apical migration of epithelial attachment.

### 64. How is progressive periodontal disease activity measured?

Typically, disease activity (attachment loss) is measured by using a periodontal probe and fixed reference point, such as the cemento-enamel junction (CEJ). The change in the probing depth, excluding any changes in the gingival height caused by inflammation, determines disease activity.

### 65. What is the classic definition of the presence of periodontal disease?

It is attachment loss with the presence of plaque-induced gingival inflammation and radiographic evidence of bone loss.

### 66. How is the radiographic evidence of bone loss determined?

In a healthy state, the crestal bone levels are about 2 mm below the CEJ. In periodontitis, crestal bone is below this level.

### 67. Which radiographs tend to be most accurate in the determination of bone loss?

Vertical bitewings.

### 68. What is the most common pattern of bone loss in periodontal disease?

Horizontal bone loss.

### 69. What is bone sounding?

Sounding is used to provide the clinician with additional information regarding the morphology of a bony defect. The area in question is anesthetized, and a probe is forced through the epithelium and connective tissue in the sulcus/pocket until it strikes the crestal bone. Sounding may facilitate flap design.

### 70. How is periodontal disease activity described?

Patterns of periodontal disease activity include random burst and slow continuous processes.

### 71. What is the difference between a nonspecific and specific plaque hypothesis?

The nonspecific hypothesis simply states that it is the quantity—not the quality—of the plaque that causes periodontal disease. The specific plaque hypothesis states that specific organisms in the plaque cause periodontal disease.

### 72. What traditional clinical marker (other than a great change in attachment loss) may be significant in determining active periodontal disease?

It is bleeding on probing—the more bleeding, the higher the likelihood of periodontal breakdown.

### 73. Which two inflammatory mediators may be indicators of disease activity?

Interleukin-1 (IL-1) beta and tumor necrosis factor alpha may indicate disease activity.

### 74. What are the major risk factors for periodontal disease?

- Plaque
- Smoking
- Diabetes
- Incompetent immune system
- Genetics

### 75. What is the effect that open interproximal contacts can have on the periodontium?

Open interproximal can lead to food impaction, caused by plunger cusp activity, which can lead to inflammation and increased alveolar bone loss.

## PERIODONTAL DIAGNOSIS

### 76. How is a periodontal pocket defined?

It is a pathologically deepened sulcus that cannot be accessed by the patient for plaque removal.

**77. What is the difference between a suprabony and infrabony pocket?**

- An infrabony pocket is where the tip of the probe is apical to the crest of the adjacent alveolar bone.
- A suprabony pocket is where the tip of the probe is at or coronal to the crest of the adjacent alveolar bone.

**78. Which sites are routinely probed during a thorough periodontal examination?**

Six sites are commonly checked—the mesio-, mid-, and distobuccal sites, as well as the corresponding lingual and palatal sites. Most periodontists sweep the probe continuously through the sulcus to get a better feel for the pocket depths as a whole.

**79. What is a pseudopocket?**

It is a pathologically deepened sulcus formed by gingival enlargement or incomplete passive eruption without attachment loss.

**80. What is clinical attachment loss (CAL)?**

The most coronal portion of the epithelial attachment is apical to the cemento-enamel junction (CEJ). It is measured by adding the measurement of visible recession plus pocket/sulcus depth. If there is no visible recession it is the distance from the CEJ to the most coronal part of the epithelial attachment.

**81. Which is more important in the progression of periodontal disease, attachment loss or periodontal pocketing?**

Periodontal pocketing is more important because it is a pathologically deepened sulcus that cannot be maintained by the patient and can lead to additional attachment loss.

**82. Which is more important in defining periodontal disease, attachment loss or periodontal pocketing?**

Attachment loss is more important because the depth of a pocket does not necessarily indicate that there is bone loss.

**83. What are the two most significant clinical parameters for the prognosis of a periodontally involved tooth?**

The two most significant clinical parameters are mobility and attachment loss.

**84. What is gingival hypertrophy?**

Gingival hypertrophy indicates that there is an increase in size, generally because of edema.

**85. What causes gingival recession?**

- Toothbrush or floss abrasion
- Periodontal disease
- Trauma
- Prominent roots with a thin biotype
- Absence of a minimal zone of attached gingiva

**86. Which area of the oral cavity has the least amount of attached gingiva?**

The buccal mandibular premolar area commonly has the least amount of attached tissue.

**87. What is a long junctional epithelium?**

After a periodontal pocket has been scaled, root-planed, and curetted, a reattachment by epithelial cells to the root surface may occur. This reattachment is called a long junctional epithelium.

**88. What is the term for gingival cells that attach to the root cementum? How do they attach to the root?**

The term is *junctional epithelium*; the cells attach via mucopolysaccharides through hemidesmosomes.

**89. What are mucogingival defects?**

Mucogingival defects are defined by periodontal pocketing that extends to or beyond the mucogingival junction. It is an absence of attached gingiva.

**90. Is periodontal disease a risk factor for other diseases?**

Some epidemiologic evidence indicates that periodontal disease is a risk factor for some other chronic systemic diseases (e.g. diabetes, cerebrocardiovascular (CVA) disease, adverse pregnancy outcome).

**91. What is the crown-to-root ratio in a healthy dentition?**

As a general rule, the crown-to-root ratio in a healthy dentition is 1:2 (for each tooth). Teeth with poor crown-to-root ratios tend to have a poor prognosis, especially if mobility is significant.

**92. What root shapes generally have a more favorable prognosis?**

The crown-to-root ratio is very important. Long tapering roots are usually sturdier than short conical roots. Long root trunks in multirrooted teeth are more favorable than short root trunks.

**93. What is the difference between bony fenestration and bony dehiscence?**

Fenestration refers to a window in the bone, exposing the root. A dehiscence is where denuded areas of teeth extend through the marginal bone. Both are commonly noted in thin periodontium.

**94. What is positive bony architecture?**

Positive bony architecture is when the interproximal marginal bone is coronal to the cervical bone.

**95. What is negative bony architecture?**

Negative bony architecture is when the interproximal marginal bone is apical to the cervical bone.

**96. What is flat bony architecture?**

It is when both the cervical and the interproximal alveolar bone is at the same level.

**97. What is an ideal bony architecture?**

It occurs when positive bony architecture is at the same level throughout the arch.

**98. What are the basic classifications of bony defects?**

Bony defects are generally classified according to the number of bony walls that remain. For example, a one-wall defect has only one remaining wall of bone and two-wall defects have two remaining walls.

**99. Which bony defect is most likely to repair or fill naturally after treatment?**

Narrow three-wall periodontal defects are most likely to repair naturally after therapy because there is less denuded surface of tooth to regenerate.

**100. Name different microbiologic methods of assessing bacterial plaque.**

There are numerous ways to assess bacterial plaque. General categories include culturing, microscopic, enzymatic, and genetic methods.

**101. How are furcations classified?**

Furcations are classified according to probing. Class I furcations are incipient furcations, class II, approximately are halfway into the furcation, and class III are completely through a furcation, from the facial to the lingual.

**102. Why do diabetes, Papillon-LeFevre, and Chediak-Higashi diseases affect periodontium?**

With all these diseases, the normal cellular immunologic response is impaired. The white cells (PMNs) do not function properly. Therefore, patients are susceptible to periodontal infections.

**103. What is gingival crevicular fluid (GCF)?**

GCF is an ultrafiltrate of serum. Therefore, it contains many of the components of serum, particularly complement and antibody. The flow rates of GCF have been studied in an attempt to predict disease activity. Furthermore, investigators have been interested in GCF for other markers of periodontal breakdown (e.g., beta-glucuronidase, interleukin, and collagenase).

**104. Do links to specific genetic alleles predict a risk for periodontitis?**

Yes, a variation in the IL-1 beta allele may indicate a risk for periodontitis. This variation has been shown to be especially important in smokers.

**105. Do current smokers have the same levels of periodontitis as nonsmokers?**

Generally, smokers have more attachment loss than nonsmokers.

**106. What is the healing response of current smokers?**

Typically, the response to nonsurgical and surgical therapy is poorer in smokers than non-smokers.

**107. What happens to the risk of periodontitis and healing response if a patient stops smoking?**

When a patient becomes a former smoker, the risk for periodontitis decreases and the healing response improves.

**ADJUNCTIVE PERIODONTAL THERAPY****108. What antibiotics are used frequently to treat an acute periodontal abscess?**

After the establishment of drainage, penicillin V (500 mg every 6 hours for 7 days) provides adequate antibiotic coverage.

**109. What local delivery antibiotics may be advised for the treatment of chronic periodontitis?**

They are minocycline and doxycycline.

**110. What is the protocol for systemically treating aggressive periodontitis using antibiotics?**

Localized aggressive periodontitis has a preponderance of *A. actinomycetemcomitans* and is treated with a combination of amoxicillin and metronidazole.

**111. In a patient who is allergic to penicillin and erythromycin, what is the next antibiotic to be used for prophylaxis?**

It is clindamycin, 600 mg, 1 hour before treatment.

**112. Why are third-generation cephalosporins frequently contraindicated for the treatment of a periodontal abscess?**

Frequently, the spectrum of a third-generation cephalosporin becomes so specific that it does not provide adequate antimicrobial coverage. Penicillin should be the first choice; erythromycin or clindamycin may be used in penicillin-allergic patients.

**113. What complication may occur with the use of broad-spectrum antibiotics?**

A major problem is the development of pseudomembranous colitis, caused by the overgrowth and toxin production of *Clostridium difficile*.

**114. What are the major advantages and disadvantages of using local delivery doxycycline or minocycline for the treatment of periodontal disease?**

The spectrum of doxycycline and minocycline may be slightly better than mechanical debridement alone, particularly in covering *P. gingivalis*. Other advantages include less photosensitivity, less chelating, and better patient compliance when compared with systemic antibiotics. Because both antibiotics are fat-soluble, the dose is reduced to 50 or 100 mg twice daily.

**115. What is the major problem with the use of metronidazole?**

When prescribing metronidazole, you should advise patients that they must refrain from alcohol or they may become violently ill from the combination (Antabuse effect). Patients should always be advised not to mix any medicine with alcohol.

**116. Why is metronidazole effective in treating a periodontal infection?**

The periodontal pathogens are predominantly anaerobic, and metronidazole is effective in treating anaerobic infections.

**117. What is local drug delivery?**

Local drug delivery devices have been developed to administer a drug directly to the site of infection, the periodontal pocket. The advantages of such devices include the elimination of many of the side effects associated with systemic delivery.

**118. What are the typical indications for locally administered antibiotics?**

This mode of delivery is generally used for periodontal pockets that are more than 5 mm, bleed on probing, and are resistant to conventional mechanical therapy.

**119. What preparation is required before administering locally delivered antibiotics?**

Teeth should be thoroughly scaled and root-planed.

**120. What pathway do nonsteroidal anti-inflammatory drugs (NSAIDs) block?**

NSAIDs block the cyclooxygenase metabolism of arachidonic acids.

**121. Which mouth rinse appears to be most effective in the control of bacterial plaque?**

Chlorhexidine gluconate is the most effective oral rinse for controlling bacterial plaque, particularly because it leaves the greatest residual concentration in the mouth after use.

**122. HIV-positive patients frequently manifest a condition termed hairy leukoplakia in their oral cavity. Which microbe is commonly associated with hairy leukoplakia? What is the treatment for this condition?**

*Candida albicans* (yeast) is frequently associated with hairy leukoplakia and should be treated with an antifungal medication, such as nystatin or fluconazole. Chlorhexidine rinses should also be used because chlorhexidine is effective against *C. albicans*.

**123. What is the primary symptom of root sensitivity?**

In general, the primary symptom is sensitivity to cold.

**124. What other symptoms indicate dental sensitivity?**

In addition to cold, hot, touch (tactile), biting pressure, sweets, and sour foods may cause sensitivity.

**125. What is the cause of root sensitivity?**

Root sensitivity is believed to be caused by the movement of fluid in the dentinal tubules, which stimulates the pain sensation (hydrodynamic theory).

**126. What factors may contribute significantly to dentinal sensitivity?**

Toothbrush abrasion, periodontal and orthodontic treatment, gingival recession, acidic foods, and bruxism contribute significantly to dentinal sensitivity.

**127. How is root sensitivity treated?**

Primary treatment is good plaque control by the patient. In addition, treatment of root sensitivity can involve seal coating of the root. Substances routinely used are fluoride mouth rinses, fluoride toothpastes, desensitizing toothpaste, and application of composite restoration.

**128. How do root desensitizers work?**

A number of methods are used, including protein precipitants (e.g., strontium chloride), dentinal tubule blockers (e.g., fluorides, oxalates), nerve desensitizers (potassium nitrate), and physical means, such as burnishing the root and using composites, monomers, and resins.

**OCCLUSAL TREATMENT****129. What is the role of occlusion in periodontal disease?**

Occlusal trauma by itself will not cause attachment loss; however, with preexisting periodontitis, it may exacerbate attachment loss.

**130. Define primary and secondary occlusal trauma.**

Primary occlusal trauma refers to excessive force applied to a tooth or teeth with normal supporting structures. Secondary occlusal trauma refers to when normal occlusal forces become excessive because of loss of attachment.

**131. Define fremitus.**

Fremitus is vibration or movement of tooth in functional (centric) occlusion. It is premature contact in functional occlusion.

**132. Is trauma from occlusal force reversible?**

Yes. However if attachment loss occurs as a result of periodontal disease and occlusal trauma, the removal of force will not reverse the attachment loss.

**133. Does traumatic occlusion lead to pockets or recession?**

There is no research to show that occlusal trauma alone leads to pockets or recession.

**134. When is a night guard indicated?**

A night guard is indicated whenever the signs or symptoms of bruxism or parafunctional habits are found.

**135. What are the clinical signs of bruxism?**

Signs of bruxism may include occlusal or incisal wear facets, temporomandibular joint (TMJ) symptoms, masticatory muscle soreness, tooth mobility, fractured teeth or restorations, and widened periodontal ligament spaces (seen on radiographs). These signs may occur in various combinations.

**136. What criteria should be followed in constructing a night guard for the treatment of bruxism?**

A night guard should have four characteristics: (1) it should be made of processed acrylic; (2) it should snap gently over the occlusal surfaces of the maxillary teeth; (3) it should occlude evenly with the mandibular teeth in centric occlusion; (4) it should not interfere with lateral or protrusive excursion; and (5) it should be adjusted so that it is comfortable.

**137. When should the splinting of teeth be considered?**

Splinting of teeth is performed to stabilize mobile teeth and stabilize teeth that might become more mobile following periodontal therapy and for the patient's comfort. Any fixed splint should allow access for the patient to clean the teeth.

**138. What types of splints may be fabricated?**

Examples include interproximal application of composite, composite with mesh or wire reinforcement, and other fixed prostheses.

**139. What do widened periodontal ligament spaces indicate?**

Widened periodontal ligament spaces can be indicative of occlusal trauma.

**140. Can orthodontic treatment mitigate the forces of occlusion?**

Yes, it can be used along with occlusal adjustment, occlusal guards, and splinting.

**141. What are the causative factors of the defect on #30 distal shown in Figure 6-8?**

- Plaque
- Occlusal trauma

**142. What is the trauma from occlusion?**

The microscopic changes in the periodontal ligament as a result of traumatic forces represent trauma from occlusion.



**Figure 6-8.** Defect on tooth #30 caused by plaque and occlusal trauma.



## INITIAL TREATMENT OF PERIODONTAL DISEASE

### 143. What is scaling?

Scaling is the removal of hard and soft deposits (plaque and calculus) from tooth surfaces.

### 144. When are scalers used?

Scalers are used to remove hard and soft deposits supragingivally.

### 145. What is root planing?

Root planing is the smoothing of the subgingival root surfaces with a curette. The objective of root planing is to remove deposits and cementum in an attempt to achieve gingival reattachment.

### 146. What is gingival curettage?

Curettage is the removal of the gingival sulcular lining of the periodontal pocket. This procedure is frequently performed with root planing to promote gingival attachment.

### 147. What are the goals of initial periodontal therapy?

The objectives of initial therapy are to instruct and motivate the patient in plaque removal, remove hard and soft tissue deposits from tooth and root surfaces, and achieve pocket reduction, with possible reattachment.

### 148. When do bacterial populations reach pretreatment levels?

Typically, bacteria repopulate the periodontal pocket as soon as 4 to 6 weeks.

### 149. What is the treatment routinely used for NUG and NUP?

Treatment consists of debridement (scaling and root planing) with an antibiotic. Penicillin VK, 500 mg, four times daily for 7 days. Pain relievers are prescribed, if needed. Rinsing with hydrogen peroxide or chlorhexidine is also recommended. Instructions for oral hygiene must be emphasized.

### 150. What is nonsurgical therapy to treat periodontal disease?

Nonsurgical therapy is plaque control technique instruction and scaling and root planing.

### 151. A patient presents with pain and swelling associated with mandibular anterior teeth. Radiographic evidence of bone loss is seen. What is the ideal initial periodontal treatment for the patient at this visit?

The patient is diagnosed with a periodontal abscess, so mechanical debridement to establish drainage and systemic administration of an antibiotic (e.g., penicillin VK, 500 mg 4 times daily for 7 days) are indicated (Fig. 6-9).



**Figure 6-9.** Left, Significant swelling on the mandibular anterior teeth. The patient was diagnosed with periodontal abscess. Right, Radiographic view shows bone loss.

## SURGICAL TREATMENT OF PERIODONTAL DISEASE

### 152. What are the advantages of pocket-reducing periodontal surgery over nonsurgical treatment?

The most important reason for performing periodontal surgery is to provide the clinician with access for thorough scaling and root planing and other hard tissue therapy. In addition, it is performed to reduce the pocket so that the patient will have access for plaque control.

### 153. Name the major complications that may be associated with periodontal surgery.

As with any form of surgery, the patient might experience pain, swelling, infection, and bleeding. In addition, gingival recession and root hypersensitivity may occur.

### 154. When is gingivectomy indicated?

Gingivectomy is indicated for pocket reduction with normal osseous architecture in the presence of an adequate zone of gingiva.

### 155. What drugs may cause gingival hyperplasia?

These include phenytoin, nifedipine, and cyclosporine A. These medications stimulate the proliferation of gingival fibroblasts, causing an overgrowth of the gingiva. Other drugs that may cause gingival hyperplasia include calcium channel blockers (e.g., verapamil, felodipine, nisoldipine, diltiazem, amlodipine), antiepileptics e.g., lamotrigine, mephenytoin), mycophenolate, an immunosuppressive, sertraline, an antidepressant, pimozide, an antipsychotic, and interferon alpha-2 beta.

### 156. In performing a gingivectomy, how do you assess the level of initial incision?

A gingival pocket marker will provide a bleeding point on the facial gingiva at the level of the initial incision.

### 157. What instruments are commonly used to perform a gingivectomy?

Interproximal knives (e.g., Orban 1/2) or gingivectomy knives (e.g., Kirkland 15/16) are used.

### 158. What is a Widman flap?

A Widman flap is also known as open or flap curettage. Sulcular or submarginal incisions are made initially, and full-thickness flaps are elevated beyond the mucogingival junction for debridement, scaling, and root planing. Flaps are then apically positioned and closed with sutures.

### 159. What is a modified Widman flap?

It is similar to the original Widman flap, but it does not remove noninflamed gingiva and does not displace the gingival margin apically.

### 160. What is a full-thickness periodontal flap?

After the incision is made, a full-thickness flap involves elevation of the entire soft tissue, including periosteum.

### 161. What is a partial-thickness periodontal flap?

A partial-thickness flap involves the splitting (dissection) of the gingival flap, leaving the periosteum adherent to the bone.

### 162. Why are inverse bevel incisions frequently used in flap surgery?

Inverse bevel incisions facilitate degranulation by thinning the flap. Also, thinning of the flap may promote reattachment of the gingiva to the root by placing connective tissue elements against the root when the flap is closed.

### 163. What is an apically positioned flap? When is it most frequently performed?

After the flap has been elevated, and the necessary treatment has been performed, the gingiva is positioned at the crest of bone. This procedure is usually performed after osseous surgery (e.g., positive architecture, crown lengthening) and may require a vertical releasing incision.

### 164. What is an osteoplasty?

An osteoplasty is the reshaping or recontouring of nonsupportive bone. An example is the recontouring and ramping of interproximal bone to eliminate a crater.



**Figure 6-10.** Grade I furcation on the mesial of tooth #14. No other areas of attachment loss are present. Note the overhanging amalgam restoration.

**165. What is an osteotomy?**

An osteotomy is the removal of supporting bone. This procedure is usually performed to create positive or flat architecture or to increase the clinical crown length.

**166. What is an odontoplasty? Where is it commonly applied?**

An odontoplasty is the reshaping and smoothing of the root morphology. Teeth with developmental grooves in the roots, such as the premolars and maxillary lateral incisors, may develop localized periodontal defects because bacterial plaque and calculus are found in the defects.

**167. What comprises the biologic width?**

The biologic width consists of junctional epithelium and connective tissue attachment.

**168. When is a physiologic crown-lengthening procedure indicated?**

The procedure is indicated when the clinical crown length is inadequate for the placement of a dental restoration. Generally, there should be 4 to 6 mm between the apical extent of preparation and the crest of bone. This measurement maintains a proper biologic width plus sulcus depth.

**169. A patient presents with a grade I furcation involvement on the mesial of tooth #14 and no other areas of attachment loss. What is the contributing factor for this?**

It is violation of the biologic width by a plaque-retentive overhanging amalgam restoration (Fig. 6-10).

**170. A dentist refers you a patient for a #19 crown lengthening procedure. What factors need to be considered prior to performing the procedure?**

There is a buccal furcation involvement, and the margin of the restoration ends at the buccal furcation (Fig. 6-11).

**171. How are furcation involvements detected clinically?**

A periodontal probe and Nabers periodontal probe are used to detect furcation involvements.

**172. How are furcations routinely treated?**

The treatment of furcations depends on the extent of bone loss. Therapy ranges from scaling and root planing to curettage or guided tissue regeneration, with or without grafting material.

**173. What is the relationship between root trunk length and a furcation invasion?**

The longer the root trunk, the less likelihood of having a furcation invasion.



**Figure 6-11.** Tooth #19 presents with buccal furcation involvement. Note the margin of the restoration ends at the buccal furcation.

**174. What is a distal wedge procedure? Where is it commonly found clinically?**

As the name implies, in the distal wedge procedure, a block of soft tissue is removed from the distal aspect of a tooth to reduce the pocket depth. Distal wedge procedures are frequently done after the extraction of a third molar.

**175. Why is a palatal flap pocket-reducing procedure done in the maxillary anterior without elevating a labial flap?**

The rationale behind this procedure is to maintain the buccal gingival architecture to minimize aesthetic changes.

**176. In what location should a vertical-releasing incision be made?**

It should be made at the line angle to include entire papilla.

**177. What is crestal anticipation?**

This term is commonly used to describe the width of the submarginal incision technique on palatal tissue so that the flap will be positioned at the crest of the alveolar bone, as the flap cannot be apically repositioned.

**178. When is a root amputation indicated?**

It is indicated for stable teeth with a periodontal defect when there is a root proximity problem. The removal of the root will eliminate the pocket and create an interradicular space.

**179. Which teeth are most frequently involved in root amputation procedures?**

They are generally the maxillary molars.

**180. What is the potential obstacle for performing pocket-reducing osseous surgery for teeth #2 to #3?**

It is root proximity and an overhanging amalgam restoration (Fig. 6-12).

**181. List common suturing techniques for an apically positioned flap.**

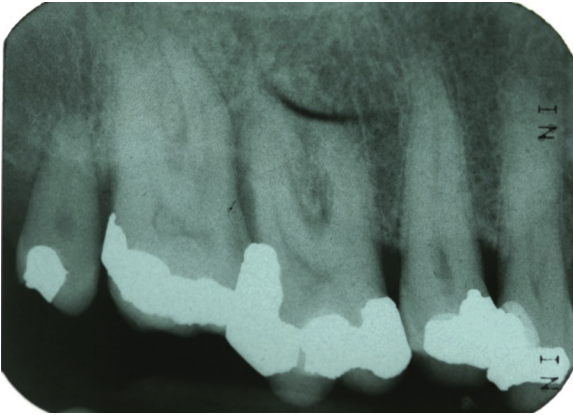
They are the sling suturing technique, vertical mattress suturing technique, and simple interrupted technique.

**182. A patient presents with localized osseous defect on the mesial of tooth #31 and expresses a strong desire to retain the tooth. What is the most ideal surgical periodontal treatment option for this patient?**

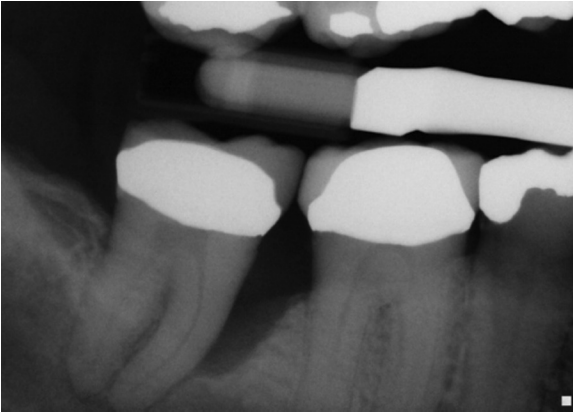
It is open flap debridement, with a possible osseous regeneration procedure (Fig. 6-13).

**183. Ideally, when and why should a silk suture be removed following periodontal surgery?**

It should be removed in 7 days because of the wicking effect of the silk.



**Figure 6-12.** Radiographic view of teeth #2 and #3 showing root proximity and overhanging amalgam restoration.



**Figure 6-13.** Radiographic view of localized osseous defect on the mesial of tooth #31.

**184. What surgical periodontal procedure is performed as adjunctive therapy for orthodontic tooth rotation? How successful is it?**

Routinely, a fibrotomy is performed to prevent relapse of the tooth rotation. However, a fibrotomy generally is not enough. The rotated tooth still requires some type of stabilization.

**185. What medications may affect salivary flow? How may they affect periodontal health?**

Many medicines may influence salivary flow, especially tricyclic antidepressants and antihypertensives. Decreased salivary flow diminishes the natural cleansing of the oral cavity, thus increasing the incidence of periodontal disease and caries. Be alert for supragingival and subgingival root caries.

## **MUCOGINGIVAL SURGERY**

**186. When should a gingival augmentation be considered as treatment for gingival recession?**

It should be considered when there is an inadequate zone of attached gingiva.

**187. What are the most common autogenous soft tissue graft procedures used to treat mucogingival defects?**

The most common grafting procedures are connective tissue and free gingival grafts. Other grafting procedures include the pedicle or lateral sliding flap.

**188. How is bleeding controlled after the palate has been used as the donor site for a free gingival graft?**

There are a number of ways to control bleeding at the donor site, including the following: (1) pressure with a moistened gauze; (2) pressure with a tea bag; (3) vasoconstriction (epinephrine in the local anesthetic); (4) suturing (tie off the bleeders); (5) collagen, with or without a stent; (6) topical thrombin; and (7) chemical or electrical cauterization. If bleeding continues, it may be prudent to assess the prothrombin time (PT), partial thromboplastin time (PTT), and platelet count.

**189. What is the primary reason for failure of a free gingival graft?**

It is an inadequate blood supply.

**190. What is the ideal treatment for the lack of attached gingiva on tooth #27?**

It is a free gingival graft (Fig. 6-14).

**191. What is meant by sloughing of a free gingival graft?**

After a free gingival graft has been placed, healing involves revascularization of the graft. The superficial layers of the graft are the last to be revascularized; therefore, the layer dies, producing a slough.

**192. What type of flap is used at the recipient site of a connective tissue or free gingival graft?**

Partial-thickness flaps are used so that the periosteum remains attached to the bone because the periosteum is the blood supply for the graft.

**193. Why does caution need to be taken when placing a free gingival graft in the buccal area of the mandibular premolars?**

One should be aware of the location of the mental foramen in relation to the apical aspect of the bed preparation to avoid injuring the mental nerve.

**194. When does the greatest amount of shrinkage occur with a free gingival graft procedure?**

It occurs within the first 6 weeks.

**195. In relationship to gingival recession, when is a frenectomy indicated?**

Because the frenum is a mucosal tissue, recession could occur when the attachment of the frenum provides an insufficient zone of attached gingiva; therefore, removal of the frenum is indicated.



**Figure 6-14.** Tooth #27 showing a lack of attached gingiva.

**196. What procedure may be performed in conjunction with a frenectomy to prevent recurrence?**

A free gingival graft is performed in conjunction with a frenectomy to prevent recurrence of fiber attachment to the papilla.

**197. What classification system is used to characterize mucogingival defects?**

The Miller classification, classes I to IV, is used; the class depends on the width, depth, and location relative to the mucogingival junction.

**198. Which of the Miller classes respond best to a root coverage procedure?**

Miller class I and II defects can have excellent results when treated with a connective tissue graft.

**199. Why do certain Miller classes have better root coverage predictability?**

The presence of interdental bone provides a better blood supply.

**200. What are the factors that could have contributed to the gingival recession on the palatal side of the maxillary right posterior teeth shown in Figure 6-15?**

They are toothbrush abrasion, a prominent root, and thin bone.

**201. What is the ideal treatment for facial gingival recession for the mandibular right posterior teeth?**

It is a root coverage procedure using autogenous or allogeneic tissue (Fig. 6-16).



**Figure 6-15.** Gingival recession on the palatal side of the maxillary right posterior teeth.



**Figure 6-16.** Facial gingival recession on the mandibular right posterior teeth.



**Figure 6-17.** Infrabony defect on the distal of tooth #6.

## REGENERATIVE PROCEDURES

### 202. What type of bony defect is found on the distal of #6?

It is an infrabony defect (Fig. 6-17).

### 203. What are the basic types of bone-grafting materials used for the treatment of periodontal defects?

Grafts include autografts (intraoral, extraoral), allografts, alloplasts, and xenografts. The autografts may be harvested from the patient's hip and rib (extraoral) or from a healing extraction socket, chin, maxillary tuberosity, or retromolar areas (intraoral). Allografts consist of freeze-dried bone and freeze-dried decalcified bone from another source (usually cadaver bone). Alloplasts are synthetic materials; the most commonly used are tricalcium phosphate, calcium carbonate, and hydroxyapatite. Xenografts are typically bovine-based.

### 204. What is osseous coagulum? Where is it used?

Osseous coagulum is another type of grafting material, normally obtained during osseous surgery. The bone or blood shavings are collected and then packed into the defect in an attempt to promote new bone formation. Because the bone is predominantly cortical, the results are not predictable.

### 205. What is bone swaging?

Bone swaging is the bending and breaking of the bony walls into the periodontal defect. It also has poor predictability and is not often used.

### 206. When should an intraoral autograft from an extraction site be harvested?

As a general guideline, the intraoral autograft should be harvested 6 to 8 weeks after extraction. This gives the extraction site enough time to become organized with osteogenic components.

### 207. What negative sequelae may occur with autogenous bone grafts when used in a periodontal regeneration procedure?

Possible sequelae include ankylosis and root resorption.

### 208. Why are connective tissue grafts used for soft tissue ridge augmentation?

They are used for aesthetic and phonetic reasons to augment an edentulous concave site.

### 209. What sites are commonly used to harvest connective tissue for grafting?

Common sites include the hard palate and maxillary tuberosity.

### 210. What commercially available growth factors may potentially be used to stimulate osseous regeneration?

Platelet-derived growth factor and bone morphogenetic protein have been used in human clinical trials.





**Figure 6-18.** Panoramic (left) and clinical views (middle, right) of a Seibert class III ridge defect in the mandibular anterior ridge.

**211. What is guided tissue regeneration (GTR)? How is it done? Where is it most successful?**

GTR is a regeneration of cementum, periodontal ligament (PDL), and bone. A barrier membrane with and without underlying graft material or growth factor is used for this procedure. This procedure is most successful for narrow, three-wall defects.

**212. What is the purpose of a barrier membrane?**

The membrane prevents apical migration of the epithelium and growth of connective tissue into the defect and allows for proliferation of the PDL along the root surface. It stabilizes the graft and helps to maintain space.

**213. What surgical techniques may be used for hard tissue ridge augmentation?**

Bone graft materials with a barrier membrane are commonly used.

**214. What are the indications for ridge augmentation?**

Basically, it is used whenever more bony volume is indicated. Examples include future placement of an implant and filling a concavity after tooth extraction for aesthetic reasons.

**215. When is ridge preservation indicated following tooth extraction?**

It is indicated when the facial or lingual walls are thin or missing in the aesthetic zone, and when bone remodeling following healing would preclude an adequate volume of bone for the placement of dental implants.

**216. Following the extraction, which bony surface resorbs the most?**

It is the facial surface towards the lingual.

**217. What are the Seibert classes for edentulous ridge defects?**

Class I: Buccolingual loss of ridge contour

Class II: Coronoapical loss of ridge contour

Class III: A combined loss of both coronoapical and buccolingual dimensions

**218. What is the Seibert classification for the mandibular anterior edentulous ridge?**

It is Seibert class III (Fig. 6-18).

## DENTAL IMPLANTS

**219. Define osseointegration.**

Osseointegration is defined as direct bone-to-implant contact at the light microscopic level. At the clinical level, bone appears to be fused to the implant.

**220. What is the difference between one-stage and two-stage implant placement?**

For a one-stage implant, a healing abutment is attached at the time of implant placement while a cover screw is attached to the implant and soft tissue is placed over the two-stage implant.

A second surgical procedure is required to remove the cover screw and place the healing abutment. This is generally done a few months after implant placement.

**221. Clinically, what determines a successful implant?**

It is indicated by healthy peri-implant soft tissue, with a stable bone level around the implants. Patient comfort, function, and aesthetic requirements need to be considered.

**222. In which region of the jaws are dental implants the most successful?**

Dental implants in the anterior mandible have the highest success rate. The highest rate of failure is in the posterior maxilla.

**223. When is sinus elevation indicated?**

It is indicated when there is insufficient volume of bone to place an implant without invading the sinus.

**224. What is the minimum crestal bone height required for an osteotome sinus elevation procedure?**

A minimum of 4 to 5 mm of crestal bone height is necessary to stabilize the implant.

**225. When do you consider doing bone augmentation around the dental implant?**

Bone augmentation should be considered when implant threads are exposed or the facial or lingual bone is less than 1 mm thick.

**226. What parameter usually indicates a failing implant?**

It is indicated by radiographic bone loss in combination with soft tissue inflammation (bleeding on probing and purulence).

**227. What parameter indicates a failed implant?**

It is implant mobility.

**228. What considerations are important during the surgical placement of implants?**

During the osteotomy, the implant site should be cooled during drilling. In addition, the implant should have primary stability (no movement).

**229. What bacteria are associated with peri-implantitis?**

Many of the same species associated with peri-implantitis are also associated with periodontitis, including *A. actinomycetemcomitans*, *P. gingivalis*, and *P. intermedia*. Other species frequently detected by cultural methods are *Capnocytophaga* spp., *Campylobacter rectus*, and *Eikenella corrodens*.

**230. What can cause a dental implant to fail?**

Dental implant failure can result from occlusal overload and/or peri-implantitis.

**231. How are implants maintained?**

Implants require maintenance, much like crowns, bridges, and natural teeth. The maintenance instruments on the implant or abutment are usually plastic-tipped or made of titanium so that the surface of the implant is not scratched. Floss, superfloss<sup>®</sup>, and braided floss are also handy.

**PERIODONTAL MAINTENANCE****232. What does the typical periodontal maintenance procedure involve?**

Generally, the appointment involves reviewing medical and dental histories, evaluating periodontal status, an oral hygiene review and instructions, scaling, root planing, and polishing. Radiographs may also be indicated.

**233. Why is it preferable to review oral hygiene technique prior to doing scaling and root planing during the maintenance visit?**

It is important to reinforce plaque control techniques because patients have to maintain their dental health following the appointment. If the techniques are reviewed at the outset of the appointment it will be perceived by the patient as most important and because if the patient has difficulty with the techniques they can be again reviewed at the completion of the scaling and polishing.

**234. After periodontal therapy is completed, what should be the recall interval?**

The recall interval should be individualized. Usually, a 3- to 4-month interval is recommended for periodontally compromised patients.

**235. How important is periodontal maintenance?**

Regular periodontal maintenance is extremely important to the long-term prognosis of the dentition. If patients fail to adhere to routine maintenance, their periodontal status is likely to become worse.

**236. Which clinical parameters are generally used to indicate periodontal breakdown?**

Bleeding on probing and increased probing depths typically indicate periodontal breakdown.

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# ENDODONTICS

Steven Levine

## DIAGNOSIS

### 1. What is the proper role of the pulp tester in clinical diagnosis?

The pulp tester excites the nervous system of the pulp through electrical stimulation. However, the pulp tester suggests only whether the tooth is vital or nonvital; the crucial factor is the vascularity of the tooth. The pulp test alone is not sufficient to allow a diagnosis and must be combined with other tests.

### 2. What is the importance of percussion sensitivity in endodontic diagnosis?

Percussion sensitivity is a valuable diagnostic tool. Once the infection or inflammatory process has extended through the apical foramen into the periodontal ligament (PDL) space and apical tissues, pain is localizable with a percussion test. The PDL space is richly innervated by proprioceptive fibers, which make the percussion test a valuable tool.

### 3. Listening to a patient's complaint of pain is a valuable diagnostic aid. What differentiates reversible from irreversible pulpitis?

In general, with **reversible pulpitis**, pain is elicited only on application of a stimulus (e.g., cold, sweets). The pain is sharp and quick but disappears on removal of the stimulus. Spontaneous pain is absent. The pulp is generally noninflamed. Treatment usually is a sedative dressing or a new restoration with a base. **Irreversible pulpitis** is generally characterized by pain that is spontaneous and lingers for some time after stimulus removal. There are various forms of irreversible pulpitis, but all require endodontic intervention.

### 4. What are the clinical and radiographic signs of an acute apical abscess?

Clinically, an acute apical abscess is characterized by acute pain of rapid onset. The affected tooth is exquisitely sensitive to percussion and may feel "elevated" because of apical suppuration. Radiographic examination may show a totally normal periapical complex or slightly widened PDL space because the infection has not had enough time to demineralize the cortical bone and reveal a radiolucency. Electric and thermal tests are negative.

### 5. Discuss the importance of inflammatory resorption.

Resorption after avulsion injuries depends on the thickness of cementum. When the PDL does not repair and the cementum is shallow, resorption penetrates to the dentinal tubules. If the tubules contain infected tissue, the toxic products pass into the surrounding alveolus to cause severe inflammatory resorption and potential loss of the tooth.

### 6. After a luxation injury, ankylosis and replacement resorption can occur. How does this process take place?

After extensive dental trauma that affects a large part of the root surface, an acute inflammatory response ensues. Because of the inflammatory response, the root surface loses its cementum. The cells that repopulate the root surface are often bone cells instead of periodontal ligament cells, which migrate more slowly. Thus, the migratory precursor bone cells produce bone that forms where cementum was and directly contacts the root without any attachment complex, such as the PDL. This bone ingrowth, which continually forms and resorbs the root, is characteristic of replacement resorption.

### 7. A patient presents with a gumboil, or fistula. What steps do you take to diagnose the cause or determine which tooth is involved?

All fistulas should be traced with a gutta percha cone because the originating tooth may not be directly next to the fistula. Fistulas positioned high on the marginal gingiva, with concomitant deep probing and normal response of teeth to vitality testing, may have a periodontal cause.

**8. Why is it often difficult to find the source of pain in endodontic diagnosis when a patient complains of radiating pain without sensitivity to percussion or palpation?**

Teeth are often the source of referred pain. Percussion or palpation pain may be lacking in a tooth in which the inflammatory process has not reached the proprioceptive fibers of the periodontal ligament. The pulp contains no proprioceptive fibers.

**9. What is the anatomic reason that pain from pulpitis can be referred to all parts of the head and neck?**

In brief, nerve endings of cranial nerves (CNs) VII (facial), IX (glossopharyngeal), and X (vagus) are profuse and diffusely distributed within the subnucleus caudalis of the trigeminal cranial nerve (CN V). A profuse intermingling of nerve fibers creates the potential for referral of dental pain to many sites.

**10. Is there any correlation between the presence of symptoms and histologic condition of the pulp?**

No. Several studies have shown that the pulp may actually degenerate and necrose over a period of time without symptoms. Microabscess formation in the pulp may be totally asymptomatic.

**11. Describe the process of internal resorption and the necessary treatment.**

Internal resorption begins on the internal dentin surface and spreads laterally. It may or may not reach the external tooth surface. The process is often asymptomatic and becomes identifiable only after it has progressed enough to be seen radiographically. The cause is unknown. Trauma is often but not always implicated. Resorption that occurs in inflamed pulps is characterized histologically by dentinoclasts, which are specialized, multinucleated giant cells similar to osteoclasts. Treatment is prompt endodontic therapy. However, once external perforation has caused a periodontal defect, the tooth is often lost.

**12. How can one deduce a clinical impression of pulpal health by examining canal width on a radiograph?**

Although not a definitive diagnostic tool, pulp chamber and root canal width on a radiograph may suggest pulp health. When compared with adjacent teeth, very narrowed root canals usually indicate pulpal pathology, such as degeneration caused by prior trauma, capping, pulpotomy, or periodontal disease. Conversely, root canals that are very wide in comparison to adjacent teeth often indicate prior pulp damage that has led to pulpal necrosis.

**13. What is the significance of the intact lamina aura in radiographic diagnosis?**

The lamina aura is the cribriform plate or alveolar bone proper, a layer of compact bone lining the socket. Because of its thickness, an x-ray beam passing through it produces a white line around the root on the radiograph. Byproducts of pulpal disease, passing from the apex or lateral canals, may degenerate the compact bone; its loss can be seen on a radiograph. However, this finding is not always diagnostic, because teeth with normal pulp may have no lamina aura.

**14. Which radiographic technique produces the most accurate radiograph of the root and surrounding tissues?**

The paralleling or right angle technique is best for endodontics. The film is placed parallel to the long axis of the tooth and beam at a right angle to the film. This technique allows the most accurate representation of tooth size.

**15. What is the definition of a true combined lesion?**

A true combined lesion is caused by endodontic and periodontal disorders that progress independently. The lesions may join as the periodontal lesion progresses apically. Such lesions, if any chance of healing is to occur, require endodontic and aggressive periodontal therapy. Usually, the prognosis is determined more by the extent of the periodontal lesion.

**16. Why does the radiographic examination not show periapical radiolucencies in certain teeth with acute abscesses?**

One study showed that 30% to 50% of bone calcium must be altered before radiographic evidence of periapical breakdown appears. Therefore, in acute infection, apical radiolucencies may not appear until later, as treatment progresses.

**17. Why do pulpal-periapical infections of the mandibular second and third molars often involve the submandibular space?**

Extension of any infection is closely tied to bone density, proximity of root apices to cortical bone, and muscle attachments. The apices of the mandibular second and third molars are usually below the mylohyoid attachment; therefore, infection usually spreads to the lingual and submandibular spaces. The masticator space is often also involved.

**18. A patient presents with a large swelling involving her chin. Diagnostic tests reveal that the culprit is the lower right lateral incisor. What factor determines whether the swelling extends into the buccal fold or points facially?**

A major determining factor in the spread of an apical abscess is the position of the root apex in relation to local muscle attachments. In this particular case, the apex of the lateral incisor is below the level of the attachment of the mentalis muscle; therefore, the abscess extends into the soft tissues of the chin.

**19. A middle-aged woman has been referred for diagnosis of multiple radiolucent lesions around the apices of her mandibular incisors. The patient is asymptomatic, the teeth are normal on vitality tests, no cortical expansion is noted, and the periodontium is normal. Medical history and blood tests are normal. What is your diagnosis?**

The most likely diagnosis is periradicular cemental dysplasia or cementoma. This benign condition of unknown cause is characterized by an initial osteolytic phase in which fibroblasts and collagen proliferate in the apical region of the mandibular incisors, replacing medullary bone. The teeth remain normal to all testing. Eventually, cementoblasts differentiate to cause reossification of the area. Treatment is to monitor over time.

## CLINICAL ENDODONTICS (TREATMENT)

**20. What endodontic treatment guidelines should be followed for patients taking bisphosphonates?**

The literature suggests that patients taking intravenous (IV) bisphosphonates are at a much higher risk for developing bisphosphonate-associated osteonecrosis of the jaw (BONJ) than patients taking oral bisphosphonates. As recommended for patients with osteoradionecrosis, if the coronal structure is nonrestorable, it is prudent to perform nonsurgical endodontic treatment on involved teeth that would usually be extracted, even if only the roots are retained.

**21. What is current thinking on use of the rubber dam?**

The dam is an absolute necessity for treatment. It ensures a surgically clean operating field that reduces the chance of cross-contamination of the root canal, retracts tissues, improves visibility, and improves efficiency. It protects the patient from aspiration of files, debris, irrigating solutions, and medications. From a medicolegal standpoint, use of the dam is considered the standard of care.

**22. What basic principles should be kept in mind for proper access opening?**

Proper access is a crucial and often overlooked aspect of endodontic practice. The root canal system is usually a multicanaled configuration with fins, loops, and accessory foramina. When possible, the opening must be of sufficient size, position, and shape to allow straight-line access into the canals. Access of inadequate size and position invites inadequate removal of caries, compromises proper instrumentation, and inhibits proper obturation. However, overzealous access leads to perforation, weakening of tooth structure, and potential fracture.

**23. What is current thinking on the use of irrigating solutions in endodontics?**

Irrigating solutions, used in copious amounts during instrumentation, are critical in root canal therapy. Constant irrigation helps remove dentinal debris to prevent blockage, can dissolve organic tissue in the root, and exerts an antimicrobial effect in the root canal. Sodium hypochlorite, minimally in a 0.5% solution, exerts an antimicrobial effect, and a 2% chlorhexidine irrigation can eradicate *Enterococcus faecalis* biofilm in vitro and in vivo.



**24. Of what materials are endodontic files made?**

Hand instruments such as K-files, Hedstrom files, reamers, and K-Flex files are made from stainless steel. In the past, these instruments were made of carbon steel, but stainless steel bends more easily, is not as brittle, and can be autoclaved without dulling.

More recently, the explosion of nickel-titanium rotary and hand instruments has occurred. Nickel titanium (Ni-Ti) is very flexible and resists fracture well. The alloy has good elastic flexibility because of its low elastic modulus. The alloy is approximately 55% nickel and 45% titanium by weight, and its superelastic behavior allows the files to return to their original shape after the file is removed from the canal.

**25. Describe the metallurgic characteristics of nickel titanium rotary instruments that influence their use?**

Ni-Ti is a metallic alloy that exists in two crystalline forms, austenite and martensite. The transformation of the instrument between these two phases occurs when stresses that are applied suddenly change, such as the speed of use of the rotary or resistance, such as rotation around a narrowing curved canal. At such times, instrument separation can occur. The austenite phase occurs mainly at higher temperatures, whereas the martensite phase is predominant at lower temperatures and has higher fatigue resistance than the austenite form. Ni-Ti or nitinol wire has been subjected to a thermomechanical process that resulted in the manufacture of M-wire instruments, which exist more in the martensite phase at room temperature, versus the conventional Ni-Ti wire, which is in the austenite phase at room temperature. The M-wire instruments have much greater resistance to cyclic fatigue.

**26. What are the characteristics of a K-file?**

The K-file is made by machine grinding of stainless steel wire into a square shape (some companies produce a triangular shape). The square wire is then twisted by machines in a counterclockwise direction to produce a tightly spiraled file.

**27. What are the characteristics of a reamer?**

A reamer is made by machine twisting of a triangular stainless steel stock wire in a counterclockwise direction but into a less tightly spiraled instrument than the K-file.

**28. How does the K-flex file differ from a reamer?**

The K-flex file is produced from a rhomboid or diamond-shaped stainless steel stock wire twisted to produce a file. However, the two acute angles of the rhombus produce a cutting edge of increased sharpness and cutting efficiency. The low flutes made from the obtuse angles form an area for debris removal.

**29. How does filing differ from reaming?**

Filing establishes its cutting action on withdrawal of the instrument. The instrument is removed from the canal without turning. Thus, it basically uses a push-pull motion. Reaming is done by placing the instrument in the canal, rotating, and withdrawing.

**30. What is the recommended use for Gates-Glidden and Reeso drills?**

These two types of engine-driven instruments, especially the Gates-Glidden drills, are useful in the new recommended instrumentation technique of step-down preparation. They are helpful for the initial coronal preparation of the canal, thereby allowing easier, more efficient, and less traumatic apical preparation.

**31. What is RC-prep? How is it used?**

RC-prep is composed of ethylenediaminetetraacetic acid (EDTA) and urea peroxide in a Carbowax base. Its use as a canal lubricant is also enhanced by combination with sodium hypochlorite, which produces a bubbling action, allowing enhanced removal of dentinal debris and permeability into the tubules.

**32. What is the "Tooth Slooth"?**

Diagnosis of tooth fractures is often difficult. This simple but highly effective and well-designed instrument allows biting force to be applied one cusp at a time into an indentation (the cusp receptacle on the Slooth), thereby selectively examining each cusp separately in an attempt to locate a weakness caused by fracture.

**33. What is the status of the acceptability of root canal obturation materials?**

Gutta percha remains the most popular and accepted filling material for root canals. Numerous studies have demonstrated that it is the least tissue-irritating and most biocompatible material available. Although differences occur among manufacturers, gutta percha contains transpolyisoprene, barium sulfate, and zinc oxide, which provide an inert, compactible, dimensionally stable material that can adapt to the root canal walls.

N-2 pastes and other paraformaldehyde-containing pastes have not been approved by the U.S. Food and Drug Administration (FDA). Several studies have shown conclusively that such root-filling pastes are highly cytotoxic in tissue culture; reactions to bone include chronic inflammation, necrosis, and bone sequestration. Compared with gutta percha, the pastes are highly antigenic and perpetuate inflammatory lesions. Therefore, they are not considered the standard of endodontic care.

Recently, Resilon has been gaining popularity as an obturation system. It is a thermoplastic synthetic polymer root-filling material, containing bioactive glass and radiopaque fillers. The RealSeal technique, which uses Resilon, involves smear layer removal and then the use of a self-etching primer and sealer to provide a chemical bond between the filling material and sealer.

**34. Thermafil has become a popular technique. Describe some of its basic characteristics.**

Thermafil is a patented endodontic obturation technique that has become popular. After proper débridement and shaping of the root canal, the final working length is confirmed with an Ni-Ti verifier, which passively reaches the apical constriction. A corresponding Thermafil obturator made of a radiopaque plastic material (flexible central carrier), with a layer of alpha phase gutta percha, is selected. The obturator is heated and, on heating, the gutta percha is said to have excellent flow properties. The carrier and heated gutta percha are inserted to working distance and severed.

**35. What is the proper apical extension of a root canal filling?**

The proper apical extension of a root canal filling has been discussed extensively, and the debate continues. In the past, recommendations were made to fill a root canal to the radiographic apex in teeth that exhibited necrosis or areas of periapical breakdown and to stop slightly short of this point in vital teeth. It is now generally recommended that a root canal be filled to the dentinocementum junction, which is 0.5 to 2 mm from the radiographic apex. Filling to the radiographic apex is usually overfilling or overextending and increases the chance of chronic irritation of periapical tissues.

**36. Describe the walking bleach technique.**

The walking bleach technique is used to bleach nonvital teeth with roots that have been obturated. The technique involves the placement of a thick white paste composed of sodium perborate and Superoxol (35% H<sub>2</sub>O<sub>2</sub>) in the tooth chamber with a temporary restoration. Several repetitions of this procedure, along with in-office application of heat to Superoxol-saturated cotton pellets in the tooth chamber, are efficacious.

**37. Extensive cervical resorption after bleaching of pulpless teeth with the walking bleach technique using Superoxol, sodium perborate, and heat has been reported. What is the cause?**

In approximately 10% of all teeth, defects at the cementoamel junction allow dentinal tubules to communicate from the root canal system to the PDL. These tubules remain open, without sclerosis, if the tooth becomes pulpless at a young age. It is thought that the bleaching agents may leach through the open tubules to cause the resorption. Therefore, a barrier of some type is recommended, such as zinc, phosphate cement, or some type of light canal bonding agent.

**38. The treatment of cracked teeth is among the most complex decisions in endodontics and restorative dentistry. What tools should be used for the diagnosis of cracked teeth?**

1. Bite test with cotton roll and bite stick
2. Periodontal probing
3. Pulp testing
4. Transillumination

5. Methylene blue dye staining
6. Use of the microscope
7. Radiographs will not directly show a crack but will reveal lateral defects in long-standing cracks causing periodontal defects.

**39. Describe the crown-down pressureless technique of root canal instrumentation.**

With the crown-down pressureless technique, the canal is prepared in a coronal to apical direction by initially instrumenting the coronal two thirds of the canal before any apical preparation. This technique, popularized by Marshall and Pappin, minimizes apically extruded debris and eliminates coronal binding of instruments, thereby making apical preparation more difficult.

**40. What is the balanced forced concept of root canal instrumentation and preparation?**

The balanced force technique, popularized by Roane and Sabala in the mid-1980s, is based on the idea of balancing the cutting forces over a greater area and focusing less force on the area where the file tip engages dentin. The instruments of choice are K-type files, especially the Flex-R file, made with a triangular cross section and modified tip. This design allows for a decreased cross-sectional dimension, an increase in flute depth, and greater flexibility. The technique involves a quarter turn clockwise, with slight apical pressure, to engage dentin and then a half to three-quarter turn counterclockwise to remove debris from the first turn. After a few turns, the file is removed, cleaned and the canal copiously irrigated. Using a continuous motion, canals can be prepared with less ledging, less zipping of the apex, and lower chance of perforations.

**41. What is the frequency of fourth canals in mesial roots of the maxillary first molars?**

In an extensive study of maxillary first molars, 70% of the mesiobuccal roots contained a larger buccal and smaller lingual canal or two separate canals and foramina. This finding shows the importance of searching for a fourth canal to ensure clinical success.

**42. What about the manner of storage of an avulsed permanent tooth and its relationship to postreplantation success?**

After 15 to 20 minutes of extraoral exposure, the cell metabolites in the periodontal ligament have been depleted and need to be reconstituted before replantation. If available, the best storage media is Hanks' Balanced Salt Solution. This solution is biocompatible and can keep the periodontal ligament cells viable for hours because of its ideal pH and osmolality. Research has shown that soaking an avulsed tooth in this solution for 30 minutes prior to replantation can achieve a 90% success rate. This solution is available as Save-A-Tooth, is found in schools, and is prevalent at sporting events. If not available for storage, the best alternatives are saliva, milk, or saline.

**43. What is the current guideline for how long to splint an avulsed, mature tooth with complete root formation?**

A replanted mature tooth (root fully formed) should be splinted for a minimal period of 1 week. This amount of time is usually sufficient to ensure that periodontal support is adequate, because gingival fibers are usually healed by this time.

**44. What is the current thinking on the need for prophylactic root canal treatment on a mature, avulsed permanent incisor with closed apical foramen, where injury occurred less than one hour prior to treatment?**

Andreasen recommended that for an avulsed permanent incisor with mature apical formation ( $\leq 1$  mm), endodontic treatment should be performed prophylactically because the chance of pulp necrosis is extremely high. However, treatment should be delayed for 1 week after replantation because the root canal procedure and extraoral handling could adversely affect the periodontal ligament fibers. Therefore, replant and then splint for 1 week to allow periodontal fiber splicing; perform prophylactic endodontic treatment prior to splint removal.

**45. What is the recommendation for endodontic therapy for the avulsed permanent incisor (apex > 1 mm) in which treatment is initiated within 3 hours of injury?**

Andreasen recommended that in such cases, it is justified to replant and wait for possible revascularization of the pulp. However, the radiographic examination should be accomplished at 2 and 3 weeks postreplant to examine for any evidence of apical

periodontitis and root resorption. If any evidence is found, endodontic therapy should be started immediately, with calcium hydroxide placed to arrest root resorption.

**46. When an avulsed tooth is replanted, what are the recommendations concerning rigid or functional splinting?**

Studies have shown that an early functional stimulus may improve the healing of luxated teeth. It is advantageous to reduce the time of fixation to the time necessary for clinical healing of the periodontium, which may take place in a few weeks. Andreasen noted that prolonged rigid immobilization increases the risk of ankylosis; thus, the splint should allow some vertical movement of the involved teeth.

**47. What is the physiologic basis for the use of calcium hydroxide pastes for resorptive defects and avulsed teeth?**

The theory behind the use of calcium hydroxide pastes is that areas of resorption have an acidic pH of approximately 4.5 to 5. Such areas are more acidic than normal tissue because of the effects of inflammatory mediators and tissue breakdown products. The basic pH of calcium hydroxide neutralizes the acidic pH, thereby inhibiting the resorptive process of osteoclastic hydrolases.

**48. What is the current thinking on the use of intracanal medications in endodontic practice?**

The use of intracanal medications has changed greatly over the years. In the early years of endodontics as a specialty, many intracanal agents were used, such as formocresol, cresatin, and PBSC (penicillin-bacitracin-streptomycin-chloramphenicol paste). Calcium hydroxide pastes have become popular because several studies have shown their antibacterial effects. Their high pH can cause inactivation of bacterial enzymes, neutralize endotoxins, and dissolve organic tissue.

More recently, a 2% chlorhexidine gel has been studied and used as an intracanal agent, and a combination of calcium hydroxide and chlorhexidine has been found to be effective against *E. faecalis*, an organism shown to be prevalent in failed endodontic cases.

Therefore, the use of intracanal calcium hydroxide or chlorhexidine is considered of great importance in cases of treatment failure, teeth with apical lucencies, or teeth with persistent symptoms.

**49. Discuss the variations of postoperative pain in one-visit versus two-visit endodontic procedures.**

Several studies have shown no difference in postoperative pain in one-visit versus two-visit endodontic procedures. One study found that single-visit therapy resulted in postoperative pain approximately half as often as multiple-visit therapy.

**50. What is the treatment of choice for an intruded maxillary central incisor with a fully formed apex?**

Repositioning or surgical extrusion should be done immediately, with splinting for 7 to 10 days. Because pulpal necrosis is the usual outcome, pulpectomy prior to splint removal and placement of calcium hydroxide are recommended. Close observation every few months is needed.

**51. What is the desired shape of the endodontic cavity (root canal) for obturation in lateral and vertical condensation techniques?**

The canal should be instrumented and shaped so that it has a continuously tapering funnel shape. The narrowest diameter should be at the dentinocemental junction (0.5 to 1 mm from apex) and the widest diameter at the canal opening.

**52. Are electronic measuring devices for root canal of any clinical value in endodontic practice?**

Yes. Electronic measuring devices have been shown by several investigators to be accurate. In general, they work by measuring gradients in electrical resistance when a file passes from dentin (insulator) to conductive apical tissues. When the tip of the file contacts apical tissue, the circuit is complete, resistance decreases, and current can flow. This is announced to the operator by a signal such as flashing lights, beep, or dial readout, depending on the unit. These units are useful when the apex is obscured on a radiograph by sinus superimposition, other roots, or osseous structures.

**53. What is the accepted material of choice for pulp-capping procedures?**

Over the years, many materials have been studied for pulp capping. The importance of a biocompatible substance on an exposed pulp can prevent bacterial microleakage and protect the pulp against irritation caused by an operative procedure and toxicity of operative restorative procedures. For many years, calcium hydroxide was the material of choice for pulp capping and is still widely used. Calcium hydroxide, applied to exposed pulp, seems to cause necrosis of the underlying tissue, but the tissue contiguous to this forms calcific bridges. More recently, MTA (mineral trioxide aggregate) applied to pulp has been shown to stimulate dentin bridges, but with no significant differences from the use of calcium hydroxide. Recent studies have also shown that Biodentine, a calcium silicate cement with dentin-like mechanical properties, can stimulate reparative dentin when it contacts vital pulp tissue.

**54. Describe the process of apexification.**

Apexification involves the placement of agents in the pulpless permanent tooth, with an incompletely formed apex, to stimulate continued apical closure. Calcium hydroxide pastes have traditionally been the material of choice to achieve this, but a newer technique, gaining popularity, involves the use of MTA. The difference is that the traditional calcium hydroxide technique is performed over several visits, depending on the inductive effect of the calcium hydroxide to form a hard tissue barrier. The MTA technique is a one-visit technique during which the MTA is placed apically to form an apical barrier; MTA has been shown to support new hard tissue formation in the apical area of immature necrotic teeth.

**55. Describe the process of regenerative endodontic treatment, sometimes called pulpal revascularization, that is often used for the treatment of nonvital immature teeth?**

This process is another treatment technique for the necrotic tooth with immature root formation. The main difference from traditional apexification is that the canal is not mechanically cleaned to its determined length, but a file is used to induce bleeding into the root canal space. The resultant bleeding has been shown to form a blood clot in the canal and provide growth factors for cells and a matrix for pulp regeneration.

The procedure is done with copious irrigation. During the initial visit, an antibiotic paste of minocycline, ciprofloxacin, and metronidazole is introduced into the canal, not to the apex. A calcium hydroxide paste can also be used. During the second visit, the paste is flushed out, some apical bleeding is again induced and, on clotting, an MTA plug is gently placed in the canal and the access sealed. Again, the main difference between this process and classic apexification is that the regenerative procedure involves irritation of the apical tissues to induce bleeding into the canal.

**56. What is the accepted treatment for carious exposures in primary teeth?**

For carious exposures in primary teeth in which the tissue appears vital and the inflammation is only in the coronal pulp, the formocresol pulpotomy is still widely accepted. When a carious exposure shows total pulpal degeneration (necrosis), full pulpectomy is indicated, with placement of a resorbable zinc oxide–eugenol (ZOE) paste.

**57. What is the role of sealer cements in root canal obturation?**

Sealer cements are still widely recommended for use with a semisolid obturating material (gutta percha). The sealers fill discrepancies between the root filling and canal wall, act as a lubricant, help seat cones of gutta percha, and fill accessory canals and/or foramina apically.

**58. What biologic property is shared by all sealer cements used in endodontics?**

Studies of biocompatibility have shown that all sealer cements are highly toxic when freshly mixed, but the toxicity is reduced on setting. Chronic inflammatory responses, which usually persist for several days, are often cited as a reason not to avoid apical overextension of the sealer. Several studies have recommended the use of sealers that are more biocompatible, such as AH-26 and other calcium hydroxide–based sealers (noneugenol polymeric root canal sealer [Sealapex] and composite resin cements [CRCs]).

**59. When using Cavit as an interappointment temporary seal, what precautions must be taken?**

Cavit, which is a hygroscopic single paste containing zinc oxide, calcium and zinc phosphate, polyvinyl and chloride acetate, and triethanolamine, requires placement of at least 3 mm of material to ensure a proper seal and fracture resistance.

**60. What materials or devices are useful for removing gutta percha for retreatment?**

Initial removal should be done with endodontic drills (Gates-Glidden or Peezo) or by using a heated plugger to remove the coronal portion of the gutta percha. This procedure allows space in the canal for placement of solvents to dissolve any remaining material. Solvents include chloroform, xylene, methyl chloroform, and eucalyptol. Chloroform is the most effective, although it has been used less because of reported carcinogenic potential. Xylene and eucalyptol are the least effective. Once the remaining gutta percha has been softened, it can often be removed by files or reamers.

**61. What are the cause, histologic characteristics, and treatment of internal resorption?**

The exact cause is unknown, but internal resorption is often seen after trauma that results in hemorrhage of vessels in the pulp and infiltration of chronic inflammatory cells. Macrophages have been shown to differentiate into dentinoclast-type cells. With this proliferation of granulation tissue, resorption can occur. Treatment is to remove the pulpal tissues as soon as possible so that the tooth structure is not perforated.

**62. How can you diagnose the difference between internal and external root resorption?**

Often, it is difficult to tell the difference between the two definitively. One of the best techniques is often radiographic:

- External resorption defects move away from the pulpal space as the radiographic angle changes. With an internal defect, it does not change.
- Internal defects do not involve bone; thus, the lucent defect involves only the root. External resorption also includes bone resorption adjacent to the root.
- Periodontal probing is often a useful aid. A resorption defect at the level of the attachment apparatus often creates a periodontal defect that can easily be probed.
- With the advent of cone beam radiology (cone beam computed tomography [CBCT]), a more accurate diagnosis of the extent of the process can be elucidated.

**63. Does preparation of the post immediately on obturation have a different effect on the apical seal of a root canal filling than delayed preparation?**

Dye leakage studies have shown no difference and no effect on the apical seal whether post preparation is immediate or delayed.

**64. What is the best and easiest technique for sterilization of gutta percha cones?**

Immersion of the cone in a 5.25% solution of sodium hypochlorite for 1 minute is effective for killing spores and vegetative organisms.

**65. What techniques can be used to avoid apical ledging and perforation?**

Even with the advent of Ni-Ti instruments with great flexibility, ledging is a constant problem. To prevent such occurrences, a number of steps can be taken.

1. Proper access to allow for straight line access (if possible)
2. Initial canal negotiation with small, precurved files to allow for access to full apical extent
3. Use of smaller files, with proper lubrication and irrigation, until passive fit
4. Never forcing instruments to the apex
5. Proper technique, including crown-down instrumentation and balanced forced instrumentation
6. Patience

**66. Recently, MTA has gained acceptance as a root end filling material and a perforation repair material. Describe its properties and benefits.**

MTA is a powder composed mainly of tricalcium oxide, tricalcium aluminate, and tricalcium silicate, along with silicate oxide, which crystallizes in the presence of moisture. It is easy to mix and place in the root ends or perforations, is hydrophilic, and in leakage studies has been found to be favorable compared with amalgam and super EBA cement, which are other materials commonly used for the same purpose.

MTA is biocompatible and antibacterial, but has a long setting time and is expensive. Newer MTA formulas have shortened the long setting time.

**67. Which type of file is the strongest and cuts least aggressively?**

K-files are the strongest of all files. Because they cut the least aggressively, they can be used with a quarter-turn pulling, rasping, or clockwise-counterclockwise motion.

**68. List four criteria that must be met before obturation of a canal.**

1. The patient must be asymptomatic; the tooth in question must not be sensitive to percussion or palpation.
2. No foul odor should emanate from the tooth.
3. The canal should not produce exudate.
4. The temporary restoration should be intact—that is, no leakage has contaminated the canal.

**69. How does preparation of the canal for filling techniques that use gutta percha injections differ from that for conventional techniques?**

All injection techniques require a more flared canal body and a definite apical constriction to prevent flow of softened gutta percha into periapical tissues.

**70. Root perforations are an unfortunate consequence of root canal therapy. What factors are important in considering the potential success or failure of a root perforation?**

The most important consideration is the position of the perforation. Perforations near the cervical area of a root or into the pulp chamber have a poorer prognosis because of their proximity to the sulcus and potential for periodontal breakdown.

The second consideration is the use of a repair material that is biocompatible with periapical tissues, easy to use, adapts well with the perforation site, is stable, and is radiopaque. MTA has been in use for years. It is a bioactive biocompatible material, stable, and with a high ability to seal. A newer material, Biodentine, a calcium silicate–based material with positive regenerative properties, can be used for perforations.

Third, the timeliness of the perforation repair is important to minimize any potential for leakage in periradicular tissues, minimize inflammation, and promote repair.

**71. What is the treatment of choice for a primary endodontic lesion in a mandibular molar with secondary periodontal involvement (including furcation lucency) in a periodontally healthy mouth?**

Treatment generally consists solely of endodontic therapy. Necrotic pulpal tissue that causes furcation and lateral root or apical breakdown also may cause periodontal pockets through the sulcus, but these are actually fistulas rather than true pockets. Endodontic therapy alone often heals this secondary periodontal involvement.

**72. What about the prognosis for pulp capping and partial pulpectomy procedures on traumatically exposed pulps?**

In a study of traumatically exposed pulps, including mature teeth and teeth with immature apices, Cvek found that pulp capping or partial pulpectomy procedures were successful in 96% of cases. In all teeth, the superficial pulp in the traumatized area was carefully excised. Cvek and others have noted that such procedures are generally more successful in vital teeth with immature root formation.

**73. What is the ideal treatment for carious exposure of a mature permanent tooth?**

There is general agreement that carious exposure of a mature permanent tooth generally requires endodontic therapy. Carious exposure implies bacterial invasion of the pulp, with toxic products involving much of the pulp. However, partial pulpotomy and pulp capping of a carious exposure in a tooth with an immature apex have a higher chance of success.

**74. You have elected to perform partial pulpotomy and place a calcium hydroxide cap on a maxillary permanent central incisor with a blunderbuss apex in a young boy. What follow-up is necessary?**

Close monitoring of the tooth is necessary. First, it is important to see whether any pathology develops. If necrosis occurs with apical pathology, extirpation with apexification is needed. On the other hand, if vitality is maintained in such teeth, root formation continues, along with dystrophic calcification.

**75. What is the recommended technique for the access opening in endodontic therapy for maxillary primary incisors?**

A facial approach is generally recommended for such teeth, which need pulpectomy with a filling of ZOE paste. Because of aesthetic problems and the difficulty in bleaching, endodontic therapy is followed by composite facial restoration.

**76. Can infections of deciduous teeth cause odontogenesis of the permanent teeth?**

In one study, local infections of deciduous teeth for up to 6 weeks did not influence odontogenesis of the permanent central incisors. However, long-standing infections may have a profound effect on permanent teeth buds because of direct communication between the pulpal and periodontal vasculature of the deciduous tooth and the plexus surrounding the developing permanent tooth.

**77. Describe the characteristics of the Profile rotary instrumentation series.**

This series of Ni-Ti rotary files has a rounded guided tip and U-shaped flute for collecting debris. It is available in a 0.04 and 0.06 taper series; the 0.06 taper is used in a sequential series, allowing for a crown-down preparation.

**78. During instrumentation of a mandibular first molar, you separate the tip of an 0.06 series Profile Ni-Ti rotary file in the distal root. What steps should you take to rectify the situation and deal with any future problems?**

Separation of instruments during endodontic therapy is an unfortunate occurrence. With the increased use of Ni-Ti rotary instruments, it may even be increasing, because these instruments can thread into the canal.

The initial step is to try to remove the separated instrument. Currently, the best techniques are with the aid of a microscope. Ultrasonics is often used successfully to aid in the removal of instruments that are lodged in canals. In addition, several instrument systems are available to aid in removal if ultrasonic tips are not successful. One of the most popular is the Cancellier system, which uses cannulas glued onto the separated instrument tip in the canal and then attached to a threaded hand cannula, which hopefully will remove the instrument. Other techniques include the Masserann kit, Endo-Extractor system, and canal finder system. All these systems use small cannulas, which engage the fractured instrument, or a hand piece with specifically designed files that move in a vertical reciprocating movement to engage and loosen the file.

If all this fails, the canal is débrided and obturated to the best of your ability. The patient should be made aware of the fact that a portion of a sterile instrument has separated in the canal space and was incorporated into the root canal filling. The tooth should be restored, and there is a need for periodic follow-up. If any clinical or radiographic signs of failure occur, apical surgery with retrograde filling is required.

**79. In treating a maxillary lateral incisor, what particular care must be taken in instrumenting the apical portion?**

The apical root portion usually curves toward the distal palatal; this configuration must be negotiated carefully.

**80. Should the smeared layer of dentinal debris be removed from canal walls?**

Yes. Even though this has been a controversial topic, it is generally recommended to remove it. The smeared layer overlying the dentinal tubules has been shown to harbor microorganisms, so maintaining it affects a crucial goal in endodontic therapy, which is canal disinfection. In addition, its persistence increases microleakage after obturation.

One other important factor when recommending its removal is that studies have shown that removal of the layer enhances the retention of posts cemented with unfilled composite resin because of the ability of the resin to flow into open dentinal tubules, enhancing micromechanical retention.

**81. What is considered the most reliable technique to remove the smeared layer of organic and inorganic dentinal debris from canal walls?**

The recommended technique is the use of a chelating agent, such as 17% EDTA with sodium hypochlorite, during instrumentation. Other agents that have gained popularity are SmearClear, citric acid, and BioPure MTAD Root Canal Cleanser (an irrigant consisting of 3% doxycycline, 4.25% citric acid, and 0.5% polysorbate 80).



**82. What is the single most important factor in determining the degree and severity of the pulpal response to a tooth preparation (cutting) procedure?**

Research has shown that the remaining dentin thickness between the floor of the cavity preparation and pulp chamber is the most crucial determinant of the pulpal response. In general, a 2-mm thickness of dentin provides a sufficient degree of protection from the trauma of high-speed drills and restorative materials. With a thickness less than 2 mm, the inflammatory response in the pulp seems to increase dramatically. Neither age nor tooth size has as significant an effect.

**83. In restoring a tooth with a deep carious lesion, clinicians often excavate the caries and place a temporary sedative restoration to allow symptoms to subside. What is the rationale behind this procedure in relation to pulpal physiology?**

A deep carious lesion produces an inflammatory response in the pulp tissue adjacent to the dentinal tubules in the area of the caries. Removal of the irritation to the pulp and placement of a sedative filling allow new odontoblasts to differentiate and produce a reparative dentin in the involved area. This process usually requires approximately 20 days for odontoplastic regeneration and 80 days for reparative dentin formation.

**84. What is the most common reason for failure of root canals?**

Although an endodontically treated tooth may fail for various reasons, including fracture, periodontal disease, or prosthetic complication leading to one of these, the most common cause of failure is incompletely and inadequately débrided and disinfected root canals. The time-honored saying that what you take out of the canal is not as important as what you put in has much merit. The chemomechanical débridement of the root canal system, which is necessary to remove all irritants to the surrounding apical and periodontal tissues, is still the crucial aspect of root canal treatment.

**85. What is CBCT, and what are its benefits in endodontic therapy?**

Volumetric tomography was approved for dental use in the United States in 2000, and the current advances in cone beam computed tomography allow for very high-resolution and limited field images. In complex diagnostic cases, this limited field view approximates the same radiation as two periapical films while obtaining important diagnostic and treatment information. CBCT has excellent applications in patients in whom it would be difficult, with conventional radiography, to ascertain root morphology, presence or absence of additional canals, resorptive defects, root fractures, perforations, dens invaginatus, anatomic evaluation prior to surgery, and extent of bone lesions. It has become an invaluable tool in endodontic treatment planning.

**86. A patient presents with a chief complaint of sharp pain on mastication. On examination, a fractured cusp of a mandibular left first molar is noted, and on removal of the fractured cusp and placement of a provisional restoration, the pain goes away. What explains the pain?**

The pain was “dentinal pain” because of the effect of the movement of the fracture on the odontoblastic processes in the dentinal tubules. The removal of the fractured cusp and provisional restoration removed the cause.

**87. What is the proper treatment for a patient presenting to your office with acute thermal sensitivity associated with a fractured maxillary molar?**

Acute thermal pain usually signifies that the fracture is not just into the dentin, but has progressed deeper, proximally or into the pulp. If the periodontal examination is normal, and there are no moveable segments of the tooth, treatment would be endodontic therapy and prompt placement of a provisional crown.

## **PULP AND PERIAPICAL BIOLOGY**

**88. What is the dental pulp? Describe briefly the ultrastructural characteristics of this remarkable tissue.**

The dental pulp is a matrix composed of ground substance, connective cells and fibers, nerves, microcirculatory system, and highly specialized and differentiated cells called the odontoblasts. The dental pulp is similar to other connective tissues in the body, but its ability to deal with

injury and inflammatory reactions is severely limited by the mineralized walls that surround it. Therefore, its ability to increase blood supply during vasodilation is impaired.

**89. The odontoblast is a remarkable and unique cell. Briefly describe its major characteristics.**

The odontoblast is a highly differentiated cell that forms a pseudostratified layer of cells along the periphery of the pulp chamber. It is a highly polarized cell with synthesizing activity in its cell body and secretory activity in the odontoblastic process, which forms the predentin matrix. Because it is the main cell for dentin formation, injury by caries or restorative procedures may affect this activity.

**90. Give a brief description of the most accepted theory about the mechanism of dentin desensitization.**

The most plausible theories are based on the fact that the dentinal tubule acts as a capillary tube. The tubule contains fluid, or a pulpal transudate, that is displaced easily by air, heat, cold, and explorer tips. This rapid inward or outward movement of fluid in tubules may excite odontoblastic processes, which have been shown to travel within the tubules, or sensory receptors in the underlying pulp.

**91. A 45-year-old woman presents for consultation. She is asymptomatic. Radiographs reveal a radiolucent lesion apical to teeth #24 and #25, with no swelling or buccal plate expansion. The dentist has diagnosed periapical cemental dysplasia. How is this diagnosis confirmed?**

Periapical cemental dysplasia or cementoma presents as a radiolucent lesion in its early stages. It is a fibro-osseous lesion developing from cells in the periodontal ligament space. The teeth involved respond normally to vitality testing.

**92. What is the effect of orthodontic tooth movement on the pulp?**

In progressive, slow, orthodontic movement, minor circulatory changes and inflammatory reactions are reversible. However, with excessively severe orthodontic forces, disruption of pulpal vascularity may be irreversible, leading to disruption of odontoblasts and fibroblasts and possible pulpal necrosis. Rupture of blood vessels in the periodontal ligament also may affect pulpal vascularity. In addition, orthodontic tooth movement is associated with excessive root resorption and blunted roots, both of which may occur with continued vitality.

**93. Inflammatory mediators cause vasodilation of blood vessels. How does vasodilation in the pulp differ from that in other tissues?**

Vasodilation in all tissues is a defense mechanism, controlled by various inflammatory mediators, to allow tissue survival during inflammation. The pulp responds differently, with an increase in blood flow followed by a sustained decrease. This secondary vasoconstriction often leads to the demise of the pulp.

**94. Is it possible to differentiate a periapical cyst from a periapical granuloma on the basis of radiographic appearance alone?**

No. Radiographic appearance is not diagnostic. Often, a sclerotic border may be present, but its absence does not preclude cystic formation. An exhaustive study indicates that lesions larger than 200  $\mu\text{m}^3$  are usually cystic in nature.

**95. A patient presents with a maxillary central incisor that has a history of trauma. The patient is asymptomatic, and the radiograph is normal. Because the tooth gives no response to an electric pulp tester, you elect to do endodontic therapy without anesthesia. However, with access and instrumentation, the patient feels everything. Explain the inconsistency.**

The electric pulp tester excites the A-delta fibers in the tooth. The pulp contains A-delta and C nociceptive fibers. A-delta fibers have a lower stimulation threshold than C fibers. C fibers are more resistant to hypoxia and can function long after A-delta fibers are inactivated by injury to pulp tissue. The electric pulp tester does not stimulate C fibers.

**96. List six normal changes in pulp tissue because of age.**

1. Decrease in size and volume of pulp
2. Increase in number of collagen fibers,

3. Decreased number of odontoblasts
4. Decrease in number and quality of nerves
5. Decreased vascularity
6. Overall increase in cellularity

**97. What is the meaning of the term *dental pain*?**

Dental pain is caused by the outflow of fluid in dental tubules that stimulates free nerve endings, most likely A-delta fibers. Dental pain is usually associated with cracked teeth (into the dentin), defective fillings, or hypersensitive dentin. The pain produced by such stimulation does not usually signify that the pulp is inflamed or the tissue injured, whereas pulpal pain is caused by true tissue injury associated with the stimulation of C fibers.

**98. Do the odontoblastic processes extend all the way through the dentin?**

This topic has been debated extensively. The process is basically an extension of the cell body of the odontoblast. It is the secretory portion of the odontoblast and contains large amounts of microtubules and microfilaments. Light microscopic studies have generally shown odontoblastic processes only in the inner third of dentin; this finding agrees with scanning electron microscope studies and transmission electron microscope studies, which showed processes mainly in the inner third of dentin. However, one series of studies suggested that processes go all the way through dentin. More elaborate techniques with immunofluorescent antibody labeling against microtubules have also shown staining the entire length of the dentin, suggesting that the processes extend over the entire length of the dental tubule.

**99. Describe briefly the circulatory system of the dental pulp.**

The pulp contains a true microcirculatory system. The major vessels are arterioles, venules, and capillaries. The capillary network in the pulp is extensive, especially in the subodontoblastic region, where the important functions of transporting nutrients and oxygen to pulpal cells occurs, and waste products are removed. The pulpal microcirculation is under neural control and also under the influence of chemical agents, such as catecholamines, that exert their effects at the alpha and beta receptors found in pulpal arterioles.

**100. Have immunoglobulins and immunocompetent cells been found in the dental pulp?**

Yes. Numerous studies have demonstrated that the pulp and periapical tissues can mount an immune response against injury to the pulp and apical tissues. All classes of immunoglobulins have been identified in the dental pulp, and microscopic examination of damaged pulpal tissue reveals the presence of leukocytes, macrophages, plasma cells, lymphocytes, giant cells, and mast cells.

## MICROBIOLOGY AND PHARMACOLOGY

**101. Which two drugs are the latest of the macrolide class to be available for oral use?**

Two macrolide antibiotics have been developed and are available for oral use, azithromycin (Zithromax) and clarithromycin (Biaxin). Both drugs are part of the antibiotic prophylactic regimen for subacute bacterial endocarditis (SBE) prevention by the American Heart Association (AHA). Both drugs are absorbed well from the gastrointestinal (GI) tract when taken orally and are available for use in the AHA regimen for penicillin-allergic patients.

However, with the usual precautions for the use of this class, such as allergic reactions or GI upset, the FDA warned in 2012 that azithromycin should be used cautiously in patients at risk for cardiovascular events because it can cause abnormal changes in electrical activity, which could lead to a fatal, irregular heart rhythm.

**102. What types of bacteria are the predominant pathogens in primary endodontic-periapical infections?**

Many studies have shown the predominant role of gram-negative obligate anaerobic bacteria in endodontic-periapical infections. Earlier studies generally implicated facultative organisms (e.g., streptococci, enterococci, lactobacilli), but improved culturing techniques established the predominance of obligate anaerobes. Other studies have further demonstrated the important role of black-pigmented bacteria, mostly *Prevotella* and *Porphyromonas* spp. In the latter group, *Porphyromonas endodontalis* and *Porphyromonas gingivalis* are prominent. Other species implicated in primary endodontic cases include

*Fusobacterium nucleatum*, *Veillonella parvula*, and *Eubacterium* spp. A subsequent question will deal with the microbiology of periapical disease in failed root-filled teeth.

**103. What is considered the antibiotic of choice for the treatment of orofacial infections of endodontic origin?**

With all the microbiologic studies implicating the predominance of obligate anaerobes, drug sensitivity tests still show penicillins to be the drug class of choice. It is highly effective against most of the obligate anaerobes in endodontic infections and, because the infections are of a mixed nature, with strict substrate interrelationships among various bacteria, the death of several strains has a profound effect on the overall population of an endodontic-periapical infection. The penicillin class includes amoxicillin and Augmentin, a combination of amoxicillin and clavulanate.

**104. What antibiotics are considered most effective for the treatment of orofacial infections of endodontic origin that do not respond to penicillins?**

For infections not responding to penicillins, clindamycin is often recommended. It produces high bone levels and is highly effective against anaerobic bacteria, but must be used with caution because of the potential for pseudomembranous colitis. A second choice is metronidazole, which also is effective against gram-negative obligate anaerobes. In addition, metronidazole (Flagyl), can be combined with penicillin or amoxicillin for increased effectiveness.

**105. A patient presents to your office for endodontic therapy on a lower right first molar. The molar is extremely "hot," and you anticipate the need for intraligamentary anesthesia and potential instrumentation beyond the apex. Because of the patient's medical history, which is significant for mitral valve prolapse with regurgitation, antibiotic prophylaxis for endocarditis prevention is necessary. In addition, the patient has been on clarithromycin (Biaxin), 500 mg twice daily for 2 weeks, for a respiratory infection. Does the fact that the patient has been on this antibiotic obviate the need for additional prophylaxis?**

The current recommendation by the AHA committee on antibiotic prophylaxis for the prevention of SBE is that this patient should be treated with another class of antibiotics before endodontic therapy to prevent endocarditis. After 2 weeks of clarithromycin therapy, resistant organisms may be growing, and procedures such as ligamentary anesthesia and endodontic therapy, which can cause bacteremias, may allow resistant organisms to seed on a susceptible site, vegetate, and cause endocarditis. Therefore, the patient should be premedicated with another class of antibiotics, such as amoxicillin or clindamycin, before the endodontic procedure.

**106. What is the status of culturing and sensitivity testing for endodontic-periapical infections?**

Culturing and sensitivity testing have been a controversial topic in endodontic practice for years. According to current thinking, if the proper clinical guidelines are followed, including the use of a rubber dam, proper chemomechanical cleaning of the root canal system, and proper use of correct antibiotics as indicated, culturing and sensitivity testing are not required. Proper culturing for facultative and anaerobic bacteria is expensive, time-consuming, and not cost-effective, given the high success rate of properly done endodontic therapy.

**107. The role of gram-negative anaerobic bacteria is an established fact in the pathogenesis of endodontic lesions. What role do the bacterial endotoxins play?**

Endotoxins are highly potent lipopolysaccharides released from the cell walls of gram-negative bacteria. They are able to resorb bone via stimulation of osteoclastic activity, activation of complement cascades, and stimulation of lymphocytes and macrophages. Studies have demonstrated their presence in pulpless teeth (with necrotic tissue) and apical lesions.

**108. What three types of bacteria have been implicated in a large percentage of failed endodontic cases?**

Investigations have especially implicated *Enterococcus faecalis*, *Actinomyces* spp., and *Streptococcus anginosus* in cases of endodontic failure. These bacteria seem to be able to adhere to dentinal walls and debris forced through the apex and to colonize the dentinal tubules of pulpless necrotic teeth.

**109. What is the significance of these bacteria, which are commonly found in cases of endodontic failure?**

For years, it had been assumed that gram-negative bacteria are associated with symptomatic endodontic disease, and much evidence supported this assumption. However, more recent findings have shown that gram-positive bacteria are more often associated with persistent infections in cases of endodontic failure.

- *Enterococcus faecalis*, which is usually found in a low percentage in primary endodontic infections, is found in almost 30% to 40% of root canal failures. *E. faecalis* may be resistant to chemomechanical endodontic procedures and to calcium hydroxide, a common intracanal medication. Increased resistance to antibiotics has been noted in this species.
- *Actinomyces* spp., although of low pathogenicity, seem to be able to thrive in necrotic pulpal tissues and chronic periapical tissues for long periods without causing a host response. Low pathogenicity and ability to invade host tissues to set up a chronic infection is prevalent in therapy-resistant lesions.
- The *Streptococcus anginosus* group (*S. intermedius*, *S. constellatus*, and *S. anginosus*) is part of the normal oral flora, prevalent in purulent infections and highly prevalent in acute and chronic endodontic-periapical infections. This group is usually found in symbiotic relationships with other bacteria.

**110. The term *biofilm* is in the endodontic literature. What is the definition of biofilm?**

Various bacteria, each with different ecologic requirements, different abilities to create pathology, and different susceptibilities to antibiotic agents, can form a complex organized structure that is much more resistant to antimicrobial agents. The challenge in endodontics is to eliminate these biofilms as effectively as possible. The bacteria mentioned in question 109 are often implicated in these biofilms.

**111. What is the current recommendation for antibiotic prophylaxis for patients with a joint prosthesis?**

Even though there is no definitive antibiotic prophylactic regimen for patients with prosthetic joints, bacteremias during dental procedures are considered to be a major risk factor for a late joint prosthesis infection. For this reason, antibiotic prophylaxis is strongly urged. Consultation with the orthopedist is recommended. Usually, the prophylaxis regimen used for SBE prevention can be used for joint prosthetic protection, but variations may be recommended by various orthopedic surgeons.

**112. What role do nonsteroidal anti-inflammatory drugs (NSAIDs) have in endodontic practice?**

NSAIDs have a significant role in endodontic practice. Many patients require postoperative medication to control pericementitis, which can be painful after pulpectomy and may persist for several days. NSAIDs are effective; their mechanism of action is to inhibit the synthesis of prostaglandins. One study has shown that ibuprofen, when given preoperatively to symptomatic and asymptomatic patients, significantly reduces postoperative pericementitis.

**113. What about the role of black-pigmented anaerobic rods in the cause of infected root canals and periapical infection?**

Black-pigmented anaerobic rods have been shown to play an causative essential role in endodontic infections when present in anaerobic mixed infections. The most strongly implicated organism is *Porphyromonas endodontalis*, which, because of its need for various growth factors, is directly related to the presence of acute periapical inflammation, pain, and exudation.

**114. A patient presents with swelling and is in obvious need of endodontic therapy. His medical history is significant for penicillin allergy and asthma, for which he is taking theophylline (Theo-Dur). What precautions should you exercise?**

Erythromycin should not be used as an alternative to penicillin. Theo-Dur is a form of theophylline used for chronic reversible bronchospasm associated with bronchial asthma, and erythromycin has been shown to elevate serum levels of theophylline significantly.

**115. What efficacy do cephalosporins have for treating acute pulpal-periapical infections?**

Although the cephalosporins are broad-spectrum antibiotics, their activity is limited in pulpal-periapical infections, which are mixed infections predominantly caused by

obligate anaerobic bacteria. The cephalosporins are not highly effective against these bacteria and actually have lower activity against many anaerobes than penicillin. For serious infections that are penicillin- or erythromycin-resistant, clindamycin is much more effective because of its activity against the obligate and facultative organisms in pulpal-periapical infections.

**116. What precautions should be taken when prescribing antibiotics to a female patient who takes birth control pills?**

The dentist should warn the patient that oral antibiotics may decrease the effectiveness of birth control pills and that they may be ineffective during the course of antibiotic therapy. The most often implicated antibiotic is the penicillin class, although erythromycin, cephalosporin, tetracyclines, and metronidazole also have been implicated.

**117. The quinolone class of antibiotics, which includes ciprofloxacin, has become popular. Do quinolones have any role in treating alveolar infections?**

They have a very small role, if any. Most anaerobes implicated in endodontic-alveolar abscesses are resistant to the quinolones.

## ANESTHESIA

**118. What is the physiologic basis of the difficulty in achieving proper pulpal anesthesia in the presence of inflammation or infection?**

Attaining effective pulpal anesthesia in the presence of pulpal-alveolar infection or inflammation is often difficult because of changes in tissue pH. The normal tissue pH of 7.4 decreases to 4.5 to 5.5. This change in pH, caused by pulpal-periapical pathology, favors a shift to a cationic form of the local anesthesia molecule, which cannot diffuse through the lipoprotein neural sheath. Therefore, anesthesia is ineffective.

**119. What is the significance of the mylohyoid nerve in obtaining anesthesia of the mandibular first molar?**

The mylohyoid nerve is often implicated in unsuccessful anesthesia of the first molar. This nerve branches off the inferior alveolar nerve above its entry into the mandibular foramen. The mylohyoid nerve then travels in the mylohyoid groove in the lingual border of the mandible to the digastric and mylohyoid muscles. However, because it often carries sensory fibers to the mesial root of the first molar, lingual anesthetic infiltration may be required to block it.

**120. What is the method of action of injection into the periodontal ligament?**

Injection into the periodontal ligament is not a pressure-dependent technique. The local anesthetic works by traveling down the periodontal ligament space and shutting off the pulpal microcirculation. To be effective, this technique requires the use of a local anesthetic with a vasoconstrictor.

**121. The Gow-Gates block is an effective alternative to the inferior alveolar block. When is it indicated? Briefly describe how it works.**

In patients for whom the traditional inferior alveolar block is ineffective or impossible to perform because of infection or inflammation, the Gow-Gates block has a high success rate. It is a true mandibular block that anesthetizes all the sensory portions of the mandibular nerve. The injection site is the lateral side of the neck of the mandibular condyle; thus, it is effective when intraoral swelling contraindicates use of the inferior alveolar block.

**122. What is the reason for attempting to anesthetize the mylohyoid nerve for endodontic treatment of a symptomatic lower first molar?**

The mylohyoid nerve has been shown to supply sensory innervation to mandibular molars, especially the mesial root of first molars. Infiltration of this nerve as it courses along the medial surface of the mandible is often helpful.

**123. What is the status of ester-based local anesthetics in dentistry?**

Because of their increased allergenicity compared with amide-type local anesthetics, ester-based anesthetics were phased out in the mid-1990s.

- 124. A patient presents with an extremely painful lower molar requiring endodontic therapy. You have already used six cartridges of lidocaine with epinephrine to achieve anesthesia. The patient begins to react adversely. In brief, what are the signs of local anesthetic toxicity?**

Local anesthetic toxicity depends on the blood level and patient's status. In general, a mild toxic reaction manifests as agitation, talkativeness, and increased vital parameters (blood pressure, heart rate, and respiration). A massive reaction manifests as seizures, generalized collapse of the central nervous system, and possible myocardial depression and vasodilation.

- 125. A local anesthetic available in dental cartridges is called septocaine (Articaine). In brief, what features have made it so popular?**

Septicaine is an amide local anesthetic in the same class as lidocaine, prilocaine, and bupivacaine. It comes in a 4% solution, with a 1:200,000 concentration of epinephrine. However, because it is the only amide local anesthetic with an additional ester ring and thiophene ring, it has increased liposolubility, is extremely diffusible, and has a high capability to penetrate tissue. In addition, its plasma protein-binding value of 95% is higher than almost all local anesthetics and contributes to its effectiveness.

- 126. Many practitioners are now using phentolamine (OraVerse, Septodont) to reverse the effects of local anesthetics at the end of a dental procedure. What is the mechanism of action, and is it recommended for endodontic use?**

Phentolamine, available in 1.7-mL cartridges since May 2008, is given as a local injection in the same site as the local anesthetic injection. It is a nonselective, alpha-adrenergic blocking agent whose primary mode of action is vasodilation, thereby counteracting the vasoconstrictive action of locals with a vasoconstrictor added. Remember that all locals have vasodilator properties, which is why the vasoconstrictor is added. In endodontic therapy, it is often preferable to maintain the effects of the local anesthesia into the postoperative period and even to supplement with long-acting anesthesia, because of the potential for pain postoperatively in cases of acute periodontitis or apical abscess.

## SURGICAL ENDODONTICS

- 127. Methylene blue dye is a useful adjunct during endodontic surgery. What is its purpose?**

During endodontic surgery, it is often difficult to determine accurately the location of the exact root outline and where pulp tissue exists apically to prepare the retrograde preparation properly with ultrasonic tips. The methylene blue dye stains vital tissue, therefore well delineating the periodontal ligament space and any pulp tissue remaining in an isthmus or poorly instrumented and obturated root canal space.

- 128. What is the purpose of the apicoectomy procedure in surgical endodontics?**

Perpetuation of apical inflammation or infection often is caused by poorly obturated canals, tissue left in the canal or, often, an apical delta of accessory foramina containing remnants of necrotic tissue. The removal of this apical segment via apicoectomy usually removes the nidus of infection.

- 129. A patient presents for apicoectomy on a maxillary central incisor with failed endodontic therapy. A well-done porcelain to gold crown is present, with the gold margin placed in the gingival sulcus for aesthetic purposes. What flap design is most appropriate?**

A full mucoperiosteal flap involving the marginal and interdental gingival tissues may potentially cause loss of soft tissue attachments and crestal bone height, thereby causing an aesthetic problem with the gold margin of the crown. Instead, a submarginal rectangular flap (Luebke-Ochsenbein flap) that preserves the marginal and interdental gingiva is recommended.

- 130. What is the material of choice for root end fillings in surgical endodontics?**

Histologic studies have compared several materials, including amalgam, reinforced ZOE (EBA) cement, resins, polycarboxylate cements, glass ionomers, and gold foils. Although no study has shown a definitive superiority of one over another, the most commonly used today are Super EBA cement, MTA, and amalgam. The type is probably secondary in importance

to the root resection technique, apical preparation, curettage of the lesion, and technique for placement.

- 131. What type of scalpel is best used for intraoral incision and drainage of an endodontic abscess?**  
A pointed no. 11 or 12 blade is preferred over a rounded no. 15 blade.
- 132. In performing apical surgery on the mesial root of maxillary molars, what mistake is commonly made?**  
It is important to look for unfilled mesiolingual canals in such roots. Therefore, a proper long bevel is necessary to expose this commonly unfilled fourth canal.
- 133. Numerous studies have addressed the success rates of endodontic surgery. Most agree, however, on certain basics. Name the most common conclusions.**  
All the successful studies share certain basic conclusions. First, the success of endodontic surgery is closely related to the standard of treatment of the root canal. Second, orthograde (conventional) root fills are preferred, if possible. Third, the success rate for endodontic surgery, which years ago was considered to be significantly lower than conventional therapy, is now considered to be much higher because of the use of the operating microscope, ultrasonic techniques, and newer root and filling materials.
- 134. What is the recommended surgical approach for apical surgery on the palatal roots of maxillary molars?**  
The palatal approach is recommended; with proper flap design and size, proper reflection is not a difficult procedure. The buccal approach is potentially too damaging to supporting bone of the molar and may actually cause more risk of postoperative sinus problems.
- 135. Why is a so-called slot preparation often recommended for the preparation of root end fillings for mesial roots of maxillary or mandibular roots?**  
The slot preparation is a trough-type preparation that extends from one canal orifice to another canal orifice in the same root. This procedure is accomplished with undercuts in the adjacent walls. The slot preparation allows not only sealing of the canal orifices, but also small anastomoses between the main canals.
- 136. After root end resection during endodontic surgery, many practitioners apply citric acid to the exposed dentin surface. What is the rationale behind this practice?**  
A desired result of root end surgery (apicoectomy) is to achieve, if possible, a functional apical dentoalveolar apparatus, with cementum deposition on the root end. However, the resected root end is covered with a smeared layer of dentin from the high-speed bur, which does not allow reattachment of newly deposited cementum. Applying citric acid for 2 or 3 minutes dissolves the smear layer and causes a small degree of demineralization of dentin. This, in turn, exposes collagen fibrils of the dentinal organic matrix and creates a suitable area for the attachment of collagen fibrils from newly formed cementum.
- 137. Several studies have shown that resected mandibular molars fail twice as often as resected maxillary molars. What are the major causative reasons for failure?**  
The most common cause of failure is root fracture, followed in order by cement washouts around restorations, undermining caries, and recurrent periodontal pathoses around remaining roots.
- 138. When performing apical surgery, what is current thinking about the angle of the apical bevel during apicoectomy and how it relates to the depth of retrograde fillings?**  
Studies have shown that increasing the angle of the apical bevel increases the potential for apical leaking because of exposure of more dentinal tubules. A bevel as close to 0 degrees as possible is ideal. In addition, increasing the depth of retrograde preparation and filling decreases apical leaking by sealing more dentinal tubules.
- 139. Why, in the past, did the mesial roots of maxillary first molars and mandibular first molars fail so commonly after endodontic surgery?**  
Before the advent of enhanced illumination and magnification with surgical loupes and the operating microscope, the isthmus between the mesial canals was generally not prepared. The isthmus may contain necrotic tissue that can perpetuate the apical lesion.



**140. Why have ultrasonic techniques become the most popular instruments for retropreparation during apical surgery?**

The ultrasonic systems available today are a huge improvement over former procedures. They allow retropreparations that align properly with the long axis of the tooth, and they can be sufficiently deep to conform to the true shape of the apical root canal system.

**141. Formerly, during apical surgery, teeth with extensive periodontal defects were extracted because of their poor prognosis. Today, however, guided tissue regeneration can save many of these teeth. How does it work?**

An inert barrier is placed over the periodontal defects. These membranes allow proliferation of undifferentiated cells of the PDL and surrounding bone to grow across the wound, potentially forming a new attachment, and prevent the downgrowth of epithelial cells to form a junctional epithelium.

**142. What is the ultimate goal of apical surgery?**

The goal is to eliminate the source of periapical irritation emanating from the root canal, which perpetuates apical infection. Also, it is important to allow reformation of cementum around the apex, reestablish a functioning PDL, and allow alveolar bone repair. If these goals are not possible, we aim at least to perform scar tissue repair, which is less than ideal but is still a form of repair.

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# RESTORATIVE DENTISTRY

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## CARIOLOGY

### 1. What is the definition of dental caries?

Over the decades, a number of definitions for dental caries have evolved, depending on the perspective of the author. A few are presented here.

1. Dental caries is an infectious, communicable disease, resulting in destruction of tooth structure by acid-forming bacteria found in dental plaque, an intraoral biofilm, in the presence of sugar.
2. Dental caries is an infectious, communicable, transmissible disease caused by bacterial invasion resulting in the breakdown of the tooth structure.
3. Dental caries is a microbial disease of the calcified tissues of the teeth, characterized by demineralization of the inorganic portion and destruction of the organic substance of the tooth. The former constitutes the acidogenic theory and the latter the proteolytic theory.

### 2. List five key facts about dental caries.

1. Dental caries, otherwise known as tooth decay, is one of the most prevalent chronic diseases of people worldwide; individuals are susceptible to this disease throughout their lifetime.
2. Dental caries forms through a complex interaction over time between acid-producing bacteria and fermentable carbohydrates and many host factors related to teeth and saliva.
3. The disease develops in the crowns and roots of teeth; it can arise in early childhood as an aggressive tooth decay that affects the primary teeth of infants and toddlers.
4. Risk for caries includes physical, biologic, environmental, behavioral, and lifestyle-related factors (e.g., high numbers of cariogenic bacteria, inadequate salivary flow, insufficient fluoride exposure, poor oral hygiene, inappropriate methods of feeding infants, malnutrition).
5. The approach to primary prevention should be based on common risk factors. Secondary prevention and treatment should focus on management of the caries process over time for individual patients, with a minimally invasive, tissue-preserving approach.

### 3. According to the CDC (Centers for Disease Control and Prevention), what is the most common disease among children age 5 to 17 years?

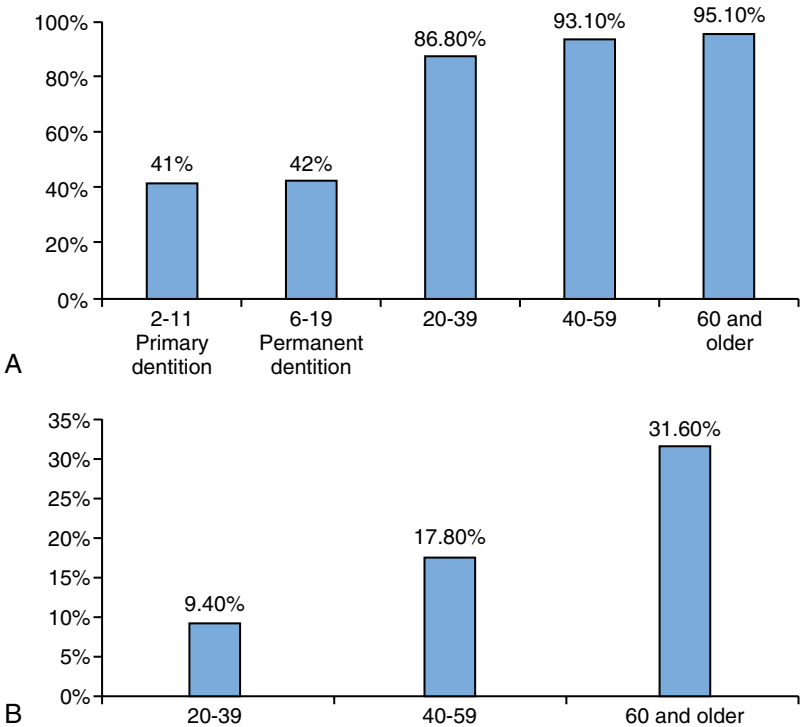
Dental caries is now considered an epidemic in the United States and far exceeds the next most common disease, asthma (42% vs. 9.5%).

### 4. What are some prevalence statistics related to dental caries from the CDC?

- 28% of children age 2 to 5 years have decay in their primary teeth.
- 50% of children have decay by age 11 years.
- 68% of 19-year-olds have decay in their permanent teeth.
- Children from lower income families are twice as likely to have decay than those from higher income families.
- 16% of children age 6 to 19 years and 23% of adults 20 to 64 years have untreated dental caries.
- 85% of all adults experience tooth decay, and 60% of adults will lose a permanent tooth because of decay (Fig. 8-1).

### 5. What is the dental plaque biofilm?

A biofilm is any group of microorganisms in which cells stick to each other on a surface. These adherent cells are frequently embedded within a self-produced matrix. Dental plaque



**Figure 8-1.** Dental caries prevalence by age. (Data from the National Health and Nutrition Examination Survey [NHANES]: Beltran-Agular ED, Barker LK, Canto MT, Dye BA, Gooch BF, Griffin SO, et al.: Surveillance for dental caries, dental sealants, tooth retention, edentulism, and enamel fluorosis – United States, 1988–1994 and 1999–2002. In *MMWR CDC Surveill.* Volume 54. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention; 1-44, 2005.)

is structurally and functionally an organized biofilm. The community of microorganisms remains stable over time, with pathogenic organisms present in low numbers. In dental caries, there is a shift toward community dominance by acidogenic and acid-tolerating species. Evidence shows that conditions that foster a low pH select for the cariogenic species *Streptococcus mutans* and lactobacilli. The result is a higher acid level in the biofilm of acid production and demineralization of tooth structure.

#### 6. Describe the bacterial elements of the biofilm community that contribute to dental caries.

*S. mutans* and *Lactobacillus* are the dominant species.

- Aciduric—survive in an acid environment
- Acidogenic—produce higher amounts of acid from sugars
- Produce extracellular polysaccharides to thicken plaque and aid in adherence within the biofilm
- Use high levels of adenosine triphosphate (ATP) to maintain an intracellular neutral pH and pump out acids

#### 7. What is generally accepted as a new standard of dental care for preventing dental disease and managing a patient's risk?

According to the American Dental Society and American Academy of Pediatric Dentistry, an individual caries risk assessment analysis should be part of a complete dental examination. Disease indicators and risk factors will determine the probability that a specific patient will become susceptible to dental caries, and early intervention therapies may be implemented.



**Figure 8-2.** CariScreen testing meter and testing swabs. (Courtesy Oral Biotech, Albany, OR.)

### 8. What does the acronym CAMBRA stand for, and what is its value in caries prevention?

CAMBRA stands for *caries management by risk assessment*. Using a written form or oral interview, specific elements that could lead to a bacterial imbalance of dental pathogens can be assessed. Dental treatments and restoration recommendations are formulated from this data.

### 9. List the elements of CAMBRA.

- Current decay levels (number of decayed teeth)
- Current bacterial challenge (measured by testing levels)
- Decay history (e.g., decay-missing-filled [DMF] index, missing filled teeth)
- Dietary habits (food types, degree of snacking)
- Current medications
- Saliva status (e.g., amount, buffering capacity)
- Medical conditions
- Oral appliances present (e.g., braces)
- Oral hygiene habits

### 10. How does ATP testing determine if someone is at risk for dental caries?

ATP is the basic energy molecule in all living cells. The caries-linked bacteria *S. mutans* and lactobacilli produce large quantities of acid during sugar metabolism and use ATP to pump this metabolite out of their intracellular space. By assaying the amount of ATP, a correlation can be made to the quantity of bacteria present. By mixing rather simple reagents, a bioluminescence assay for light produced can be correlated with quantities of microorganisms.

Taking an oral swab and placing it in an ampule containing luciferin and luciferase (the firefly enzyme), the following reaction occurs:



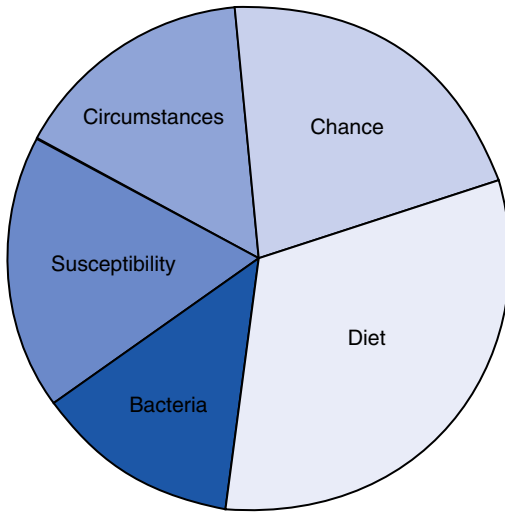
The ampule is placed into a sensitive light meter, and the numeric value obtained correlates with the bacterial population, indicating at-risk levels. See [www.carifree.com](http://www.carifree.com) and the CariScreen (Fig. 8-2).

### 11. What is the cariogram?

Developed in Sweden, the cariogram is a simple software program that generates a pie graph representation of the elements of a risk assessment survey (Fig. 8-3).

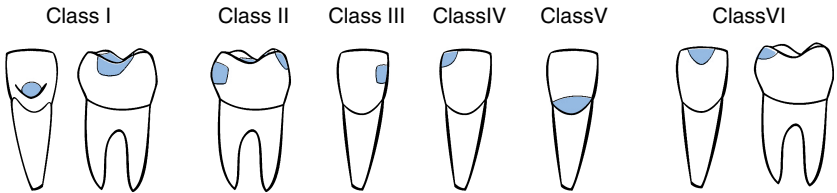
### 12. How are dental caries classified?

1. Anatomic site
  - Pit and fissure: class I



High-risk patient with 25% “chance” of avoiding caries

**Figure 8-3.** Example of a cariogram. (Adapted from Bratthall D, Hänsel Petersson G, Sjöernsward JR: *Cariogram—Evaluation of the Caries Risk Assessment*. Malmö Sweden, 2004, Malmö University.)



**Figure 8-4.** Black classification. Various tooth defects are categorized into six classes based on the specific location of the lesions. (From Shen J: *Advanced Ceramics for Dentistry*. Waltham, MA, 2014, Butterworth-Heinemann.)

Smooth surface: interproximal: class II posterior, class III anterior  
 Cervical and root surface: class V

2. Rate of progression—incipient (early enamel surface or white spot lesion)  
 Acute or rampant (rapid progression and widespread)  
 Chronic or arrested (demineralization has ceased)  
 Recurrent (new decay at sites of previous lesions or restorations)
3. Hard tissue involved—enamel, dentin, cementum
4. Cause—radiation caries, early childhood caries (ECC), baby bottle caries, xerostomia
5. Caries (reduced or absent saliva)

The ICDAS (International Caries and Detection System) has standardized the classification system ([www.icdas.org](http://www.icdas.org)). The GV Black classification system is illustrated in Figure 8-4.

**13. Outline the caries susceptibility of teeth in the dental arches.**

Maxillary > mandibular arch

Tooth type: first molars (upper and lower) > second molars (upper and lower) > second bicuspid (upper) > first bicuspid (upper) and second bicuspid (lower) > central and lateral incisors (upper) > canine (upper) and first bicuspid (lower) > lower anteriors

Tooth surface: occlusal >> mesial > distal > buccal > lingual

#### 14. List the key risk factors associated with dental caries.

- Susceptible tooth surface that can maintain plaque and bacteria
- Presence of acidogenic bacteria
- Steady supply of dietary fermentable carbohydrates
- Inadequate salivary flow or buffering capacity
- Low exposure to topical or dietary fluoride

#### 15. What organisms are responsible for caries formation?

*S. mutans* and lactobacilli are the most cariogenic, with contributions from *Streptococcus sanguis* and *Streptococcus salivarius*. These organisms metabolize sucrose to form acidic byproducts destructive to enamel surfaces. Root surface caries are initiated by *Actinomyces viscus* on accumulated plaque deposits.

#### 16. What are the properties of cariogenic bacteria?

Specifically unique are their ability to survive at low pH and metabolize simple sugars to form acid byproducts. During the process, extracellular polysaccharides are produced, which aid in adhesion within the plaque biofilms.

#### 17. What is the role of saliva in caries susceptibility?

- Adequate flow reduces plaque accumulation on tooth surfaces and rate of clearance of carbohydrates.
- Diffusion of the salivary components calcium, phosphate, hydroxyl, and fluoride ions into plaque can reduce the solubility of enamel and promote remineralization of early carious lesions.
- The bicarbonate-buffering ability of saliva can reduce or limit the fall in pH when bacteria metabolize sugars.
- Salivary proteins form the protective acquired pellicle, which retards the flow of ions out of enamel.
- The salivary components of secretory immunoglobulin A (IgA), lysosomes, lactoperoxidase, and lactoferrin have antibacterial activity.

#### 18. Describe the role of fluoride in preventing dental caries.

- The anticaries effects of fluoride are primarily topical for children and adults.
- Fluoride inhibits demineralization at enamel crystal surfaces inside teeth.
- Fluoride enhances the remineralization of the enamel crystal surface after demineralization and increases acid resistance.
- The systemic benefits of fluoride are minimal.

#### 19. What is the effect of fluoride on bacteria?

Fluoride can enter the bacterial cell only as hydrogen fluoride (HF), where it can dissociate and inhibit bacterial enzymes (enolases). As acid production proceeds, some  $H^+$  and  $F^-$  ions form HF, which can enter the bacterial cell. At neutral pH, within the bacterial cell, it dissociates, and the fluoride ion is free to act on bacterial enzymes as an inhibitor (Fig. 8-5).

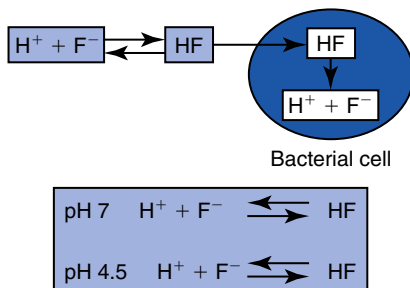
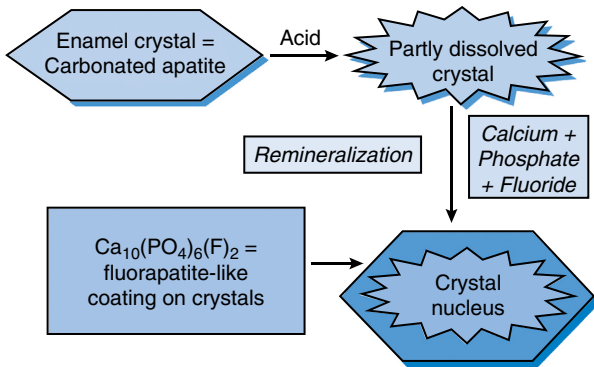


Figure 8-5. Fluoride's effect on bacteria.



**Figure 8-6.** Demineralization and remineralization processes. (Adapted from Featherstone JDB: *Prevention and reversal of dental caries: Role of low level fluoride. Community Dent Oral Epidemiol* 27:31–40, 1999.)

## 20. How does fluoride aid in remineralization of tooth structure?

Fluoride present in saliva or plaque fluid will become incorporated into a new crystal surface during remineralization. It competitively displaces OH<sup>-</sup> ions and then acts topically, from the surface inward, exerting its effects against acid dissolution of the crystal surface. Present in plaque fluid, it will travel into the subsurface enamel with the acids, adsorb to the crystal, and protect it from dissolution. In summary, fluoride present in solution from topical sources enhances remineralization by speeding up the growth of a new surface on the partially demineralized subsurface crystals of the carious lesion. The new crystal surface is fluorapatite-like, with much lower solubility than the original carbonated apatite tooth mineral (Fig. 8-6).

## 21. Express the caries risk factors in a functional relationship.

**Functional Relation In Dental Caries**

$$C_A \equiv f \left[ (\text{Bacteria}) \times (\text{CHO}) \right] \times \left[ \frac{1}{(\text{S})(\text{F})} \right]$$

$C_A$  = Caries activity  
 Bacteria = *S. Mutans/Lactobacillus* activity  
 CHO = Fermentable carbohydrate substrate  
 F = Fluoride availability  
 S = Saliva (flow/buffering capacity/components)

Dental caries occurs when the process of demineralization is faster than the process of remineralization and there is a net loss of tooth mineral into the environment. If the acid production is reduced by removing plaque accumulation or reducing dietary sugar substrates, tooth mineral dissociation will cease (decrease in caries activity [ $C_A$ ]). The presence of topical fluoride increases enamel resistance to dissolution (forming fluorapatite) and enhances remineralization. It also inhibits bacterial metabolism. Thus, increases in fluoride relate inversely to  $C_A$ . Finally, a high salivary buffering capacity decreases caries activity, whereas low flow rates tend to increase  $C_A$ .



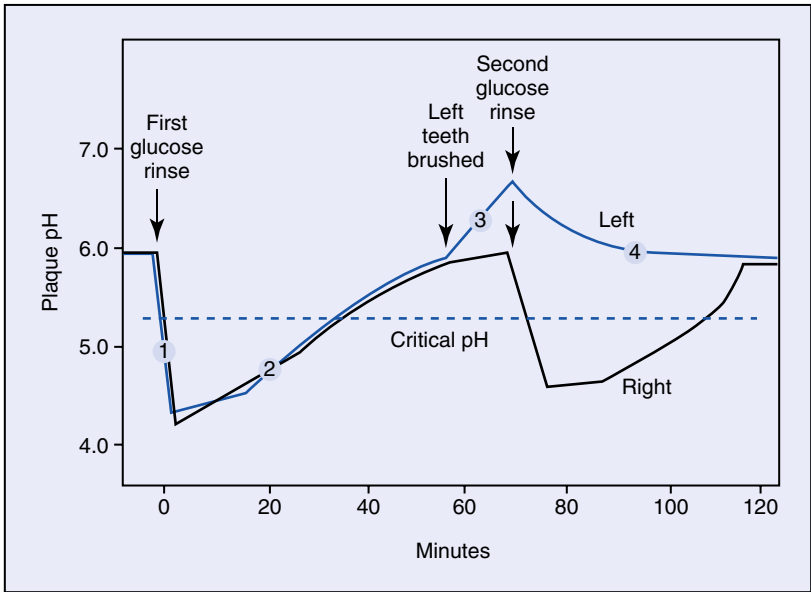


Figure 8-7. Stephan plot.

## 22. What are the three main tooth mineral complexes and their relative solubilities?

The enamel and dentin of a tooth are composed of tiny crystals embedded in a protein/lipid matrix. The mineral formed during tooth germination is a highly substituted carbonated apatite. It is related to hydroxyapatite but is more acid soluble, as well as calcium-deficient (replaced by sodium, magnesium, and zinc) and contains 3–6% carbonate replacing phosphate ions in the crystal lattice. During demineralization, carbonate is preferentially lost, and during remineralization, it is excluded and replaced by  $\text{OH}^-$  or  $\text{F}^-$  ions, thereby decreasing the acid solubility. This is the maturation cycle. Mature enamel is mostly hydroxy or fluorapatite.

Tooth Mineral
<b>Carbonated apatite (most soluble)</b> $\text{Ca}_{10-x}(\text{Na})_x(\text{PO}_4)_{6-y}(\text{CO}_3)_z(\text{OH})_{2-u}(\text{F})_u$
<b>Hydroxy apatite (less soluble)</b> $\text{Ca}_{10}(\text{PO}_4)_{10}(\text{OH})_2$
<b>Fluorapatite (least soluble)</b> $\text{Ca}_{10}(\text{PO}_4)_{10}(\text{F})_2$

## 23. What is a Stephan plot?

The classic experimental measurement of pH changes on tooth enamel surfaces during exposure to fermentable carbohydrates in the presence of acidogenic bacteria (in plaque) over time is called a Stephan plot. It demonstrates the acid production of bacteria (pH decrease) with a glucose swallow, and the gradual rise caused by salivary buffering. At position #3, after left side brushing, the unbrushed side pH drops, whereas the left brushed side #4 remains above the critical pH (Fig. 8-7).

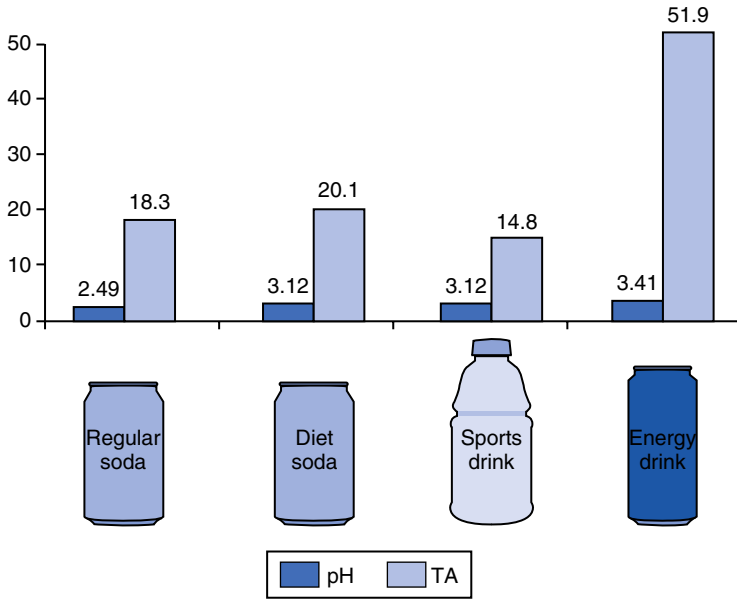


Figure 8-8. Comparison of pH and TA in common beverages.

**24. What is the critical pH for enamel dissociation?**

The critical pH for enamel (hydroxyapatite) is 5.3 to 5.5; for fluorapatite, it is 4.5. Carbonated beverages (e.g., Coke, Pepsi) have a pH of about 3.5.

**25. What are the pH values of some common beverages?**

Knowing that the critical pH of enamel demineralization is 5.5, carbonated beverages can be very destructive (Fig. 8-8). The TA (titratable acidity) is the equivalent to titrate to neutral pH. Energy drinks (e.g., Red Bull) and sports drinks (e.g., Gatorade) showed the greatest degree of enamel surface dissolution. Possible explanations for the higher degree of enamel dissolution by sports and energy drinks is the addition of high concentrations of refined carbohydrates (e.g., sucrose, glucose) by the manufacturer, which promotes greater degrees of acid production and, in turn, higher buffering capacities. In addition, beverages containing citric acids have the ability to irreversibly chelate (bind) calcium at higher pH values, with the net effect of an accelerated loss of calcium from tooth structure; this maintains the pH of the beverage below the threshold level (pH = 5.5) for enamel erosion to occur. Red Bull contains sodium citrate (sodium salt of citric acid), a buffering agent that might help in maintaining the pH levels in soft drinks (Fig. 8-9).

**26. What is the term for the earliest observable enamel caries lesion?**

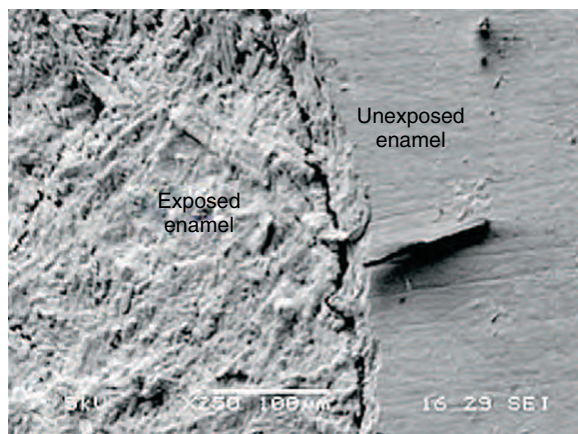
The term *white spot lesion* is applied to the earliest visually observable or macroscopic lesion in enamel. It represents dissolution of the surface structure, with increased porosity, and takes on a dull appearance when air-dried because of the differences in light scattering (refractive index) from the surrounding enamel. These lesions may maintain their surface integrity, become stained and arrested, or progress to frank cavitation lesions.

**27. What are the differences in the mechanisms of enamel and dentinal caries?**

Enamel caries is primarily an acidogenic or physicochemical progression of tooth mineral dissolution, whereas dentinal caries involves acid decalcification followed by proteolytic or enzymatic degeneration of the organic matrix.

**28. What is the current thinking about treating early enamel caries or the incipient lesion?**

Most early enamel lesions are capable of remineralization, or arresting, if the risk factors are reduced and there is adequate fluoride content in the microenvironment. Risk factor



**Figure 8-9.** Scanning electron microscope image of enamel before and after exposure to cola.

assessment (including diet, bacterial, and salivary analysis), followed by fluoride supplements from topical sources, is thus the first line of therapy.

### 29. What clinical tests are available to determine caries susceptibility?

Proprietary kits from Ivoclar Vivadent and Viadent provide the essential components to culture and grade levels of *S. mutans* and lactobacilli in saliva and measure salivary pH, flow rates, and buffering capacity. A rapid test by CariFree ([www.carifree.com](http://www.carifree.com)) is a simple, 1-minute chairside bacterial test for assessing patients' caries risk. CariScreen uses ATP bioluminescence to identify oral bacterial load and has been proven to correlate with patients' risk for decay. The test is quick and painless. A swab sample of the plaque is taken from the patient's teeth, which, when combined with special bioluminescence reagents within the swab, creates a reaction that is measured with a meter. The CariScreen will give a score between 0 and 9999 relative light units (RLUs); a score under 1500 RLUs is considering relatively healthy, whereas a score above that shows considerable risk for decay.

### 30. What are the histologic zones of enamel caries?

Four zones of alternating levels of demineralization illustrate the dynamic nature of caries. The surface zone blocks passage of calcium ions into the body of the lesion. It is well mineralized by replacement ions from plaque and saliva. The body of the lesion is poorly mineralized. The dark zone has some remineralization, whereas the translucent zone has high demineralization (Fig. 8-10).

### 31. What are the histologic zones of cavitated dentinal caries?

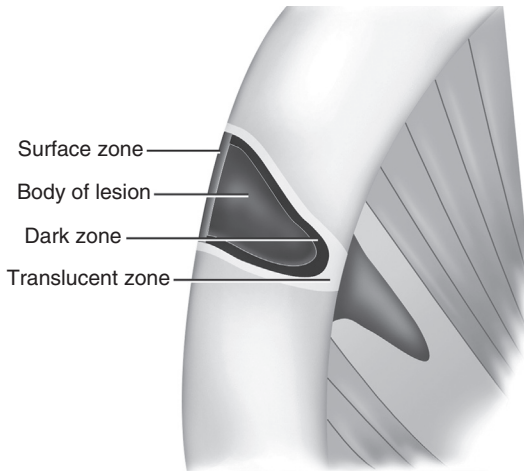
There are two distinct layers.

1. Outer layer—dentin heavily infected with bacteria; organic matrix and mineral are lost and cannot be repaired; liquefaction foci and clefts form.
2. Inner layer—dentin affected by plaque acids and demineralized; few bacteria, damage reversible.

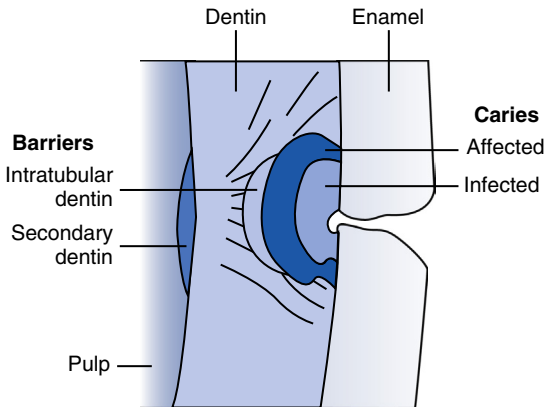
A barrier layer of sclerotic (translucent), well-mineralized dentin may be formed by odontoblast deposits into intratubular spaces. Finally, a layer of secondary reactionary-reparative dentin forms at the dentin-pulp junction. These preceding two layers are dependent on a vital pulp's reaction to noxious stimuli (Fig. 8-11).

### 32. Describe the progression of caries in dentin.

Because dentin is a vital tissue, it shows reactivity with bacterial invasion. Caries generally spreads laterally along the dentoenamel junction (DEJ), involving dentinal tubules. At the **infected layer** of dentin, bacteria enter the dentinal tubules and decalcify the matrix by acid and proteolytic dissociation (microscopic liquefaction foci and clefts are present). The inner **affected layer** is demineralized, but contains few bacteria. The damage here is reversible if the bacterial metabolism is halted by excavation of the infected layer. Under



**Figure 8-10.** Microscopic zones of enamel caries. (From Sapp JP, Eversole, LR, Wysocki GP: *Contemporary Oral and Maxillofacial Pathology*, ed 2, St. Louis, Mosby, 2004.)



**Figure 8-11.** Sclerotic and reparative dentin.

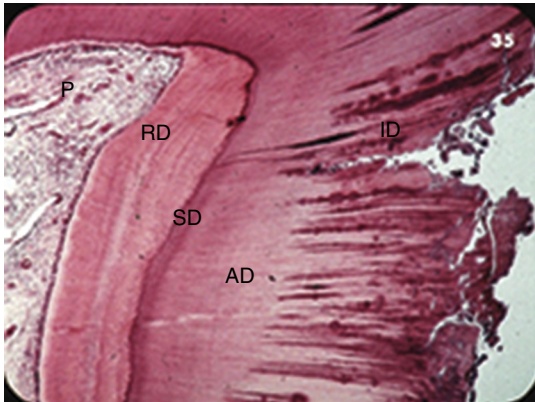
the affected layer is the **sclerotic** or microscopic **translucent layer**, followed by a layer of **reparative** or **reactionary dentin** produced by odontoblasts at the dentopulpal boundary.

**33. Identify the labeled structures in this cavitated carious lesion shown in Figure 8-12.**

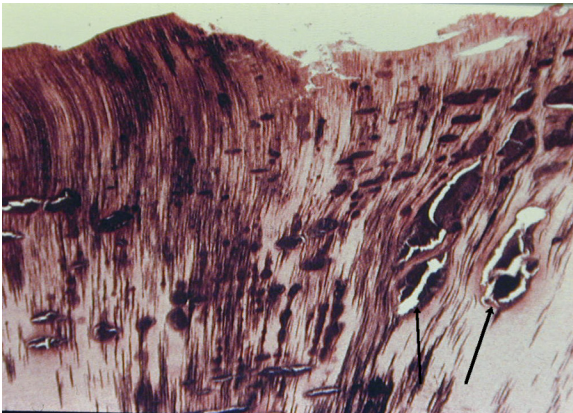
Cariou dentin fills most of the slide, on the right. At the far left is the **pulp**; the faint blue dots are lymphocytes (chronic inflammation). To its right is a band of **reparative dentin** that protected the pulp from infection for a time. Next, progressing right, is a thin band of **sclerotic dentin**, followed by a layer of **affected dentin**, and at the far right is **infected dentin**.

**34. Identify structures shown in Figure 8-13.**

Note that zones of destruction coalesce to form clefts and liquefaction foci. These are filled with necrotic debris. These advancing bacteria seem to have acidogenic and proteolytic properties, resulting in the enzymatic destruction of the organic dentin matrix. Horizontal clefting is typical of dentinal caries. The process of beading, coalescence, and clefting typifies progression of dental caries.



**Figure 8-12.** Cavitated carious lesion. AD, Affected dentin; ID, infected dentin; P, pulp; RD, reparative dentin; SD, sclerotic dentin.



**Figure 8-13.** Arrows indicate liquefaction foci filled with necrotic debris.

**35. Describe the elements shown in Figure 8-14.**

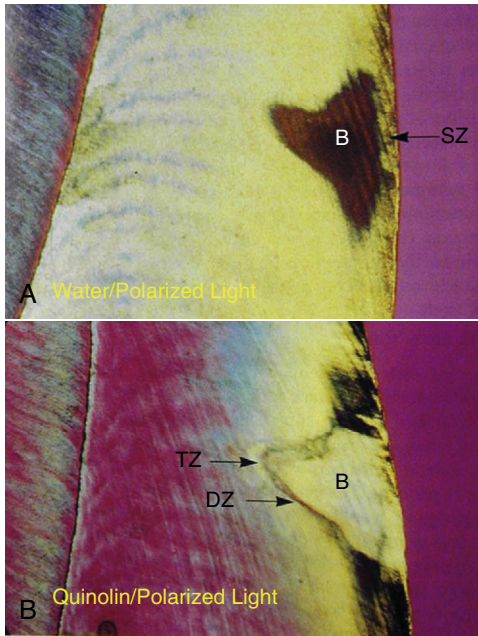
**Figure 8-14A**—small, smooth-surfaced enamel caries in water with polarized light; lesion is cone-shaped; body appears dark beneath intact surface layer.

**Figure 8-14B**—same section in quinolin (same refractive index as enamel) with polarized light

1. Translucent zone visible as porous, less mineralized leading zone in enamel
2. Dark zone thought to be area of redeposition of mineral
3. Body is demineralized, with striae of Retzius evident
4. Surface zone (SZ) intact because of constant demineralization (destruction) and remineralization (repair) if fluoride present

**36. Clinically, how are the different types of carious dentin treated?**

All infected dentin must be removed for successful tooth viability. Because affected dentin has undergone only early demineralization, removal may not be necessary. Topical bonded dentin sealants containing fluoride affect a barrier under restorations.



**Figure 8-14.** Small, smooth-surface enamel caries. **A**, In water (polarized light). **B**, In quinolin (polarized light). B, Body; DZ, dark zone; SZ, surface zone; TZ, translucent zone.

**37. Explain the differences between smooth and pit and fissure caries.**

Because **smooth surface caries** (interproximal or cervical) have a wide enamel surface pattern that converges with the anatomic form of the enamel rods toward the DEJ, fewer dentinal tubule are affected, enamel undermining is generally less, and the rate of progression is slow. These lesions have a high success of remineralization with adequate fluoride exposure and reduction in risk factors.

**Pit and fissure caries** are narrow at the enamel surface and spread widely as the caries progresses to the DEJ, involving many dentin tubules and creating extensive undermining. The progression is often more rapid than that of smooth surface caries. Because of the anatomic sheltering of bacterial plaque, remineralization is not easy, and fissurotomy followed by sealants is necessary for early lesions.

**38. Develop a decision tree for the management of pit and fissure tooth surfaces.**

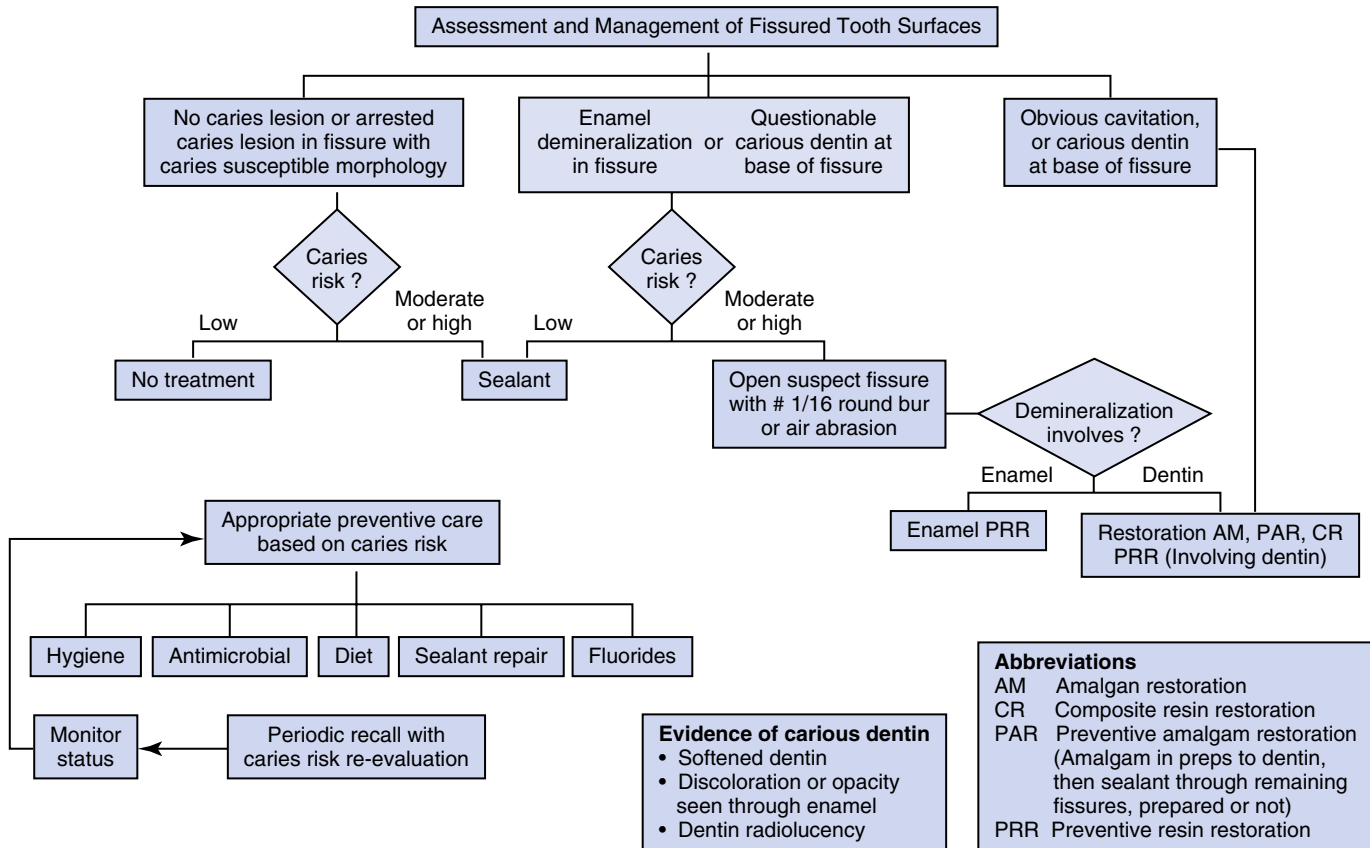
See Figure 8-15 for an example of a decision tree for the management of pit and fissure tooth surfaces.

**39. How may caries be diagnosed?**

Caries may be detected by a combination of techniques. The most commonly accepted criteria for identifying infected tooth structure are the following: (1) discolored, softened tooth structure; (2) frank cavitation; and (3) areas of radiolucency on radiographs. Direct visual inspection of pits and fissures, root surfaces, and interfaces of restorations and tooth with a sharp explorer and air-drying with the use of magnification are the first steps of the examination. This procedure is supplemented by evaluating properly angulated bitewing and periapical radiographs. Finally, the use of transillumination from a visible light curing wand can reveal shadowing and discoloration on occlusal and interproximal tooth surfaces.

**40. Describe two high-tech methods of diagnosing dental caries.**

1. **Quantitative light-induced fluorescence (QFL)** measures the scattering of light induced by the degree of enamel demineralization. KaVo's DIAGNOdent ([www.kavousa.com](http://www.kavousa.com)),



**Figure 8-15.** Example of a decision tree. (Adapted from Summitt JB: Conservative cavity preparations. Dent Clin North Am 46:171–184, 2002.)

Midwest's Caries I.D. ([www.mwdental.com](http://www.mwdental.com)), and AirTechniques' Spectra probe ([www.airtechniques.com](http://www.airtechniques.com)) use red laser light to assess pit and fissure and smooth-surfaced lesions. A newly developed system, the Canary System, uses frequency domain photo-thermal radiometry and modulated luminescence (FD-PTR and LUM) to detect carious tooth structures ([www.thecanarysystem.com](http://www.thecanarysystem.com)).

2. **Digital imaging fiberoptic transillumination (DIFOTI; [www.difoti.com](http://www.difoti.com))** provides a highly sensitive method of diagnosing occlusal and interproximal carious lesions. Images of trans-illuminated visible light are captured by a digital charge-coupled device (CCD) camera and sent to a computer where analysis of the decreased densities caused by demineralization are shown as images. This method is claimed to be twice as sensitive for detecting interproximal caries and three times more sensitive for occlusal caries than currently used x-rays.

#### 41. What are the objectives of operative treatments in carious teeth?

1. To remove bacterially infected enamel and dentin
2. To protect the dental pulp
3. To preserve healthy tooth structure and restore missing structure
4. To remove the sources of cariogenic bacteria by facilitating plaque control
5. To provide minimal fluoride concentrations in the microenvironment

#### 42. List logical steps to stabilize dentition with active and multiple caries.

1. Carry out a thorough medical and dental history and examination to assess caries risk factors.
2. Initiate appropriate preventive measures.
3. Plan extraction of nonsalvageable teeth.

**NOTE:** This step may be resequenced in the apprehensive patient until full trust and compliance are achieved because extractions may be too traumatic as an initial treatment phase.

4. Evaluate of caries in vital teeth and protect with pulp-capping agents such as  $\text{Ca}(\text{OH})_2$  sealed with bonded and flowable resins or resin-reinforced glass ionomers. Use glass ionomer build-up materials for the temporary filling.
5. In frank pulpal exposures, removal of the pulpal tissues is advisable to prevent potential pain, followed by temporization with a suitable glass ionomer material and endodontic treatment.
6. In very deep carious lesions, whether symptomatic or not, if pulpal exposure is to be expected, it is probably best to go directly to endodontic treatment rather than try an intermediate step of excavation and temporary stabilization.
7. Finalize a treatment plan with permanent restorations for the existing teeth and make suitable provisions for replacement of missing teeth.

#### 43. What are caries detector solutions? How are they used?

Caries detector solutions are usually a colored dye (red, green, blue) in a propylene glycol base; they help distinguish between infected and affected dentin. The dye bonds to the denatured collagen in the infected dentin that is part of the decay process. The affected dentin, which may be slightly softer than sound dentin, is not infused with bacteria and is not stained, but still may show a dye-stained haze (pink haze with red dye). This dentin should not be removed. The caries detector solution is applied for 10 seconds and then rinsed off. Any deeply stained tooth structure is then removed. The materials also help identify cracks in tooth structure (e.g., Seek [Ultradent], Snoop [Pulpdent]).

**NOTE:** Some products may decrease the bond strength to dentin and careful consideration of their use is necessary when high bonding requirements are needed.

#### 44. Are cavity disinfectants useful?

Some current thought reflects the goal of cleaning a preparation before bonding or placing a restoration with the addition of a bactericidal agent to reduce sensitivity and bacterial growth under a restoration. It is thought that bacteria reaching the pulp may contribute to sensitivity. Current products contain benzalkonium chloride and EDTA or 2% chlorhexidine gluconate.

#### 45. What supplemental sources of topical fluoride may be used for caries prevention?

- Public water supplies: 1 ppm sodium fluoride (NaF)
- Toothpaste: OTC (over-the-counter) regular brands contain 0.10% to 0.15% NaF



- Prescription: PreviDent 5000 Plus, 1.1% NaF
- Mouth rinses: Act, FluoriGuard, Prevident rinse, 0.2% to 0.5% NaF
- Brush-on gels, fluoride trays: Prevident, 1.1% NaF, neutral pH

**46. What is a contraindication to the use of acidulated or stannous fluoride preparations?**

0.4% stannous fluoride (pH, 3.0) = 0.2% sodium fluoride (pH, 7.0)

Acidulated fluoride (APF) solutions and topical 0.4% stannous gels (Gel-Kam, Colgate) remove the glaze from porcelain, glass ionomer, and composite restorations. It is best to use neutral pH supplements if these restorations are present. Always check the product specifications.

**47. Describe a medical model of caries treatment.**

The medical model attempts to shift the caries balance toward no caries by using medical and behavioral components. The key elements are:

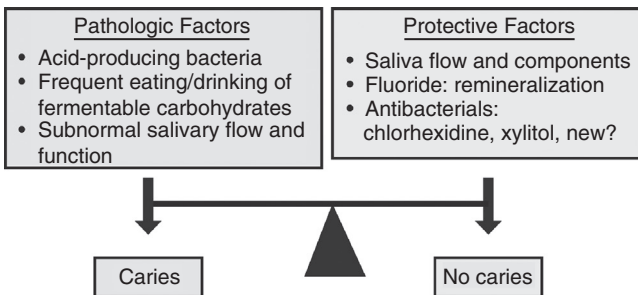
1. Control bacteria.
  - a. Surgical antimicrobial treatment: fill or temporize cavitated lesions.
  - b. Chemotherapeutic antimicrobial treatment: use chlorhexidine, cetylpyridinium, fluoride varnish, xylitol chewing gum.
2. Reduce risk level of at-risk patients.
  - a. Diet
  - b. Oral hygiene
  - c. Sealants
3. Reverse active sites (remineralization) with fluoride supplements via gels, rinses, or toothpastes.
4. Carry out long-term follow-up and maintenance (Fig. 8-16).

**48. What is Pro-t-action, and how is it used to prevent tooth decay?**

BASF, in collaboration with the Berlin-based OrganoBalance GmbH, will commercialize Pro-t-action, made from probiotic microorganisms (*Lactobacillus* spp.). The active ingredient in Pro-t-action binds to and eliminates caries-causing bacteria (*S. mutans*) from the mouth. A particular strain of *L. paracasei* has been identified, and BASF developed a proprietary production process so that the active ingredient can easily be integrated into common consumer products used for daily oral care such as toothpaste, mouthwash, candies, lozenges, and chewing gums. By swishing and swallowing or rinsing, the clumped pathogens are easily expectorated from the mouth. This is the first pathogen-specific clearance rinse. See [http://www.basf.com/group/corporate/en\\_GB/innovations/research/innovation/innovative-solutions/pro-t-action](http://www.basf.com/group/corporate/en_GB/innovations/research/innovation/innovative-solutions/pro-t-action).

**49. What is CAMBRA?**

As noted earlier, in questions 8 and 9, CAMBRA is a modern caries treatment concept that attempts to identify pathologic and risk factors and implements protective strategies that can prevent cavitation or progression of carious lesions. Clinicians identify the patient's



**Figure 8-16.** The caries balance. (Adapted from Featherstone JDB: *The caries balance: Contributing factors and early detection*. *J Calif Dent Assoc* 31:129–133, 2003.)

caries risk by evaluating disease indicators, risk factors, and preventive efforts. After evaluation, a caries risk classification can be determined, and preventive chemical measures and lifestyle and habit changes can be suggested and implemented by the clinician.

#### 50. How may caries be diagnosed?

Caries may be detected by a combination of techniques. The most commonly accepted criteria for identifying infected tooth structure are the following: (1) discolored softened tooth structure; (2) frank cavitation; and (3) areas of radiolucency on radiographs. Direct visual inspection of pits and fissures, root surfaces, and interfaces of restorations and tooth, along with additional tactile information from a sharp explorer and air-drying with the use of magnification, are the first steps of examination. This procedure is supplemented by evaluating properly angulated radiographs. Finally, laser fluorescence and fiberoptic devices can be used in diagnosing carious lesions.

#### 51. Describe light-based methods of diagnosing dental caries.

1. **Fiberoptic transillumination (FOTI)** uses light transmission through the tooth to measure surface scattering on the outside of the lesion. Digitized fiberoptic transillumination (DIFOTI, Electro-Optical Sciences; now licensed with KaVo Dental GmbH as DIAGNOcam) is a light-based tool that captures images of transilluminated visible light on a digital CCD camera and sends them to a computer, where analyses of the decreased densities because of demineralization are shown as images.
2. **Optical coherence tomography (OCT)** can create cross-sectional images of biologic tissues using nonionizing imaging techniques. When a carious tooth is illuminated with infrared light, OCT provides two- or three-dimensional (3D) images and a quantitative image of the subsurface lesion to the depth of the enamel.
3. **Quantitative light-induced fluorescence (QLF)** measures the scattering of light produced by the degree of enamel demineralization. KaVo's DIAGNOdent probe uses red laser light to assess pit and fissure lesions ([www.kavousa.com](http://www.kavousa.com)).

#### 52. What about caries vaccines?

Studies have focused on anticaries vaccines for *S. mutans*. These vaccines have antibodies against bacteria surface receptors Ag I and II, preventing microorganism adhesion to tooth structure. Newer investigations have targeted intranasally administered anticaries DNA vaccines to produce mucosal and systemic responses and protection against caries.

#### 53. What are some indications for fluoride gel applications using a custom tray?

Patients who exhibit high caries incidence, root caries, or cervical caries and who might fit into one or more of the following groups:

- High consumption of carbonated beverages (pH, 3.2-3.5) or citric fruits (e.g., lemons, limes)
- Bulimic patients (10% of female adolescents)
- Older patients and nursing home patients
- Gastric reflux patients
- Chemotherapy and head and neck radiation-treated patients

#### 54. What is tooth attrition?

Attrition is the physiologic wear of tooth structure resulting from normal tooth to tooth contact over time.

#### 55. What is erosion? What are its possible causes?

Erosion is the loss of tooth structure by a chemical process that does not involve bacterial action. It is generally caused by the consumption of foods that contain phosphoric or citric acid, such as fruits, fruit juices, and carbonated or acidic beverages. Excessive exposure to gastric acids because of vomiting is also a contributing factor.

#### 56. What is the theory of tooth abfraction?

Abfraction is defined as the pathologic loss of tooth substance caused by biomechanical loading forces. The loss of structure is usually seen as wedge-shaped cervical lesions at the cemento-enamel junction (CEJ) that may not be carious. This theory is used as an alternative explanation for areas that historically were attributed to toothbrush abrasion. They are also referred to as noncarious cervical lesions (NCCLs).

**57. List generally accepted principles for cavity preparation.**

1. Cavity preparations should be governed by tooth anatomy, tooth position in the dental arch, extent of the carious lesion, and physical properties of the filling material.
2. Gingival margins should be ended on enamel whenever possible.
3. Cavity preparations margins should be supragingival whenever possible.
4. Margins of posterior cavity preparations should not end directly in occlusal contact areas. Contact areas should be composed of one material to allow even wear. Uneven wear results if two materials meet at the contact area, thereby producing open margins.
5. Weakened and unsupported tooth structures should be removed.
6. Maintaining a dry work field with the use of a rubber dam always enhances the consistent quality of restorations.

**58. Describe the principles of cavity preparation for composite resins and amalgam alloy.**

The classic cavity preparations, according to Black's principles, are generally not needed for contemporary bonded retained composite and amalgam restorations. Dovetails, retention grooves, and extension into uninvolved occlusal grooves are generally not needed. Maximizing tooth structure dominates design, with sealants replacing groove extensions.

**59. How do the basic principles of operative microdentistry differ from those of traditional operative dentistry, as advocated by Black?**

The Black approach to operative dentistry tends toward the destruction of healthy tooth structure to remove smaller amounts of unhealthy tooth structure (extension for prevention). The concept of microdentistry seeks to diagnose unsound tooth structure that is a threat to the tooth and remove that threat, with minimal encroachment on the surrounding healthy tooth structure.

**60. What is a fissurotomy procedure? What are its applications?**

A fissurotomy involves the conservative preparation of occlusal pits and fissures using air abrasion or special burs designed for this purpose; the fissurotomy kit (Ivoclar Vivadent) is one example. This procedure is used to treat pits and fissures with incipient decay. Preparations are typically narrow, long, and irregularly deep, so they are often restored with flowable composites. Hybrid composites, although stronger and more wear-resistant than flowables, may be clinically more difficult to place into such preparations without the incorporation of voids.

**61. What are the advantages of the fissurotomy procedure over pit and fissure sealants?**

It is often difficult to determine caries activity in pits and fissures, particularly with conventional means. Concerns arise about the placement of sealants over undiagnosed caries. Questionable occlusal grooves covered with a sealant, particularly in fluoridated communities, may mask more extensive subsurface caries activity. The fissurotomy offers better access and is a conservative technique for maximizing the retention of healthy tooth structure while ensuring certain removal of all decay.

**62. Describe the so-called tunnel preparation.**

The tunnel preparation is a conservative approach to restoring class II caries in teeth with relatively small interproximal lesions. It conserves the proximal marginal enamel by using only occlusal, buccal, or lingual access and then angulating mesially or distally until the external tooth enamel is perforated. Usually, application of a matrix band beforehand protects the adjacent tooth wall. The tooth cavity is then packed from the access dimension.

**63. What is a slot preparation?**

Any narrow access to reach interproximal caries can be called a slot preparation. The access may be buccal or lingual, as in a class III lesion, or from the occlusal aspect. The ideal is to conserve tooth structure by removing only caries and a minimal amount of tooth structure.

**64. Define micro air abrasion. When is it used?**

This technique uses pressurized delivery of an abrasive powder (e.g., aluminum oxide) to prepare teeth for restoration. The claimed advantages are less trauma and a less invasive, heatless procedure, often not requiring local anesthesia. It is ideally suited for pit and fissure

sealant preparations and conservative class I and V preparations using flowable composites. Disadvantages include the need for special high-speed evacuation equipment and high cost of the units.

**65. Describe the principle behind air abrasion for cavity preparation.**

Air abrasion is based on kinetic energy. Abrasive particles, typically 27- to 50- $\mu\text{m}$  aluminum oxide, are propelled at high velocity to remove tooth structure. By varying the speed of the particles, the length of time to remove tooth structure and often the level of sensitivity can be controlled.

**66. What are the various sources of propellant for air abrasion units?**

Depending on the type of unit and manufacturer, the propellant can range from compressed air or nitrogen to operatory-compressed air lines or units with built-in air compressors.

**67. What dental procedures are well suited for the use of air abrasion? Are any procedures contraindicated?**

All classes of cavity preparation may be performed with air abrasion. Some operators may use a high-speed hand piece to gain initial access to deep grooves, pits, marginal ridges, and hard-to-reach areas. Although air abrasion units have the ability to remove dental amalgam, some questions remain about the amount of mercury released by air abrasion versus removal with conventional, high-speed hand pieces.

**68. Why is air abrasion considered well suited to the application of microdentistry?**

Treatment goals of microdentistry include preservation of sound occlusal enamel with minimally invasive occlusal preparations and the use of tunnel or slot preparations to treat primary interproximal caries. Air abrasion is much more selective in the structure it cuts, thereby removing very little sound tooth structure relative to the use of high-speed hand pieces. Additionally, the vibration from high-speed hand pieces can cause enamel fractures that air abrasion cannot (Table 8-1).

## DENTAL ADHESIVES

**69. What are dental adhesives?**

Dental adhesives are products that allow the predictable adhesion of restorative material to dentin and enamel. They are based on using a number of agents to prepare the surface, bond to the tooth surface, and act as a substrate to which the restorative material bonds. In general, they are technique-sensitive and constantly evolving in the marketplace.

**70. What are the goals of dental bonding?**

- Eliminate or minimize the contraction gap of composite polymerization.
- Sustain thermal expansion and contraction cycles.
- Create 20- to 30-MPa bond strengths to enamel and dentin.
- Eliminate microleakage.

**71. What are signs of microleakage?**

They are stains, sensitivity and pulpal symptoms, recurrent caries, and bond failures.

**72. What are the components of adhesive systems?**

Most current systems are combinations of components. Some are multicomponent, depending on whether they are self-cure, light-cure, or both, whereas others have a single component. Unlike early-generation systems, all the new bonding agents are hydrophilic to allow compatibility to dentin bonding. The basic components are an acid etchant solution, hydrophilic primer, and resin.

**73. What types of adhesive systems are available?**

**Type 1.** Etchant applied, washed off to remove smear layer; primer and adhesive resin applied separately as two solutions. Type 1 systems are all-purpose types. They generally bond to light-, dual-, and self-cured composites.

**Type 2.** Etchant applied and washed off to remove smear layer; primer and adhesive applied as a single solution. Type 2 systems have almost all-purpose capability.

**Table 8-1.** Air Abrasion Systems

COMPANY	PRODUCT NAME	MODEL TYPE	ABRASIVE PARTICLE SIZE	TYPE OF ABRASIVE	PROPELLANT	MAXIMUM PROPELLANT PRESSURE	BUILT-IN COMPRESSOR
Air Techniques	Air Dent II CS	Chairside	27 and 50 micron	Aluminum oxide	High-pressure compressor	160 psi	No
Bisco	Accu-prep Deluxe	Chairside	50 micron	Aluminum oxide	Air	40 psi	No
Crystalmark Dental Systems, Inc.	Crystal Air	Tabletop	27 micron	Aluminum oxide	High-pressure air	125 psi	Yes
Danville Engineering	PrepStart (add on PrepStart H <sub>2</sub> O)	Tabletop	27 and 50 micron	Aluminum oxide	Air or bottled gas	145 psi	No
Gendex	AirTouch	Tower, Desktop	27 and 50 micron	Aluminum oxide	Carbon dioxide, compressed air	120 psi	Yes
Lares Research	MicroPrep Director	Cart	27 micron	Aluminum oxide	Compressed air	120 psi	Yes
	MicroPrepProducer	Tabletop	27 micron	Aluminum oxide	House or compressed air	120 psi	No

**Table 8-2.** Dental Adhesives

BRAND NAME	COMPANY	NUMBER OF COMPONENTS	SHEAR BOND STRENGTH MPA, DENTIN	SHEAR BOND STRENGTH, MPA, ENAMEL
<b>Type 1</b>				
All Bond 2	Bisco	4	13.9	12.3
Amalgam-bond Plus	Parkell	4	17.6	20.5
Scotchbond Multipurpose	3M ESPE	3	19.4	18.0
Optibond FL	Kerr	3	20.3	34.1
<b>Type 2</b>				
Excite	Ivoclar Vivadent	2	16.6	15.1
Fuji Bond LC	GC America	3	10.8	14.3
One-Step Prime & Bond NT	Bisco	2	10.2	24.7
Optibond Solo Plus	Dentsply Caulk	2	10.3	20.0
Single Bond	Kerr	2	15.3	19.8
	3M ESPE	2	16.3	17.8
<b>Type 3</b>				
ClearFill SE Bond	Kuraray	2	21.3	24.0
ClearFill liner Bond	Kuraray	3	21.1	22.8
<b>Type 4</b>				
One-Up Bond	J Morita	2	17.8	16.6
Prompt L-Pop	ESP	1	8.8	22.2

From *Clinical Research Associates Newsletter*, 24(11):1, 2000. A publication of CR Foundation, [www.CliniciansReport.org](http://www.CliniciansReport.org).

**Type 3.** Self-etching primer (SEP) is applied to dissolve smear layer and not washed off; adhesive is applied separately.

**Type 4.** Self-etching primer and adhesive are applied as a single solution to dissolve and treat the smear layer simultaneously (Table 8-2).

#### 74. What types of adhesive systems are currently used in clinical practice?

Many variables, including timing, rinsing, drying, rewetting dentin, and maintaining a controlled operative field are important in the placement of dental adhesives. Over time, manufacturers focused research efforts on the development of simplifying these systems to reduce the potential for inconsistencies in treatment by reducing the number of steps required for application. Classification systems became confusing as generational models advanced. Bonding systems that required phosphoric acid etching with rinsing were referred to as total etch whereas those that did not require the additional step were called self-etch. The sixth- and seventh-generation systems were self-etching models. In current practice, adhesives can be classified as total etch (TE) and self-etch (SE; Table 8-3).

#### 75. What is the hybrid layer?

The hybrid layer is a multilayered zone of composite resin, and dentin and collagen. After removing the organic and inorganic debris of the smear layer by etching and reducing some hydroxyapatite from the intertubular dentin down to 2 to 5  $\mu\text{m}$ , a plate of moist collagen

**Table 8-3. Total-Etch (TE) and Self-Etch (SE) Adhesives**

<b>Etch-and-Rinse Adhesives (TE)</b>	
Three-step multiple bottle etch-and-rinse adhesives (3-E&R)	ProBond, Dentsply Caulk; Optibond FL, Kerr; ScotchBond MP, 3M-ESPE
Two-step single-bottle etch-and-rinse adhesives (2-E&R)	Prime and Bond NT, Dentsply Caulk; XP Bond, Dentsply Caulk; Optibond Solo Plus, Kerr; One Step Plus, Bisco
<b>Self-Etch Adhesives (SE)</b>	
Two-step multiple-bottle self-etch adhesives (2-SEA)	Clearfill SE Bond, Kuraray; Tyrian, Bisco; Adhese SE, Ivoclar Vivadent
One-step multiple-bottle mix self-etch adhesives (1-SEA)	Adper Prompt and Adper Prompt L-Pop, 3M ESPE
One-step no-mix self-etch adhesives (1-SEA)	iBond, Heraeus Kulzer; H-Bond, GC America

(From van Meerbeek B, et al: *Buonocore memorial lecture. Adhesion to enamel and dentin: current status and future challenges. Oper Dent* 28:215-35, 2003.)

remains on the dentin floor. Priming agents penetrate this moist collagen substrate and migrate into the tubules, lateral canals, and all areas of peritubular dentin. This becomes the hybridization process as the dentin, both collagen and hydroxyapatite crystals, become totally impregnated with bonding resin. The resin further penetrates into the dentin tubules. Light curing produces a mechanically and chemically bonded surface that can polymerize to composite restoratives.

#### 76. What is essential for successful hybrid layer formation?

Supersaturating of the dentin substrate with primer or wetting agent is essential. If the etchant time is 15 seconds, the wash should be at least as long. The water is then dispersed to leave the dentin moist. Multiple coats of priming agent are applied to achieve a glossy surface on air dispersion. Resin is then applied and cured.

#### 77. How is enamel bonding achieved?

Bonding to enamel is micromechanical; a low-viscosity resin penetrates the microporosity created by acid etching on the enamel surface. Once the resin is cured, it strongly adheres to the enamel and forms the suitable substrate for composite bonding. Although previously done under dry conditions, contemporary adhesive systems use a wet bond to enamel. If one is bonding only to enamel, it is necessary to use only an unfilled resin without the primer application.

#### 78. How is bonding to dentin achieved?

Dentin is largely composed of organic materials, mostly collagen and water. (Enamel is 86% mineralized, whereas dentin is 45%.) Bonding to dentin can require removal of preparation debris (**smear layer**) and demineralization of the dentin surface by acid etchant. This leaves a lattice of unsupported collagen as long as the surface stays moist. Hydrophilic primers and resins (applied in solvents of acetone or alcohol) can then penetrate this matrix, infusing a micromechanical lock similar to enamel. When cured, this resin-reinforced dentin complex forms the **hybrid layer**, and is a suitable substrate for composite bonding. With newer self-etch primer adhesives (SEPs), the etchant and primer are applied and not washed off; the smear layer remains. An adhesive is applied separately. The dentin with these latter systems is never denuded, and there may be less technique sensitivity because the process of leaving dentin to damp-dry is eliminated.

#### 79. How long should you etch?

Etching dentin demineralizes its surface to a depth of 1 to 10  $\mu\text{m}$ . If you etch too long, you may create a depth of demineralized collage that is too deep for adhesives to penetrate, thus weakening the bond or denaturing the remaining collagen. The total etch of a tooth preparation with 32% to 40% phosphoric acid gels should be a **maximum of 15 seconds**, which also works for enamel.

**80. Why must the dentin surface be kept wet?**

When using types 1 and 2 adhesive systems, the etching step leaves the dentin collagen lattice largely unsupported. If this layer dehydrates, it will collapse and the applied adhesives will not be able to infuse through the collage. The surface should be left moist by only the slightest application of air to eliminate puddles of water—or, even better, blotted with a sponge or gauze. Some adhesive systems rehydrate the demineralized zone, even if it is overdried.

**81. What potential problem may cause an incomplete seal of dentin tubules?**

Incomplete placement of the bonding reagents may result in an increase in postoperative pulpal sensitivity. There may be incomplete wetting on application of the primer agent or incomplete curing of the bonding agent. One must be sure to place incremental layers of wetting agent until a glossy appearance is observed on gentle air dispersion, and a well-calibrated curing light must be used for sufficient exposure times.

**82. What factors contribute to increased pulpal sensitivity, even with proper technique?**

If the dentin is dried too completely, air emboli may enter the dentin tubules and the dentin bonding layer may overseal the layer of air. There is thus a potential for mechanical masticatory stresses and a resultant sensitivity on biting on the tooth restoration unit. To avoid this problem, leave the dentin moist by gentle air dispersion; do not use drying. Then the hydrophilic primers will follow fluid down the tubules and fill intertubular dentin and tubules with resin.

**83. How long should you apply the adhesive?**

The adhesive must penetrate through the demineralized dentin to form the hybrid layer for maximal bond strength. Some systems are faster than others; thus, following the manufacturer's instructions is important. In general, after applying the adhesive, 15 to 20 seconds should be allowed for penetration. Air evaporation of the solvent (acetone or alcohol) is followed by curing (generally, visible light-cured). This should leave a shiny dentin surface. If this goal is not achieved, reapplication of the adhesive should be performed until a shiny layer appears.

**84. Describe the composition of contemporary primers in adhesive systems.**

Primers are bifunctional molecules. One end is hydrophobic to bind to the adhesive, and the other end is hydrophilic. The hydrophilic end permeates conditioned dentin and chases the water of the moist surface, assisted by solvents (acetone or alcohol). After this penetration, the solvents need to be evaporated by air drying. Examples of primers are HEMA (2-hydroxyethyl methacrylate), 4-META (4-methacryloyloxyethyl trimellitate anhydride), and PENTA (dipentaerythritol penta-acrylate monophosphate). Generally, they do not have any light-curing capabilities.

**85. Describe the bonding resin adhesive.**

Bonding resins are unfilled bis-GMA (bisphenol A glycidyl methacrylate) or UDMA (urethane dimethacrylate). They may be visible light-cured (VLC), autocured, or dual-cured. The later generation of adhesive systems consolidated the primer and adhesive into premixed applications, which leads to a time savings. There has been a trend to add fillers to the adhesive bonding agents to enhance their physical properties.

**86. What enhancement do fillers contribute to newer adhesive bonding resins?**

- Increase the bond strength at the hybrid layer
- Improve stress absorption at the tooth restoration interface, enabling better retention
- Have a lower modulus of elasticity to impart added flexibility and thus relieve contraction stress caused by polymerization shrinkage; adhesive absorbs within itself some of the contraction stress
- Help adhesive cover the dentin in one application rather than multiple applications

**87. What are the seventh-generation adhesive systems?**

The latest systems combine applications of conditioning, priming, and adhesive resin all in one bottle. They are referred to as “single-component, one-step, self-etch adhesives” or “all-in-one adhesives.” Examples include Clearfil S<sup>3</sup> Bond (Kuraray Dental), G-Bond (GC America), iBond (Heraeus Kulzer), and Xeno IV (Dentsply Caulk).



**88. Can you use any adhesive with any composite?**

Generally, any light-cured composite should bond to any light-cured adhesive. However, self-cured composites such as core pastes are not compatible with most single-component adhesives. Dual-component or self-cure adhesives must be used with self-cure composites.

**89. Outline the adhesive procedures for bonding composites and amalgam to tooth structure.**

1. For composite materials

To enamel: Clean surface with pumice, wash, etch 15 seconds, wash, air-dry, and apply unfilled VLC resin only.

To dentin and enamel: Clean surface, etch 15 seconds, wash, leave moist, use VLC adhesive components in layers before composite, and consider filled adhesives.

2. For amalgam (bonding to dentin only): Clean surface, etch 15 seconds, wash, use VLC primer to seal tubules, self-cure resin adhesive (two-component system), and pack amalgam before resin sets.

**COMPOSITES****90. What are the components of composite resins?**

- Monomers: Bis-GMA, UDMA
- Diluent monomers: TEGDMA (tetraethyleneglycol dimethacrylate), MMA (methyl methacrylate)
- Inorganic fillers: quartz, glass, zirconium
- Organic fillers: silica
- Coupling agents: silane
- Initiators: tertiary amines, camphorquinone (CMP), phenyl propanedione (PPD), benzoyl peroxide
- Inhibitors: ether of hydroquinone
- Ultraviolet absorbers: benzophenone

**91. Describe the function of each monomer component.**

**Principal monomers** are high-molecular-weight compounds that can undergo free radical addition polymerization to create rigid, cross-linked polymers. The most common monomer is Bis-GMA (an aromatic dimethacrylate that is the addition product of bisphenol A and glycidyl methacrylate [GMA]). An alternative monomer is urethane dimethacrylate.

**Diluent monomers** are low-molecular-weight compounds used to reduce the viscosity of the unpolymerized resins to improve physical properties and handling. There are two types, monofunctional (MMA) and difunctional (ethylene glycol dimethacrylate or triethylene glycol). The latter are used most often because they form harder and stronger cross-linked composite structures because of a lower coefficient of thermal expansion. They also have less polymerization shrinkage, are less volatile, and have less water absorption.

**92. What are filler particles?**

Inorganic filler particles used in composite resins include quartz, glass, and colloidal silica, along with additions of lithium, barium, or strontium to enhance optical properties. These fillers are coated with a silane coupling agent (organosilane) to bond adhesively to the organic resin matrix. Silane bonds to the quartz, glass, and silica particles, whereas the organic end bonds to the resin matrix.

**93. Describe the mechanism of silane coupling.**

During free radical polymerization of the organic Bis-GMA, covalent bonds are formed between this polymer matrix and the silane coupling agent, commonly gamma-methacryloxypropyltrimethoxy silane. The coupling agent that coats the filler particles at the silane end thus holds the inorganic and organic phases together, which prevents further water absorption.

**94. What is the mechanism of polymerization in composite resin systems?**

Benzoyl peroxide and aromatic tertiary amines are used to initiate polymerization reactions by supplying free radicals. This process is induced by photoactivation with visible light

in the 420- to 450-nm range using alpha diketones and a reducing agent, often a tertiary aliphatic amine. The diketone absorbs light to form an excited triplet state, which together with the amine produces ion radicals to initiate polymerization.

**95. Describe the function of polymerization inhibitors.**

Inhibitors are necessary to provide shelf life and delay the polymerization reaction, thus allowing clinical placement of composite materials. The dimethyl acrylate monomers spontaneously polymerize in the presence of atmospheric oxygen. To this end, monomethyl ethers of hydroquinone are used as inhibitors.

**96. What are radiation absorbers?**

Ultraviolet absorbers provide color stability to composite resins and thus limit discoloration.

**97. How are composites classified?**

There are a number of classification systems, generally based on filler particle size and how the fillers are distributed.

- Large-particle (conventional) composites: 20 to 50  $\mu\text{m}$  in diameter
- Intermediate: 1 to 5  $\mu\text{m}$
- Hybrids or blends: 0.8 to 1.0  $\mu\text{m}$
- Fine particle and minifilled: 0.1 to 0.5  $\mu\text{m}$
- Microfilled: 0.05 to 0.1  $\mu\text{m}$
- Nanofilled: 5 to 75 nm
- Homogenous microfilled: organic matrix and directly admixed microfiller particles
- Heterogeneous microfilled: organic matrix, directly admixed microfiller particles, and microfiller-based complexes

**98. Which are presently the most commonly used composite materials?**

They are the microfilled, hybrid, and nanofilled composites.

**99. List major characteristics of hybrid composites.**

- Most universal in application, anterior and posterior usage
- Combine strength and polishability
- Easier to use than thin microfills and more closely match the refractive index of tooth structure
- Composed of several filler particles, a glass in the 1- to 3- $\mu\text{m}$  range plus silica, 0.04  $\mu\text{m}$
- Hybrids get darker when cured; match shade with cured sample
- Fillers are 75% to 80% by weight
  1. First-generation hybrid composite, with smaller filler size (1 to 2  $\mu\text{m}$ ) and high filler content (70% to 75% by weight; e.g., Prisma APH [Herculite]).
  2. Second-generation hybrid composite with high filler content (70% to 75% by weight) and uniform cut (1  $\mu\text{m}$ ) glass and submicron particles (e.g., TPH Spectrum [Dentsply Caulk], Z100 and Z-250 [3M ESPE], Tetric Ceram [Ivoclar Vivadent]).

**100. What are microhybrid composites?**

Microhybrid composites evolved from hybrid composites in efforts to decrease the size of the largest particles. Typically the largest size particle found in today's microhybrid is <1  $\mu\text{m}$ . They maintain the strength of hybrid composites with improved handling and esthetics (e.g., EsthetX [Dentsply Caulk], Point 4 [Kerr], Filtek Supreme [3M ESPE], 4 Seasons [Ivoclar Vivadent]).

**101. What are the major properties of microfill composites?**

- Allow the most aesthetic polishability and mimic porcelain in result
- Used in class III, IV, and V restorations; diastema closure; hand-sculpted facial veneers
- Resist wear; more elastic than hybrids and may be better suited to abfraction lesions
- Particle size 0.01 to 0.1  $\mu\text{m}$
- Color gets lighter when cured; match shade with cured sample.
- Fillers are 40% to 50% by weight
 

Product examples include Renamel (Cosmedent), Druafil VS (Heraeus Kulzer), Heliomolar (Ivoclar Vivadent), and Filtek A100 (3M ESPE).

**102. What are nanofilled composites?**

The application of nanotechnology to composites is one of the greatest advancements in the last few years in this field. Microfilled composites were the precursor material for nanofilled formulations that contain filler particles, ranging from 5 to 100 nm, and nanoclusters. Nanoclusters are 0.6- to 1.4- $\mu\text{m}$  agglomerates of primary zirconia-silica nanoparticles, 5 to 20 nm in size, fused together at contact points. The remainder of the porous structure is infiltrated with silane. Overall, nanofilled composites have similar mechanical and physical properties as microhybrids, but provide superior polish and sustained gloss. They are highly aesthetic, with favorable handling properties, and have demonstrated excellent strength and wear. Thus far they are commercially successful, suggesting more clinical acceptance. An example is Filtek Supreme Plus (3M ESPE).

Another category, nanohybrid composites, includes a combination of glass particles and nanofillers. Examples include Herculite Ultra (Kerr), EsthetX HD (Dentsply Caulk), Venus Diamond (Heraeus Kulzer), IPS Empress Direct (Ivoclar Vivadent), Grandio (Voco America), Aelite Aesthetic Enamel (Bisco), Clearfil Majesty Esthetic (Kuraray America), and Artiste (Pentron Clinical Technologies).

**103. How are hybrids, microfilled, and nanofilled composites used together for maximizing strength and esthetics, the so-called sandwich technique?**

1. A sandwich technique is a layering of materials to create the maximum of desirable properties in a restoration. In a class IV anterior restoration of an incisal angle, for example, using a hybrid composite first to build up the body of the underlying dentin provides strength and dentin-like opacity. Then, overlaying the final tooth structure with a microfilled composite provides incisal translucency, desired reflective characteristics, and high polishability of a microfill.
2. A layer of hybrid, together with opaquers, may block out undesirable colors prior to using a microfill.
3. All posterior restorations, as well as porcelain repairs and periodontal splinting, benefit from the superior strength of a hybrid.
4. Nanofilled composites can be used for the entire restoration and are stronger than microfills. They can be finished as smooth as microfills, but the process may be more technique-sensitive and time-consuming.

**104. What are packable composites?**

Packable composites have a consistency that more closely resembles that of amalgam than conventional composites. They are most commonly used in class I and II restorations. However, they cannot be condensed, but are more packable than hybrids. Because they are much stiffer in consistency, there is some ability to sculpt the restoration before curing. Bulk curing, however, is 2 to 3 mm at best. Products include Prodigy (Kerr), Filtek (3M ESPE), Heliomolar HB (Ivoclar Vivadent), AElite LS (Bisco), and Renamel Posterior (Cosmedent).

**105. What are low-shrinkage composites?**

Most current microhybrid and nanohybrid composites have a 2% to 3.5% polymerization shrinkage. Minimizing shrinkage is the goal of composite resin manufacturers. 3M created Filtek LS with less than 1% polymerization shrinkage, but the product was not widely accepted because it could only be used with its own unique bonding agent. Another low-shrinkage material N'Durance (Septodont) uses dimer-based chemistry, with polymerization shrinkage less than 2%, and can be used with any bonding system. Surefil SDR (Dentsply Caulk) claims to use a polymerization modifier to reduce polymerization stress up to 60% and allows a bulk fill up to 4.0 mm, with self-leveling capabilities.

**106. What are self-adhesive composites?**

Self-etching bonding agents set the stage for the new self-adhesive composites that contain the bonding agent within the restorative material. These restorative products bond and seal without the need for etchants or adhesives. Product examples are Embrace Wetbond Class V (Pulpdent), Vertise Flow (Kerr) and Fusio (Pentron Clinical Technologies).

**107. What are composite opaquers or tints? How may they be used?**

Opaquers and tints are light-cured, low-viscosity, highly shaded composites used to add aesthetic characteristics to restorations. They often match the VITA shade guide

(Vident) and can be brushed on in layers to create lifelike matches to natural teeth. They may be applied on a bonded tooth, between layers of the sandwich buildup, or even on the surface to characterize the restoration, (e.g., Renamel Creative Color, Cosmedent).

#### 108. What is a compomer?

A compomer is a polyacid modified composite that incorporates the properties of resin ionomers and composites. Compomers are self-adhesive to dentin because of their acid-base reaction and light curing and release fluoride. They still require a primer-adhesive and may not require etching first for dentin bonding, but etching increases bond strength to enamel. They may be used in carious class V lesions, as a flow application in the gingival wall of a proximal box in class II preparations, and to block out undercuts in inlay-only crown preparations. They are also suitable for all restorations in primary teeth. Dyract (Dentsply Caulk) is the leading material.

#### 109. Define composite sealant.

Composite sealants are unfilled resins applied to seal microcracks that may be left after finishing and polishing of composite or bonded restorations. They are very thin-film and have a minimal air-inhibited layer. Application is done after a 20-second etch, wash, and then allow a 20-second light cure.

#### 110. What are flowable composites?

Flowable composites are low-viscosity, VLC, radiopaque hybrid composite resins, often containing fluoride and dispensed by syringe directly into cavity preparations. They have 37% to 53% filler by volume (compared with 60% for conventional composites). They are claimed to be easy to deliver via a narrow syringe tip, offer flexibility for class V preparations, and are able to access small areas. They may be used as a base material under class I and II restorations. Although long-term performance is not known, they seem well suited for the long channels of air abrasion preparations, cementing veneers, dental sealants, margin repairs of all types, inner layer in sandwich techniques, porcelain repairs, and sealing the head of implants. Examples include Aeliteflo (Bisco), Florestore (DenMat), Revolution (Kerr), and Ultraseal XT Plus (Ultradent).

#### 111. How are flowable composites used?

**Class V defects:** Use for abfraction, erosions, and sealing marginal defects.

**Minimal class I restorations:** Use like a thick sealant for pit and fissure restorations prepared with air abrasion or fissurotomy burs.

**Gingival wall of class II restorations:** Use in the gingival wall of a proximal box has been shown to reduce leakage at this margin in composite restorations. Be sure to cure for a minimum of 40 seconds with halogen lights (also for buccal and lingual).

**Blocking out small undercuts:** Thus eliminates removing sound tooth structure, and is a fast and simple application.

#### 112. What are the advantages of all-purpose composite resins?

Products such as Geristore (DenMat) are termed *multipurpose products*. They are small-particle composites, release fluoride, are self- or dual-curing, and have high compressive strengths and low viscosity. They have applications as cements, bases and liners, or pediatric restoratives. They bond to dentin, enamel porcelain, amalgam, precious and semiprecious metals, and moist surfaces. They function as luting materials for crowns (with dentin-bonding systems) and are suitable for Maryland bridge bonding.

#### 113. What is anOrmocer?

Ormocer is an acronym for **o**rganically **m**odified **c**eramic. Ormocers are a class of restorative material that links glasslike inorganic components with organic polymer components to make them almost as hard as glass but similar to polymer materials in behavior. The prepolymerized filler particles in Ormocers are large and tightly packed, which leads to less shrinkage on curing. Admira (Voco GmbH) is a commercially available Ormocer-based restorative material. It features low polymerization shrinkage, high biocompatibility, tooth-like thermal expansion, and a nonsticky packable consistency. The technique for placement is direct and similar to that for traditional composites.

**114. What is a ceromer?**

Ceromer is an acronym for **ceramic optimized polymer**. It was introduced by Ivoclar Vivadent as Tetric Ceram. Other commercial products of this type include belleGlass (Kerr), Sculpture (Pentron Clinical Technologies and Artglass (Heraeus Kulzer)). The formulations of these materials give them many of the ideal properties found in composites and porcelain, but with a much higher level of fluoride release. These materials have high strength because of their low modulus of elasticity, as well as high flexural strength and fracture toughness. Also, their surface hardness is similar to that of enamel, giving them low wear and excellent polishability. These materials can be used for inlays, onlays, veneers, and crowns, using the direct-indirect or indirect techniques.

**115. What are “smart” composites?**

Smart composites were introduced by Ivoclar Vivadent as Ariston pHc. This material is an ion-releasing composite formulation that releases fluoride, hydroxyl, and calcium ions in response to a decrease in the pH in the area adjacent to the material. What makes these composites “smart” is that the greater the decrease in pH, which results from plaque, the greater the release of active ions. The effect is a reduction in secondary caries formation by inhibiting bacterial growth and reducing demineralization. The fluoride release from this material is not as high as from glass ionomer but is much higher than from other aesthetic materials.

**116. With all these products, how does the clinician know the best to use?**

It depends on physical and mechanical properties, aesthetic appeal, ease of use and, most importantly, personal preference.

**117. Define direct resin, indirect resin, and indirect-direct resin restorations.**

- **Direct resin** restorations are the placement of composite resins into class 1, 2, 3, and 5 preparations directly at chairside. They are the most commonly performed.
- **Indirect resin** procedures involve tooth preparation, impressions, and temporization at a first visit. Laboratory fabricated onlays or inlays of resin or ceramic restorations are cemented on a second visit.
- **Indirect-direct resin** restorations are a single-visit technique using fast-setting die stones to allow preparation, impression taking, chairside fabrication of the restoration, and delivery of the final inlay or onlay.

**118. What are the characteristics of the newer indirect composite resin systems?**

These composite resin systems are fabricated in the laboratory from impressions of prepared teeth. They are referred to as prosthetic composites or laboratory composites. They may be fiber-reinforced for crowns and bridges. By treating with heat, high-intensity light, vacuum, nitrogen, and/or pressure, the restoration's physical properties are greatly advanced. They exhibit reduced polymerization shrinkage, increased flexural and tensile strength, resistance to abrasion and fracture, and improved color stability. Examples of current materials are belleGlass (Kerr), Sinfony (3M ESPE), and Targis/Vectris (Ivoclar Vivadent).

**119. What criteria are used to choose direct placement composite resins in class II restorations?**

1. The best use is in narrow slot-type restorations and smaller restorations of one-fourth to one-third of the intercuspal distance.
2. If used in larger restorations, more than one-third the intercuspal distance, weak cusps must be covered, and longevity is not considered long term.
3. Persons with known metal allergies or patients who wish to avoid metal restorations should use these.
4. Use is contraindicated in bruxers or clenchers or when extensive tooth loss places resin margins in occlusal contact.

**120. Discuss the challenges of the class II composite restoration.**

1. Most current resins wear significantly more than amalgam, gold, or porcelain. To minimize wear, sufficient light curing is suggested (30- to 40-second cures on facial, occlusal, and lingual surfaces, with a calibrated light source).

2. They are generally time- and technique-sensitive restorations. Contact areas are harder to establish, and finishing is time-consuming. Use magnification to view; also use thin, dead, soft matrix bands or sectional matrices, well burnished against the proximal tooth, and held tightly with one instrument because the second places composite against the band and curing occurs. Finish and dry with sharp 12-bladed burs and a light touch.
3. Sufficiently light-cure the primer and bonding resins before placing composite to avoid postoperative tooth sensitivity. Apply composite in 2-mm increments.

**121. Compare indirect resins with porcelain.**

Indirect resins' inlays tend to fit better, are easier to adjust and polish intraorally, can be repaired with similar materials in the mouth and, most importantly, are not as hard or abrasive to the opposing teeth as porcelain. Porcelain restorations may be better for onlays or when restoring multiple cusp and occlusal schemes, but the wear to opposing teeth is significant and the need to adjust occlusion and polish intraorally after cementation requires time and is more difficult.

**122. Summarize guidelines for indirect resin and full-coverage ceramic crown preparations.**

1. Indirect resin preparations
  - 1.5-mm reduction on occlusal aspect
  - 1.5- to 2.0-mm reduction on cusps
  - Rounded internal line angles
  - No bevel margins
  - Butt joint or deep chamfer margins
  - Divergent walls
2. Specialized ceramics full crowns (e.g., Empress, Procera, e.max)
  - 2.0-mm occlusal reduction
  - 1.5-mm chamfer margin or butt joint margin
  - 1.5 to 2.0 facial reduction
  - No internal preparations with Procera (fill-in)

**123. Outline the step by step procedure for the direct posterior resin restoration.**

1. Apply rubber dam.
2. Remove the defective tooth structure or restoration.
3. Use a caries indicator (e.g., Seek-Ultra crown dent), if desired.
4. Prepare the tooth for the restoration.
5. Place a matrix system (sectional matrix or full-band); wedge.
6. Wash and clean preparation; you may use an antibacterial, if desired.
7. Use total etch time of 15 seconds for enamel and a maximum of 10 to 15 seconds for dentin with phosphoric acid. Do not overetch dentin.
8. Rinse etchant off well, and lightly air-dry or blot excessive water; leave surface moist.
9. Apply multiple layers of primer-adhesive to enamel and dentin, leaving for 20 seconds for penetration and hybrid layer formation.
10. Air-disperse to evaporate the solvent.
11. Light-cure for 10 to 20 seconds.
12. Apply a layer (<2-mm increments) of flowable composite to the pulpal floor in the proximal box.
13. Build up with composite (e.g., hybrid, packable, reinforced microfill).
14. Sculpt, shape, and gross occlusal adjustment.
15. Remove rubber dam, and adjust occlusion.
16. Apply occlusal resin stains, if desired (Kolor-plus [Kerr]).
17. Polish with points, cups, discs, and wheels.
18. Etch surface; rinse and dry.
19. Apply composite surface sealant and cure for 20 seconds.

**124. What methods are used to provisionalize indirect resin restorations?**

Take a preoperative polyvinyl matrix in a triple tray. Then fill with an acrylic or provisional composite resin and cement with a temporary cement such as Temp Bond (Kerr). Use a light-cured flexible resin such as Fermit (Ivoclar Vivadent) to insert, light-cure, and trim.

**125. Outline the cementation technique for resin-bonded inlays and onlays.**

1. Remove provisional restoration.
2. Apply rubber dam.
3. Clean preparation, rinse, dry; try restoration, checking margins, interproximal contacts, and overall fit.
4. Remove restoration, clean with etch, and rinse; place a silane coupling agent on the internal surface for 1 minute.
5. Etch tooth enamel and dentin for 15 seconds, rinse, and lightly air-disperse moisture.
6. Apply multiple layers of single-component adhesive; air-disperse to evaporate solvent; leave for 20 seconds.
7. Light-cure 20 seconds.
8. Apply thin layer of adhesive to internal surface of restoration.
9. Mix dual-cure resin cement (e.g., Calibra [Dentsply Caulk], Nexus2 [Kerr]), and apply into preparation; seat restoration.
10. While holding restoration, remove as much cement as possible with brush or rubber tip.
11. Spot cure into place 10 seconds from buccal and lingual aspects.
12. Apply floss through contacts.
13. Light-cure finally for 30 seconds on each surface; remove rubber dam and adjust occlusion; finish and polish.
14. Re-etch for 15 seconds, rinse, and dry.
15. Brush on a thin layer of surface sealant and light-cure.

**126. Describe the direct-indirect technique for posterior resin restorations.**

This combination technique involves taking an elastomeric impression of the prepared teeth and pouring up a die in a fast-setting material, such as an ultrafast-setting gypsum product. The clinician then generates the restoration in the office laboratory, light-cures it, and cements it in the same visit.

**127. List the advantages and disadvantages of the direct-indirect technique over the indirect, laboratory-processed, resin restorative technique.**

1. Major advantages
  - Decreased chair time
  - Decreased laboratory expenses
  - No need for temporization
2. Major disadvantages
  - Possible deformation of the restoration, especially if a flexible die material is used
  - Restorative material formulations available in the dental laboratory provide better strength and wear resistance
  - Processes available in the dental laboratory provide a better cure of the resin polymer material

**128. Give examples of laboratory-processed resin restorative materials. How are they cured compared with in-office resins?**

Most laboratory-processed resins are cured by a combination of light of varying intensities, pressure, and heat. Examples include Cristobal+ by Dentsply Ceramco and Sculpture by Pentron Clinical Technologies. Another material in this category is belleGlass HP by Kerr, which is processed in a nitrogen environment under heat and pressure. The nitrogen removes any oxygen-inhibiting air from the resin and improves the cure.

**129. What cementing materials should be used with indirect resin restorations?**

All three of the polymer resin systems mentioned above should be luted with resin cements. Only resin cements possess the ability to bond adequately to tooth structure and the internal surface of the restoration. All other types of cements are strictly contraindicated. Hybrid-type resin cements are best suited for onlay and full-coverage restorations because of their higher strength. Microfill resin cements are preferred for inlays because they possess greater wear resistance to occlusal masticatory forces.

**130. Why are the polymer resin restorative materials such as belleGlass HP well suited for restoring the occlusal surfaces of implant-supported restorations as opposed to conventional porcelains?**

Because porcelain has poor shock-absorbing ability, masticatory energy in implant restorations is transferred almost totally to the interfacial region between the implant and osseous

tissue that supports the fixture. In contrast, polymer resins such as belleGlass HP are much more energy-absorbent while still providing excellent resistance to wear on occlusal surfaces.

### 131. What considerations shall be kept in mind for repair of older composite restorations?

As composites age, it is harder to bond to the surface chemically. There are fewer reactive sites on the resin surface, and impregnated proteins and debris limit the bonding capacity. It is necessary to remove the outer surface with a bur to remove contaminants and increase the surface area. Pumice, followed by etching, proceeds as usual. Then coating with silane allows better bonding to the silica particles. Final application of unfilled resin and curing before placement of the composite should result in predictable bonding.

### 132. How is a fractured porcelain restoration repaired?

The first step is to determine the cause. Is it a structural weakness or perhaps an occlusal stress-related fracture? Try to resolve any causative factors first. The next step is to create some mechanical hold wherever possible. Roughen and bevel around the defect because the restorative cannot bond to a glazed surface. Microetch when possible with an air abrasion microetcher, or use a porcelain acid etchant such as 10% to 12% hydrofluoric acid gel. Then silanate and apply bonding resin, opaques, and finally the appropriate color of composite restorative.

### 133. What is the function of a curing light?

Primarily curing lights apply a visible light spectrum (400 to 700 nm) to photo imitators such as camphorquinone (450 to 525 nm) and PPD (430 nm) that allow polymerization on demand of a vast array of dental materials. Output should be at least 300 mW/cm<sup>2</sup>, and built-in radiometers are advantageous.

### 134. List the current basic light types.

- Quartz halogen bulb
  - Most common, least expensive, reliable
  - Wide-spectrum bandwidth, 400 to 510 nm
  - Cures all materials
  - Top models: Optilux 501 (Kerr); Spectrum 800 (Dentsply/Caulk)
- Plasma arc curing (PAC)
  - Very fast, expensive, larger than halogen
  - May not cure all materials
  - Example: Rembrandt's Sapphire
- Argon laser
  - Fast, expensive, larger than halogen
  - May not cure all materials
  - Example: Arago (Premiere Laser Systems)
- Light-emitting diode (LED)
  - Cordless, lightweight, small, long battery life
  - May not cure all materials
  - NRG (caulk)
- High-powered LED
  - Reduced curing times
  - More efficient curing
  - Caution pulp temperature
  - Lightweight, portable, long life span
  - Examples: Elipar Freelight-2 (3M ESPE), SmartLite PS (Dentsply Caulk)

### 135. Why and how should lights be tested and maintained?

The power output of a light is critical to proper curing of a restoration. Any decrease is likely to give inadequate polymerization. The power output should be tested with a radiometer (built in to many newer lights) when new and weekly thereafter. Any decrease should be checked. Usually, a deterioration in bulb strength (change the bulb), a dirty wand tip (clean regularly), or a worn light filter or optical guide (replace as needed) can decrease output. When all these steps fail, return the light to the manufacturer.



**136. What constitutes an ideal cure?**

- Pack and cure materials incrementally to a 2-mm maximal thickness, with 20- to 40-second cure times.
- Keep light at right angles to the cure material.
- Keep distance from tip to material less than 6 mm.
- Use a proper diameter tip for the curing objective.
- Darker shades and thicker layers need more time.
- There is apparently no difference in ramped, stepped, or pulsed delivery of light and final cure results.

Composites do not shrink toward the light, but direction is determined by cavity shape and bond quality. The latter is determined by proper adhesive technique.

**CEMENTS****137. What are resin cements?**

They are modified, low-viscosity composites used to bond ceramic and indirect resin restorations.

**138. Summarize the types of resin cements and the indications for each.**

1. Light-cured
  - Metal-free restorations < 1.5 mm in thickness
  - Metal-free orthodontic retainers
  - Metal-free periodontal splints
  - Product examples: Insure (Cosmedent); RelyX Veneer (3M ESPE)
2. Dual-cured
  - Metal-free inlays, onlays, crowns, and bridges
  - Any application where a curing light may not reach
  - Product examples: Variolink II (Ivoclar Vivadent); RelyX ARC (3M ESPE); Panavia F2.0 (Kuraray); Duo-link (Bisco)
3. Self-cure
  - Metal-based inlays, onlays
  - Ceramometal crown and bridges
  - Full metal crowns and bridges
  - Endodontic posts
  - Bonded amalgams
  - Product examples: Panavia 21 (Kuraray); RelyX (3M ESPE) C&B Metabond (Parkell); Post Cement Hi-X (Bisco)

**139. What are the advantages of glass ionomer restorative materials?**

They bond to tooth structure, have an almost ideal expansion-to-contraction ratio and low microleakage, and release fluoride. Glass ionomers tolerate moisture and adhere directly to tooth structure with a solid marginal seal. The light-cured materials are the easiest to work with because they provide extended working times, have rapid on-demand set, and are less technique-sensitive on mixing. The chairside experience is quicker and easier for the patient and dentist.

**140. How are glass ionomer cements (GICs) classified?**

GICs are mixed powder-liquid component systems. The powder consists of a calcium aluminum fluorosilicate glass that reacts with polyacrylic acid to form a cement of glass particles surrounded by a matrix of fluoride elements.

1. **Hydrous types:** a slower-setting material characterized by a viscous liquid of polyacrylic acid, tartaric acid, itaconic acid, and water plus fluoroaluminosilicate glass powder. Examples: GC Lining cement (GC America), Chelon-Silver (3M ESPE)
2. **Anhydrous types:** fluoroaluminosilicate glass, vacuum-dried polyacrylic acid, itaconic acid powder, and a water and tartaric acid solution. These materials have a better shelf life. Example: Ketac Cem (3M ESPE)
3. **Hybrid forms:** combination of anhydrous and hydrous forms of glass ionomer powder and liquid. Example: Fuji II (GC America)

4. **Light-cured glass ionomers:** an acid-base setting material in a photo-initiated liquid. These materials offer extended working times and rapid, on-demand setup and are less technique-sensitive on mixing.  
Examples: Vitrabond (3M ESPE) and XR Ionomer (Kerr)

#### 141. What are metal-reinforced GICs?

Metallic silver particles of up to 40% by weight are added to GICs to increase the strength and to speed the setting time. Metal-reinforced GICs may be used for the following: (1) core buildups when at least 50% of tooth structure remains (GICs alone do not have the strength to be a total core); (2) as a temporary filling material; and (3) as a filler, base, or liner for undercuts in any cavity preparation. They provide excellent thermal and electrical insulation and are radiopaque. An example is KetacSilver (3M EPSE).

#### 142. What are resin-modified glass ionomers?

The addition of methacrylate monomer in aqueous polyalkenoic acid solution with monomer containing free radical double bonds in a fluoroaluminosilicate-containing component improved the strength of traditional glass ionomers. The monomer sets via VLC polymerization and cross-links, but the acid-base setting reaction is undisturbed. The initial self-setting is accelerated and light curing offers final control. The latest products do not require any etching, priming, or bonding, and the dual cure provides longer working times and shorter setting times. A variety of aesthetic shades are available. Examples are Fuji II LC (GC America) and Photac (3M ESPE).

#### 143. What are glass ionomer resin (GIR) cements?

These resin-modified glass ionomers improve the properties of glass ionomers significantly.

1. They are easy to mix and place.
2. They are equal or higher in fluoride release.
3. They have higher retention, higher strength, lower solubility, and lower postoperative sensitivity than glass ionomer or zinc phosphate cements.

Current brands are Nexus RMGI (Kerr), Vitremer (3M ESPE), Advance (Dentsply Caulk), and Fuji Plus (GC America).

### TECHNIQUE TIPS

#### 144. What is considered the most important requisite for successful adhesive dentistry?

The formation of maximal-strength bonding requires a clean operating field, free of debris and contamination. Whenever possible, this goal is best accomplished with a rubber dam.

#### 145. What is the function of a matrix band? What types are currently available?

Matrix bands establish the foundation for a missing proximal wall of a tooth preparation. They may be metal or plastic and usually have a retainer to keep their form against the axial tooth walls and support tight contacts. The use of a wedge adapts the band fully at the gingival margin, but the wedge should not be placed under too much pressure to avoid unwanted effects on the gingival papilla. The traditional metal band and Tofflemire-type retainers have been replaced by **sectional types**, which are used to form predictable proximal contacts when posterior direct resins are placed. They require an individual matrix for each proximal box (two are used for mesial-occlusal-distal boxes). The concaved metal or transparent form is placed interproximally and gently wedged. Then, using a rubber dam or dedicated forceps, the retaining ring is grasped, expanded, and positioned over the proximal line angles. When released, the ring tines grab the matrix and hold it against the tooth. The result is close adaptation of band to tooth to minimize excessive composite at the line angles but also to exert pressure on the band against the adjacent tooth to ensure a tight contact. Product examples are Palodent Plus (Dentsply Caulk), V3 and V4 ClearMetal (Triodent); Composit-Tight 3D (Garrison); and Contact Matrix (Danville Materials). Omni-Matrix (Ultradent) is a disposable retainer and matrix.

#### 146. How can one achieve a tight interproximal contact in direct class II posterior composite restorations?

1. Use a thin burnished band, well-adapted and wedged, or a prefabricated sectional matrix system.

2. Apply a proximally applied force with an instrument to the band while curing the composite. This technique keeps the restoration tightly against the band and provides optimal contact.

**147. What are clinical procedures that may cause injury to pulps of teeth?**

1. Dull burs and diamonds can result in increased heat production.
2. Noncentric hand pieces traumatize teeth like mini-jackhammers.
3. Inadequate water delivery causes heat and dehydration.
4. Overdrying tooth preparations dehydrates the pulp, causing sensitivity.
5. The acidity of astringent materials such as Hemodent (pH of 1.9) can injure if left in dentin or root contact. Use only minimally on packing cord or in the gingival sulcus.
6. Temporary resin exothermic reactions for provisional restorations may be harmful. Cool with water often during exothermal period.
7. Poor-fitting temporary restorations can result in leakage that injures pulps. Margins should fit well.
8. Overcontoured restorations can result in trauma from occlusion. Carefully adjust occlusion and check in all excursions.

**148. Describe the symptoms generally associated with coronal fracture syndrome (CFS).**

Patients who have CFS typically present with pain on chewing, particularly with hard foods and at the correct contact angle on the offending tooth. Additionally, there may be some sensitivity to cold and sweets, depending on the extent and nature of the fracture. Symptoms that include lingering temperature sensitivity may indicate that the pulp has undergone irreversible damage as a result of the fracture.

**149. What diagnostic tools and methods may be used to determine the location of the fracture in a patient with CFS?**

In addition to the customary methods of locating dental pathology, the use of a bite stick or Tooth Slooth (Professional Results) enables you to isolate cusps to see whether pain can be elicited by occlusal stress on a potential offending cusp. The offending cusp often elicits a response on release of the bite on the stick. Intraoral cameras, magnification, and light refraction are also helpful in determining the location and extent of fractures.

**150. Describe the use of diagnostic restoration removal in the treatment of coronal fracture syndrome.**

Diagnostic restoration removal is the removal of an existing filling material to inspect the pulpal floor visually and evaluate the integrity of the dentin at the base of the cusps. This procedure is performed when a hairline crack is visible externally but its extent and disposition are unclear.

**151. What types of restorations should be considered for teeth with CFS?**

Generally speaking, restorations that bond and/or provide cuspal reinforcement should be used on CFS teeth. Fractures that have minimal dentin involvement may be restored with direct or indirect resins. Fractures involving significant amounts of dentin or involving one or more cusps should be restored with ceramic or gold onlays and crowns.

**152. Describe the clinical relationship among bruxism, tooth wear, and the incidence of CFS.**

Bruxism and tooth wear often lead to loss of cuspid guidance, resulting in more of a group function occlusal scheme. This leaves the posterior teeth, especially those that are more heavily restored, prone to fracture.

**153. If a patient presents with tooth sensitivity to biting and cold in a clinically normal-appearing molar with a MOD amalgam, what are the possible differential diagnoses? What is the suggested treatment?**

First, to confirm the specific tooth, attempt to duplicate the symptoms with a cold spray (Hygenic Endo-Ice, Coltène/Whaledent) and when biting on a wet cotton roll. Take a radiograph to rule out recurrent decay, periapical pathology, or periodontal involvement. If there are no positive radiographic findings, consider a cracked tooth or a pulp that is hyperemic and may or may not be approaching irreversible change.

The best initial treatment is to remove all old amalgam and explore the tooth for cracks or decay. Placing a bonded nonmetallic restoration allows one to see whether the pulp can resolve. If symptoms subside within 3 to 6 weeks, a permanent restoration (full-coverage crown or onlay) may be placed. If symptoms persist or worsen at any time, endodontic treatment should begin. If endodontic treatment does not resolve the pain, it may be concluded that the fracture proceeds subgingivally or through the furcation. At this time, extraction must be considered.

**154. What is the biologic width? Explain its relationship to restorative dentistry.**

The biologic width is an area that ideally is approximately 3 mm wide from the crest of bone to the gingival margin. It consists of approximately 1 mm of connective tissue, 1 mm of epithelial attachment, and 1 mm of sulcus. As it relates to restorative dentistry, if a restorative procedure violates this zone, there is a higher likelihood that periodontal inflammation will ensue, causing the attachment apparatus to move apically.

**155. When it becomes necessary for restorative reasons to impinge on the biologic width, what steps can be taken before final restoration to create a maintainable periodontal environment?**

Crown lengthening and orthodontic extrusion are the two most common ways to deal with this problem. Crown lengthening exposes more tooth structure surgically and is, in effect, surgical repositioning of the biologic width. Orthodontic extrusion is done when crown lengthening would unduly compromise the periodontal health of the adjacent teeth or create an unfavorable aesthetic situation, as can often occur in the anterior maxilla.

**156. What techniques can be used to achieve marginal exposure and to control hemorrhage in a class V cavity preparation?**

If the preparation is less than 2 mm below the gingival sulcus, an impregnated retraction cord with a gingival retraction rubber dam clamp may be effective. If the defect approaches 3 mm or more, the hemostasis and margin exposure often require surgical exposure (crown lengthening) or excision via electrosurgery.

**157. Describe the options for treatment of root surface sensitivity.**

Root sensitivity is a common problem and can be adequately resolved in many cases by modifying the patient's tooth-brushing technique and having her or him use desensitizing toothpaste, such as Sensodyne or a fluoride gel. Other desensitizing agents, such as Protect (Butler), use oxalate precipitates to occlude the dentin tubules. Gluma (Heraeus Kulzer) has a patented glutaraldehyde-hydroxyethyl methacrylate formula that acts quickly to seal dentinal tubules. Dentin-bonding systems also work well to reduce sensitivity. Others advocate iontophoresis to apply fluoride to the sensitive surface.

**158. Should composite resins be placed to cover exposed root surfaces in a patient with gingival recession?**

In the absence of caries, the placement of composite to cover exposed root surfaces should generally be performed after careful consideration. Composites bond only marginally well to cementum and, like all restorative materials, can further promote gingival recession. In addition, if surgical root coverage is performed, success depends on the establishment of a biologic attachment between the grafted tissue and cementum. Grafts do not attach to composites. Root surface coverage may be considered in cases of protracted and extreme root sensitivity or when it is of significant aesthetic concern to the patient.

**159. Should direct placement composites be placed in bulk or in increments to the cavity preparation?**

Opinions vary about the optimal method of composite placement. Some manufacturers and clinicians advocate bulk placement, but most recommend the layering and curing of material in approximately 2.0-mm increments to allow more thorough curing. Incremental placement also allows the layering of materials of different shades, opacities, and viscosities to achieve a better aesthetic result.

**160. What is the relationship between the size and location of the restoration and the potential for failure when direct resins are used on posterior teeth?**

The more posterior the composite resin is placed, the greater the occlusal force. This force greatly increases the possibility of fracture, especially when there is an occlusal stop on the

resin. Additionally, the larger the restoration, the greater the likelihood that polymerization shrinkage will compromise the integrity of the margins, leading to postoperative sensitivity and failure.

**161. Describe the ideal clinical situation for placement of a class II direct resin restoration.**

Ideally, a class II resin should be fairly conservative, with minimal exposure of dentin, all margins should be in enamel for optimal seal and marginal integrity, and there should be no occlusal stops on the restoration to minimize the likelihood of resin fracture.

**162. What are helpful aids in shade matching for anterior teeth?**

Choose the shade with color-corrected or natural light. Match teeth that are moist. Liquid coatings (saliva) alter reflected light. Place a cotton roll behind adjacent teeth to study changes in color, and note incisal shade changes that occur with light and dark backgrounds. Place a small amount of composite on the facial aspect of a tooth and light-cure. Hybrid composites turn darker and microfills lighter on curing.

**163. Describe recent technologic advances in chairside shade taking for porcelain restorations.**

In the past, shade taking involved manual shade tabs and the subjective viewpoint of the practitioner. Today, digital shade-taking systems, such as ShadeVision (X-Rite), ShadeScan (Cynovad), ShadeEye NCC (Shofu), and SpectroShade (MHT International) allow dentists to digitally map teeth with all their variations of hue, value, and chroma. This information can be sent to the laboratory via e-mail, CD, or Flashcard. The software then calculates the shades of porcelain to be layered to achieve the proper match.

**164. List uses of the stainless steel crown (SSC) in adult dentition.**

1. Extensive decay in the dentition of young adults may leave a vital tooth with limited structure that requires a crown. If a permanent cast or ceramic restoration is not feasible, one may use the SSC in conjunction with a pin-bonded, composite core buildup to stabilize the tooth until a permanent crown is constructed. A typical restoration involves the following steps: (1) complete excavation; (2) application of a glass ionomer liner or dentin bonding; (3) optional placement of pins at the four corner line angles; (4) beveling of the cervical enamel or dentin margin; (5) trial fitting of the SSC with careful adaptation of the cervical margins and checking for occlusal clearance; (6) etching of the preparation; (7) application of a self-cure bonding resin; (8) filling of a well-adapted SSC with self-curing composite core material; and (9) seating of the crown. Removal of excessive and expressed composite leaves a well-sealed restoration that may serve for many years. When it is time to prepare the tooth for the permanent crown, slitting the SSC leaves the core buildup ready for final preparation.
2. SSCs may be used to stabilize rampant decay at any age.
3. SSCs may be used as a substitute for the copper band to stabilize a tooth before endodontic treatment. The SSC is more hygienic and kinder to the periodontium when it has been well adapted. Traditional access is through the occlusal dimension.
4. The SSC may be used as a temporary crown when lined with acrylic.

**165. Outline design criteria for closing spaces in the anterior dentition.**

1. Usually, composite bonding and/or porcelain veneers may close the maxillary central diastema. Careful space analysis with calipers allows the most aesthetic result. The width of each central incisor is measured, along with the diastema space. Half the dimension of the diastema space is normally added to each crown, unless the central incisors are unequal. Then adjustment is made to create equal central incisors.
2. If the central incisors appear too wide aesthetically, one can reduce the distal incisal to narrow the tooth and bond it over to seal any exposed dentin. One then adds to the mesial incisal of the lateral incisor to effect closure of space.
3. A tooth in the palatal crossbite may even be transformed into a two-cuspid tooth by building up the facial aspect to the buccal profile. This bicuspidization is reasonably durable and aesthetically pleasing.

4. Peg laterals and congenitally absent laterals replaced by cuspids may similarly be transformed by bonding and/or porcelain veneers. Reduction of protrusive contours, followed by addition to mesial and distal incisal areas, establishes aesthetic results.

**166. List the indications for the porcelain veneer restoration.**

1. Stained teeth or teeth in which color changes are desired
2. Enamel defects
3. Malposed teeth
4. Malformed teeth
5. Replacement for multisurfaced composite restoration when adequate tooth structure remains (at least 30%)

Each patient must be evaluated on an individual basis. A general requirement is excellent periodontal health and good hygiene practices. In the case of stained teeth, prior bleaching (passive home or in office) helps ensure better color aesthetics.

**167. Describe the basic tooth preparation for the porcelain veneer restoration on anterior teeth.**

1. **Vital bleaching.** This is optional.
2. **Preparation.** Enamel reduction of at least 0.5 mm, which may extend to 0.7 mm at the cervical line angles, is necessary to avoid overcontouring. The only exception may be a tooth with a very flat labial contour and slight linguoversion. Chamfer-type labial preparations can be achieved with bullet-type diamonds, and the use of self-limiting 0.3-, 0.5-, or 0.7-mm diamond burs is essential for consistent depth of preparation. The gingival cavosurface margin should be level with the free gingival crest. The mesial and distal proximal margins are immediately labial to the proximal contact area. The contacts are not broken but may be relaxed with fine specialty strips of 15- to 120- $\mu$ m thickness. This allows placement of smooth metal matrix strips at the time of placement. The incisal margin is placed at the crest of the incisal ridge. Placing retraction cord into the gingival sulcus prior to preparing the gingival cavosurface margin helps in the atraumatic completion of the preparation.
3. **Impressions.** Standard impression techniques use vinyl polysiloxane materials.
4. **Temporization.** If at all possible, this should be limited in use; it may be time-consuming and add to the expense of the procedure. One should use fine discs on the labial enamel surface for polishing the rough surface of the diamond-cut preparation to limit the accumulation of stain and debris. If it is necessary to temporize, preconstructed laboratory composite veneers or chairside direct temporization may be used. The techniques are similar. Spot-etch two or three internal enamel areas on the labial preparation. Apply unfilled resin and tack-bond the veneer, or place some light-cured composite on the tooth and spread it with a gloved finger dipped in unfilled resin to a smooth finish. The preparation should be light-cured, and one should be able to lift it off relatively easily at the unetched areas and polish down the etched spots.

**168. Describe the technique for insertion of porcelain veneers.**

1. After isolation, pumicing, and washing, the fragile porcelain veneers are tried on the chamfer-prepared tooth. First, the inside surface of the veneer is wetted with water to increase the adhesion. Margins are then carefully evaluated.
2. Try-in pastes are used to determine the correct color matching. Water-soluble pastes are the easiest to use. The try-in pastes closely match the final resin cements but are not light-activated.
3. The porcelain veneers are prepared for bonding. Apply a 30-second phosphoric acid etchant for cleaning. Wash and dry. Apply a silane coupling agent, and air-dry. Apply the unfilled light-cured bonding resin, and cure for 20 seconds.
4. To bond the porcelain veneer to the tooth, first clear interproximal areas with fine strips. Pumice and wash thoroughly. Place strips of dead, soft interproximal matrix, and etch the enamel for 30 seconds. Wash for 60 seconds and dry. Apply the bonding resin. Any known dentin areas should be primed (with dentin primer materials) before applying the bonding resin. Any opaquers or shade tints may now be applied. The light-cured resin luting cement is then applied to tooth and veneer. The veneer is carefully placed into position, and gross excessive composite is removed. Precure at the incisal edge for 10 seconds,

and remove any partially polymerized material gingivally and proximally. Light-cure fully for 30 to 60 seconds. Finish the margins with strips, discs, and finishing burst. Check for protrusive excursions. Apply the central incisors first and then the laterals and the cuspids.

**169. What are the newer “no-prep” veneers?**

No-prep veneers are made of ultrathin, highly translucent porcelain (0.2 to 0.3 mm) and are used to close diastemas and cover stained, discolored, crowded, or chipped teeth in the anterior region. Little to no reduction in tooth structure is necessary for placement, so the use of local anesthesia, provisionals, and postoperative sensitivity may be eliminated. The downside of nonpreparation veneering techniques includes poor marginal adaptation and poor aesthetics. If the palatal or functional side remains uncorrected, maintenance and restoration may be challenging. Examples are Lumineers (DentMat) and Vivaneers (Glidewell Laboratories).

**170. What are CAD-CAM restorations?**

CAD-CAM stands for computer-aided design—computer-aided manufacturing. The Cerec system, introduced in 1986 by Sirona Dental Systems, fabricates an aesthetic restoration using an intraoral camera, software, and precision milling machine, thus allowing the completion of the restoration in one appointment. The latest version is the Cerec AC. Digital impressions can be taken with the Bluecam or Omnicam and milled by the Cerec MC (X, XL). The software, version 4.2, has an intuitive user interface with the option of editing the virtual restoration and the possibility for multiple restorations.

**171. Describe the process whereby the Cerec CAD-CAM unit fabricates a restoration.**

The Cerec intraoral camera is placed over the tooth preparation, and a three-dimensional image of the preparation is generated. The operator then delineates the margins on the computer screen, and the system calculates and proposes the other morphologic contours, which the operator accepts or modifies. Once the design is accepted, the software directs the modular milling unit to fabricate the restoration from a preselected block of restorative material. When completed, the restoration can be adjusted chairside, if necessary, and stained internally and externally to modify the shade.

**172. How do the intraoral cameras capture the image of the tooth preparation?**

The Cerec Bluecam is an intraoral camera that captures an optical impression of the prepared teeth. Titanium oxide powder is sprayed in a very thin layer on the surface of the teeth to be imaged. This powder is needed to make the preparation reflective to the optical impression. Obtaining the optical impression takes the unit less than 0.5 second. The Omnicam is a coating-free scanning device that saves the additional powder step. It provides precise 3D images in natural color, making scanning more ergonomic.

**173. Describe the milling system used in the Cerec CAD-CAM unit.**

The Cerec milling units use sharp, fine milling cutters for gross preparation and finer detail. Step burs and cylinder-pointed burs are used; their size is specific to the type of material being milled (silicate ceramic vs. hybrid ceramic vs. composite vs. sintered ceramic). The system provides a warning to the operator when the milling instruments need to be replaced, and changing them is easily done.

**174. What restorative materials are available for the Cerec unit?**

The initial material developed for the Cerec CAD-CAM units was ceramic. Currently, a variety of materials are used, including silicate ceramics (Cerec Blocks [Sirona], Vitablocs Mark II [Vident], IPS e.max [Ivoclar Vivadent]), hybrid ceramics (Vita Enamic [Vident], Lava Ultimate [3M ESPE]), infiltration ceramics (Vita In-ceram - Zirconia, Alumina, or Spinell [Vident]), sintered ceramics (InCoris ZI [Sirona]), and composites (Vita CAS-Temp monoColor [Vident], TelioCad [Ivoclar Vivadent]).

**175. Describe the classification for dental casting gold alloys.**

Dental gold casting alloys are classified as types I to IV according to their composition as it affects surface hardness and strength as measured by their Vickers hardness number (VHN).

**Type I (soft):** VHN 50 to 90

**Type II (medium):** VHN 90 to 120

**Type III (hard):** VHN 120 to 150

**Type IV (extra hard):** VHN 150+

**176. What are the benefits of cast gold inlays and onlays?**

It is generally accepted that cast gold is the standard against which all other restorative materials are judged. The gold onlay provides cuspal protection, as well as the following benefits:

1. Low restoration wear
2. Low wear of opposing teeth
3. Lack of breakage
4. Burnishable and malleable
5. Proven long-term service
6. Bonded cast gold restorations offer improvement in their main weakness, the cementing media.

**177. What type of gold is recommended for use in a class II gold inlay?**

Type II gold such as Academy Gold (Ivoclar Vivadent), JRVT (Jensen Industries), and Argenco High Purity 77 (Argen) should be used.

**178. What are the advantages of cast gold onlays over other materials for restoring posterior teeth?**

It is generally accepted that cast gold is the standard against which all other restorative materials are judged. Cast gold onlays afford cuspal protection to prevent fracture, have excellent marginal integrity and, unlike porcelain, are kind to the opposing dentition.

**179. Describe two methods to improve the seating of gold onlays and crowns.**

1. Die spacers used in the laboratory provide a thin layer of cement and ensure more complete seating of castings.
2. Venting of a gold casting has also been shown to improve seating. The vent hole allows entrapped air and excess cement to escape during cementation. The vent hole is then filled with a cast pin, which is tapped in place and finished down as needed.

**180. What is a Captek crown?**

Captek is short for capillary casting technology and is a type of porcelain fused to the high noble type of crown. The technique involves the layering of gold by capillary action on a previously placed layer of platinum on a die. This process is followed by placement of a bonding agent and application of porcelain.

**TOOTH WHITENING****181. What are the most common methods to lighten vital teeth?**

Generally, most tooth whitening is done with home bleaching kits using custom tray fabrication. In-office techniques are suitable for some patients based on the type and intensity of stain and temperament and wishes of the patient. Home treatment requires compliance and patience, whereas chairside techniques are faster, but often more costly. Direct composite or laboratory porcelain veneers are the next most conservative approach and may be used when bleaching does not produce satisfactory results. Veneers are also useful when the shape, size, or arrangement of teeth is aesthetically unacceptable. Finally, full-coverage porcelain and porcelain fused to metal crowns are the most invasive methods; these may be used when there is a need to replace damaged or missing tooth structure.

**182. What factors influence tooth discoloration?**

Extrinsic agents either consumed or not subject to removal by proper hygiene can stain and darken teeth. Intrinsic discoloration may be caused commonly by aging (increased yellowing), disease, injury, or certain exposures, such as to tetracycline.

**183. For intrinsic stains, what agent has proved most effective for general use?**

Intrinsic stains respond favorably to the chemical oxidation actions of peroxides. The use of vital bleaching with tray-delivered peroxide-based systems was the fastest growing dental procedure in the 1990s and continues to grow. Over 90% of U.S. dental practices offer this service.

**184. What are the peripheral benefits of tooth whitening?**

Often, patients describe increased self-esteem, improved oral hygiene practices, and increased interest and involvement in dentistry.



**185. List appropriate expectations of present bleaching techniques.**

1. Natural teeth generally darken with age. Patients older than 50 years accumulate brown, orange, or yellow stains that are decreased by bleaching. Light yellow or brown shades lighten better than gray shades. External stains respond better than deeper internal stains, such as those from tetracycline staining or staining related to endodontic events.
2. Teeth lighten visibly regardless of the system used (in-office or home methods).
3. The degree of lightening is a function of the concentration of active ingredient and time of contact. In-office techniques use higher concentrations applied for up to 1 hour on isolated teeth, whereas home methods use lower concentrations applied over several weeks in custom-molded trays constructed with or without reservoirs on the facial surfaces.
4. Generally, few side effects are reported, and they tend to be transient.
5. Bleached teeth retain color for up to several years, although some patients request touch-ups at 6- to 12-month intervals. Patients with high consumption of coffee, tea, cola, or red wine, and tobacco users may require more frequent applications.
6. All current tooth-lightening products are generally similar when adjusted for contact time and concentration of reagent. Changes of two to six or more shades on the Vita scale are common.

**186. How are bleaching procedures currently performed?**

1. **Professionally administered chairside.** After tooth isolation with latex or paint on a rubber dam, a peroxide gel is coated on teeth and usually activated via high-energy light to shorten the treatment interval. Higher concentrations of peroxide gels in the form of up to 35% carbamide peroxide are used in 1- to 2-hour treatment sessions.
2. **Professionally dispensed systems.** These use custom-fabricated trays to deliver 10% to 20% carbamide peroxide solution in home procedures. Trays are worn for 2 hours or overnight for a period of 2 to 3 weeks. Favorable results have been reported, even with tetracycline staining, with prolonged applications of up to 3 to 6 months. Opalescence Whitening Gel 10% (flavors: regular, mint, and melon [Ultradent]) has fulfilled the requirements of the American Dental Association (ADA) Seal of Acceptance Program for safety and efficacy.
3. **Self-administered, over-the-counter, and professionally dispensed whitening strips.** Whitening strips (Crest) containing 5% to 6.5% hydrogen peroxide (equivalent to 10% carbamide peroxide) that are adherent to the teeth and worn for two 30-minute intervals daily for 2 weeks take about half the time of tray-delivered systems.

**187. What are the active ingredients in bleaching systems?**

Hydrogen peroxide ( $H_2O_2$ ) is the active ingredient in all bleaching systems. In carbamide peroxide formulations, the hydrogen peroxide is stabilized by urea and appears to be more stable than  $H_2O_2$  alone and produces fewer side effects. A 10% carbamide peroxide solution contains 7% urea and 3% hydrogen peroxide. Presently available formulations contain 3% to 50%  $H_2O_2$ . Formulations are based in viscous gels to avoid side effects and maximize the retention to teeth. They are buffered to a near-neutral pH.

**188. Describe the mechanism of action of hydrogen peroxide in lightening teeth.**

Hydrogen peroxide oxidizes and removes interprismatic organic matter within the tooth to lighten the shade.

**189. Describe “energized” in-office methods to speed the lightening of teeth.**

The application of a curing light or laser has been claimed by manufacturers to shorten the lightening process; generally, less than 1 to 2 hours in the office will equal 2 weeks at home. This is because much higher peroxide concentrations are delivered on properly isolated teeth; it does not seem to be based on the method of energizing. Higher in-office concentrations require tooth isolation by paint on rubber dam material or a traditional dam.

**190. Which method of bleaching produces the best results?**

Split arch comparisons seem to indicate that no discernable differences in lightening are achieved by any properly performed home or energized method; the effect is a function only of concentration and time.

**191. What are the two major complications of vital tooth bleaching?**

Tooth sensitivity and gingival irritation may affect up to two-thirds of patients during the course of treatment. Tooth sensitivity is often mild and self-limiting and usually involves

increased response to cold. Gingival irritation is often attributed to peroxide contact with tissues or poorly contoured trays that irritate the marginal tissues. There are no structural or functional effects on teeth.

**192. What is thought to be the cause of bleach-induced tooth sensitivity?**

Pulpal penetration of peroxide, dehydration, and tray-related tooth movements have been implicated. This sensitivity is transient and generally dissipates within a short time.

**193. If a patient reports tooth sensitivity during the initial phase of treatment, what strategies may be implemented?**

Decreasing the contact intervals may be a start—using 1-hour instead of 2-hour contact times or even every other day. Decreasing the concentration of the product chosen, 10% or less carbamide peroxide rather than higher levels, is a second choice. It has been reported that not prebrushing the teeth decreases sensitivity without undue impairment in bleaching result. Dentifrices contain detergents (e.g., sodium lauryl sulfate) that may readily denature proteins on contact, which allows greater penetration of peroxide into the tooth and increases transient irritation. A prescription-strength fluoride dentifrice such as Prevident 5000 Plus (Colgate) can be used to resolve persistent cases. Soft tissue irritation can occur with in-office methods unless proper isolation is used. Home bleaching trays must be well adapted and properly contoured to prevent prolonged soft tissue contact. Patients should be instructed not to overfill their trays to avoid swallowing excessive bleach material on insertion.

**194. What contributes to the safety of peroxide as an oral bleaching agent?**

Natural tissue peroxidases available on tooth and tissue surfaces limit the penetration of peroxide and degrade it readily. These enzymes are thought to play a role in the efficacy and tolerability of vital bleaching.

**195. All methods of tooth whitening improve tooth color to some degree, provided there is what?**

There needs to be a sufficient degree of peroxide diffusion into the tooth surface.

**196. Is bleaching safe for children?**

Studies in those in the 11- to 18-year-old group have shown no ill effects greater than those seen in the general population. The use of whitening strips is well accepted because of the shortened application intervals required—twice for 30 minutes each day versus hours per day with trays.

**197. What concentrations of bleaching gel are used for home bleaching?**

Available products for home bleaching come in concentrations ranging from 10% to 30%. A higher concentration allows shorter exposure times within the trays, which may decrease the effects of dehydration and lessen the chances of sensitivity. When using a higher concentration, bleaching trays must be especially well adapted and trimmed to prevent soft tissue exposure.

**198. Can tetracycline-stained teeth be successfully treated with home bleaching?**

Depending on the nature and severity of the discoloration, significant aesthetic improvement of tetracycline-stained teeth can be achieved with home bleaching. Tetracycline stain exists primarily in the dentin of teeth; discoloration in the incisal two thirds responds more favorably than that in the gingival third. Deeper and more pronounced stain is the most resistant to extensive color change.

**199. How would you modify the home bleaching regimen for patients with tetracycline-stained teeth?**

If only certain teeth exhibit stain, bleaching may be selectively limited. Treatment times often must be extended to between 2 and 6 months. Fee structures for these cases must be modified accordingly.

**200. When is the optimal time to bleach in the treatment-planning sequence?**

In general, the optimal time is before beginning the final restorative phase. Bleaching lightens tooth color. Subsequent shades of crowns and composites need to be matched to the final tooth color. This is necessary because composite and porcelain restorations do not change color and will be mismatched if subsequent bleaching is performed.

**201. Describe the technique of enamel microabrasion.**

Microabrasion is the controlled removal of discolored enamel using a rubber cup and a paste composed of medium pumice and an acid, usually 20% hydrochloric acid. This technique is effective for treating superficial enamel discolorations (white or brown spots) often seen postorthodontically and in cases of fluorosis.

**202. How can microabrasion be used as an adjunct to vital bleaching procedures?**

Although vital bleaching is extremely effective in many aesthetic cases, it tends to make areas of decalcification (white spots) even whiter in contrast to the surrounding tooth. Additionally, stains common with fluorosis are usually minimally affected by bleaching. Microabrasion is an effective technique for removing such lesions if they are superficial in nature.

**203. What are the limitations of the microabrasion technique?**

Microabrasion is useful only for the removal of enamel lesions in the outer few hundred microns (100 to 200  $\mu\text{m}$ ) of the tooth. Lesions that penetrate deeper into enamel or into dentin must be restored with restorative materials. Teeth with deeper intrinsic staining, such as that caused by tetracycline, cannot be treated effectively with microabrasion.

**204. Should you wait to do bonded restorations on recently bleached teeth?**

Alterations in the surface microstructure from peroxide treatments can reduce bond strength. It is advised to wait 3 weeks or longer before doing bonded restorations.

**205. Describe a logical sequence for whitening an anterior dentition with older class III and IV composite restorations.**

Usually, older restorations are replaced after whitening because they will not match the new enamel shade. Before gel application, these older restorations should be carefully disked back to uncover all facial enamel. This process allows full bleach coverage of exposed enamel and leaves a more uniformly colored surface to replace and match the composite restorations.

**206. Are reservoirs necessary in prefabricated bleaching trays?**

It was thought that leaving a space on the facial surface of models before making a custom tray allows more of the gel to stay in contact with the teeth. There is generally no difference reported with or without tray reservoirs; they may not be necessary.

**207. How effective are whitening toothpastes?**

Generally, given their low concentration of bleaching agent and short tooth contact time, whitening toothpastes have a minimal effect on actual tooth color but may prolong the effect of direct bleaching.

**208. How are endodontically treated teeth bleached?**

Most discoloration of pulpal degeneration is internal and/or from remnants of endodontic paste fillers. Such teeth generally require bleaching from the access cavity. The sooner the bleaching is started after the endodontic event, the more successful is the lightening. Often, the pulp chamber is packed with a mixture of hydrogen peroxide and sodium perborate, so-called walking bleach. This mixture is changed as needed until the result is satisfactory. Care must be taken not to allow the bleach mixture to leach into the pulp canal, especially if there is any doubt about the integrity of the pulpal seal.

**209. What is the BriteSmile tooth-whitening system?**

BriteSmile is a franchised whitening system that uses a proprietary 15% hydrogen peroxide gel in conjunction with a patented gas plasma light source to provide a 1-hour, in-office bleaching treatment. The unique marketing and distribution network has shown rapid growth and patient acceptance ([www.britesmile.com](http://www.britesmile.com); Tables 8-4 and 8-5).

**DENTAL LASERS****210. List the categories of application of dental lasers.**

Dental lasers are used for various categories of application, including soft tissue, hard tissue, curing, caries detection, photostimulation, low-level laser therapy (LLLT), and biostimulation.

**Table 8-4.** At- Home Bleaching Products

COMPANY NAME	PRODUCT NAME	WHITENING COMPONENT	CONCENTRATION	MAXIMAL RECOMMENDED WEAR TIME	NO. OF SESSIONS TO COMPLETE TREATMENT	SHELF LIFE
DenMat	Rembrandt Xtra- Comfort	Carbamide peroxide	16%, 22%, 30%	Overnight if tolerated	Twice daily for 14 days	3 years
Dentsply Professional	Nupro White Gold Whitening	Carbamide peroxide	10%, 15%	4–6 hours	7–14 days	1.5 years
Discus Dental	Day White 2Z	Hydrogen peroxide	7.5%, 9.5%	30 min twice/day	7–10 days	3 years
Heraeus Kulzer	Venus White Pro	Carbamide peroxide and 3% potassium nitrate	16%, 22%, 35%	Varies by % and daytime v. nighttime use	Varies by % and daytime v. nighttime use	2 years refrigerated
Ivoclar Vivadent	Viva Style	Carbamide peroxide	10%, 16%	2 hours	10–12 treatments	2 years
Lumalite	LumaCool Whitening Pen	Hydrogen peroxide	7.5%	3 times/day apply pen with wrist click dispenser and brush tip	40–50 applications per month	18 months
3M ESPE	Zaris White & Brite	Carbamide peroxide	10%, 16%	4 hours or overnight	Variable	2 years
Ultradent Products	Opalescence PF	Carbamide peroxide	10%, 15%, 20%	8–10 hours	5–7 overnight sessions	2 years refrigerated

**Table 8-5.** In-Office Bleaching Products

COMPANY NAME	PRODUCT NAME	WHITENING COMPONENT	CONCENTRATION	HEAT OR LIGHT SOURCE	TREATMENT TIME	ISOLATION REQUIRED
Biolase Technology	LaserSmile	Proprietary	Proprietary	Laser (810 nm diode)	15–20 min.	Paint-on dam
BriteSmile, Inc.	BriteSmile	Hydrogen peroxide	15%	Gas plasma/LED	3 treatments, 20 min. each	Paint-on gel
DenMat	LUMIBRITE	Hydrogen peroxide	35%	Sapphire plasma arc	1–2 treatments, 30 min. each	Paint-on dam
Phillips	Zoom Whitespeed	Hydrogen peroxide	25%	LED	4 treatments, 15 min. each	None or IsoPrep lip retractors
Ivoclar Vivadent	Viva Style	Carbamide peroxide	30%	Neither	20–30 min.	None
LumaLite, Inc.	LumaCool	Hydrogen peroxide	35%	LED 1	24 min.	Paint-on dam
Ultradent Products	Xtra Boost	Hydrogen peroxide	38%	Neither	20–60 min.	OpalDam Paint-on dam

**211. What is the purpose of the lasing medium in dental lasers? Give examples.**

The lasing medium is the material within the laser system that is electrically stimulated to produce energy. Lasing materials can be solid, liquid, or gas, and the laser is generally named after the medium. Examples include diode, carbon dioxide, argon, neodymium yttrium aluminum garnet (Nd:YAG), and erbium lasers—Er,Cr:YSGG (yttrium scandium gallium garnet) and Er:YAG. Currently, Er:YAG lasers are those considered most often for hard tissue use. Diode lasers are generally used for soft tissue applications.

**212. What are the current uses and limitations of hard tissue lasers in restorative dentistry?**

Currently, hard tissue lasers allow the trained practitioner to perform many aspects of restorative dentistry, including class I to V cavity preparations and the removal of carious tooth structure, in many cases without the use of local anesthesia. However, more complex procedures requiring more refined tooth preparation, such as crown preparation, onlays, and veneers, still require the use of high-speed hand pieces.

**213. Describe the mechanism whereby hard tissue lasers remove tooth structure and caries.**

Highly energetic, short-pulsed laser light causes a rapid heating of dental tissue in a small area. An explosive shock wave is created when the energy causes a volumetric expansion of the water in the hard tissue. In other words, the water molecules in the tissue are superheated, explode, and, in turn, ablate tooth structure and caries. Also, the increased water content of caries allows the laser to interact preferentially with the carious tissue, helping preserve sound tooth structure.

**214. How does the laser preparation of enamel, dentin, and caries differ?**

The laser parameters required for the ablation of enamel, dentin, and caries differ because these structures have a different water content. Because the erbium wavelength has an affinity for the water content of hard tissue, less laser energy is required to ablate caries than enamel or dentin.

**215. Should hard tissue lasers be used to remove amalgam fillings?**

Laser ablation of dental amalgam is strictly contraindicated because of the potential release of mercury vapor. Lasers currently do not have U.S. Food and Drug Administration (FDA) clearance for this procedure.

**216. What are soft tissue applications for the laser?**

Diode laser wavelengths are primarily absorbed by melanin and hemoglobin in the tissues. They are poorly absorbed by hydroxyapatite and water composing the enamel. Diode lasers are commonly used for gingival recontouring or soft tissue crown lengthening, exposure of soft tissue–impacted teeth in orthodontics, biopsy, removal of inflamed tissues, frenectomies, and photostimulation of aphthous or herpetic lesions (Table 8-6).

**AMALGAM****217. What is the difference between an alloy and an amalgam?**

An alloy is a mixture of metals; an amalgam is an alloy containing mercury.

**218. What is the composition of dental amalgam?**

Dental amalgam is an alloy composed of silver, tin, copper, and mercury. The basic setting reaction involves the mixing of the alloy complex of silver (Ag) and tin (Sn) with mercury (Hg) to form the so-called gamma phase alloy (original silver and tin) surrounded by secondary phases called gamma-1 (silver and mercury) and gamma-2 (tin and mercury). The weakest component is the gamma-2 phase, which is less resistant to corrosion.



Alloys are manufactured as filings or spherical particles; dispersed alloys are mixtures of both. Smaller particle size results in higher strength, lower flow, and better carvability. Spherical amalgams high in copper usually have the best tensile and compressive characteristics.

**Table 8-6.** Hard and Soft Tissue Laser Manufacturers

COMPANY NAME	PRODUCT NAME	PERFORMED	PROCEDURE LASING MEDIUM	LIFETIME OF LASING MEDIUM
<b>Hard Tissue Laser Manufacturers</b>				
American Dental Technologies	PulseMaster 600 IQ	Hard and soft tissue procedures	Solid state Nd:YAG crystal	No limit
Biolase Technologies	Millennium II	Hard and soft tissue procedures	Er, Cr:YSGG	Depends on usage
Continuum Biomedical	DELight Dental Laser System	Hard and soft tissue procedures	Erbium:YAG	N/A—solid state
<b>Soft Tissue Laser Manufacturers</b>				
AMD Lasers	Picasso	Soft tissue procedures and whitening	Diode	0.1–7.0 Watts at 808 nm
Ivoclar Vivadent	Odyssey 2.4G	Orthodontic, restorative, and palliative soft tissue procedures	Diode	5.0 Watt 810±20 nm
Biolase	Ezlase 940	Temporary relief of TMJ minor pain, whitening, soft tissue procedures	Diode	Up to 7.0 Watts 940 ± 15 nm

N/A, Not applicable.

### 219. What is the function of each component?

- Silver increases strength, hardness, and reactivity while decreasing creep.
- Tin increases reactivity and corrosion but decreases strength and hardness.
- Copper increases strength, expansion, and hardness while decreasing creep.
- Zinc increases plasticity, strength, and the mercury-to-alloy ratio; it also decreases creep and causes secondary expansion.
- Mercury wets alloy particles, but decreases strength in excessive amounts.

### 220. How can one tell when an amalgam is properly triturated?

A properly triturated amalgam mix appears smooth and homogeneous. No granular appearance or porosity should be evident. An overtriturated mix is preferable to an undermixed preparation.

### 221. What types of amalgam alloys are commonly used today?

Alloys are supplied in different particle shapes and sizes to influence the handling and setting properties. The blended alloy is a mixture of fine-cut and spherical particles, whereas all-spherical alloys are composed of spherical particles. Because spherical alloys are very fast-setting, they are particularly suitable for core buildups and impression taking in one visit (Table 8-7).

### 222. What are the indications for the various amalgam product types?

- All class I preparations: spherical or spheroidal
  - Class II preparations: admixed or spheroidal
  - Around pins and for internal retention: spherical
- It is not advisable to combine spherical and admixed types.

### 223. List current principles for amalgam tooth preparations.

Basically, a conservative preparation that salvages the maximal amount of tooth structure while removing carious material is advocated:

- Use of the 333 and 245 burs allows slot and tunnel preparations.
- Prepare rounded internal line angles, 90-degree cavosurface margins, with removal of unsupported enamel during excavation of all caries past the DEJ.

**Table 8-7. Current Amalgam Products**

SPHERICAL	SPHEROIDAL	ADMIXED (DISPERSED PHASE)
Tytin (Kerr)	Tytin FC (Kerr)	Contour (Kerr)
Valiant (Ivoclar Vivadent) Valiant Snap-Set (Fast-Setting Formulation) (Ivoclar Vivadent)		Valiant PhD (Ivoclar Vivadent)
Unison and Megalloy EZ (Dentsply Caulk), Zenith Type-T (DMG America)		Dispersalloy (Dentsply Caulk) Zenith Premium (DMG America)

- Use a caries detector solution when necessary.
- Create mechanical retention by undercuts, channels, and grooves or bonding.
- Properly wedge and create tight interproximal contacts.
- Seal dentin tubules with adhesive liners.
- Provide enough amalgam bulk for strength.

**224. List six common causes of amalgam failure.**

1. Inadequate retention
2. Insufficient bulk for strength  
Amalgam should be in peripheral contact with tooth structure to avoid a “trampoline effect” of a stiff structure bouncing on a too-flexible base.
3. Nonremoval of unsupported enamel
4. Incomplete caries removal
5. Inadequate condensation
6. Recurrent caries caused by microleakage

**225. Should all amalgams be bonded?**

Current practice says that they should; however, this practice has not been confirmed over time. A better concept is that amalgam bonding effectively seals dentin tubules, eliminating postoperative sensitivity, with the added benefits of retention of the restorative and a stronger total cohesive mass to support all remaining cuspal segments of the tooth.

**226. What is the mechanism of bonding amalgams?**

The use of a self-curing resin liner (Amalgambond, Parkell, All Bond 2, Bisco) provides a bond to tooth substrate and to amalgam. As the amalgam is condensed into the unpolymerized resin, a micromechanical bond is formed.

**227. What is the purpose of finishing and polishing amalgam restorations?**

Amalgam restorations should be finished and polished for three main reasons: (1) to reduce marginal discrepancies and create a more hygienic restoration; (2) to reduce marginal breakdown and recurrent decay; and (3) to prevent tarnishing and increase the quality of appearance of the restoration. Polishing is often a neglected part of treatment because of lack of opportunity for recall visits or from the consideration of not being compensated for the added service. However, polishing one or two restorations at each recall may allow this quality service to define state-of-the-art dental practice.

**228. Describe the sequence for polishing amalgams.**

Begin gross contouring with multifluted finishing burs, usually at least 1 day after insertion. Burs come in a variety of round, pear, flame, and bullet-nosed shapes and allow anatomic contouring. Shofu-type brownie and greenie points can be used to create a high luster. Final pumicing with rubber cups can complete the finishing.

**229. What additional means may be used to retain alloy restorations?**

Optimal retention warrants the use of pins, grooves, channels, or holes placed in sound tooth areas. Although bonding has replaced much of pin usage, it arguably still provides the best possible retention.



**230. List guidelines for the use of pins to retain dental restorative material.**

1. Pins should extend 2 mm into tooth structure and then backed off a half-turn to reduce stress.
2. Pins should be placed fully in dentin. If they are too close to the DEJ, the enamel may fracture from the tooth. In general, they should be placed at the line angles where the root mass is the greatest and at least 0.5 mm from the DEJ.
3. Pins should extend 2 mm into amalgam; further extension only weakens the tensile and shear strength of the amalgam.
4. Pins should be aligned parallel to the radicular emergence profile or parallel to the nearest external enamel wall. Additional angulations may be used when there is no danger of pulpal or periodontal ligament perforation.
5. If the tooth structure is flat, the use of small retentive channels that are cut into the tooth structure prevents potential torsional and lateral stress.

**231. What are the major complications to the use of pins to retain restorations?**

Pin placement can result in pulpal exposure, perforation through the periodontal ligament, and fracture of a tooth. Additionally, pins may weaken an amalgam if they extend more than 2 mm into the mass. The use of a dentin-bonded resin liner can help seal any potential fracture lines, but placement requires skill and expert technique.

**232. What should be done if accidental exposure of the pulp or perforation of the periodontal ligament occurs during pin placement?**

If the pulp is exposed by the pinhole, allow the bleeding to stop, dry with a sterile paper point, and place calcium hydroxide in the hole. Bond over with an adhesive glass ionomer resin. Do not place a pin in the hole. Usually, the pulp will heal. If penetration of the gingival sulcus or periodontal ligament space occurs, clean, dry, and place the pin to the measured depth of the external tooth surface to seal the opening.

**233. What alternatives to pins are available for increasing retention and resistance in large amalgam restorations?**

Practitioners use bonding resin along with boxes, slots, grooves, dovetails, parallel walls, and divergent amalgam gaps to increase resistance and retention substantially without the inherent disadvantages of pins. The amalgam concept uses 245 burs to create 2-mm points into dentin, which are then packed with amalgam. The resistance is comparable to pins, but the retention is less.

**234. Discuss current concepts of pulpal protection.**

Formerly, a thermal liner or base under amalgam restorations was advocated. If 1 to 3 mm of dentin remains under the cavity preparation, sufficient thermal protection is present. Sealing dentin tubules is considered important to minimize postoperative pulpal sensitivity and prevent bacterial contamination by microleakage. Microleakage can wash out liners such as calcium hydroxide. Sealing dentin tubules by bonding protects the pulp from postoperative sensitivity and offers long-term protection against bacterial contamination from microleakage.

**235. Discuss the classic role of calcium hydroxide.**

Calcium hydroxide compounds have a long tradition of providing pulpal protection as a liner under restorative materials. Calcium hydroxide is known to serve as an insulator, stimulator of repair dentin via bridge formation, and bactericidal agent because of its high pH. However, it does not bond to dentin, does not seal tubules, and is prone to wash out if microleakage occurs. If calcium hydroxide is used, it should be sealed by using some type of bonded resin system.

**236. What compounds stimulate dentin bridging?**

- Calcium hydroxide
- Zinc phosphate cements
- Resin composite systems

Eugenol and amalgam compounds do not show bridge formation.

**237. Summarize the recommended treatment for a direct vital pulp exposure.**

1. Control hemorrhage using irrigation with saline or sodium hypochlorite.
2. Apply a calcium hydroxide capping agent (Dycal, Dentsply).
3. Cover with a layer of glass ionomer cement.

4. Etch, bond, and restore.
5. Alternatively, some advocate direct etching, priming, and bonding after hemorrhage control as a direct cap procedure.

**238. What is the purpose of a cavity varnish?**

Usually, cavity varnishes, such as Copalite (DentAmerica), were used to seal dentin tubules without adding bulk and to protect pulpal tissue from the phosphoric acid in zinc phosphate cements. Current dentin bonding systems fulfill the concept of a cavity varnish more ideally, and the use of copal varnishes is probably obsolete.

**239. What is a cavity liner? What are the indications for its use?**

A cavity liner is a relatively thin coating over exposed dentin. It may be self-hardening or light-cured, and it is usually nonirritating to pulpal tissues. The purpose is to create a barrier between dentin and pulpally irritating agents or stimulate the formation of reparative secondary dentin. Calcium hydroxide has traditionally been placed on dentin, with a thickness of 0.5 mm, as a pulpal protective agent. Contemporary practice uses newer dentin bonding agents for liner materials. They not only provide a barrier to pulpally toxic agents, but also seal the dentin tubules against bacterial microleakage and provide a bondable surface to increase the retention of the restoration. Glass ionomer cements and dentin bonding systems have become the standard liner materials in restorative dentistry.

**240. What is a base? What are the indications for use?**

Generally, cements thicker than 2 to 4 mm are termed *bases* and, as such, function to replace lost dentin structure beneath restorations. A base may be used to provide thermal protection under metallic restorations, increase the resistance to forces of condensation of amalgam, or block out undercuts in taking impressions for cast restorations. A base should not be used unnecessarily. Pulpal thermal protection requires a thickness of at least 1 mm, but covering the entire dentin floor with a base is not thought to be necessary. Generally, the following guidelines may be used:

1. For deep caries with frank or near exposures or with less than 0.5 mm of dentin, apply calcium hydroxide.
2. Under a metal restoration, a hard base may be applied (over the calcium hydroxide) up to 2.0 mm in thickness to increase resistance to forces of condensation.
3. If more than 2 mm of dentin is present, usually no base is needed under amalgam; a liner may be used under the composite.
4. Use of a dentin bonding agent that seals the dentin tubules and bonds to the restorative material is desirable.

## POSTS AND CORES

**241. What is the purpose of placing a post in an endodontically treated tooth?**

Posts are needed only to retain coronal buildup when the remaining coronal tooth structure to support a build-up by itself. Although the cast post has been the standard for years, it is insufficient, requires additional time and expense, and is being replaced by alternatives. The use of titanium posts and metal-free, fiber-reinforced posts for better aesthetics in anterior teeth has become popular. Retention of posts is usually by micro (sand blasting) or macro (channel undercuts) mechanical methods. Furthermore, posts are now bonded into place by self-cured or dual-cured resin cements.

**242. Does a post strengthen endodontically treated teeth?**

Contrary what was formerly thought, posts do not reinforce teeth and may weaken some root structures. Widening a canal space for a larger post can weaken a root. Long posts are more retentive, but too much length may perforate a root or compromise the apical seal. A good guide is to make the length about half of the bone-supported root length, allow at least 1 mm of dentin lateral to the apical end of the post, and leave at least 3 to 5 mm of apical gutta percha filling.

**243. Which canals are generally chosen for post space?**

Generally, the largest canal is chosen—in maxillary molars it is the palatal canal and in mandibular molars it is the distal canal. Two-rooted bicuspid with minimal tooth structure may require one post in each canal.

**244. How may vertical fractures develop in roots?**

- Wedged or tight fitting posts may cause fractures.
- Overpreparation of the internal canal space may weaken a root and cause fractures.

**245. When are posts indicated? When are they not needed?**

1. Indicated
  - If more than half the coronal tooth structure is missing, place a post to attach the core material to the root structure.
  - If all the coronal tooth structure is missing, place a post to attach the core material to the root structure.
2. Not needed
  - If minimal coronal tooth structure is missing, as when an access cavity is made centrally with no caries on proximal walls, no post is required. Placement of a bonded filling material to the level of the pulpal floor adequately restores the endodontic access preparation.
  - If up to half of the coronal tooth structure is missing, a post may not be needed, except for teeth with high lateral stresses (e.g., cuspids with a cuspid rise occlusion). Place a bonded crown buildup.

**246. How are antirotational features created?**

1. Cast cores can be placed in anterior teeth with recessed boxes to limit rotation.
2. Small cut boxes or channels 1 to 1.5 mm deep and about the width of a 330 bur may be placed into the remaining tooth structure.
3. An accessory pin (Minim and Minikin [Coltène/Whaledent]) may be placed nonparallel to the posts.

**247. When a crown preparation is made, where should the finish line be placed?**

The gingival margin should be 1 to 1.5 mm apical to the core buildup material and on the root surface for optimal retention and antirotational resistance. If there is a ferrule post and core, the crown margin may be placed on the core material.

**248. List the characteristics of ideal posts.**

- The post space must provide adequate retention and support for the core, and the core must provide adequate support for the fixed restoration.
- Passive-fitting posts are best.
- Resin-bonded posts transmit less force to the root and increase the structural integrity by bonding the post to the root.

**249. What are the indications for a cast post?**

For buildup of a single rooted tooth with little supragingival structure or thin-walled roots, a cast post or core with an inset lock preparation and ferrule design may strengthen the root and prevent rotation. The casting is air-abraded or microetched and bonded into the root.

**250. Of what materials are prefabricated posts constructed?**

The most common types are made of stainless steel and titanium alloys. Newer posts are made of fiber-reinforced resin (ParaPost Taper Lux, Coltène/Whaledent).

**251. Outline the clinical steps in resin-bonding a cast or prefabricated posts.**

1. Prepare the canal space with a hot instrument to remove gutta percha to a depth of half the bone-supported root length, or as dictated by root shape.
2. Refine the canal preparation with Parapost drills or diamonds.
3. Cleanse the canal of debris with hydrogen peroxide using a syringe.
4. Treat with etchant 37% for 15 seconds or with 17% EDTA for 1 minute to remove the smear layer.
5. Rinse well with water and lightly dry.
6. Microetch the post with air abrasion.
7. Apply resin cement primers and resins to the post and canal according to product directions.
8. Mix the resin cement and inject into the canal quickly, seating the post.
9. Wipe the excessive cement with a brush dipped in resin while holding the post until the cement has set.

**252. Summarize the guidelines for fillers, buildups, and post and cores.**

For full-crown preparations, all old restorative material should be removed after preliminary tooth preparation. Small areas or missing teeth can be replaced with a bonded filler (compomer, reinforced glass ionomers, flowable composite); larger sections of missing teeth should be replaced with a buildup (bonded composite); and an endodontically treated tooth with more than half its coronal structure missing should have a titanium alloy post and core with a composite buildup.

**253. What materials are used to rebuild tooth core structure?**

These are gold, amalgam, composites, and glass ionomers.

**254. List advantages of using composite materials for core buildups.**

- Composite materials can bond to tooth structure.
- Usually, they achieve adequate strength in 5 to 10 minutes so that preparation of the core may be done at the same appointment as placement.
- They may be tooth-colored to avoid shade-matching problems with the final restoration.
- They may also be shaded to differentiate core structure from tooth when placing finish lines.
- They can be prepared easily and placed into a matrix or core form or placed freehand.

**255. What current types of core composite materials are available?**

**Light cure.** These use traditional large-particle materials that are made to cure deeply. Any hybrid composite also may be used.

**Dual cure.** These materials have the advantage that the surface may be light-cured immediately, whereas deeper layers can be chemically cured, allowing preparation to take place soon after placement.

**Self-cure.** In areas in which light penetration cannot be achieved, such as around posts and in deep recesses, these materials may be the best choice.

**NOTE:** Some self-cure or dual-cure materials will not bond to light-cured adhesives. It is important to use a self-cure adhesive system and read the manufacturer's instructions carefully.

**AMALGAM, MERCURY, AND HEALTH ISSUES****256. Summarize the current status of the use of amalgam.**

Dental amalgam continues to be the most common material for the restoration of carious teeth worldwide. In the United States, 100 million people have amalgam fillings, and 100 million amalgams are placed each year. To date, there are no epidemiologic links between their use and ill health. The National Institutes of Health noted that only around 50 documented cases of allergy to mercury have been reported since 1906. As newer materials evolve, which are as durable and cost-effective, it is likely that mercury-containing restorations will be phased out. Until then, it is the opinion of world health agencies, medical and dental societies, and the scientific community at large that amalgam is a safe, easy, durable, bacteriostatic, and cost-effective restorative material. The choice of using a particular material should be left to an informed patient, with adequate scientific information supplied by a knowledgeable professional.

**257. What three forms of mercury are found in the environment and may result in human exposure?**

1. **Elemental mercury** is a small contributor to the total human body burden. It is very short-lived because of rapid oxidation. It is the common form found in dentistry; it is lipid-soluble and adsorbed in the lungs. Elemental mercury is the least toxic form.
2. **Inorganic mercury** is formed by the oxidation of elemental mercury and has limited solubility. It is sequestered in the kidney and excreted slowly in urine, with a half-life of about 60 days. It is of moderate toxicity.
3. **Organic mercury** is usually in the methyl mercury form. It is only found in nondental sources. Organic mercury forms in the gut of fish from bacterial action on mercury and accumulates in red blood cells; it is sequestered in the central nervous system and liver and has high lipid solubility. It is not found in urine but is secreted in feces, and 90% is absorbed in the gut. Organic mercury is the most toxic form.

**258. What should a dentist know to be prepared to respond to a patient's inquiry about amalgam restorations and safety?**

The clinician must know all the facts about amalgam, health-related sensitivities, ethics of replacements, and alternative restorative choices.

**259. What consideration should be given to a patient's concern about sensitivity to dental alloys?**

A real allergy or hypersensitivity (as differentiated from toxicity or poisoning) to dental alloys and metals is not uncommon. Approximately 3% of the population has some type of metal sensitivity. Health questionnaires should ask about skin reactions to jewelry and/or known metal sensitivities. Allergy testing can confirm these sensitivities.

It is important to determine the type of inquiry:

1. Patients who have aesthetic concerns and do not wish to have non-tooth-colored restorations
2. Patients who have phobias about the alleged toxicity of dental materials
3. Patients who have chronic diseases, such as multiple sclerosis, and are looking for some causative agent

Each group of patients requires appropriate information from dental and medical sources to help them make informed choices about dental health.

**260. What dental materials are reported to be the most allergenic? What are the manifestations of these exposures?**

Allergic reactions have been reported to chromium, cobalt, copper, nickel (the most common), palladium, tin, zinc, silver, and gold and platinum (least allergenic). The symptoms may range from localized chronic inflammation around restorations and crowns to more generalized oral lichen planus, geographic glossitis, angular cheilitis, and plicated tongue.

**261. Are certain people hypersensitive to mercury?**

Yes. However, according to the North American Contact Dermatitis Group, true sensitivity to mercury in subtoxic doses is rare. Studies have shown that 3% of people respond to a 1% mercury patch test. Of these, less than 0.6% have any clinical manifestations of mercury sensitivity allergy. It is important to note that these testing levels are extreme in relation to the exposure possible from dental amalgam restorations.

**262. Are there any known harmful effects from the mercury content of dental amalgam?**

As a restorative material, silver amalgam has been used in dentistry for more than 200 years. Its safety has been studied throughout this long period, and no epidemiologic evidence has associated general health problems with this amalgam.

In July 2009, the ADA Council on Scientific Affairs prepared a comprehensive literature review on amalgam safety. Based on their results from a literature review from January 2004 to April 2009, the ADA Council reaffirmed that amalgam is a valuable, viable, and safe choice for dental patients. Previously, many health groups worldwide also came to this conclusion. The World Health Organization, Swedish Medical Research Council and Swedish National Board of Health and Welfare (1994), British Dental Association (1995), U.S. Public Health Service (1993), National Institutes of Health, Institutes of Dental Research, FDA (1991), and even *Consumer Reports* (1991) noted that dental amalgam fillings are safe to use and that no beneficial health benefits will result from the removal of existing restorations.

More recently, organizations such as the Life Sciences Research Office (2004), Scientific Committee of the European Commission (2008), and FDA (2009) reached a consensus. Organizations such as the National Multiple Sclerosis Society characterize claims of recovery after removal of dental amalgams as unsubstantiated, unscientific, and a "cruel hoax." A study of aging and Alzheimer's disease found no evidence that amalgams reduced cognitive function in a group of 129 Roman Catholic nuns between the ages of 75 and 102 years.

In conclusion, in nonallergic patients, no scientific evidence implicates dental amalgam as a harm to general health. The *New England Journal of Medicine* published a report in 2003 stating that "patients who have questions about the potential relation between mercury and degenerative diseases can be assured that the available evidence shows no connection."

The FDA issued its final rule on encapsulated dental amalgam in July 2009, classifying it and its component parts as a class II medical device. This places amalgam in the same class as other restorative materials, such as gold and composite resin. Repeated human studies on those with and without amalgam restorations have shown no significant difference in any organ system. Comparisons of immune cells have shown no difference in function. Furthermore, no recovery or remission from any chronic disease after removal of amalgams has been scientifically demonstrated.

**263. Discuss the relative safety of composite resins as restorative materials.**

Although they appear safe, health concerns have been raised about the use of composite resins. Composite materials contain many components that are potentially hazardous and possibly carcinogenic during the polymerization reaction or later because of degradation of the material. To consider these materials a “nontoxic” alternative to dental amalgam is premature and surely warrants further study. A randomized trial of 534 children found no differences in neurobehavioral or renal function when comparing the safety of amalgam with composite resin restorations after a 5-year follow-up.

**264. By what physical pathways can mercury enter the body?**

Elemental mercury is abundant in the earth’s environment. It exists in the soil, oceans, and air. The burning of fossil fuels and even volcanic eruptions have contributed to the widespread decimation of this element. The use of mercury in manufacturing through the centuries has led to much of the environmental contamination. Furthermore, in high enough doses, mercury is neurotoxic. The questions of exposure to mercury from dental amalgams require some clinical elucidation.

Dental amalgam fillings contain up to 50% mercury and elements of silver, tin, and copper, bound into a metallic complex from which the mercury is not free. Small amounts of mercury vaporize from the surface with function, pass into the air, and are exhaled. This amount, which is absorbed into the body as a function of the number of surfaces of amalgam, is largely excreted by the kidneys into the urine. The smaller amount, which may accumulate in other organs, has raised concern. Mercury accumulates in organs such as the brain, lungs, liver, and gastrointestinal tract, but this accumulation represents exposures from all environmental sources. The ultimate question is the percentage of the dental amalgam component compared with total mercury exposure from all sources.

The daily intake of mercury attributable to dental amalgams, as measured by urine levels of mercury, is reported to be only one-seventh (14%) of that measured from eating one seafood meal per week. The total daily intake from 8 to 12 amalgam surfaces is about 1 to 3  $\mu\text{g}$ . This is again seven times lower than the intake from one seafood meal per week and only about 10% to 20% of the average total exposure (9  $\mu\text{g}/\text{day}$ ) from all environmental sources. Clearly, the general environmental exposure is much more of a concern.

By comparison, the maximal limit of elemental mercury inhalation exposure for industrial workers was found to be urine levels of 82  $\mu\text{g}/\text{L}$ . People without amalgam fillings have urine levels of 5 to 10  $\mu\text{g}/\text{L}$ , and dentists have urine levels of less than 10  $\mu\text{g}/\text{L}$ . It may easily be seen that the ambient environmental exposure to mercury is the significant exposure.

There should be an overall effort to lower environmental mercury, and there appears to be no dispute on this issue. It is therefore predicted that as newer substitutes for silver amalgam are developed that prove to be as durable, simple to use, and cost-effective, we may see the gradual phasing out of its use. Many dental practices are now amalgam-free.

**265. What has contributed to the so-called amalgam phobia?**

Because it is well known that elemental mercury is an environmentally toxic waste, and because hundreds of millions of people have dental amalgams containing mercury, it is only natural for people to question the effects on human health. Some in the media have used sensationalism in reporting stories related to health and dental amalgam in much the same distorted way that fluoride was reported by some to be a harmful water additive for caries prevention. Furthermore, as scientific efforts continue to describe the biocompatibility of mercury, various animal models have been extrapolated to humans without scientific validity (e.g., it has been said that sheep absorb 18 to 25 times more mercury than humans). Even the dental profession was implicated when analytic mercury vapor detectors were sold to dentists, who found distortedly high levels of mercury vapor over amalgam restorations

because their calibrations were inaccurate. The sampling rate of the intake manifolds of the vapor analyzers was much greater than the rates of mercury inspired by humans, and the air intake calculated for humans was in error by as much as a factor of 16. The use of these detectors led many responsible dental clinicians to erroneous conclusions.

Finally, the reports of many people who experienced a health improvement when their amalgams were replaced or removed must be viewed carefully before coming to any causality links. A few weeks of monitoring the newsgroup [AMALGAM@Listserv.gme.de](mailto:AMALGAM@Listserv.gme.de) will show hundreds of “cases” of those who experienced better health after amalgam removal. Many psychodynamic issues can be observed in people who report such changes, and direct links to the amalgam contribution needs scientific scrutiny. After all, some people have genuine allergies to some materials, and it is from the observation of human experience that we as a profession learn to ask the questions that lead to productive clinical research.

#### 266. What are the ethical issues related to removing a patient’s amalgams?

According to the ADA’s Principles of Ethics and Code of Professional Conduct with official advisory opinions, revised in 2012: “Based on current scientific data, the ADA has determined that the removal of amalgam restorations from the non-allergic patient for the alleged purpose of removing toxic substances from the body, when such treatment is performed solely at the recommendation of the dentist, is improper and unethical.”

If a dentist represents that such dental treatment has the capability to cure or alleviate systemic disease, when there is no scientific evidence or knowledge of this, this action is considered unethical. However, a dentist may remove amalgams at a patient’s request, as long as no inference is made to improving the patient’s health and the risk and benefits are discussed. A dentist may also ethically decline to remove the amalgam if there is no sound medical reason.

#### 267. How can one maintain mercury hygiene in the dental office?

- Use capsulated amalgam.
- Calibrate amalgam triturators.
- Use rubber dam, high-volume suction, and amalgam traps in office procedures.
- Dispose of amalgam waste by certified collectors.

#### 268. What health groups agree on amalgam safety?

American Association for Dental Research  
 American Dental Association (ADA)  
 Centers for Disease Control and Prevention  
 Consumers Union (Consumer Reports Magazine)  
 Dental Board of California  
 National Institute of Dental and Craniofacial Research  
 U.S. Public Health Service  
 U.S. Food and Drug Administration  
 World Health Organization

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## FIXED PROSTHODONTICS

### 1. What is the definition of *fit* for a full-crown restoration? What is the clinical acceptance of the fit of a full-crown restoration?

The fit of a full-crown restoration is normally measured in relationship to two reference areas, (1) the occlusal seat and (2) the marginal seal. The two areas are interrelated and affect each other. The ideal fit of a full crown (marginal discrepancy) is related to the film thickness of the cementing medium (normally, 10-30  $\mu\text{m}$ ). The clinical acceptance of marginal discrepancy is approximately 80  $\mu\text{m}$  (Fig. 9-1).

### 2. What is the best marginal tooth preparation?

There is no ideal marginal tooth preparation. The selection of the marginal design depends on many factors, including:

1. The material used in construction of the full crown:
  - All-ceramic restoration—shoulder or deep chamfer
  - Metal-ceramic with porcelain extended to marginal edge—shoulder or deep chamfer
  - Metal-ceramic with metal collar—shoulder with bevel or chamfer
  - Full gold crown—feathered edge, bevel, or chamfer
2. The amount of retention needed. A beveled or feathered edge affords the most retention.
3. Seating resistance. Shoulder preparation affords the least resistance.
4. Sealing capability. A beveled or feathered edge affords the best seal.
5. Pulpal consideration. More tooth reduction is necessary with a shoulder preparation than with a chamfer; the feathered edge requires the least reduction.

### 3. How does one determine the number of abutments to be used?

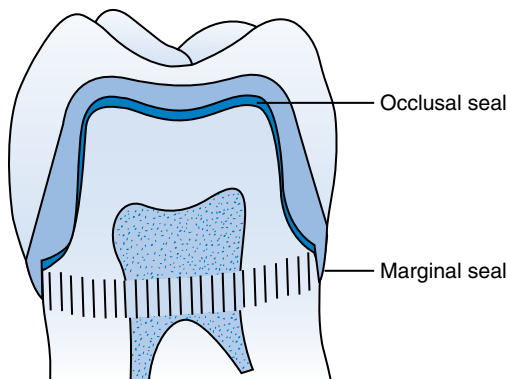
There is no rigid rule. Determining factors include:

1. The greater the number of pontics, the greater the increase in loading forces on the abutments.
2. The position of the pontics affects the loading forces of the abutments; the more posterior the pontics, the greater the loading forces on the abutments.
3. The crown-to-root ratio of the abutments (bone support); a periodontally compromised mouth increases the abutment-to-pontic ratio.
4. Roots of the abutments that are parallel to each other distribute the loading forces down the long axis of the teeth. When the loading forces do not fall within the long axis of the tooth, the lateral forces on the abutments are increased. This situation necessitates the use of additional abutments.

### 4. In periodontally compromised patients, is splinting the entire dental arch with a one-piece, roundhouse fixed bridge the treatment of choice?

Splinting an entire dental arch with a roundhouse fixed bridge is far from the treatment of choice because it is fraught with potential problems, including the following:

1. All tooth preparations must be parallel to each other.
2. Impression taking and die construction are extremely difficult.
3. Accuracy of fit for the one-piece unit is extremely difficult.
4. Premature setting of the cement is a major risk because total seating of the fixed bridge onto the abutments is made extremely difficult by the mobility of the existing teeth.
5. If one of the abutments fails, it may be necessary to replace the entire prosthesis. It is better to split up the prosthesis in some fashion than to construct a one-piece unit.



**Figure 9-1.** Fit is a relationship between the occlusal seal and the marginal seal.

### 5. Is the cantilever fixed bridge a sound treatment?

A cantilever fixed bridge places more torquing forces on terminal abutments than desirable. Certain guidelines should be followed if a cantilever is used:

1. Cantilever pontics are limited to one per fixed bridge.
2. If the cantilever is replacing a molar, the size of the pontic should be the same as for a bicuspid, and at least one more abutment unit should be incorporated than in a conventional bridge. In addition, there should be no lateral occlusal contact on the pontic, and the bridge should be cemented with a rigid medium.
3. If the cantilever pontic is anterior to the abutments, the mesial aspect of the pontic should be designed to allow some interlocking effect.

### 6. Can a three-quarter crown be used as an abutment for a fixed bridge?

A three-quarter crown can be used successfully as an abutment for a fixed bridge if certain guidelines are followed:

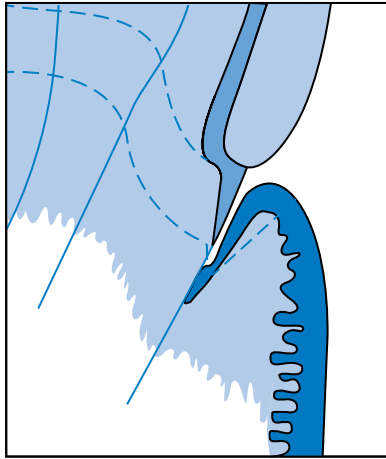
1. Because there is less tooth reduction than with a full crown, retention may be compromised. Internal modifications, such as grooves or pins, must be used to compensate for potential loss of retention.
2. Proper tooth coverage is necessary for a three-quarter crown abutment:
  - Anterior—linguoincisal
  - Posterior, upper—linguo-occlusal
  - Posterior, lower—linguo-occlusal plus coverage over the buccal cusp tips
3. A three-quarter crown should be made only of metal; therefore, aesthetics may be compromised.

### 7. Must a post and core be constructed for an endodontically treated tooth that is to be used in a fixed bridge?

An endodontically treated tooth is generally more brittle than a vital tooth. Because of the tooth reduction for the full-crown restoration and preparation of the access cavity for the endodontic procedure, the remaining coronal tooth structure is likely to be small. Therefore, a post and core is more likely to be necessary in the anterior and bicuspid regions. If the access cavity is small and sufficient tooth structure remains after tooth preparation in the molar region, a post and core may not be necessary. In this case, the coronal chamber should be filled, preferably with a bonded material.

### 8. What is the proper length for the post? Should a post be made for each canal in a multirooted tooth?

In general, the length of a post should be such that the fulcrum point, determined from measuring the height of the core to the apex of the tooth, is in bone. This guideline normally places the post approximately two thirds into the root length. Improper length allows a potential for root fracture. It is not necessary to construct a post for each canal in a multirooted tooth, provided that the dominant root (i.e., palatal root of maxillary molar) is used and proper length has been established. If proper length cannot be obtained, it is necessary to place posts in at least one of the other remaining roots.



**Figure 9-2.** The subgingival margin should not impinge into the attachment apparatus.

**9. Can one use the preformed single-step post and core in place of the two-step cast post and core?**

A preformed, single-step post and core can be used in fixed prosthodontics, but the potential for failure is greater with many of the single-step systems than with a cast gold post and core for the following reasons:

1. The canal preparation must be shaped to the configuration of the preformed post. This requirement may lead to overpreparation of the canal and potential root perforation. In contrast, a cast post is made to fit the existing configuration of the canal.
2. A screw-type post has the greatest retentive value, but also has the greatest stress forces during insertion.
3. The core buildup of the single-step post and core may not be as stable as a cast gold core.
4. If the single-step post is metal, the modulus of elasticity is normally much higher than that of the root. This may lead to root fracture during loading. In contrast, a type 3 cast gold post has a modulus of elasticity similar to that of the root.

**10. Where should a crown margin be placed in relationship to the gingiva—supragingivally, equigingivally, or subgingivally?**

It is better for gingival health to place a crown margin supragingivally, 1 to 2 mm above the gingival crest or equigingivally at the gingival crest. Such positioning is often not possible because of aesthetic or caries considerations. Subsequently, the margin must be placed subgingivally. The question then becomes whether the subgingival margin ends slightly below the gingival crest, in the middle of the sulcular depth, or at the base of the sulcus. In preparing a subgingival margin, the major concern is not to extend the preparation into the attachment apparatus. If the margin of the subsequent crown is extended into the attachment apparatus, a constant gingival irritant has been constructed. Therefore, for clinical simplicity, when a margin is to be placed subgingivally, it is desirable to end the tooth preparation slightly below the gingival crest (Fig. 9-2).

## MATERIALS

**11. What materials are used in the construction of a full crown?**

- Gold alloy
- Nongold alloy
- Acrylic resin
- Acrylic resin with a metal alloy
- Composite resin
- Composite resin with a metal alloy
- Ceramic with a metal alloy
- All ceramic

**12. Are the same materials used in the construction of a fixed bridge?**

In general, a fixed bridge needs a metal support for strength. The veneer coating may be acrylic, composite, or ceramic. Newer ceramic materials, including alumina, leucite, and zirconium, have increased strength that in some cases may eliminate the metal substructure.

**13. What are the major advantages and disadvantages of the metal-ceramic crown?**

In general, the metal-ceramic crown combines certain favorable properties of metal in its substructure and of ceramic in its veneer coating.

Advantages

1. The metal substructure gives high strength, which allows the materials to be used in fixed bridgework and for splinting teeth.
2. The fit of a metal casting can also be achieved with the metal-ceramic crown.
3. Aesthetics can be achieved by the proper application of the ceramic veneer.

Disadvantages

1. To allow enough space for the metal-ceramic materials, adequate tooth reduction is necessary ( $\geq 1.5$  mm). The marginal tooth preparation is critical in relation to the design of the metal with the ceramic.
2. The fabrication technique is complex. The longer the span of bridgework, the greater the potential for metal distortion and/or porcelain problems.

**14. What tooth preparation is necessary for the metal-ceramic crown?**

The amount of tooth reduction necessary for the metal-ceramic crown depends on the metal and ceramic thickness. The necessary thickness of the metal is 0.5 mm, whereas the minimal ceramic thickness is 1.0 to 1.5 mm. Therefore, the tooth reduction is approximately 1.5 to 2.0 mm. With this porcelain-metal sandwich, a shoulder preparation is generally necessary for adequate tooth reduction.

**15. What happens if tooth preparation or reduction is inadequate in the marginal area?**

If the tooth reduction is less than 1.5 mm at the marginal area, only metal can be present in that area. If porcelain is applied on metal that has been reduced in thickness because of lack of space, marginal metal distortion is likely during the firing cycle. If the porcelain thickness is reduced to compensate for the reduced space, the opaque porcelain layer is likely to be exposed or to dominate, leading to an unaesthetic result. If both the porcelain and metal have adequate thickness, then the crown is overcontoured (Fig. 9-3).

**16. Can the marginal area of a metal-ceramic crown be constructed in porcelain without metal?**

There are many techniques with which to construct a porcelain margin with optimal aesthetics, proper fit, and correct contour (emergence profile).

**17. If the tooth preparation is sufficient to accept the porcelain edge of the metal without distortion, why is it necessary to construct a margin in porcelain solely for aesthetic reasons?**

It is possible to cover the metal correctly with porcelain in the marginal area, but most often the aesthetic results fall short of expectation in the most critical area. Incident light that transmits through the porcelain and reflects from the metal often creates a shadowing effect. If porcelain is present only at this marginal area, light transmission and reflection through the porcelain and the tooth create the proper blend between the marginal aspect of the crown and the tooth.

**18. For a successful porcelain marginal construction, how far should the metal extend in relation to the shoulder?**

Originally the metal was finished slightly shy of the edge of the shoulder, with porcelain extending to the edge. Another technique finished the metal at the axiocaval line angle of the preparation, creating a porcelain margin that totally covered the horizontal shoulder. With both techniques, however, shadowing was still present. To create proper light transmission and reflection of the porcelain-tooth interface, the metal should be finished to about 1 to 2 mm above the axiocaval line angle of the shoulder (Fig. 9-4).



**Figure 9-3.** Margin tooth reduction (1.0-1.5 mm) is necessary for acceptance of the porcelain to cover metal.



**Figure 9-4.** Diagram of porcelain margin.

**19. What are noble alloys?**

Noble alloys in general do not oxidize on casting. This feature is important in a metal substrate so that oxidation at the metal-porcelain interface can be controlled by the addition of trace oxidizing elements. If oxidation cannot be controlled on repeated firings, porcelain color may be contaminated, and the bond strength may be weakened. Noble alloys are gold, platinum, and palladium. A silver alloy that oxidizes is considered semiprecious.

**20. What is a base metal alloy? Can it be used in the construction of a metal-ceramic crown?**

The base metal or nonprecious alloys most often used in the construction of a metal-ceramic crown are nickel and chromium. Because these alloys readily oxidize at elevated temperatures, they create porcelain to metal interface problems. The oxidation must be controlled by a metal-coating treatment, which is somewhat unpredictable. Casting and fitting are also difficult. Authorities agree that a noble alloy is preferable.

**21. What are the criteria for selecting a specific alloy?**

1. Compatibility of the coefficient of thermal expansion with the selected porcelains
2. Controllability of oxidation at interface
3. Ease in casting and fabrication
4. Fit potential
5. High yield of strength
6. High modulus of elasticity (stiffness) to avoid stress in the porcelain

**22. How does porcelain bond to the alloy?**

Ceramic adheres to metal primarily by chemical bond. A covalent bond is established by sharing  $O_2$  in the elements in the porcelain and the metal alloy. These elements include silicon dioxide ( $SiO_2$ ) in the porcelain and oxidizing elements such as silicon, indium, and iridium in the metal alloy.

**23. How is a porcelain selected?**

The criteria for selecting a specific porcelain include:

1. Compatibility with the metal used in regard to their respective coefficients of thermal expansion (of prime importance)
2. Stability of controlled shrinkage with multiple firings
3. Color stability with multiple firings
4. Capability of matching shade selection with various thicknesses of porcelain
5. Ease of handling (technique-sensitive)
6. Full range of shades and modifiers

**24. How many layers or different porcelains can be applied in the buildup of a metal-ceramic crown?**

- |                    |                             |
|--------------------|-----------------------------|
| 1. Shoulder        | 5. Incisal                  |
| 2. Opaque          | 6. Translucent              |
| 3. Opacious dentin | 7. Modifiers in every layer |
| 4. Body            | 8. External colorants       |

**25. What is the function of the opaque layer?**

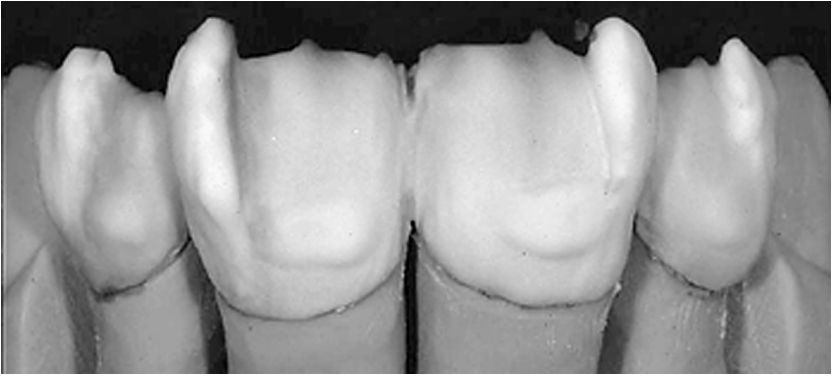
The elements in the opaque layer create the chemical bond of the porcelain to the metal substrate. The opaque layer masks the color of the metal and is the core color in determining the final shade of the crown.

**26. What is opacious dentin?**

Opacious dentin is an intermediary modifying porcelain that affords better light transmission than the opaque layer, in part because of its optical properties. Opacious dentin is less opaque than the opaque layer but less translucent than the body (dentin) porcelain. It is also used for color shifts or effect properties.

**27. What differentiates shoulder porcelain from dentin (body) porcelain?**

The principal difference between shoulder and body porcelain is the firing temperature. Because the shoulder porcelain is established before the general buildup, its color and dimension must remain stable during subsequent firings. Therefore, the shoulder porcelain matures at a higher temperature than the subsequent body porcelain firings.



**Figure 9-5.** Segmental buildup to construct a porcelain crown.

**28. What is segmental buildup in the construction of the metal-ceramic crown?**

Segmental buildup refers to the method of applying the porcelain powders in incremental portions horizontally. Each increment differs from the others in opacity and translucency or hue, value, or chrome. This technique is used to construct a crown that attempts to mimic the optical properties of a natural tooth (Fig. 9-5).

**29. What is the coefficient of thermal expansion? What is its importance in prosthodontics?**

The coefficient of thermal expansion is the exponential expansion of a material as it is subjected to heat. The coefficient is extremely important during joint firing of two dissimilar materials. For example, the coefficient of thermal expansion should be slightly higher (rather than the same) for the metal substrate than for the porcelain coating. This slight difference results in compression of the fired porcelain coating, which gives it greater strength.

**30. What is the proper coping design for the metal-ceramic restoration?**

The purpose of the metal coping is to ensure the fit of the crown and maximize the strength of the porcelain veneer. The metal must have the proper thickness so as not to distort during the firing. The coping should be reinforced in load-bearing areas, such as the interproximal space and can be strengthened in areas in which metal exists alone, such as the lingual collar. To maximize the strength potential of the porcelain, uniform thickness should be attempted in the final restoration. This thickness can be obtained by designing the wax-up of the framework to accommodate the porcelain layer.

**31. How does the marginal tooth preparation affect the design of the metal-ceramic crown?**

The marginal tooth preparation determines the marginal configuration of the metal-ceramic crown. The three options are:

1. Beveled or feathered edge—the preparation is covered only in metal.
2. Chamfer—if the depth of the chamfer is at least 1 mm, the porcelain can extend over the metal and a supported porcelain margin can be constructed.
3. Shoulder—the preparation must be 1 mm for the porcelain to cover the metal.

**32. Is the design of the metal framework of a fixed bridge different from the design of a single unit?**

The design of the metal framework must incorporate four basic interrelationships—strength, aesthetics, contour, and occlusion. In fixed bridgework, however, strength of the substrate plays the dominant role. Therefore, greater attention must be paid to reinforcement of the framework than of a single unit.

**33. How do design problems of the metal framework influence the function of the metal ceramic restorations?**

1. The color of the porcelain is compromised between abutments and pontics if the thickness of the porcelain varies.

2. If the porcelain veneer is too thick ( $>2$  mm) because of improper framework design, much of the strength of the interface bond is lost.
3. If the porcelain veneer is too thin ( $\leq 0.75$  mm), the aesthetic effect is compromised.
4. The metal framework is designed to resist deformation. If strut-type connector design is not used in the fixed bridgework, the bridge may flex and result in porcelain fracture.

#### 34. What is metamerism? How does it affect the metal-ceramic restoration?

Metamerism is the optical property whereby two objects with the same color but different spectral reflectance curves do not match. This property is important in matching the shade of the metal-ceramic restoration to the natural tooth. Even if the colors are the same, different reflectance curves can create a barely noticeable difference.

#### 35. What is the importance of fluorescence in porcelain?

Fluorescence is the optical property whereby a material reflects ultraviolet radiation; it reflects different hues. Natural teeth can fluoresce yellow-white to blue-white hues. Fluorescence in porcelain is important to minimize metamerism of porcelain to natural teeth in varying light conditions.

#### 36. What are hue, value, and chroma? What is their importance in dentistry?

Color consists of three properties:

1. *Hue* refers to color families (e.g., red, green).
2. *Value* refers to lightness or darkness as related to a scale from black to white.
3. *Chroma* refers to the saturation of a color at any given value level.

The properties have a practical use in ordering color.

#### 37. What is opalescence?

Opalescence is the optical property seen in an opal during light transmission and light reflection. During transmission, the opal takes on an orange-white hue, whereas during reflection it takes on a bluish-white hue. This phenomenon also occurs in the natural tooth as a result of light scattering through the crystalline structure of the opal. The structure size is in the submicron range ( $0.2\text{--}0.5\ \mu\text{m}$ ). A porcelain restoration can demonstrate the opal effect by incorporating submicron particles of porcelain into the enamel (incisal) layer.

#### 38. How do you select a shade to match the natural teeth?

There is no truly scientific method to analyze the shade of a natural tooth and apply this information to the selection of porcelain and fabrication of the crown. Attempts to establish such a technique have met with limited success. At present, shade determination is designed to match natural teeth with a synthetic replication (shade guide) that results in a range of acceptability rather than an absolute match. The most widely used guide is the VITA Classical Shade Guide by Vident.

#### 39. What improvements have been made in selecting a shade in more recent years?

The **3D guide** was developed over 10 years ago based on the three dimensions of hue, chroma, and value. The VITA 3D-Master Shade Guide (Vident) improves accuracy in selection based on a value numbering system of 0 to 5, with 0 being the brightest and 5 the darkest shade. Chroma is also categorized from 1 to 3, with 1 being the lowest and 3 being the highest. Hue is categorized as left, middle, or right (orange to red).

**Digital photography** for shade analysis has also been used. Digital photography with Adobe Photoshop has been used in shade selection. Images of the compared tooth and the shade guide are taken in the same vertical plane in a RAW file format. The images are then opened in Photoshop and the background area is turned to black. A duplicate image is made and turned to gray scale. The "HSB" color model is selected in the "INFO" palette, and when the cursor is placed on the shade guide or the compared tooth, the hue will be given by an "H" number, chroma by the "S" number, and the value by the "B" number. The difference in these parameters can be measured between the tooth and the guide. The ceramist can use this information to choose the most appropriate porcelains to match the tooth structure.

**Computerized digital shade technology** and software are used in conjunction with visual shade guides and digital photography. Instruments store data for various shade guides and use fiberoptics along with spectrometers to aid dentists in determining the tooth shade



and color zones. Light waves are sent through the tooth and refracted or reflected back to the receiver in the spectrometer. The digital spectrophotometers determine the shade, hue, chroma, and value. VITA Easyshade Compact by Vident and Crystaleye by Olympus America are two product examples.

#### 40. Can you change a shade with external stains?

External stains or colorants are frequently used to minimize the differences between natural and ceramic teeth. They should be used rationally rather than empirically. An understanding of the color phenomenon is necessary in all aspects of shade control and is essential if extrinsic colorants are to be used correctly. Extrinsic colorants follow the physical laws of subtractive color.

#### 41. What guidelines derived from the color phenomenon apply to the use of external colorants?

The understanding of hue, value, and chroma and their effect on external staining of a crown are essential. The major guidelines are as follows:

**Hue:** Drastic change of the shade of the ceramic restoration by use of external colorants is often impossible. Slight changes in shade may be accomplished (e.g., orange to orange-brown).

**Value:** External colorants can be used to lower the value of the ceramic. The complementary color of the shade to be altered may have a darkening effect. It is almost impossible to increase the value or shade of the ceramic.

**Chroma:** Chroma can be successfully increased by external colorants, usually in the gingival or interproximal areas.

#### 42. What effects can be created with surface stains?

1. Separation and individualization with interproximal staining
2. Coloration of a cervical area to emulate root surface and produce the illusion of change of form
3. Coloration of hypocalcified areas
4. Coloration of check lines
5. Coloration of stain lines
6. Neutralization of hue for increase of apparent translucency (usually violet)
7. Highlighting and shadowing
8. Incisal edge modification—emulated opacities, high chrome areas, stain areas
9. Synthetic restorations
10. Aging

#### 43. Are external colorants stable in the oral cavity?

External colorants are metallic oxides that fuse to the ceramic unit during a predetermined firing cycle. Although stable in an air environment, they are susceptible to corrosion when subjected to certain oral environments. Depending on the stain and pH of the oral fluids, external colorants may be lost from the ceramic unit over a long period of time.

#### 44. What is the most important factor in determining the strength of a ceramic?

The most important factor in the strength of a ceramic material is control of small flaws or microcracks, which often are present at the surface and internally. In most cases, the strength of the ceramic depends on surface flaws rather than porosity in the normal range.

#### 45. Should porcelain be used on the occlusal surface of a metal-ceramic crown?

In general, the surface hardness of dental porcelains is greater than that of tooth structure, metal alloys, and all other restorative materials. This may lead to excessive wear of the opposing dentition if certain occlusal guidelines are not followed. In the best scenario, the opposing material is porcelain, but results are good if the occlusal loads have good force distribution. Porcelain is contraindicated in patients who engage in bruxism or parafunctional activities in which occlusal overloading may occur.

#### 46. Can a porcelain fracture of a metal ceramic restoration be repaired?

It is now possible to bond composite or ceramic materials to a fractured restoration. The bond, which may occur on porcelain or on the metal substrate, is sufficiently strong to be

resistant in a non- or low stress-bearing area. However, if the fracture occurs in a stress-bearing area, the probability of a successful repair is low.

**47. On what basis do you choose between an all-ceramic and metal-ceramic crown?**

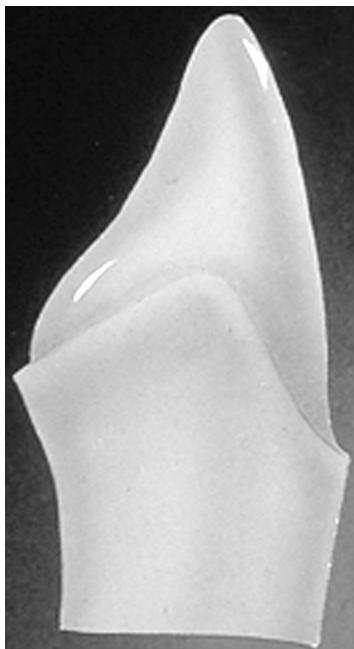
All-ceramic crowns have been frequently used. As with their predecessor, the porcelain jacket crown, which was introduced at the turn of the century, the main reason for their use is superior aesthetics. Unlike the metal-ceramic crown, which is hindered by the metal substrate, the all-ceramic crown can mimic the optical properties of the natural tooth. However, all other factors—including strength, fit, ease of fabrication, and tooth selection and preparation—may inhibit its use.

**48. Is tooth preparation the same for an all-ceramic crown and metal-ceramic restoration?**

The same amount of overall tooth reduction is needed for a metal-ceramic restoration as for an all-ceramic crown (1.0-1.5 mm labially, lingually, and interproximally). However, unlike the metal-ceramic restoration, which will accept any marginal design, marginal tooth preparation for the all-ceramic crown must be a shoulder or deep chamfer (minimum of 1.0 mm tooth reduction) (Fig. 9-6).

**49. What tooth preparation is necessary for solid zirconia crowns?**

BruxZir Solid Zirconia (Glidewell Laboratories) is a monolithic zirconia restorative material used for crowns, bridges, screw-retained implant crowns, inlays, or onlays with no porcelain overlay. The material was originally designed to provide a more durable and aesthetic alternative to posterior metal occlusal PFMs (porcelain fused to metal crowns) and cast gold restorations for demanding situations such as bruxers or restorations with limited occlusal space. These restorations are milled through CAD-CAM (computer-aided design—computer-aided manufacturing) technology and are meant to be fracture- and chip-resistant. Marginal preparation can be feather-edged and a shoulder is not necessary. A conservative preparation is indicated, similar to a full-cast gold crown, so any preparation with at least 0.5 mm of occlusal reduction is



**Figure 9-6.** Tooth preparation for an all-ceramic crown.

acceptable. Occlusal reduction of 1.0 mm is ideal. Labial, lingual, and interproximal reduction is 1.0 mm. Tooth preparation for a BruxZir Solid Zirconia crown is shown in Figure 9-7.

**50. Can the newer all-ceramic materials with high strength values be used in place of metal-ceramic restorations?**

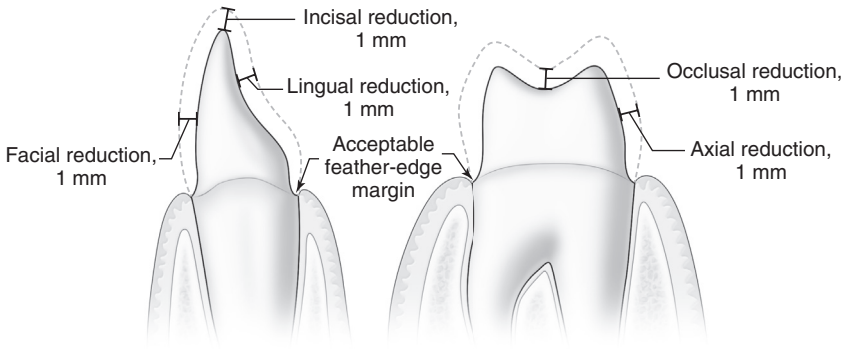
Some manufacturers claim that the newer ceramic materials with high theoretical strength values can be used in place of metal-ceramic restorations for any tooth and for small-unit, anterior fixed bridges. However, the guidelines for usage, such as tooth preparation, are more critical and in general more complicated than for metal-ceramic restorations. It is advisable, therefore, to use the all-ceramic crown in the anterior segment, in which aesthetics is the dominant factor (Fig. 9-8).

**51. What are the different types of all-ceramic crowns?**

All-ceramic crowns may be categorized by composition and method of fabrication:

**Composition**

1. Feldspathic porcelain, such as a conventional porcelain jacket crown
2. Aluminous porcelain: Vitadur, Hyceram, Cerestore, Procera, Inceram



**Figure 9-7.** Requirements for the preparation of a BruxZir Solid Zirconia crown consist of using a feather edge, a shoulder preparation is not necessary, and a minimum 0.5 mm occlusal reduction. A 1 mm occlusal reduction is ideal, though.



**Figure 9-8.** All-ceramic crowns on maxillary anterior segment (teeth #6-11).

3. Mica glass: Dicor, Cerapearl
4. Crystalline-reinforced glass: Optec, IPS Empress, IPS e.max
5. Zirconia: BruxZir, PrismaTik, Lava
6. Lithium silicate: Obsidian

#### Method of fabrication

1. Refractory die technique: Optec, Mirage, HyCeram, InCeram
2. Casting: Dicor
3. Press technique: Cerestore, Procera, Empress
4. CAD-CAM or milled technique: IPS e.max, Prettau, Izir, BruxZir

#### 52. What is crystalline-reinforced glass?

A crystalline-reinforced glass is a glass in which a crystalline substance such as leucite is dispersed. This composition is used in the Optec and Empress systems. Strength is derived from the crystalline microstructure within the glass matrix. The higher concentration of leucite crystals in the matrix limits the progress of microcracks within the ceramic.

#### 53. What is the importance of alumina in an all-ceramic restoration?

Alumina ( $Al_2O_3$ ) is a truly crystalline ceramic, the hardest and probably the strongest oxide known. Alumina is used to reinforce glass (as in HyCeram). The strength is determined by the amount of alumina reinforcement. Alumina is also used in total crystalline compositions (Cerestore, Procera, InCeram), which may serve as the substructure, much like metal coping. With this technique, the ceramic has high strength.

#### 54. Is the cementing of an all-ceramic crown different from the cementing of a metal-ceramic crown?

The major difference is that a trial cement is not recommended for the all-ceramic crown, which obtains much of its strength from the underlying support of the tooth. If the cement washes out, the unsupported crown is susceptible to fracture. In general, all-rigid cements can be used, but a bonded resin cement is highly recommended to maximize the underlying support.

#### 55. Can all the all-ceramic materials be bonded to the tooth preparation?

It is important that the ceramic material be chemically etched for bonding to a tooth. If the ceramic material cannot be properly etched, alumina is used in the substrate (Fig. 9-9).

#### 56. What is the significance of the refractory die?

A refractory die is used in many techniques for the construction of different types of all-ceramic crowns and veneers. Basically, it is a secondary die obtained by duplicating the

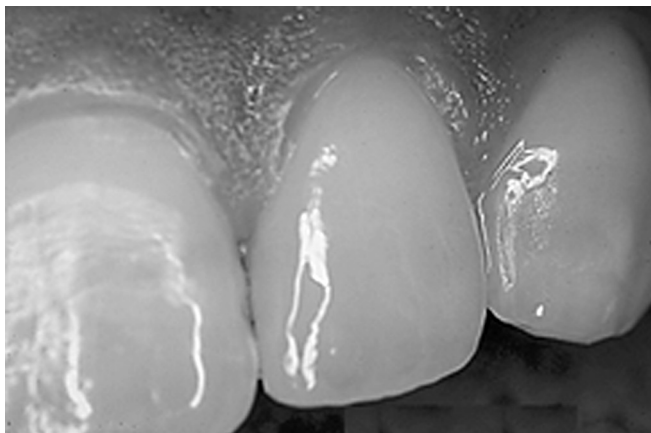


Figure 9-9. Ceramic veneer (tooth #10) bonded to tooth.

master die. The ceramic material is applied on the refractory die for the firing cycles. Once the cycles have been completed, the refractory die is removed, and the ceramic piece is returned to the master die. Refractory die material must have the following properties:

1. Compatibility with impression materials
2. Dimensional stability for measurements
3. Tolerance of high-heat firing cycles
4. Compatible coefficient of thermal expansion with the ceramic material used
5. Easy removal from the ceramic piece

#### 57. What determines the design of the pontic?

The design of the pontic is dictated by the special boundaries of the following: (1) edentulous ridge; (2) opposing occlusal surface; and (3) musculature of tongue, cheeks, or lips. The task is to design a tooth substitute within these boundaries that favorably compares in form, function, and appearance with the tooth it replaces. The tooth substitute must provide comfort and support to the adjacent musculature, conformity to the food flow pattern, convenient contours for hygiene, and cosmetic value, if indicated.

#### 58. How should the contact area of the pontic on the edentulous ridge be designed?

Three concepts in pontic design are popular:

1. The sanitary pontic design leaves space between the pontic and ridge.
2. The saddle pontic design covers the ridge labiolingually. Total coronal width is usually concave.
3. The modified ridge design uses a ridge lap for minimal ridge contact. Labial contact is usually to the height of the ridge contour (straight emergence profile).

The selection of the design depends on the following factors:

1. Spatial boundaries
2. Shape of edentulous ridge (normal, blunted, or excessive resorption)
3. Maxillary or mandibular posterior arch

In contrast to the mandibular posterior pontic, the maxillary edentulous ridge is usually broad and blunted and has superior cosmetic effects.

4. Anterior pontic

The overriding cosmetic requirement is that form and shape reproduce the facial characteristics of the natural tooth.

#### 59. What is the emergence profile? What is its importance?

The emergence profile is the shape of the marginal aspect of a tooth or a restoration and relates to the angulation of the tooth or restoration as it emerges from the gingiva. This gingival contour is extremely important for tissue health after placement of a crown.

The most obvious error of the emergence profile of a crown is overcontouring, which creates abnormal pressure of the gingival cuff and leads to inflammation in the presence of bacteria. Overcontouring and a poor emergence profile are caused primarily by the following: (1) inadequate tooth preparation, (2) improper handling of materials; and/or (3) inadequate communication between the dentist and technician.

#### 60. After periodontal therapy, when can the dentist complete the marginal tooth preparation?

A certain waiting time is necessary between completion of periodontal therapy and completion of the marginal tooth preparation so as to establish and stabilize the attachment apparatus on the root surface. If this waiting time is not observed, impingement of the restoration into the attachment apparatus frequently occurs. The result is an iatrogenic gingival inflammation. The amount of waiting time necessary depends on the aggressiveness of the gingival procedure. A reasonable guideline, however, is to wait at least 6 weeks for tissue resolution.

#### 61. What is a biologically compatible material?

A biologically compatible material elicits no adverse response in the tissue or systemically. Adverse tissue response may be the result of any of the following:

1. Allergic reaction
2. Toxic response
3. Mechanical irritation
4. Promotion of bacterial colonization

In general, highly polished noble alloys and highly glazed porcelains are the most biologically compatible materials.

**62. Is any material used to construct crowns suspected of biologic incompatibility?**

In general, most materials used in the construction of crowns are biologically compatible. Adverse reactions have occurred with some materials, primarily because of unpolished metal or unglazed porcelain surfaces. However, literature reports have indicated that nickel-chrome alloys used in castings may be biologically incompatible. An allergic response may occur in 10% of women and 5% of men.

## REMOVABLE PARTIAL DENTURES

**63. What is the most important factor in determining the success of a bilateral, free-end mandibular removable partial denture (RPD)?**

The most important factor in determining success is proper coverage over the residual ridge. Coverage should extend over the retromolar pad to create stability of the RPD and minimize the torquing forces on the abutment teeth.

**64. When clasps are to be used on the abutment teeth, what important factors must be considered?**

When clasps are used, it is important to design the prosthesis so that the path of insertion is parallel to the abutment teeth. This factor is important in eliminating torquing forces on the abutment teeth during insertion and removal of the partial denture. If the planes are not parallel, the abutment teeth must be adjusted. The abutment teeth must also be evaluated for placement of the retentive clasps and reciprocal bracing arm. The abutment teeth are then shaped to accept the clasps. The proper positioning of occlusal rests on the abutment teeth is extremely important, and the teeth are prepared to optimize positioning.

**65. What are the advantages and disadvantages of the cingulum bar as a connector?**

**Advantages**

1. Space problems for bar placement seldom exist unless anterior teeth have been worn down by attrition.
2. No pressure is exerted on the gingival tissues with movement of the RPD.
3. The major connector forms a single unit with the anterior teeth, thus contributing to comfort of the RPD.
4. Indirect retention is provided.
5. Repair of the RPD is simple when natural anterior teeth are lost.

**Disadvantages**

1. The metal bar situated on the lingual surface of the anterior teeth is relatively bulky, especially if crowding is present.
2. Aesthetics is compromised if spacing exists.
3. Marked lingual inclination of the anterior teeth precludes use of the bar.

**66. What laboratory requirements should be implemented when a cingulum bar is used?**

1. For sufficient rigidity, a minimal height of 4 mm and thickness of 2.5 mm are necessary. These dimensions should be increased when the cingulum bar traverses more natural teeth.
2. No notches should be made in the metal to stimulate tooth contour because they weaken the bar. In the presence of reduced height, the bar is placed more gingivally and made thicker to provide rigidity.
3. The junction of the bar to the denture base must be sufficiently strong. The bar can cover the lingual surfaces of premolars, if present. The contour of the teeth should be adapted to the path of insertion of the RPD.

**67. Are indirect retainers necessary in the construction of an RPD? If so, where should they be placed?**

The function of an indirect retainer is to prevent dislodgment of the RPD toward the occlusal plane. In a total tooth-bearing RPD, it is unnecessary to include indirect retainers.

However, when the RPD has a free end saddle portion, it is advisable to include indirect retention to prevent vertical dislodgement.

The ideal positioning of the indirect retainer is at the furthest point from the distal border of the free end saddle. For example, if the free-end saddle is on the lower right quadrant, the indirect retainer is placed on the lower left canine.

**68. Is it advantageous to place stress-breaking attachments adjacent to a free end saddle in an RPD?**

The advantage of constructing a stress-breaking attachment next to a free end saddle is to relieve torquing forces on abutment teeth that have been periodontally compromised. However, further displacement of the free end saddle toward the underlying ridge may cause an acceleration of resorption of the residual ridge. It is preferable, therefore, to compensate for torquing forces on the abutment teeth by the proper extension of the saddle area.

**69. Is it necessary to use clasps around abutment teeth in an RPD?**

Clasps may be eliminated around abutment teeth if the teeth are restored with a partial or full crown containing some form of attachment that replaces the functions of the clasps. These functions include the following:

1. Guide planes for the RPD
2. Prevention of vertical displacement toward the ridge by the occlusal and lingual rest
3. Retentive function from the retentive arm
4. Bracing function from the reciprocal arm

Depending on the type of attachment, all or part of these functions may be replaced. With partial replacement, the remaining functions are incorporated into the RPD.

**70. What is the difference between a precision and semiprecision attachment?**

A **precision attachment** is preconstructed with male and female portions that fit together in a precise fashion, with little tolerance. Normally, there is no stress, and retention can be adjusted within the attachment. The attachment parts, constructed of a metal that can be placed into the crown and RPD, normally are joined by solder. In general, no other clasps are necessary.

A **semiprecision attachment** is cast into the crown and RPD. The female portion is normally made of preformed plastic that is positioned into the wax form and then cast. The male portion is cast with the RPD framework. The female and male parts fit together with much more tolerance than in the precision attachment, resulting in less retention. Secondary retentive clasping is necessary. Less torque is induced on the abutments with a semiprecision than with a precision attachment.

**71. Do unlike metals in the male and female portions of the semiprecision attachment pose a problem?**

The female portion of the attachment is cast with the crown and is made of the same metal as the crown. The male portion is cast into the RPD. The male portion is made of a harder metal than the female portion, which thus is subjected to greater wear. The wear pattern normally occurs on the vertical walls rather than on the occlusal seat. This creates a loosening of the attachment but no significant vertical displacement of the RPD. The result is the need for an adjustable retentive clasp.

**72. What is the difference between an intracoronal and extracoronal attachment?**

An intracoronal attachment is placed within the body of the crown, whereas the extracoronal attachment is attached to the outer portion. The selection of one over the other depends on many factors; if designed properly, both types can be used successfully.

**73. What are the advantages and disadvantages of an intracoronal attachment?**

**Advantages**

1. Placement of torquing forces near the long access of the tooth, thus minimizing these forces
2. Elimination of clasps
3. Parallel guide planes for proper RPD insertion
4. Capability to establish proper contour at the abutment-RPD interface

**Disadvantages**

1. More tooth reduction
2. Need for adequate coronal length

3. Lack of stress-bearing capability
4. Difficulty in performing repairs

#### 74. What are the advantages and disadvantages of an extracoronal attachment?

##### Advantages

1. Same amount of reduction of the abutment tooth and conventional restoration
2. Elimination of clasps
3. Incorporation of stress breaking into attachment
4. Ease of replacing parts
5. Improved aesthetics

##### Disadvantages

1. The attachment is positioned away from the long axis of the tooth, creating a potential for torquing forces on the abutment tooth.
2. Adequate vertical space is necessary for placement of the attachment.
3. Interproximal contour at the crown-attachment interface is difficult to establish correctly.

#### 75. Is the unilateral RPD an acceptable treatment modality?

In general, a unilateral RPD is not an ideal treatment modality because cross-arch stabilization is necessary for success. A unilateral RPD may be used, however, when a single tooth is replaced and abutment teeth are on either side of the replacement tooth (Nesbitt appliance).

## FULL DENTURES

#### 76. What is the best material for taking a full-denture impression?

In taking a full-denture impression, it is important to understand that the topography of an edentulous arch includes soft displaceable tissue with undercut areas. An impression material must not distort the tissues. Therefore, the material must be low in viscosity and elastomeric so that it can rebound in the undercut areas.

#### 77. Is border molding necessary for a full lower denture?

Unlike a full upper denture, a lower denture does not rely on a peripheral seal for retention. Thus one may assume that border molding is an unnecessary procedure during impression taking. This assumption is incorrect because inadvertent overextension can greatly reduce denture stability as well as irritate tissue. Underextension of the peripheral border decreases tissue-bearing surfaces, thereby affecting denture stability.

#### 78. What is the importance of the posterior palatal seal? How is its position determined?

The posterior palatal seal is an important component because it completes the entire peripheral sealing aspect of a maxillary denture. Anatomically, the seal is located at the juncture of the hard and soft palates and joins the right and left hamular notches. If the seal is positioned more posteriorly, tissue irritation, gagging reflex, and decreased retention can result. If the seal is positioned more anteriorly, tissue irritation and decreased retention can result. Manual palpation and phonetics (the “ah” sound) are the best ways to determine the anatomic position for the palatal seal. Indelible ink can be used to transfer the vibrating line from the mouth to the record base to the master cast to determine the posterior border.

#### 79. What are the critical areas in the border-molding procedure of taking impressions for a maxillary arch?

The most critical area to capture in an impression is the mucogingival fold above the maxillary tuberosity area. Proper three-dimensional extension of the final prosthesis is extremely important for maximal retention. Other critical areas are the labial frena in the midline and the frena in the bicuspid area. Overextension in these areas often leads to decreased retention and tissue irritation.

#### 80. Should an impression be taken under functional load or passively at one static moment?

The answer to this question has been debated for years. Soft tissue constantly changes, and a static impression captures the tissue at one point in time. On the other hand, a functional



impression is taken with abnormal masticatory loads. Therefore, there is no absolute method of taking the impression. Denture stability with occlusal forces and periodic tissue evaluation, however, are critical with both methods.

**81. What are the critical areas to capture in an impression of a mandibular arch?**

Mandibular dentures do not rely on suction from a peripheral seal for retention but rather on denture stability in covering as much basal bone as possible, without impinging on the muscle attachments. Movement of the tongue, lips, and cheeks greatly affects the amount of the tissue-bearing area. Therefore, apart from identifying and covering the retromolar areas, the active border molding performed by the lip, cheeks, and tongue determines the peripheral areas of a mandibular arch, thus establishing maximal basal bone coverage.

**82. How do you determine the peripheral extent of a denture?**

For a peripheral border impression, a moldable material should be used around a well-fitting tray. The material should have moderate or low viscosity so as not to displace tissue and should set in a short period of time. The lips, cheeks, and tongue dictate the extent of the peripheral impression. The impression is captured by exaggerated movements of the anatomic structures made by the patient or manipulated by the dentist.

**83. If an impression does not capture everything that is intended, can you realign the existing impression?**

One must always bear in mind that an edentulous ridge has soft displaceable tissue. Thus, it is important to relieve the pressure before relining an existing impression. If this is not done, tissue is compressed, and dimensional stability of the final impression is compromised. This inevitably leads to an undersized, ill-fitting denture.

**84. How is vertical dimension established in a totally edentulous mouth?**

Vertical dimension is established with the aid of bite rims. The most important aspect of vertical dimension is to establish the freeway space. The minimal opening in freeway space, which is determined phonetically (the “s” sound), is normally 1 to 2 mm.

**85. How are overlap and overjet established?**

Overlap and overjet are established by the maxillary bite rim, which also establishes the occlusal plane. The bite rim is adjusted by its position relative to the lip and cheek.

**86. Is the bite registration taken in the centric relation or centric occlusion position?**

This controversy has been argued for years and remains unresolved. However, certain principles are generally accepted:

1. A centric relation position may be duplicated.
2. A centric relation is the same position in various openings of the vertical dimension.
3. A centric relation should be an unstrained position.
4. Centric occlusion may be used if the bite registration is done without increasing the vertical dimension.

**87. Is it necessary to take multiple bite registrations?**

It is not necessary to take multiple bite registrations to capture a maxillary-mandibular relationship. However, because tissue displacement makes it difficult to obtain a stable bite with wax rims, a single accurate bite registration is unlikely. It is advisable, therefore, to take multiple bite registrations throughout the fabrication procedure and even after insertion of the final dentures.

**88. What does the tooth try-in appointment accomplish?**

The most obvious reason for the try-in appointment is to visualize the aesthetics of the final teeth in regard to lip line, overbite and overjet, shape, and arrangement. The try-in appointment can also determine the fullness of the labial flanges in relationship to the cheeks and lips. The occlusal relationship can be checked and verified, and a new bite registration can be performed. Above all, the try-in appointment affords the dentist and patient a preview of the final completed denture.

**89. How is posterior occlusion selected with regard to tooth morphology?**

Posterior occlusion can range from monoplane (flat plane) to steep anatomic occlusal cusps. In general, the more anatomic the occlusion, the more efficient its function. However, it

is more difficult to establish balanced occlusion with a steep anatomic denture, and lack of balance leads to denture instability. It is therefore easier to establish occlusal harmony with monoplane teeth. Overbite and overjet of the anterior teeth also affect selection of the posterior teeth.

**90. How do overbite and overjet affect the selection of cuspid inclines of the posterior teeth?**

Overbite and overjet of the anterior teeth affect selection of the cuspid inclines of the posterior teeth when balanced occlusion is to be achieved in lateral and protrusive movements:

- Steep overbite—steep cuspal incline
- Small overbite—monoplane
- Wide overjet—monoplane
- Narrow overjet—steep cuspal incline

**91. Of what materials are denture teeth composed? How are they selected?**

Denture teeth are made from basically three materials—porcelain, acrylic, and composite-filled resin. All three materials afford excellent aesthetic capabilities.

**Porcelain teeth** afford the greatest degree of hardness and best withstand wear. However, they are brittle and difficult to change or adjust; they also have a low mechanical bond strength to the resin base.

**Acrylic teeth**, on the other hand, are the softest of the materials and therefore the least resistant to wear. They are, however, easy to use, can be easily changed or adjusted, and have the best bond strength to the denture base.

**Composite-filled resin teeth** have hardness and strength values between those of porcelain and acrylic; they bond well to the denture base and can be adjusted easily.

**92. What procedure should be followed for insertion of a full upper and full lower denture?**

During the processing of the denture base, the probability of dimensional change is high. Dimensional change affects the adaptation of the base to the tissue-bearing area and also affects the occlusion. It is advisable, therefore, to verify the adaptation of the dentures to the tissue-bearing areas. This procedure can be accomplished by placing some type of pressure-indicating material inside the denture. The extension of the peripheral borders, especially in the frenum area, should be evaluated. Once the individual bases are adjusted, the occlusal balance should be carefully checked and adjusted. A remount procedure is recommended for this equilibration.

**93. When the treatment plan calls for an immediate (transitional) denture, what are the expectations?**

If the anterior teeth are to be extracted at the time of denture insertion, the patient should be informed that the denture teeth can be placed in the same position as the existing teeth. However, the patient's facial appearance will change because of the presence of the labial flange, which affects the fullness of the lip. The patient also should be made aware of the necessary process of adaptation to the palate and of the increase in salivary flow that will become normal over time. Finally, the patient should be told that most people adapt well to such oral changes.

**94. Is the impression procedure the same for a transitional denture as for a conventional denture?**

The impression procedure is approximately the same for establishing the peripheral border. The major concern in taking an impression around existing teeth and exaggerated undercut area is to select a material that has the lowest viscosity and is nonrigid after setting. These properties are important to avoid damaging existing teeth during the removal of the impression.

**95. How is vertical dimension established in the construction of a transitional denture?**

It is important to use the existing teeth to establish the centric occlusal position, regardless of the amount and position of the teeth. At the bite registration phase, a bite rim is constructed in the edentulous space adjacent to the existing teeth, and the teeth with the wax rims are used to capture the occlusal relationship.

**96. If the master casts are altered in a transitional denture procedure (e.g., elimination of gross tissue undercuts), how is the surgical procedure altered?**

It is necessary during the surgical procedure to know exactly how the master cast has been altered. This information is critical for successful insertion of the transitional denture. It is advisable to construct a second denture base that is transparent. This surgical stent is placed over the ridge after the teeth are extracted. Pressure points and undercuts are readily visible, and surgical ridge correction can be performed.

**97. When a transitional denture is inserted, what procedures should be followed?**

It is always beneficial to have a surgical stent available to ascertain the fit of the denture base. Because many soft tissue undercut areas may be present, it is critical to establish a single path of insertion of the denture. Gross removal of areas inside the dentures may lead to poor adaptation of the denture base and instability. In this situation, immediate use of a soft lining material is indicated.

**98. During the healing phase, what procedures should be followed?**

The patient should be instructed not to remove the denture and return after 24 hours. At that time, tissue irritation and occlusion are checked, and the denture is adjusted. Then the patient is instructed about insertion and removal of the denture and told that as the ridges heal, resorption will occur. Each case varies, but in general resorption leads to a loosening of the denture. Therefore, transitional soft lining procedures should be performed throughout the healing phase, on approximately a monthly basis. The final healing may take from 3 to 6 months, at which time a permanent lining in the existing denture or a new denture is constructed.

**99. Is a face-bow transfer necessary in jaw registration in the full-denture construction?**

It is advisable to take a face-bow transfer in the construction of a full denture. The purpose of the registration is to relate the maxillary bite rims to the temporomandibular joint and facial planes. This registration aids in determining not only aesthetic factors, but also the type of occlusal plane.

**100. Is it necessary to take eccentric bite registrations in the construction of full dentures?**

Although eccentric bite registrations are not essential, they aid in establishing a balanced occlusion. A stable occlusion is important for the retention and stability of dentures and for functional efficiency.

**101. What are digital dentures?**

Computer-aided technology has recently emerged as a mechanism for fabricating complete dentures. Dentca and Global Dental Science (AvaDent Digital Dentures) are two manufacturers of CAD-CAM complete dentures. Digital dentures can be fabricated in as few as two appointments, as opposed to the traditional four or five patient visits. The first clinical appointment is for impressions, jaw records, and tooth selection. Impressions and jaw records are scanned, and digital files are created and merged. Virtual digital dentures are designed, the denture bases are milled from highly compressed biohygienic base material, and standard denture teeth are added. At the second appointment, the denture is inserted and adjusted. The digital record is maintained and, if the denture is ever lost or broken, an identical model can be refabricated and sent to the dentist, without patient involvement. The application of CAD-CAM full dentures has considerable potential for patient care but prospective clinical trials are necessary to validate this new technology.

**102. What is the neutral zone? How does it relate to the alveolar ridge?**

The neutral zone is the potential space between the lips and cheeks on one side and the tongue on the other. Natural or artificial teeth in this zone are subject to equal and opposite forces from the surrounding musculature. The alveolar ridge, which normally dictates the position of the denture teeth, may conflict with the neutral zone. Therefore, the neutral position zone also should be considered when denture teeth are positioned.

**103. Are there any advantages to retaining roots under a denture apart from retention properties?**

Retention is a critical aspect in root-retained dentures. Of equal importance, however, is that retained roots help prevent resorption of the residual ridges. Retained roots also afford the patient some proprioceptive sense of "naturalness" in the function of the dentures.

**104. What is the ideal type of attachment in a root-retained denture?**

The ideal type of attachment affords maximal retentive forces for the denture, with minimal torquing forces to the roots. Because these ideal properties cannot be totally attained, a compromise is necessary. Many factors determine how much retention a tooth can withstand without subjection to harmful forces, including the following:

1. The amount of supportive bone around the retained roots
2. The number of existing roots
3. The type and amount of occlusal forces
4. The type of attachment (e.g., intra- or extraradicular, rigid, or stress-bearing attachment)
5. Splinting or nonsplinting of roots

**105. In a root-retained denture, which is better—an intraradicular or extraradicular attachment?**

Both attachments can be equally retentive, but the intraradicular attachment places the fulcrum forces more deeply into the bone than an extraradicular attachment and thus helps withstand deleterious torquing forces. The intraradicular attachments, however, are more difficult to implement because of the following: (1) length of existing root; (2) width of existing root; (3) paralleling to other roots; (4) inability to splint; and (5) difficulty in hygiene.

**106. Is splinting a preferred treatment in a root-retained denture?**

The main purpose of splinting roots in a tooth-borne denture is to dissipate the forces, thus minimizing the torque on the existing roots. Splinting does not necessarily result in increased denture retention, but it creates a more difficult construction procedure. Splinting should be attempted after certain aspects are evaluated, such as paralleling, amount of freeway space, placement of the bar to the ridge, and type of bar.

**107. What is the difference between a rigid and stress-breaking attachment?**

In a **rigid attachment**, the male and female components join in a precise fashion, allowing almost no movement between the two parts. This creates a rigid nonflexible attachment that affords the greatest amount of retention but also produces the greatest amount of torque on the retained roots. A rigid attachment is not recommended for periodically compromised teeth.

A **stress-bearing attachment** affords movement between the male and female components, thereby relieving torque. In most cases, a stress-bearing attachment is recommended.

**108. How many roots must be retained to construct a root-retained denture?**

There is no fixed rule. A root-retained denture can be constructed with only one root. The fewer the roots, the less the retentive force that should be applied to them. The ideal distribution of retained roots would be cuspid regions and bilateral molar regions.

**109. Is it necessary to place attachments or cover the roots of a root-retained denture?**

It is not always necessary to cover a root beneath an overdenture. Retention is not the only goal of this treatment modality. Equally important is preservation of the residual ridge by retaining the roots. However, if a root is not covered, the exposed surfaces are highly susceptible to decay. Oral hygiene must be stringently maintained.

**110. Are the principles the same for a maxillary as for a mandibular overdenture?**

Many of the principles for root-retained dentures are the same for the maxillary arch as for the mandible, including the following: (1) selection of roots to be retained with regard to position and stability; (2) types of attachments; (3) paralleling; and (4) splinting. One aspect that may differ is related to morphologic differences of the residual ridges. The maxillary arch has a greater probability of undercut areas in the anterior region above the roots. This difference is apparent in the canine area. It is necessary to design the path of insertion to take the undercuts into consideration. Therefore, attachment selection may have to be altered, and the peripheral border of the denture may have to be reduced or eliminated.

**111. Can the palate be eliminated in a root-retained maxillary denture?**

If retention is adequate from the retained roots with their attachments, it is possible to eliminate the palate. It must be remembered that the palatal area affords the denture the greatest bearing area and also creates cross-arch stabilization.

**112. What are the causes of denture stomatitis? How can it be treated?**

Denture stomatitis is caused by trauma from poorly fitting dentures, by poor oral and denture hygiene, and by the oral fungus *Candida albicans*. Denture stomatitis can be treated by using resilient denture liners that stabilize ill-fitting dentures, thereby treating the inflamed tissue. Some liners may also inhibit fungal growth.

**IMPLANTS****113. What types of implants are most commonly used for prosthetic replacement of the tooth?**

1. **Endosteal implants:** Blades, screws, or cylinders are implanted into the maxilla or mandible. These implants support the dental prosthesis.
2. **Subperiosteal implants:** A metal framework is inserted on top of the maxillary or mandibular bone. Vertical posts attached to the framework protrude from the soft tissue and support the dental prosthesis.

**114. What is an osseointegrated implant?**

An osseointegrated implant is a cylinder or screw constructed of a biocompatible material that is precisely embedded into the ridge of the maxilla or mandible (Fig. 9-10). The fixture is allowed to integrate with the bone without any loading forces for a certain period. Histologically, the bone cells grow tightly around this anchor, with no membrane attachment at the interface (unlike the natural tooth-bone interface).

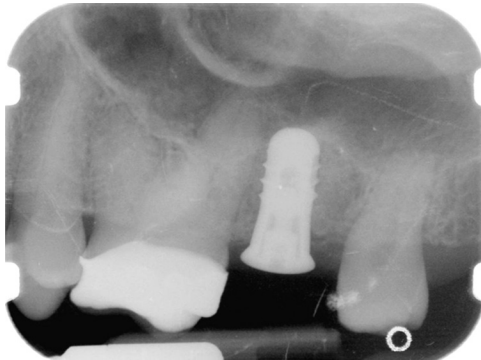
**115. What are mini-dental implants?**

These are implants fabricated of the same biocompatible materials as conventional implants but with smaller dimensions (diameter  $\approx$  1.8-2.9 mm). They are generally one piece, with a fused implant-abutment complex designed to support or retain prosthetics. They are typically placed by a surgical approach that does not require a flap or bone augmentation. They can be immediately loaded and therefore offer instant patient satisfaction. Also, they typically cost significantly less than conventional implants. Historically, mini-implants were used for interim or transitional fixed and removable prosthetics or orthodontic treatments. Some practitioners advocate for their use for the long term or permanently, but the evidence is still unclear. Examples are the MDI Mini Dental Implant (3M ESPE) and the ERA Mini Dental Implant System (Zimmer Dental).

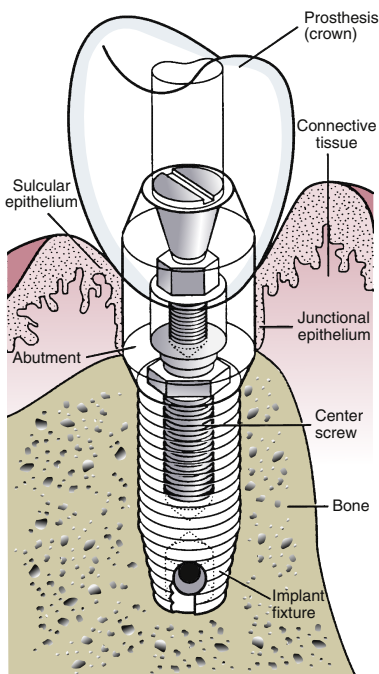
**116. Describe the components of an implant and the clinical procedures used with each.**

The technique and biocompatible materials used in the osseointegrated implant were developed by Per-Ingvar Brånemark, an orthopedic surgeon, more than 50 years ago. Brånemark identified the biocompatible material, titanium, and described the following components (Fig. 9-11):

1. **Fixture**—the anchor embedded into the edentulous ridge. It is constructed of titanium and may be coated with a biocompatible bone regeneration material, such as hydroxyapatite.



**Figure 9-10.** Osseointegrated implant. (From Spitz SD: *Lasers in prosthodontics: clinical realities of a dental laser in a prosthodontic practice*. Alpha Omega 101:188-194, 2008.)



**Figure 9-11.** Components of an implant. (From Perry DA, Beemsterboer PL: *Periodontology for the dental hygienist*, ed 3, St. Louis, Saunders, 2007.)

The fixture is carefully embedded into precision-drilled holes and allowed to integrate with the bone undisturbed for 3 to 6 months.

2. **Abutment**—the transitional piece that connects the fixture to the prosthesis. The abutment is normally attached to the fixture after a second surgical procedure.
3. **Dental prosthesis**—the dental prosthesis can then be constructed and attached to the abutment. This stage may begin a few weeks after the second surgery.

#### 117. What is the success rate of an osseointegrated implant prosthesis?

Many factors affect the success rate of an implant prosthesis; however, studies for long-term predictability have demonstrated a success rate of more than 90%.

#### 118. What factors affect the success rate of the implant?

- Careful patient selection
- Exacting diagnostic records
- Integrated treatment planning
- Precise clinical procedures

#### 119. What are the important factors in patient selection?

1. Patient's general health
  - Medical considerations
  - Medications
  - Psychiatric considerations
2. Intraoral factors
  - Bone tissue site of fixture installation free from pathologic conditions (e.g., cysts)
  - Site free from unerupted or impacted teeth, root remnants, or any other foreign bodies
  - No open communication between the bone and oral cavity
  - Healthy mucosa, free from ulceration
  - Anatomic factors

**120. What type of bone is important to osseointegration?**

Good bone consists of a thick layer of compact bone surrounding a core of dense trabecular bone of favorable strength. Poor bone consists of a thin layer of cortical bone surrounding a core of low-density trabecular bone.

**121. What anatomic factors are important to consider for implant replacement?**

- Transverse shape of the jaw bone
- Degree of resorption
- Maxilla—location of sinuses, nasal cavity, and incisive canal
- Mandible—mental foramen, inferior alveolar nerve, and blood vessels

**122. How is the intraoral condition evaluated?**

The intraoral condition is determined through radiographic evaluation:

- Intraoral radiograph of proposed site
- General view of the jaws (an orthopantomogram reveals any pathologic processes)
- Lateral cephalometric radiograph (to show relationship between jaws)
- Tomographic records (provides valuable information about the width of the alveolar crest and location of important anatomic structures)

**123. How do you plan for the proper treatment modality?**

Planning the actual course of therapy is essential to success. Before the surgery, an evaluation should be made of the desired prosthetic results. This evaluation dictates the following:

- Type of prosthetic replacement
- Number of implants
- Placement of fixtures
- Models of the jaw mounted on an articulator, if necessary

The setup of teeth on these models determines the prosthesis and helps the dentist performing the surgery to visualize the proposed prosthesis. The surgeon also may be guided for implant placement by the use of a surgical template.

**124. What are radiographic and surgical stents?**

Radiographic and surgical stents are templates constructed on the diagnostic models that aid in the position and placement of the implants. A stent with metal markers over the proposed fixture sites should be used to aid in the evaluation of radiographs. A surgical stent is also useful when the fixtures are implanted. The optimal position from a prosthetic point of view can be visualized.

**125. What are the treatment modalities for a totally edentulous jaw?**

- Overdenture supported by implants
- Fixed, high-water prosthesis
- Conventional fixed crown and bridges using implants

**126. Describe the concept of implant-supported overdenture.**

An implant-supported overdenture is supported by the implants and edentulous ridge covered by resilient mucosa. The surgeon must accommodate for this resiliency in the attachments of the implants to permit small rotational movements.

**127. What are the indications for the overdenture treatment?**

This treatment modality is a comparatively simple procedure with relatively low cost and meets the demands imposed by many patients. The most common indications are the following:

- Retention of denture
- Compromised hygiene skills (i.e., reduced dexterity, as with some older individuals)
- Interarch positions (difficulty in placing proper interdental relationships with fixed restorations)
- Phonetics and aesthetics (especially in the maxilla)

An overdenture may improve aesthetic and/or phonetic results compared with an implant-supported fixed prosthesis.

**128. How many implants are necessary to support the overdenture?**

The number of implants ranges from a minimum of two fixtures to an ideal of four. It is also important to consider the loading forces on the implant.



**Figure 9-12.** High-water prosthesis. (From Babbush CA, Hahn JA, Krauser JT, et al: *Dental implants: the art and science*, ed 2, St. Louis, Saunders, 2011.)

**129. What is the effect of loading forces on implant-supported overdentures?**

The loading forces are important to fixture survival because overloading can lead to implant failure. To reduce improper loading conditions, the following points should be considered:

1. The implants should be positioned as perpendicular to the occlusal plane as possible.
2. Shear loads and bending movements are reduced if levers are shortened by using short abutments and low attachments.
3. Resilient attachments reduce bending movements. Occlusal forces are shared between fixtures and overdenture-bearing mucosa.
4. Extension bars represent a potential risk of overloading.

**130. What is the fixed high-water prosthesis on an edentulous arch?**

The fixed prosthesis supported by implants on an edentulous arch was first developed and investigated by Brånemark in the 1960s (Fig. 9-12):

- Placement of fixtures with transmucosal abutments as parallel as possible to each other
- Cast metal frameworks that fit precisely on the abutments and support the prosthesis
- Denture teeth and processed denture material on the metal framework

**131. What does *high water* mean?**

*High water* refers to the design of an implant-supported prosthesis. The implants support the prostheses without the aid of the mucosal edentulous ridge, which is used in the implant-supported overdenture. Space between the prosthesis and mucosa is necessary for proper hygiene, thus leading to the descriptive term *high water*.

**132. What happens when the fixtures are not parallel in a fixed prosthesis?**

A precise prosthesis fit is necessary for osseointegrated rigid fixtures; therefore, relative paralleling is required. Lack of paralleling, however, can be compensated with proper abutment selection. The divergence of axial fixtures can differ by up to 40 degrees.

**133. How many fixtures are necessary to support a high-water fixed prosthesis?**

Many factors determine the number of fixtures necessary to support a fixed prosthesis, including quality of bone, placement and length of fixture, and loading of fixtures. In general, however, four to six fixtures are sufficient to support a fixed high-water prosthesis.

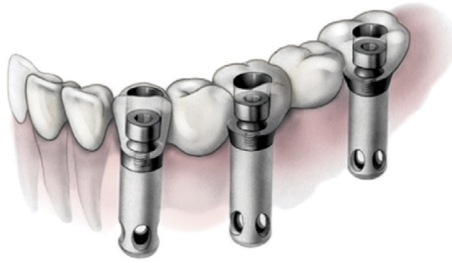
**134. Can conventional fixed bridgework be used over implants to restore a totally edentulous arch?**

Conventional fixed bridgework rather than the high-water prosthesis can be used with implants to restore a totally edentulous arch. However, fixture positioning, loading forces, and aesthetic and phonetic considerations are more critical. In addition, more fixtures are necessary to support the prosthesis (minimum of six).

**135. Should an implant prosthesis be considered in partially edentulous patients?**

The partially fixed implant-supported prosthesis is a viable treatment and should be considered as the treatment of choice when the only alternatives are a removable partial denture or fixed bridge attached to previously untouched teeth, or if the proposed abutments are periodontally compromised. Conventional bridgework may be the appropriate treatment of choice when the proposed abutment teeth are periodontally sound but need extensive restorative work (Fig. 9-13).





**Figure 9-13.** Fixed implant-supported prosthesis. (From Ebersole P, Touhy TA, Hess P, et al: *Toward health aging: human needs and nursing response*, ed 7, St. Louis, Mosby, 2008.)

**136. What factors should be considered when selecting implant treatment for partially edentulous patients?**

1. Implant placement is limited and defined by existing edentulous space; therefore, fixture placement may be near sensitive structures such as nerves and blood vessels.
2. Good aesthetic results may be difficult to achieve.
3. Greater horizontal loading forces place high demands on the anchorage of the fixture.
4. Topographic conditions of the existing bone and its relationship to the remaining teeth must be considered.
5. Occlusal considerations are essential—that is, when canines and premolar teeth are replaced in a cuspid-protected articulator with a deep overbite.
6. Periodontal disease on remaining teeth creates a pathologic condition that may contraindicate implantation.

**137. What factors influence abutment selection?**

The abutment selection is an important prosthodontic phase of treatment because it may determine the final prosthesis design. Factors for abutment selection should include the following:

1. Articulated casts with a diagnostic wax-up of the proposed prosthesis aid in determining the size and angulation of the abutment.
2. The type of abutment depends on whether the prosthesis is to be screwed to the implant or cement-retained.
3. Transmucosal space should be determined because it affects the height selection of the abutment.
4. Aesthetic and phonetic considerations also affect the selection of abutment.

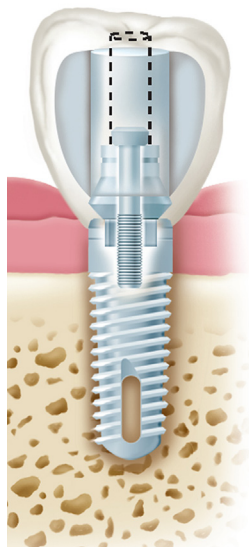
**138. What diagnostic procedure may be used for abutment selection?**

To determine the proper abutment angulation height, aesthetic factors, and occlusal considerations, it is necessary to know the position of the fixture to the bone in relation to the gingival mucosa and interarch space between the fixture and opposing dentition. Fixture angulation and transmucosal height can be measured intraorally with diagnostic gauges. However, the following is a more precise method:

1. Obtain an impression of the arch with the fixtures.
2. Construct a cast that contains replicas of the fixtures with its relationship to the mucosa.
3. Articulate this model to the opposing dentition. This method facilitates proper abutment selection and fabrication.

**139. What is an angulated abutment?**

An angulated abutment is positioned in an angulated direction from the axial position of the fixture. This angulation may vary by up to 30 degrees. Angulated abutments are used when the fixtures have been installed with an unfavorable inclination in relation to the desired position of the prosthesis.



**Figure 9-14.** UCLA-type abutment. (From Rosenstiel SF, Land MF, Fujimoto J: *Contemporary fixed prosthodontics*, ed 4, St. Louis, Mosby, 2006.)

**140. Is an angulated abutment clinically safe?**

In vitro studies have shown that as abutment increases, compressive and tensile strains around the implant also increase. A 3-year clinical evaluation, however, has shown that angulated abutments do not necessarily promote peri-implant mucosal problems. The success rate is comparable to that of the standard abutment.

**141. What is the UCLA-type abutment?**

The UCLA abutment is custom-fabricated on the fixture replica. Normally, the fabrication is done so that the final abutment appears like a full-crown preparation on which the prosthesis is cemented. It also may be screw-retained. This customized fabrication technique allows control of angulation, transmucosal shape and height, aesthetic considerations, and interocclusal space (Fig. 9-14).

**142. What is platform switching?**

It is fitting and abutment of a smaller circumference compared to the implant in an effort to preserve alveolar crestal bone. This method gained importance when researchers discovered reduced crestal bone loss around implants that had switched platforms. The likely mechanism is that a connective tissue layer develops in the horizontal direction as opposed to the vertical direction with platforms that are matched. Most studies support the use of switched platforms for reducing bone loss.

**143. Can an implant be used for single-tooth replacement?**

Yes. However, careful patient selection and presurgical analysis are critical so that function and aesthetics approximate those of the natural tooth.

**144. Can implants and natural teeth be used together to support a final prosthesis?**

Natural teeth are suspended in bone by the periodontal membrane. This situation allows tooth movement in relationship to bone. An osseointegrated implant, which is fixed rigidly to the bone, allows no movement at its interface. Joining a movable natural tooth and rigid implant with a fixed prosthesis may cause support problems that lead to failure. It is better

to separate the prosthesis, if possible (e.g., implant with implant, natural tooth with natural tooth). This strategy may not always be possible. If the prosthesis calls for joining natural teeth, provisions should be made in the prosthesis to allow for movement of the natural tooth abutment. This goal is often accomplished with a nonrigid interlocking attachment.

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# PEDIATRIC DENTISTRY AND ORTHODONTICS

Andrew L. Sonis and Isabelle I. Chase

## PEDIATRIC DENTISTRY

### 1. What is the difference between natal and neonatal teeth?

Natal teeth are present at birth, whereas neonatal teeth emerge through the gingiva during the first month of life.

### 2. How common are natal teeth?

There is a large range in the reported prevalence of natal teeth. One study used two methods of determining prevalence: method 1 prevalence was 1 in 3667 births and method 2 prevalence was 1 in 716 births. In previous studies, the prevalence ranged from 1 in 1000 to 30,000 births.

### 3. Summarize the characteristics of natal teeth.

- 95% are the actual primary teeth; 5% are supernumerary teeth.
- All natal teeth observed in one study were mandibular central incisors.
- A family history of natal teeth has been established in previous studies; the incidence of a positive family history ranges from 8% to 46%.
- When natal teeth erupt, the enamel is at the normal histologic age for the child. Because the teeth erupt prematurely, the enamel matrix is not fully calcified and wears off quickly. Once the gingival covering is lost, the enamel cannot continue to mature.

### 4. How are natal teeth managed?

In general, natal teeth are left alone unless they cause difficulty for the infant or mother. Clinical complications include ulceration of the tongue, lingual frenum, or mother's nipple during breast-feeding. Because natal teeth are usually mobile, some people worry about aspiration. Although no cases of aspiration have been reported, it is generally recommended that highly mobile natal teeth be extracted. On non-mobile natal teeth, treatment may also include grinding to smooth the incisal edge. In three reports, a breast-feeding splint was fabricated. In one study, half of the natal teeth were removed or lost before 4 months of age. If the teeth survive past 4 months of age, the prognosis for continued survival is good; most natal teeth, however, are not aesthetically pleasing because of enamel dysplasia.

### 5. Are any syndromes associated with natal teeth?

Three syndromes have been associated with natal teeth: (1) chondroectodermal dysplasia, or Ellis-van Creveld syndrome; (2) oculomandibulodyscephaly with hypotrichosis, or Hallermann-Streif syndrome; and (3) pachyonychia congenita, or Jadassohn-Lewandowski syndrome.

### 6. What is the definition of early childhood caries (ECC)?

The disease of early childhood caries (ECC) is the presence of one or more decayed (non-cavitated or cavitated lesions), missing (because of caries), or filled tooth surfaces in any primary tooth in a child 71 months of age or younger. In children younger than 3 years, any sign of smooth surface caries is indicative of severe early childhood caries (S-ECC). From ages 3 through 5 years, one or more cavitated, missing (because of caries), filled smooth surfaces in primary maxillary anterior teeth or a decayed, missing, or filled score of four or more (age 3), five or more (age 4), or six or more (age 5) surfaces constitutes S-ECC.

### 7. What should be included in an infant dental health program?

1. Prenatal oral health counseling for parents
  - Counsel parents about their own oral health habits and their effect as role models.
  - Discuss pregnancy-related gingivitis.

- Review **infant dental care:** (1) clean gums daily before eruption of the first primary tooth to help establish healthy oral flora; and (2) do not use dentifrice to avoid fluoride ingestion.
  - Review **oral care for toddlers** (1-3 years of age): (1) introduce soft toothbrush; (2) use a small “smear” of fluoride-containing toothpaste, twice daily, with the eruption of the first tooth, until 2 years of age, and a pea-sized amount of dentifrice beginning at age 2 years; (3) allow child to begin brushing with supervision (parents should remain primary oral caregiver); and (4) discuss timing of eruption of primary teeth and teething.
  - Review of **preschool oral care** (3-6 years of age): (1) parents should continue to supervise and help with oral hygiene; (2) continue with pea-sized amount of dentifrice; and (3) start flossing if teeth are in contact with each other.
2. Discussion of early childhood caries (baby bottle tooth decay) and how it can be prevented
    - Avoid putting child to sleep with a bottle.
    - Avoid on-demand nocturnal breast-feeding after the first primary tooth begins to erupt.
    - Always avoid giving sugar-sweetened beverages by bottle or sippy-cup.
    - Limit sweetened beverages to 4 ounces daily and ideally only with meals.
    - Encourage drinking from a cup around the first birthday.
  3. Discussion of timing of first dental visit (see question 9)

#### 8. What is meant by anticipatory guidance?

Anticipatory guidance is the deliberate and systematic distribution of information to parents as a tool to help them know what to expect, how to prevent unwanted conditions or events, and what to do when an anticipated or unexpected event occurs. Information should include dental and oral development, fluoride status, non-nutritional oral habits (see questions 10 to 12), injury prevention, oral hygiene, and the effects of diet on the dentition.

#### 9. When should children have their first visit to the dentist?

Currently, the American Academy of Pediatric Dentistry (AAPD) and American Dental Association (ADA) recommend an initial oral evaluation within 6 months of the eruption of the first primary tooth and no later than the child's first birthday. At this visit, the dentist should complete thorough medical and dental histories (covering prenatal, perinatal, and postnatal periods) as well as an oral examination. After completing these tasks, the dentist can best formulate a tailored prevention care plan based on the patient's risk of developing oral and dental disease. In addition, the dentist can use this appointment to provide anticipatory guidance (see question 8).

#### 10. What are non-nutritional sucking habits?

Non-nutritional sucking habits are learned patterns of muscular contraction. The most common types are as follows:

- Finger habit
- Lip wetting or sucking
- Abnormal swallowing or tongue thrusting
- Abnormal muscular habits

Sucking is the best-developed avenue of sensation for an infant. Deprivation may cause an infant to suck on the thumb or finger for additional gratification.

#### 11. Are non-nutritional sucking habits harmful to the dentoalveolar structures?

If a child stops non-nutritional sucking habits within his or her first 3 years of life, the damage usually is limited to the maxillary anterior segment and presents as an open bite. If the habit continues past 3 years, the damage may be long-lasting and detrimental to the developing dentoalveolar structures. After 4 years of age, a finger habit can become well established and is much harder to stop. Oral structures can become further deformed by palatal constriction and posterior crossbite.

Tongue and lip habits are often associated with a finger habit and produce added compensatory forces that can lead to full-blown malocclusion. Thumb and finger habits can cause an anterior open bite, proclination of the upper incisors, lingual movement of the lower incisors, and constriction of the maxillary arch. Lip sucking and lip biting can procline the maxillary incisors, retrocline the mandibular incisors, and increase the amount of overjet.

**Table 10-1.** Fluoride Supplementation

AGE	Fluoride Concentration in Local Water Supply (ppm)		
	<0.3	0.3–0.6	>0.6
6 mo–3 yr	0.25 mg/day	0	0
3–6 yr	0.50 mg/day	0.25 mg/day	0
6–16 yr	1.00 mg/day	0.50 mg/day	0

Tongue thrusting and mouth breathing may also play a part in the creation of a malocclusion. An anterior open bite is the most common dental problem associated with the anomalies.

## 12. Describe intervention therapy for non-nutritional sucking habits.

1. Ideally, the patient should understand the problem and want to correct it.
2. The timing of intervention is controversial. Some authors suggest that therapy should begin around age 4 years to prevent irreversible changes, whereas others suggest waiting until the patient is about 6 to 7 years old to ensure that he or she can understand the intent of therapy.
3. Patients who decide to accept appliance therapy should have support and encouragement from their parents to help them during treatment.
4. The dentist should know the patient well to provide intervention and advice at the correct time.
5. The dentist should be able to evaluate the deformity and extent of its effects so that it can be treated in the best possible manner.

## 13. What is the current schedule of systemic fluoride supplementation?

See Table 10-1.

## 14. Summarize the scientific basis for the use of fluoride varnishes in caries management.

1. When used appropriately, varnishes offer a 40% to 65% reduction in the incidence of caries, with a 36% reduction in fissured caries and a 66% reduction in nonfissured surfaces.
2. Varnish results in a 51% reversal of decalcified tooth structure and a reduction in enamel demineralization of 21% to 35%.
3. Varnish application is effective in arresting and reversing active enamel lesions, reducing the need for restorative treatment.
4. Varnishes are as effective as acidulated phosphate fluoride gels in controlling approximal caries.
5. In primary teeth of preschool children, varnishes result in a 44% reduction in caries.

## 15. Is prenatal fluoride supplementation effective in decreasing caries rates in the primary dentition?

No. No studies to date support the administration of prenatal fluorides to protect the primary dentition against caries.

## 16. Do home water filtration units have any effect on fluoride content?

Absolutely. For example, reverse osmosis home filtration systems remove 84%, distillation units remove 99%, and carbon filtration systems remove 81% of the fluoride from water.

## 17. Why has the prevalence of fluorosis increased in the United States?

The increased prevalence is likely because of three factors: (1) inappropriate fluoride supplementation; (2) ingestion of fluoridated toothpaste (most children <5 years ingest all the toothpaste placed on the toothbrush); and (3) high fluoride content of bottled juices. For example, white grape juice may have a fluoride concentration greater than 2 ppm.

## 18. What are the common signs of acute fluoride toxicity?

Acute fluoride toxicity may result in nausea, vomiting, hypersalivation, abdominal pain, and diarrhea.

**19. What is the first step in treating a child who has ingested an amount of fluoride greater than the safely tolerated dose?**

In acute toxicity, the goal is to minimize the amount of fluoride absorbed. Therefore, syrup of ipecac is administered to induce vomiting. Calcium-binding products, such as milk or milk of magnesia, decrease the acidity of the stomach, forming insoluble complexes with the fluoride and thereby decreasing its absorption.

**20. Are children born with *Streptococcus mutans*?**

Children are not born with *Streptococcus mutans*. Instead, they acquire this caries-causing organism between the ages of about 1 and 3 years. Mothers tend to be the major source of infection. The well-delineated age range of acquisition is referred to as the window of infectivity.

Transmission of *S. mutans* may be vertical (e.g., from caregiver to child) or horizontal (e.g., between siblings). Transmission may be decreased by reducing habits such as sharing utensils or foods. Additionally, several studies have demonstrated decreasing maternal levels of *S. mutans* decreases the transmission rate to the child.

**21. What variable is the best predictor of caries risk in children?**

Past caries rates are the single best predictor in assessing a child's future risk.

**22. Is milk a contributing factor to early childhood caries?**

Several animal and in vitro studies have suggested that milk and milk components are not cariogenic. Similarly, human breast milk by itself does not cause demineralization. However, when mixed with a sucrose-containing substance, cow's milk and human breast milk promote caries.

**23. What food components reduce the caries-inducing effects of carbohydrates?**

Phosphates, fats, and cheese decrease caries susceptibility. Phosphates apparently have a topical effect that aids in remineralization and improves the structural integrity of the enamel surface. Although the mechanism is not entirely clear, fats may form a protective barrier on the teeth or coat the carbohydrate. Cheese may contribute through a number of mechanisms, including its fat, phosphorus, and calcium content.

**24. Is there any dental health benefit to chewing gum?**

One study found that children of mothers who chewed sugar-free gum sweetened with xylitol (in addition to normal oral hygiene measures) had 70% less dental decay than children of mothers who did not chew the gum.

**25. Summarize the mechanisms of xylitol's effect.**

- Xylitol has a five-carbon chemical structure not recognized by oral bacteria.
- Because it is not fermented, no acid production results, and pH levels in the mouth do not decrease (see question 27).
- Chewing xylitol-sweetened gum promotes stimulation of salivary flow, which in turn helps rinse away excessive sucrose residues and neutralize acids from other foods. In addition, saliva contains calcium and phosphate, which promote remineralization of early caries.
- Xylitol is a polyol that inhibits the growth of *S. mutans*, thereby reducing caries susceptibility. Continued use helps reduce the number of virulent bacteria in the plaque, although xylitol is not bactericidal.
- Xylitol reduces plaque in the oral cavity and enhances the proportion of soluble to insoluble polysaccharides.
- Xylitol complements fluoride in the oral cavity.

**26. Who throws a meaner curve, Ryan or Stephan?**

Undoubtedly Stephan! The Stephan curve describes the decrease in pH that occurs following a cariogenic challenge. Hall of Fame pitcher Nolan Ryan, on the other hand, is best remembered for his fast ball, although did have a pretty good curve.

**27. What is meant by critical pH?**

Critical pH is the pH (~5.5) at which enamel is demineralized.

**28. What is the Vipeholm Study? What did it demonstrate?**

In the Vipeholm Study (1954), adult institutionalized patients were followed for several years on a variety of controlled diets. The following results were reported:

- Caries increased significantly when sucrose-containing foods were ingested between meals.
- Sucrose in a retentive form produced more caries than forms that were rapidly cleared from the mouth.
- Sucrose consumed with meals was the least detrimental form.
- Caries activity differs among people with the same diet.

### 29. Why does this CAT not have your tongue?

CAT stands for the **C**aries **R**isk **A**ssessment **T**ool developed by the AAPD to aid in assessing a child's risk of caries (Table 10-2). Recommendations based on their guidelines are as follows:

1. Dental caries risk assessment, based on a child's age, biologic and protective factors, and clinical findings, should be a routine component of new and periodic examinations by oral health and medical providers.
2. There is not enough information at present to carry out quantitative caries risk assessment analyses. However, estimating children at low, moderate, and high caries risk via a preponderance of risk and protective factors will enable a more evidence-based approach to medical provider referrals, as well as establish periodicity and intensity of diagnostic, preventive, and restorative services.
3. Clinical management protocols, based on a child's age, caries risk, and level of patient and parent cooperation, provide health providers with criteria and protocols for determining the types and frequency of diagnostic, preventive, and restorative care for patient-specific management of dental caries.

### 30. Why might children with asthma be at higher risk of developing dental caries?

The two major classes of medications used to treat asthma are anti-inflammatory agents (e.g., corticosteroids, cromolyn sodium) and bronchodilators (beta-adrenergic agonists, such as ventolin and albuterol). Over the years, numerous studies have shown that all these medications can impair salivary function, causing xerostomia (dry mouth) and thus potentially increasing susceptibility to caries. Evidence suggests that children with asthma may have double the risk of caries in their primary and permanent dentition. Therefore, it is important to implement appropriate preventive measures in asthmatic patients, such as routine fluoride application and giving extra attention to oral hygiene.

### 31. What is the earliest macroscopic evidence of dental caries on a smooth enamel surface?

A white spot lesion results from acid dissolution of the enamel surface, giving it a chalky white appearance. Optimal exposure to topical fluorides may result in the remineralization of such lesions.

### 32. Which teeth are often spared in nursing caries?

The mandibular incisors often remain caries-free as a result of protection by the tongue.

### 33. Does an explorer stick necessarily indicate the presence of caries?

Several studies have demonstrated that an explorer stick may often be caused by the anatomy of the pit and fissure and not the presence of caries (poor sensitivity). However, the lack of a stick is a good indication of lack of caries (good specificity). It has been suggested that sharp eyes are more important than sharp explorers in detecting pit and fissure caries.

### 34. What are the indications for an indirect pulp cap in the primary dentition?

An indirect pulp cap is indicated in a deep carious lesion approximating the pulp but without signs or symptoms of pulp degeneration. Long-term studies have indicated a higher success rate for indirect pulp caps compared to pulpotomies.

Calcium hydroxide is a commonly used medication that is applied to the dentin, followed by a restorative material that provides a complete seal.

### 35. What are the indications for a direct pulp cap?

A direct pulp cap maybe indicated when there is a small mechanical or traumatic exposure of the pulp. Materials commonly used include calcium hydroxide, glass ionomer and, more recently, mineral trioxide aggregate (MTA). According to one study, successful outcomes are inversely related to the amount of bleeding.



**Table 10-2.** Caries Risk Assessment Tool (CAT)

CARIES RISK INDICATORS	LOW RISK*	MODERATE RISK†	HIGH RISK‡
Clinical conditions	No carious teeth in past 24 mo No enamel demineralization No visible plaque; no gingivitis	Carious teeth in past 24 mo One area of enamel demineralization Gingivitis	Carious teeth in past 12 mo More than one enamel demineralization (enamel caries—white spot lesion) Visible plaque on anterior (front) teeth Radiographic enamel caries High titers of <i>Streptococcus mutans</i> Wearing dental or orthodontic appliances Enamel hypoplasia
Environmental characteristics	Optimal systemic and topical fluoride exposure Consumption of simple sugars or foods strongly associated with caries initiation, primarily at mealtimes High socioeconomic status of caregiver Regular use of dental care in an established dental home	Suboptimal systemic fluoride exposure with optimal topical exposure Occasional (one or two) between-meal exposures to simple sugars or foods strongly associated with caries Midlevel socioeconomic status of caregiver (i.e., eligible for school lunch program, CHIP) Irregular use of dental services	Suboptimal topical fluoride exposure Frequent (i.e., 3 or more) between-meal exposures to simple sugars or foods strongly associated with caries Low-level caregiver socioeconomic status (i.e., eligible for Medicaid) No usual source of dental care Active caries present in the mother
General health conditions			Children with special health care needs Conditions impairing saliva composition/flow

CHIP, Children's Health Insurance Program.

\*Low risk: The child does not have moderate-risk or high-risk indicators.

†Moderate risk: The presence of at least one moderate-risk indicator and no high-risk indicators present results in a moderate-risk classification.

‡High risk: The presence of a single risk indicator in any area of the high-risk category is sufficient to classify a child as being at high risk.

Adapted from American Academy of Pediatric Dentistry: American Academy of Pediatric Dentistry Caries Risk Assessment Tool (CAT). [http://www.chcs.org/usr\\_doc/AAP\\_CAT.pdf](http://www.chcs.org/usr_doc/AAP_CAT.pdf). Accessed May 7, 2014.

**36. What medication shows the greatest promise for primary tooth pulpotomies?**

Recent studies have suggested that MTA has great potential as a primary tooth pulpotomy medication. It results in less internal root resorption and improved clinical and radiographic outcomes compared with formocresol, ferric sulfate, or sodium hypochloride. (It also smells a lot better than formocresol.)

**37. What are the disadvantages of MTA as a primary tooth pulpotomy medication?**

They are mainly cost considerations. It is at least 20 times more expensive than formocresol.

**38. Which branchial arch gives rise to the maxilla and mandible?**

The first branchial or mandibular arch gives rise to the maxilla, mandible, Meckel's cartilage, incus, malleus, muscles of mastication, and anterior belly of the digastric muscle.

**39. How does the palate form?**

The paired palatal shelves arise from the intraoral maxillary processes. These shelves, originally in a vertical position, reorient to a horizontal position as the tongue assumes a more inferior position. The shelves then fuse anteriorly with the primary palate, which arises from the median nasal process, and posteriorly and with one another. Failure of fusion results in a cleft palate.

**40. When do the primary teeth develop?**

At approximately 28 days in utero, a continuous plate of epithelium arises in the maxilla and mandible. By 37 days in utero, a well-defined, thickened layer of epithelium overlying the cell-derived mesenchyme of the neural crest delineates the dental lamina. Ten areas in each jaw become identifiable at the location of each of the primary teeth.

**41. After the eruption of a tooth, when is root development completed?**

In the primary dentition, root development is complete approximately 18 months after eruption; in the permanent dentition, the period of development is approximately 3 years.

**42. Define ankylosis. How is it diagnosed?**

Ankylosis is the fusion of cementum with alveolar bone and may occur at any time during the course of eruption. Because affected teeth have retarded vertical growth, they appear to be submerged below the occlusal plane. Diagnosis involves visual determination that a tooth may be 1 mm or more below the height of the occlusal plane, radiographic evidence of lack of a periodontal ligament, and/or lack of physiologic mobility. The ankylosed tooth emits an atypical sharp sound on percussion. In addition, children with affected siblings are twice as likely to have submerged teeth compared with the general population. Ankylosis often occurs bilaterally; 67% of affected people have two or more submerged teeth.

**43. What causes ankylosis? Which teeth are usually affected?**

The definitive cause of ankylosis is unknown. Contributing factors cited in the literature include local mechanical trauma, disturbed local metabolism, localized infection, chemical or thermal irritation, and gaps in the periodontal membrane.

Mandibular first primary molars are usually affected, followed by second mandibular molars, first maxillary molars, and second maxillary molars. The prevalence of infraclusion peaks between 8 and 9 years of age, with a suspected range of 1.3% to 8.9%.

**44. How is ankylosis treated?**

The severity of submergence dictates the treatment protocol. Therefore, constant vigilance at recall appointments is crucial. The age at which ankylosis begins determines the rate of submergence. The younger the child at onset of ankylosis, the more quickly the tooth submerges because of the increased rate of growth of alveolar bone height. In minor cases, in which the occlusal surface is within 1 mm of the occlusal plane, the tooth needs only monitoring for exfoliation. In rare cases, the ankylosis is severe enough that the occlusal surface meets the interproximal gingival tissue. In such cases, the affected tooth must be extracted, with subsequent space maintenance. For moderate cases, stainless steel crowns or buildup restorations can be used to prevent space loss or supraeruption. With mismanagement or misdiagnosis, the sequelae of infraclusion include space loss, molar tipping, supraeruption of antagonist teeth, and periodontal defects with decreased height of bone.

- 45. How should dosages of local anesthetic be calculated for a pediatric patient?**  
Because children's weights vary dramatically for their chronologic age, dosages of local anesthetic should be calculated according to a child's weight. A dosage of 4 mg/kg of lidocaine should not be exceeded in pediatric patients.
- 46. Should the parent be allowed in the operatory with the pediatric patient?**  
The debate continues. However, some studies have indicated that many pediatric dentists allow the parent to be present in the operatory.
- 47. What is the treatment for a traumatically intruded primary incisor?**  
In general, the treatment of choice is to allow the primary tooth to re-erupt. Re-eruption usually occurs in 2 to 4 months. If the primary tooth is displaced into the follicle of the developing permanent incisor, the primary tooth should be extracted.
- 48. What are the potential sequelae of trauma to a primary tooth?**  
Potential sequelae include color changes, necrosis, infection and tooth loss. Color changes include yellow (pulp canal obliteration or metamorphosis), pink (internal resorption), or gray-black (hemosiderin or pulpal necrosis) color changes. Hemosiderin is not uncommon within the first 30 days after the trauma. After 30 days, a gray or gray-black color change in the crown typically indicates pulp necrosis. Necrosis may occur at any time after the injury (weeks, months, years). No treatment is indicated unless other pathologic changes occur (e.g., periapical radiolucency, fistulation, swelling, pain).  
Damage to the succedaneous permanent tooth, including hypoplastic defects, dilaceration of the root, or arrest of tooth development, has also been reported.
- 49. What are the indications for a lingual frenectomy?**  
Tongue-tie, or ankyloglossia, is relatively rare and usually requires no treatment. Occasionally, however, a short lingual frenum may result in lingual stripping of the periodontium from the lower incisors, which is an indication for frenectomy. A second indication is speech problems secondary to tongue position as diagnosed by a speech pathologist. Inability to latch on or breast-feed has been reported in some infants with a high lingual frenum. Breastfeeding in these patients has been reported to improve following frenectomy.
- 50. If a child reports a numb lip, can you be certain that the child has a profoundly anesthetized mandibular nerve?**  
Children, especially young ones, often do not understand what it means to be numb. The mandibular nerve is the only source of sensory innervation to the labia-attached gingiva between the lateral incisor and canine. If probing of this tissue with an explorer evokes no reaction from the patient, a profound mandibular block is present. No other sign can be used to diagnose profound anesthesia of the mandibular nerve.
- 51. Does slight contact with a healthy approximal surface during preparation of a class II cavity have any significant consequences?**  
Even slight nicking of the mesial or distal surface of a tooth greatly increases the possibility for future caries. Placement of an interproximal wedge before preparation significantly decreases the likelihood of tooth damage and future pathology.
- 52. Why bother with restoring posterior primary teeth?**  
Caries is an infectious disease. As at any location in the body, treatment consists of controlling and eliminating the infection. With teeth, caries infection can be eliminated by removing the caries and restoring or extracting the tooth. However, extraction of primary molars in children may result in loss of space needed for permanent teeth. To ensure arch integrity and reduce the risk of pain, infection, and loss of function, decayed primary teeth should be treated with well-placed restorations.
- 53. What is the most durable restoration for a primary molar with multisurface caries?**  
Stainless steel crowns have the greatest longevity and durability. Their 4.5-year survival rate is more than twice that of amalgam (90% vs. 40%).
- 54. How should a primary tooth be extracted if it is next to a newly placed class II amalgam?**  
Three steps can be taken to eliminate the possibility of fracturing the newly placed amalgam:

1. The primary tooth to be extracted can be disked to remove bulk from the proximal surface. Care still must be taken to avoid contacting the new restoration.
2. Placing a matrix band (T-band) around the newly restored tooth offers additional protection.
3. When luxating the primary tooth, ensure that the elevator is placed subgingivally so that the forces are against alveolar bone rather than the adjacent amalgam.

#### 55. Can composites be used to restore primary teeth?

If good technique is followed, composite material is not contraindicated. Interproximally, however, it may be difficult to get the type of isolation required for optimal bonding. There is no scientific advantage to using composite instead of amalgam for such restorations, and one has to evaluate whether aesthetic effects justify the additional time required for the composite technique in primary teeth.

#### 56. List the indications and contraindications for pulpectomy in a primary tooth.

##### Indications

- Teeth with chronic inflammation or necrosis of the radicular pulp
- Often attempted on the primary second molar before eruption of the first permanent molar

##### Contraindications

- Teeth with advanced resorption (internal or external), loss of root structure, or evidence of periapical infection involving the crypt of the succedaneous tooth
- Primary root canals that are difficult to prepare because of variable and complex morphology
- Proximity of succedaneous tooth bud (unwanted damage may result from instrumentation, medication, or filling materials)

#### 57. How successful is pulpectomy in a primary tooth?

In primary teeth with zinc oxide–eugenol (ZOE) pulpectomies, the success rate is 77.7%. Success rates as high as 100% have been reported with Vitapex (premixed calcium hydroxide and iodoform; Neo Dental International). The most important preoperative predictor of success is amount of tooth root absorption (>23% resorption reduces the success rate to only 23%). If correctly done, pulpectomy does not cause adverse effects on succedaneous tooth formation, but it does involve a 20% chance of altering the eruption path of the permanent tooth.

#### 58. What filling materials may be used for pulpectomy in a primary tooth?

The ideal properties of the filling material for pulpectomy in a primary tooth include a resorption rate similar to that of primary root, no damage or irritation of periapical tissues or the permanent tooth bud, antiseptic nature, and no discoloring of teeth. The two most commonly used materials are as follows:

- ZOE paste—different rate of resorption, potential underfilling, mild foreign body reaction with overfilling
- Calcium hydroxide and iodoform paste—rapid resorption, no deleterious effects on succedaneous tooth

#### 59. Which syndromes or conditions are associated with supernumerary teeth?

Apert syndrome	Gardner syndrome
Cleft lip and palate	Hallermann-Streiff syndrome
Cleidocranial dysplasia	Oral-facial-digital syndrome type 1
Crouzon syndrome	Sturge-Weber syndrome

#### 60. Which syndromes or conditions are associated with congenitally missing teeth?

Achondroplasia	Incontinentia pigmenti
Ectodermal dysplasia	Chondroectodermal dysplasia
Cleft lip and palate	Oral-facial-digital syndrome type 1
Hallermann-Streiff syndrome	Down syndrome
Crouzon syndrome	Rieger syndrome

#### 61. In the case of a congenitally missing second premolar, how long can the second primary molar be retained?

Most second primary molars lacking succedaneous teeth can be retained indefinitely, provided there is adequate root support in the plane of occlusion.

**62. What are the differences among fusion, gemination, and concrescence?**

**Fusion** is the union of two teeth, resulting in a double tooth, usually with two separate pulp chambers. Fusion is usually observed in the primary dentition.

**Gemination** is the attempt of a single tooth bud to give rise to two teeth. The condition usually presents as a bifid crown with a single pulp chamber in the primary dentition.

**Concrescence** is the cemental union of two teeth, usually the result of trauma.

**63. What is the incidence of inclusion cysts in the infant?**

It is approximately 75%.

**64. What are the three most common types of inclusion cysts and their cause?**

1. **Epstein's pearls** are caused by entrapped epithelium along the palatal rapine.
2. **Bohn's nodules** are ectopic mucous glands on the labial and lingual surfaces of the alveolus.
3. **Dental lamina cysts** are remnants of the dental lamina along the crest of the alveolus.

**65. What are the most common systemic causes of delayed exfoliation of the primary teeth and delayed eruption of the permanent dentition?**

Achondroplasia	Gardner syndrome
Apert syndrome	Hypopituitarism
Chondroectodermal dysplasia	Hypothyroidism
Cleidocranial dysplasia	Ichthyosis
De Lange syndrome	Osteogenesis imperfecta
Down syndrome	Vitamin D-resistant rickets

**66. What are the most common systemic causes of premature exfoliation of the primary dentition?**

Fibrous dysplasia	Hypophosphatasia
Cyclic neutropenia	Juvenile diabetes
Acatalsia	Odontodysplasia
Chediak-Higashi disease	Papillon-Lefèvre syndrome
Dentin dysplasia	Prepubertal periodontitis
Gaucher disease	Scurvy
Histiocytosis	Vitamin D-resistant rickets

**67. What are Murphy's laws of dentistry?**

1. The easier a tooth looks on radiograph for extraction, the more likely you are to fracture a root tip.
2. The shorter a denture patient, the more adjustments he or she will require.
3. The closer it is to 5 PM on Friday, the more likely someone will call with a dental emergency.
4. The cuter the child, the more difficult the dental patient.
5. Parents who type their child's medical histories are trouble.
6. The more you need specialists, the less likely they are to be in their office.
7. When a patient localizes pain to one of two teeth, you will open the wrong one.
8. The less a patient needs a procedure for dental health, the more the patient will want it (e.g., anterior veneer vs. posterior crown).

**68. Give the appropriate splinting times for the following traumatic dental injuries: luxation, avulsion, root fracture, and alveolar fracture.**

**Luxation:** 3 weeks

**Avulsion:** Splinting times depend on the extraoral dry time. If the tooth is reimplanted within 60 minutes of the trauma, it should be splinted for 2 weeks for teeth with open and closed apices. Splinting for 4 weeks is recommended when the tooth has had an extraoral dry time longer than 60 minutes. In either case, caution should be used because of the high risk of ankylosis associated with excessive splinting times.

**Root fracture and alveolar fracture:** 4 weeks for alveolar fractures and root fractures limited to the apical third and midroot. For cervical third root fractures, a longer splinting time (up to 4 months) may be beneficial.

In all cases, a flexible splint should be used to allow physiologic movement of the teeth. In addition, sound clinical judgment should be exercised to help decide whether longer splinting times are necessary. For example, an avulsed tooth with a closed apex that is still +3 mobile after 1 week may need to be splinted for 2 weeks.

**69. What can be done to prevent impaction of permanent maxillary canines?**

Within 1 year after the total eruption of the maxillary lateral incisors the maxillary canines should be palpable. Additionally, a panoramic radiograph or intraoral radiographs should be taken to determine the axial inclination of the developing permanent canine. If mesial angulation is noted with overlap of the maxillary lateral incisor root, extraction of the maxillary primary canine and maxillary first primary molars may often eliminate the impaction of the maxillary canine.

**70. What is the most important technique of behavioral guidance in pediatric dentistry?**

It is “tell-show-do.” Tell the child what is going to happen, show the child what is going to happen, and then perform the actual procedure intraorally. The major fear in pediatric dental patients is the unknown. The tell, show, and do technique eliminates fear and enhances the patient’s behavioral capabilities.

**71. What pharmacologic agents are indicated for behavioral control of the pediatric dental patient in an office setting?**

With the exception of general anesthesia, there are no absolutely predictable pharmacologic agents for controlling the behavior of pediatric dental patients. Unless the operator has received specific training in sedation techniques for children, patients with anxiety or behavioral problems are best referred to a specialist in pediatric dentistry.

**72. Do hypertrophic adenoids and tonsils affect dental occlusion?**

The incidence of posterior crossbite is increased in children with significant tonsillar and adenoid obstruction. Of children with a grade 3 obstruction, 80% have a posterior crossbite.

**73. What technique may be used if a pediatric patient cannot tolerate a conventional bitewing radiograph?**

To help reduce gagging and pushing the film out of the mouth with the tongue, try placing the film while the patient watches in a small hand mirror. This distracts the child and allows her or him to see that film is not going in the throat. A Snap-a-Ray film holder may also help the child better tolerate the film position because it reduces the vertical height and minimizes discomfort in the floor of the mouth. Digital sensors make it even more challenging due to their increased bulk.

If these techniques don’t work, a buccal bitewing is taken. The tab of the film is placed on the occlusal surfaces of the molar teeth, and the film itself is positioned between the buccal surfaces of the teeth and cheek. The cone is directed from 1 inch behind and below the mandible upward to the area of the second primary molar on the contralateral side. The setting is three times that which is normally used for a conventional bitewing exposure.

**74. What are the morphologic differences between primary and secondary teeth? How does each difference affect amalgam preparation?**

1. The occlusal anatomy of primary teeth is generally not as defined as that of secondary teeth, and supplemental grooves are less common. The amalgam preparation therefore can be more conservative.
2. The enamel in primary teeth is thinner than in secondary teeth (usually 1 mm thick); therefore, the amalgam preparation is shallower in primary teeth. A depth of 1.5 mm from the occlusal surface will place the preparation 0.5 mm into dentin, which allows for sufficient bulk of the amalgam. This depth is easy to approximate using a 330 bur because the head length of this bur is 1.6 mm.
3. Pulp horns in primary teeth extend higher into the crown of the tooth than pulp horns in secondary teeth; therefore, the amalgam preparation must be conservative to avoid a pulp exposure. The most common pulp exposure is the mesial buccal pulp horn of the mandibular first molar.

4. Primary molar teeth have an exaggerated cervical bulge that makes matrix adaptation more difficult.
5. The generally broad interproximal contacts in primary molar teeth require wider proximal amalgam preparation than those in secondary teeth.
6. Enamel rods in the gingival third of the primary teeth extend occlusally from the dentinoenamel junction, eliminating the need in class II preparations for the gingival bevel that is required in secondary teeth.

**75. What is the purpose of the pulpotomy procedure in primary teeth?**

The pulpotomy procedure preserves the radicular vital pulp tissue when the entire coronal pulp is amputated. The remaining radicular pulp tissue is treated with an agent such as formocresol.

**76. What is the advantage of the pulpotomy procedure on primary teeth?**

The pulpotomy procedure allows resorption and exfoliation of the primary tooth but preserves its role as a natural space maintainer.

**77. What are the indications for the pulpotomy procedure in primary teeth?**

1. Primary tooth that is restorable with carious or iatrogenic pulp exposure
2. Deep carious lesions without spontaneous pulpal pain
3. Absence of pathologic internal or external resorption but intact lamina aura
4. No radiographic evidence of furcal or periapical pathology
5. Clinical signs of a normal pulp during treatment (e.g., controlled hemorrhage after coronal amputation)

**78. What are the contraindications for pulpotomy in primary teeth?**

1. Interradicular (molar) or periapical (canine and incisor) radiolucency
2. Internal or external resorption
3. Advanced root resorption, indicating imminent exfoliation
4. Uncontrolled hemorrhage after coronal pulp extirpation
5. Necrotic dry pulp tissue or purulent exudate in pulp canals
6. Fistulous tracks or abscess formation
7. Medical condition (e.g., immunosuppression, severe cardiac disease)

**79. How does rubber dam isolation of the tooth improve management of pediatric patients?**

1. The rubber dam seems to calm the child because it acts as a physical and psychological barrier, separating the child from the procedure being performed.
2. Gagging from the water spray or suction is alleviated.
3. Access is improved because of tongue, lip, and cheek retraction.
4. The rubber dam reminds the child to open the mouth.
5. The rubber dam ensures a dry field that otherwise would be impossible in many children.
6. It helps prevent inadvertent swallowing and/or aspiration of materials.

**80. When do the primary and permanent teeth begin to develop?**

The primary dentition begins to develop during the sixth week in utero; formation of hard tissue begins during the 14th week in utero. Permanent teeth begin to develop during the 12th week in utero. Formation of hard tissue begins about the time of birth for the permanent first molars and during the first year of life for the permanent incisors.

**81. Summarize the chronology of development and eruption of the primary and permanent teeth.**

See Table 10-3.

**82. What is leeway space?**

Leeway space is the difference in the total of the mesiodistal widths between the primary canine, first molar, and second molar and the permanent canine, first premolar, and second premolar. In the mandible, leeway space averages 1.7 mm (unilaterally); it is usually about 0.9 to 1.1 mm (unilaterally) in the maxilla.

**Table 10-3.** Chronology of Development and Eruption of Teeth

TOOTH	TOOTH GERM COMPLETED	CALCIFICATION COMMENCES	CROWN COMPLETED	ERUPTION IN MOUTH	ROOT COMPLETED
<b>Primary</b>					
Incisor	3-4 mo i.u.	2-4 mo	6-8 mo	6 mo-2 yr	
Canines	5 mo i.u.	9 mo	16-20 mo	2½-3 yr	
First molars	12-16 wk i.u.	5 mo i.u.	6 mo	12-15 mo	2-2½ yr
Second molars	6-7 mo i.u.	11-12 mo	20-30 mo	3 yr	
<b>Permanent</b>					
Central incisors	30 wk i.u.	3-4 mo	4-5 yr	Max, 7-9 yr	9-10 yr
				Mand, 6-8 yr	
Lateral incisors	32 wk i.u.	Max, 10-12 mo	4-5 yr	7-9 yr	10-11 yr
		Mand, 3-4 mo			
Canines	30 wk i.u.	4-5 mo	6-7 yr	Max, 11-12 yr	12-15 yr
				Mand, 9-10 yr	
First premolars	30 wk i.u.	1½-2 yr	5-6 yr	10-12 yr	12-14 yr
Second premolars	31 wk i.u.	2-2½ yr	6-7 yr	10-12 yr	12-14 yr
First molars	24 wk i.u.	Birth	3-5 yr	6-7 yr	9-10 yr
Second molars	6 mo	2½-3 yr	7-8 yr	12-13 yr	14-16 yr
Third molars	6 yr	7-10 yr	12-16 yr	17-21 yr	18-25 yr

Mand, Mandibular; Max, maxillary.

\*All dates postnatal, except where designated intrauterine (i.u.).

Adapted from Bishara SE: *Textbook of orthodontics*, Philadelphia, WB Saunders, 2001.

### 83. What changes occur in the size of the dental arch during growth?

From birth until about 2 years of age, the incisor region widens, and growth occurs in the posterior region of both arches. During the period of the full primary dentition, arch length and width remain constant. Arch length does not increase once the second primary molars have erupted; any growth in length occurs distal to the second primary molars and not in the alveolar portion of the maxilla or mandible. There is a slight decrease in arch length with the eruption of the first permanent molars and a slight increase in intercanine width (and some forward extension of the anterior segment of the maxilla) with the eruption of the incisors. A further decrease in arch length may occur with molar adjustments and the loss of leeway space when the second primary molar exfoliates.

### 84. What is the pink tooth of Mummy?

It is the pink appearance of a tooth caused by internal resorption.

### 85. What intervention is indicated when permanent maxillary canines are observed radiographically to be erupting palatally?

It is extraction of the primary maxillary canine. About 75% of ectopic canines show normalization of eruption at 12 months.



**86. Does teething cause systemic manifestations?**

Although teething may be associated with drooling, gum rubbing, or changes in dietary intake, no evidence indicates that it causes systemic illness (e.g., diarrhea, fever, rashes, seizures, bronchitis). Fever associated with teething may be a manifestation of undiagnosed primary herpes gingivostomatitis.

**87. Should dental implants be placed in the growing child?**

Generally, placing implants should be deferred until growth is completed. In a growing child, the implant may become submerged or embedded. In addition, an implant that crosses the midline may limit transverse growth.

**88. Should an avulsed primary tooth be reimplanted?**

No. The prognosis of reimplanted primary teeth is poor and may adversely affect the developing succedaneous tooth.

**89. How should an avulsed primary tooth be managed?**

Rinse the tooth with water, and place it under the child's pillow.

**90. What variable is most important in the prognosis of an avulsed permanent tooth?**

Time out of the mouth is most critical. With an extra-alveolar time less than 1 hour, partial periodontal ligament (PDL) healing is possible; an extra-alveolar time longer than 1 hour results in total PDL death and progressive root resorption.

**91. What other factors affect prognosis?**

They are an extra-alveolar storage medium and stage of root development.

**92. If an avulsed tooth cannot be reimplanted immediately, which transport medium is best?**

In order of preference, they are Hank's balanced salt medium, milk, saliva, and water.

**93. How do closed versus open apices affect prognosis?****Closed apices**

- Revascularization is not likely.
- Pulp extirpation occurs in 7 to 10 days.
- Pulpal necrosis (radiolucency) is usually noted as early as 3 to 4 weeks (usually, apical third within 1 year).

**Open apices**

- Revascularization is possible.
- Pulp necrosis is evident after 2 to 4 weeks and presents with periapical pathology, sometimes with signs of internal root resorption (IRR).

**94. What are the most common complications after reimplantation of an avulsed tooth?**

- Pulpal necrosis
- Inflammatory resorption, replacement resorption (ankylosis)
- Internal calcification with pulpal obliteration (common in non-endodontically treated reimplants)

**95. Describe the occurrence of ankylosis after reimplantation of an avulsed tooth.**

- Irreversible and progressive
- More rapid progression with younger age
- Mobility and dull percussion noted as early as 5 weeks (on radiographs at 8 weeks)
- Small areas of ankylosis are reversible with functional mobility
- The tooth loss is rapid and typically occurs within 1-5 years.

**96. What is the most reliable diagnostic test for ankylosis?**

It is percussion.

**97. Why must care be taken not to nick the adjacent interproximal surface when preparing a class II restoration?**

Damaged noncarious primary tooth surfaces are 3.5 times more likely to develop a carious lesion and to require future restoration than undamaged surfaces. Damaged noncarious

permanent tooth surfaces are 2.5 times more likely to develop a carious lesion and to require future restoration than undamaged surfaces.

**98. Do all discolored primary incisors require treatment?**

The gray discoloration of primary teeth is usually the result of a traumatic episode. This discoloration is caused by hemorrhage into the dentinal tubules or a necrotic pulp. In the case of hemorrhage into the dentinal tubules, the discoloration usually appears within 1 month of the injury. Often, the teeth return to their original color as the blood breakdown products are removed from the site. Discoloration caused by a necrotic pulp may take days, weeks, months, or even years to develop. It does not improve with time and may actually worsen. A tooth that is light gray may progress to dark gray. A yellow opaque discoloration is usually indicative of calcific degeneration of the pulp. Discolored teeth do not require treatment unless there is radiographic and/or clinical evidence of pathology of the periodontium (soft and/or hard tissues).

**99. Which two dentists have appeared on the cover of *Time* magazine?**

They are Dr. Harold Kane Addelson, the originator of the tell-show-do technique, and Dr. Barney Clark, the first human recipient of a mechanical heart.

## ORTHODONTIC TREATMENT

**100. What is the relationship between overjet and dental trauma?**

Because of the high prevalence of dental trauma involving maxillary incisors, it is important to determine whether any interceptive treatment can lower a patient's risk for trauma. Children with class II malocclusions and increased overjet face a greater risk of maxillary incisor trauma. A tendency to a skeletal open bite with a negative overbite and excessive overjet predispose patients to dental trauma. Children with overjets more than 3 mm are twice as likely to injure the anterior teeth as children with overjets less than 3 mm, and a 6-mm overjet results in four times the risk of trauma. The risk of trauma increases with increasing overjet measurements.

Although definitive guidelines are not available, high-risk children with a large overjet, excessive maxillary incisor proclination, and high facial angle may benefit from an evaluation for early orthodontic intervention. It is the dentist's role to provide anticipatory guidance about injury prevention and the use of a mouth guard.

**NOTE:** The American Association of Orthodontists recommends that all children be seen by an orthodontist by age 7 years.

**101. What are the advantages of fixed versus removable orthodontic appliances?**

Fixed orthodontic appliances offer controlled tooth movement in all planes of space. Removable appliances are generally restricted to tipping teeth.

**102. What is the straight wire appliance?**

The straight wire appliance is a version of the edgewise appliance with several features that allow placement of an ideal rectangular arch wire without bends (a so-called straight wire). These features include the following: (1) variations in bracket thickness to compensate for differences in the labiolingual position and thickness of individual teeth; (2) variations in angulation of the bracket slot relative to the long axis of the tooth to allow mesiodistal differences in the root angulation of individual teeth; and (3) variations in torque of the bracket slot to compensate for buccal-lingual differences in the root angulation of individual teeth.

**103. What are so-called functional appliances? Do they work?**

Functional appliances are a group of fixed and removable appliances that are generally used to promote mandibular growth in patients with class II malocclusion. Although these appliances have been shown to be effective in correcting a class II malocclusion, most studies indicate that their effects are mainly dentoalveolar, with little if any effect on the growth of the mandible.

**104. When should orthodontic therapy be initiated?**

There is no one optimal time to initiate treatment for every orthodontic problem. For example, a patient in primary dentition with a bilateral posterior crossbite may benefit from

palatal expansion at age 4 years. Conversely, the same-aged patient with a severe class III malocclusion caused by mandibular prognathism may best be treated by waiting until all craniofacial growth is completed.

**105. What is the difference between a skeletal and dental malocclusion?**

Skeletal malocclusion refers to a disharmony between the jaws in a transverse, sagittal, or vertical dimension or any combination thereof. Examples of skeletal malocclusions include retrognathism, prognathism, open bites, and bilateral posterior crossbites. Dental malocclusion refers to malpositioned teeth, generally the result of a discrepancy between tooth size and arch length. This discrepancy often results in crowding, rotations, or spacing of the teeth. Most malocclusions are neither purely skeletal nor purely dental but rather a combination of the two.

**106. If a primary first molar is lost, is a space maintainer necessary?**

Before eruption of the 6-year molar and its establishment of intercuspation, mesial migration of the second primary molar will occur, and a space maintainer is indicated to prevent space loss.

**107. When should a crossbite be corrected?**

Whenever a crossbite is noted and the patient is amenable to intraoral therapy, correction is indicated. Although a crossbite can be corrected at a later date, optimal time for correction is as soon as possible after diagnosis.

**108. When is the proper time to consider diastema treatment?**

A thick maxillary frenum with a high attachment (sometimes extending to the palate) is common in the primary dentition and does not require treatment. However, a large midline diastema in the primary dentition may indicate the presence of an unerupted midline supernumerary tooth (mesiodens) and often warrants an appropriate radiograph.

The permanent maxillary central incisors erupt labial to the primary incisors and often exhibit a slight distal inclination that results in a midline diastema. This midline space is normal and decreases with the eruption of the lateral incisors. Complete closure of the midline diastema, however, does not occur until the permanent canines erupt. Treatment of residual midline space is addressed orthodontically at this time.

**109. What is ectopic eruption? How is it treated?**

Ectopic eruption occurs when the erupting first permanent molar begins to resorb the distal root of the second primary molar. Its occurrence is much more common in the maxilla, and it is often associated with a developing skeletal class II pattern. It is seen in about 2% to 6% of the general population and 25% in patients with cleft lip and palate; it spontaneously corrects itself in about 60% of cases. If the path of eruption of the first permanent molar does not self-correct, a brass wire or orthodontic separating elastic can be placed between the first permanent molar and second primary molar, if possible. In severe cases, one may use a Halterman appliance to upright the ectopic tooth or the second primary molar may exfoliate early because of severe resorption or require extraction, necessitating the need for space maintenance or space regaining.

**110. What is the effect of early extraction of a primary tooth on the eruption of the succedaneous tooth?**

If a primary tooth must be extracted prematurely, and 50% of the root of the permanent successor has developed, eruption of the permanent tooth is usually delayed. If more than 50% of the root of the permanent tooth has formed at the time of extraction of the primary tooth, eruption is accelerated.

**111. Where are the primate spaces located?**

In the maxilla, primate spaces are located distal to the primary lateral incisors. In the mandible, primate spacing is found distal to the primary canines.

**112. What is the normal molar relationship in the primary dentition?**

Historically, both the flush terminal plane and mesial step have been considered normal. More recent studies have demonstrated that this may not be the case, because about 45% of children with a flush terminal plane go on to develop a class II molar relationship in the permanent dentition.

**113. What is meant by the term *pseudo-class III*?**

This term refers to the condition in which the maxillary incisors are in crossbite with the mandibular incisors. Although the patient appears to have a prognathic mandible, it is caused not by a skeletal disharmony but rather by the anterior positioning of the jaw as a result of occlusal interference. The ability of the patient to retrude the mandible to the edge to edge incisal relationship is often considered diagnostic.

**114. What is the space maintainer of choice for a 7-year-old child who has lost a lower primary second molar to caries?**

The lower lingual arch (LLA) is the maintainer of choice. The 6-year-old molars are banded. The connecting wire lies lingual to the permanent lower incisors in the gingival third and prevents mesial migration of the banded molars. Unlike the band and loop space maintainer, the LLA is independent of eruption sequence. (The band and loop serve no purpose after the primary first molar exfoliates.) However, the LLA should not be used if the permanent mandibular incisors are absent because the lingual arch may prevent the eruption of these teeth.

**115. What is the space maintainer of choice for a 5-year-old child who has lost an upper primary second molar to caries prior to the eruption of the first permanent molar?**

The distal shoe is the appliance of choice. This appliance extends backward from a crown on the primary first molar and subgingivally to the mesial line of the unerupted first permanent molar, thus preventing mesial migration.

**116. A 4-year-old child with generalized spacing loses three primary upper incisors to trauma. What space maintainer is needed?**

No space maintainer is necessary.

**117. What is the best space maintainer for any pulpally involved primary tooth?**

Restoring the tooth with pulpal therapy is the best way to preserve arch length and integrity.

**118. If a primary tooth is lost to caries but has no successor, is it necessary to maintain space?**

Sometimes it is necessary to maintain the space, but not always. The decision is based on the patient's skeletal and dental development. Either way, orthodontic evaluation is of the utmost importance to formulate the future plan for this space.

**119. When do you remove a space maintainer once it is inserted?**

The space maintainer can be removed as soon as the succedaneous tooth begins to erupt through the gingiva. Space maintainers left in place too long make it more difficult for patients to clean their teeth. Furthermore, it may be necessary to replace a distal shoe with another form of space maintainer once the 6-year molar has erupted to prevent rotation of the molar around the bar arm.

**120. What are the various types of headgear and their indications?**

There are four basic types of headgear. Each type of headgear has two major components, intraoral and extraoral. The extraoral component is what generally categorizes the type of headgear.

- 1. Cervical-pull headgear.** The intraoral component of cervical-pull headgear is composed of a heavy bow that engages the maxillary molars through some variation on a male-female connector. The anterior part of the bow is welded to an extraoral portion connected to an elasticized neck strap, which provides the force system for the appliance. The force application is in a down and backward direction. This headgear is generally used in a class II, division 1 malocclusion, in which distalization of the maxillary molars and/or restriction of maxillary growth, as well as anterior bite opening, is desired.
- 2. Straight-pull headgear.** The intraoral component is similar to the cervical-pull headgear. However, the force application is in a straight backward direction from the maxillary molar, parallel to the occlusal plane. Like cervical-pull headgear, this appliance is also used for a class II, division 1 malocclusion. Because of the direction of force application, this appliance may be chosen when excessive bite opening is undesirable.

3. **High-pull headgear.** The intraoral components of high-pull headgear are similar to those described. However, the force application is in a back and upward direction. Consequently, it is usually chosen for a class II, division 1 malocclusion in which a bite opening is contraindicated (class II malocclusion with an open bite).
4. **Reverse-pull headgear.** Unlike the other headgears, the extraoral component of reverse-pull headgear is supported by the chin, cheeks, forehead, or a combination of these structures. The intraoral component usually attaches to a fixed appliance in the maxillary appliance via elastics. Reverse-pull headgear is generally used for a class III malocclusion, in which protraction of the maxilla is desirable.

#### 121. What is the basic sequence of orthodontic treatment?

1. **Level and align.** This phase establishes preliminary bracket alignment, generally with a light round wire, braided arch wire, or nickel-titanium arch wire.
2. **Working arch wires.** This phase corrects vertical discrepancies (e.g., bite opening) and sagittal position of the teeth. A heavy round or rectangular arch wire is generally used.
3. **Finishing arch wires.** This phase idealizes the position of the teeth. Generally, light, round arch wires are used.
4. **Retention.** Retention of teeth in their final position may be accomplished with a fixed or removable retainer.

#### 122. What are the dental health benefits of orthodontic treatment?

Ironically, few studies have shown any dental health benefit to orthodontic treatment. Positive effects on caries susceptibility, periodontal disease, and temporomandibular disorders (TMDs) are largely unsupported by the literature. The exception would be susceptibility to trauma, for which studies have suggested a direct relationship between overjet and trauma to the maxillary incisors.

#### 123. What is a tooth positioner?

A tooth positioner is a removable appliance composed of rubber, silicone, or polyvinyl material. Its appearance is not unlike that of a heavy mouth guard, except that it engages both the maxillary and mandibular dentition. It is generally used to idealize final tooth position at or near the completion of orthodontic therapy. The appliance is usually custom-fabricated by taking models of the teeth and repositioning them to their ideal position. The positioner is then fabricated to this ideal setup. The elasticity of the appliance provides for minor positional changes of the patient's teeth. After completion of treatment, the positioner may be used as a retainer.

#### 124. How stable is the orthodontic correction of crowding?

Approximately two thirds of all patients treated for crowding experience significant relapse without some form of permanent retention. This relapse rate is about the same whether the patient is treated with a nonextraction or extraction approach; whether third molars are present, congenitally missing, or extracted; and whether treatment is started in the mixed dentition or permanent dentition. Unfortunately, no variables that correlate with relapse potential have been identified. Also, relapse potential continues throughout life.

#### 125. What is the best way to prevent relapse?

It is lifelong retention. The type of retainer appears less important than the length of retention.

#### 126. Does eruption of third molars cause crowding of the incisors?

No. The eruption of third molars with a real or perceived increase in crowding of the incisors is coincidental. Studies have revealed that patients who are congenitally missing third molars experience the same crowding phenomenon.

#### 127. What is the ideal molar relationship in the primary dentition?

It is the mesial step. Although many pediatric dentistry and orthodontic texts suggest that the mesial step relationship and the flush terminal plane are considered normal, a longitudinal study has revealed that almost 50% of flush terminal plane relationships in the primary dentition later develop into class II malocclusions.

**128. Define early mesial shift and late mesial shift.**

These terms date back to the work of Baume in the late 1950s. The *early mesial shift* refers to the closure of the generalized spacing frequently observed in the primary dentition that closes with the eruption of the permanent first molars, causing a shift of the primary molars mesially. The *late mesial shift* occurs with the exfoliation of the second primary molars and the mesial drift of the first permanent molars into the leeway space.

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# ORAL AND MAXILLOFACIAL SURGERY

Bonnie L. Padwa and Stephen T. Sonis

## GENERAL TOPICS

### 1. Why should a patient be hospitalized for a routine oral surgical procedure?

There are a few reasons for hospitalizing a patient for a routine oral surgical procedure. Patients with developmental delays and behavioral management issues may not be able to tolerate care in an office setting. Patients who are at high medical risk are often best treated in the controlled environment of the operating room, in which constant monitoring and quick treatment of a problem are more easily managed. Another indication for treating a patient in the operating room is a patient's inability to tolerate or obtain local anesthesia.

### 2. List the American Heart Association's recommendation for antibiotic prophylaxis before dental procedures.

**Single dose, 30 to 60 minutes prior to dental procedure:**

- Amoxicillin, 2 g for adult patients (50 mg/kg for children), or
- Clindamycin, 600 mg (20 mg/kg for children), or
- Cephalexin, 2 g (50 mg/kg for children), or
- Azithromycin or clarithromycin, 500 mg (15 mg/kg for children)
- Cefazolin or ceftriaxone, 1 g IM or IV (50 mg/kg for children)

Prophylaxis prior to dental procedures is recommended for patients with cardiac conditions associated with the highest risk of adverse events related to endocarditis.

**Cardiac conditions with accompanying high risk of adverse outcome from endocarditis:**

- Cardiac transplant recipients who develop cardiac valvulopathy
- Congenital heart disease (CHD)\*
  - Unrepaired cyanotic CHD, including palliative shunts and conduits
  - Completely repaired congenital heart defect with prosthetic material or device, whether placed by surgery or by catheter intervention, during the first 6 months after the procedure<sup>†</sup>
  - Repaired CHD with residual defects at the site or adjacent to the site of a prosthetic patch or prosthetic device (which inhibit endothelialization)
- Prosthetic cardiac valve or prosthetic material used for cardiac valve repair
- Previous infective endocarditis

### 3. What are the basic technical considerations in performing an incision?

- Use a sharp blade of appropriate size.
- A firm, continuous stroke is preferable to short, soft, repeated strokes.
- Avoid vital structures.
- Use incisions that are parallel to relaxed skin tension lines.
- Consider the anatomy of the site in placement of the incision.

### 4. What factors influence the placement of incisions in the mouth?

- Anatomy and location of vital structures
- Convenience and access

### 5. For making an incision in an epithelial surface, how should the scalpel blade be oriented?

To avoid bias, the incision should be made parallel to the epithelial surface.

\*Except for the conditions listed above, antibiotic prophylaxis is no longer recommended for any other form of CHD.

<sup>†</sup>Prophylaxis is reasonable because endothelialization of prosthetic material occurs within 6 months after the procedure.



**6. What are the principles of flap design?**

- Flap design should ensure adequate blood supply; the base of the flap should be larger than the apex.
- Reflection of the flap should adequately expose the operative field.
- Flap design should permit atraumatic closure of the wound.

**7. What are the most frequent causes of the tearing of mucogingival flaps?**

1. Flaps are too small to provide adequate exposure.
2. Too much force is used to elevate the flaps.
3. The flap is not being elevated in the subperiosteal plane

**8. What are the means of obtaining hemostasis?**

- |                     |                                    |
|---------------------|------------------------------------|
| Pressure            | Ligation with sutures              |
| Thermal coagulation | Use of vasoconstrictive substances |

**9. What is an arthrocentesis?**

It is irrigation of the superior joint space of the temporomandibular joint. Sterile saline irrigation is used to flush out the inflammatory mediators associated with degenerative arthritis and pain. After irrigation, the joint can be injected with corticosteroid or low-molecular-weight hyaluronic acid (HA) to help decrease symptoms of inflammatory degenerative temporomandibular joint (TMJ) disease.

**10. What is a genioplasty?**

Genioplasty is a procedure that alters the chin position. The most common techniques are osteotomy or augmentation with natural or synthetic materials.

**11. Define distraction osteogenesis.**

It is the slow application of a force using a distraction device to widen a surgically created bone gap in the mandible or maxilla. The distraction gap fills with a collagen matrix whose fibers are oriented parallel to the force of distraction. Calcification of the collagen fibers occurs from the periphery and results in bony healing across the distraction gap.

**12. What is the role of the general dentist in managing oral cancer?**

The general dentist has three major roles in managing oral cancer:

1. The most important is detection. As the primary provider of oral health care, the dentist is in the position to detect the presence of an early lesion. A high degree of suspicion should lead to aggressive evaluation of any abnormality of the oral soft tissues. Biopsy of most areas of the mouth is within the realm of the generalist.
2. Once a diagnosis of oral cancer has been established, the dentist has the responsibility of ensuring that there are no areas of latent oral infection that may predispose to the development of osteonecrosis or other complications of therapy.
3. Because xerostomia and subsequent caries are common in patients receiving radiation therapy to the head and neck, the generalist should educate the patient about factors and behavior that increase the risk and should provide the patient with trays for the self-application of fluoride gels. An aggressive recall schedule should be established.

**13. List the symptoms of obstructive sleep apnea.**

- |                                      |                                 |
|--------------------------------------|---------------------------------|
| • Snoring                            | • Hypertension                  |
| • Excessive daytime sleepiness       | • Heart failure (cor pulmonale) |
| • Impaired cognition and memory loss | • Cardiac arrhythmias           |

**14. Explain the concept of guided tissue regeneration in preprosthetic surgery.**

Guided tissue regeneration is based on the fact that different cell types grow at various rates. The membrane physically prevents fast-growing fibroblasts and epithelium from entering the osseous defect before the slower growing osteoblasts can repopulate the defect.

**15. What are the advantages of using allogeneic or alloplastic materials under a barrier membrane?**

- They stabilize the blood clot under the membrane.
- They provide a matrix for bone growth.
- They may increase the rate of bone growth.

**16. What are the optimal dimensions (ratio) for an elliptical incisional biopsy?**

To ensure adequate margins for an incisional biopsy of an elliptic lesion, the length of the ellipse should be three times the width.

**17. What are the major oral side effects of radiation to the head and neck?**

Xerostomia	Caries
Mucositis	Osteoradionecrosis

**SUTURES: TECHNIQUES AND TYPES****18. What is the most common suture method? What are its advantages?**

The interrupted suture is the most common method. Because each suture is independent, this technique offers strength and flexibility in placement. Even if one suture is lost or loosens, the integrity of the wound and remaining sutures is not compromised. The major disadvantage is the time required for placement.

**19. What are the advantages of a continuous suture?**

- Ease and speed of placement
- Distribution of tension over the whole suture line
- A more watertight closure than interrupted sutures

**20. What factors determine the type of suture to be used?**

Tissue type	Wound condition
Healing process	Expected postoperative course

**21. How are sutures sized?**

Size refers to the diameter of the suture material. The smallest size that provides the desired wound tension should be used. The higher the number, the smaller the suture. For example, 3-0 sutures are thicker than 4-0 sutures. The larger the diameter, the stronger the suture. In general, sutures for intraoral wound closure are 3-0 or 4-0.

**22. What are the types of resorbable sutures? Nonresorbable sutures?**

<i>Resorbable</i>	<i>Nonresorbable</i>
Plain gut	Silk
Chromic gut	Synthetic
Monocryl	Nylon
Vicryl	Mersilene
Dexon	Prolene

**23. What is the difference between monofilament and polyfilament sutures?**

Monofilament sutures consist of material made from a single strand. They resist infection by not harboring organisms. Plain and chromic gut are examples. Polyfilament sutures are made of multiple fibers that are braided or twisted. They generally have good handling properties. The most common examples used in oral surgery are silk, Vicryl, and Dexon.

**24. What are the principles of suturing technique?**

- The suture should be grasped with the needle holder three fourths of the distance from the tip.
- The needle should be perpendicular when it enters the tissue.
- The needle should be passed through the tissue to coincide with the shape of the needle.
- Sutures should be placed at an equal distance from the wound margin (2-3 mm) and at equal depths.
- Sutures should be placed from mobile tissue to fixed tissue.
- Sutures should be placed from thin tissue to thick tissue.
- Sutures should not be overtightened.
- Tissues should not be closed under tension.
- Sutures should be 2 to 3 mm apart.
- The suture knot should be on the side of the wound.

**25. When should intraoral sutures be removed?**

Generally, in uncomplicated cases, sutures may be removed 5 to 7 days after placement.

## TOOTH EXTRACTION

### 26. What are the three principles of exodontia?

1. Obtain adequate access.
2. Create an unimpeded path of removal.
3. Use controlled force.

### 27. What forceps are typically used for the removal of maxillary teeth?

Single-rooted teeth are usually removed with a maxillary universal forceps (no. 150) or a no. 1 forceps. Premolars can be extracted with the maxillary universal forceps. To extract maxillary molars, no. 150 forceps usually can be used. Alternatively, the upper molar cowhorn can be used for fractured or carious teeth if care is applied.

### 28. Which forceps are typically used for the removal of mandibular teeth?

Ashe forceps are generally the most effective for the removal of mandibular incisors, canines, and premolars. A lower universal forceps (no. 151) is an alternative. The no. 151 also can be used for most molars, although a mandibular cowhorn forceps (no. 23) and no. 17 forceps are alternatives.

### 29. Name the indications for tooth extraction.

- Severe caries resulting in a nonrestorable tooth
- Pulpal necrosis that is not treatable with endodontic therapy
- Advanced periodontal disease resulting in severe irreversible mobility
- Malpositioned nonfunctional teeth
- Cracked or fractured teeth that are not amenable to conservative therapy
- Prosthetic considerations
- Impacted teeth when indicated (not all impacted teeth require extraction)
- Supernumerary teeth (when indicated)
- Teeth associated with a pathologic lesion, such as a tumor, that cannot be eliminated completely without sacrificing the tooth
- Before severe myelosuppressive cancer therapy or radiation therapy, any tooth with a questionable prognosis or that may be a potential source of infection
- Teeth involved in jaw fractures

### 30. What are the major contraindications for tooth extraction?

Contraindications may be systemic or local. Systemic contraindications are related to the patient's overall health and may include the presence of a coagulopathy, uncontrolled diabetes mellitus, hematologic malignancy such as leukemia, uncontrolled cardiac disease, and certain types of drug therapy (e.g., bisphosphonates). Elective extractions in pregnant patients are contraindicated. Local factors include radiation therapy to the area, active infection, and nonlocalized infection. The presence of a localized dentoalveolar abscess is not a contraindication for extraction.

### 31. Give reasons for extracting third molars in a teenage patient rather than waiting until the patient is in his or her 40s.

Younger patients have a follicle surrounding the crown, whereas this space is occupied by dense bone in older patients. Similarly, the periodontal ligament space is more prominent in younger patients. Finally, the roots are often incompletely formed in younger patients but completely formed in older patients, which may add to the complexity of extraction.

### 32. What factors affect the difficulty associated with tooth extraction?

- Position of the tooth in the arch. In general, anterior teeth are more easily extracted than posterior teeth. Maxillary teeth are less difficult than mandibular teeth.
- Condition of the crown. Carious teeth may be easily fractured, thus complicating the extraction.
- Mobility of the tooth. Teeth that are mobile as a consequence of periodontal disease are more easily extracted. Ankylosis or hypercementosis increases the difficulty of tooth removal. In assessing mobility, the operator needs to ensure that the crown is not fractured; fracture could produce a false sense of overall tooth mobility.
- Root shape and length
- Proximity of associated vital structure
- Patient attitude and general health

**33. What conditions may influence the difficulty of extraction of an erupted tooth?**

- Root form
- Hypercementosis
- Internal or external root resorption
- Caries
- Prior endodontic therapy

**34. What are the major forces used for tooth extraction?**

Rotation and luxation are the major forces used for tooth extraction.

**35. For multiple extractions, what is the appropriate order of tooth removal?**

In general, maxillary teeth are removed before mandibular teeth and posterior teeth before anterior teeth.

**36. What principles guide the use of elevators in tooth extraction?**

- Elevators may be used to assess the level of anesthesia and release the periodontal ligament.
- The bone, not adjacent teeth, should be used as the fulcrum for elevator assistance in tooth extraction.
- Elevators are most useful in multiple extractions.
- Elevators may assist in the removal of root tips by using a wedge technique.

**37. What are the steps in postoperative management of an extraction site?**

1. Irrigate the site with sterile saline.
2. Remove tissue tags and granulation tissue from the soft tissue of the site.
3. Aggressive curettage of the socket is contraindicated. Pathologic tissue should be removed by gentle scraping of the socket.
4. Compress the alveolar bone with finger pressure.
5. Suture if necessary at the papillae bordering the extraction site and across the middle of the socket.
6. Review postoperative instructions with the patient.

**38. What are the indications for third molar extraction?**

- Pericoronitis
- Nonrestorable caries
- Advanced periodontal disease
- Position that prohibits adequate home care of the third molar or compromises maintenance of the second molar
- Associated pathology (e.g., cyst)
- Malposition
- Chronic pain
- Resorption of adjacent tooth

**39. Should all impacted third molars be extracted?**

No. Fully impacted third molars that do not communicate with the oral cavity need not be extracted. The teeth should be followed regularly, however, to ensure that no pathologic process develops. No data support the suggestion that impacted third molars contribute to crowding of the anterior teeth.

**40. What is the most common supernumerary tooth? Summarize the indications for its removal.**

A mesiodens is the most common supernumerary tooth, followed by fourth molars and extra premolars. Indications for removal are similar to those for impacted teeth—symptoms of pain and infection, evidence of periodontal bone loss, resorption of adjacent teeth, pathology associated with the supernumerary tooth, midline diastema, and orthodontic treatment.

**41. What are the major complications of tooth extraction?**

- Fracture of the root or alveolar plate
- Displacement of a root tip
- Bleeding
- Dry socket (localized osteitis)
- Fracture of the tuberosity
- Infection
- Perforation of the maxillary sinus
- Lingual paresthesia and idiopathic avascular necrosis
- Soft tissue injury

**42. What is the most common complication of tooth extraction? How can it be prevented?**

The most common complication of tooth extraction is root fracture. The best method of prevention is to expose the tooth surgically and remove bone before extraction.

**43. Which tooth root is most likely to be displaced into an unfavorable anatomic site during extraction?**

The palatal root of the maxillary first molar is most likely to be displaced into the maxillary sinus during extraction.

**44. What is the most important factor in successful treatment of an impacted lower second permanent molar?**

Impaction of the lower second molars generally is caused by inadequate arch length. The impacted second molar can be associated with an impacted third molar, which impedes normal eruption. The second molar impaction should be diagnosed as early as possible and the third molar removed to allow eruption of the second molar. If the molar requires surgical repositioning (uprighting), this procedure should be done before full root formation.

**45. Describe the prevention and treatment of postoperative bleeding.**

A thorough preoperative medical history helps identify most patients at systemic risk for postoperative bleeding. On leaving the office, patients should receive verbal and written instructions for postoperative wound care. Of particular relevance regarding bleeding is the avoidance of rinsing, spitting, and smoking during the first postoperative day. The patient should be specifically instructed to avoid aspirin. Patients should be instructed to bite on a gauze sponge for 30 minutes after the extraction.

A patient with postoperative bleeding should return to the office. The wound should be cleared of residual clot or debris and the source of the bleeding identified. Local anesthesia should be administered and existing sutures removed. The wound should be irrigated copiously with saline. Residual granulation tissue should be removed. A hemostatic agent, such as gelatin sponge, oxidized cellulose, or oxidized regenerated cellulose, may be placed into the extraction site. The wound margins should be reapproximated and carefully sutured.

**46. What is the differential diagnosis for a radiolucent lesion associated with the crown of an impacted third molar?**

- Dentigerous cyst
- Keratinizing odontogenic tumor
- Ameloblastoma

**47. What is a dry socket?**

A dry socket is a localized osteitis of the extraction site that typically develops between the third and fourth postoperative days. The term applies to the clinical appearance of the socket, which is devoid of a typical clot or granulating wound. Consequently, patients develop moderate to severe throbbing pain. The frequency of dry socket after routine tooth extractions is approximately 2%. However, the condition may occur in as many as 20% of cases after extraction of impacted mandibular third molars.

**48. How can a dry socket be prevented?**

Prevention of a dry socket is somewhat controversial. It is generally agreed that careful technique to minimize trauma reduces the likelihood of this complication. In addition, preoperative rinsing with chlorhexidine gluconate 0.12% may be of benefit. Placement of antibiotic-impregnated Gelfoam or injection of polylactic acid granules into the socket before suturing may be of value, although these interventions are far from being universally accepted.

**49. How is dry socket treated?**

Curettage of the extraction site is contraindicated. The extraction site should be gently irrigated with warm saline. A medicated dressing is then placed into the socket. The medication used for this purpose has been the topic of much discussion. One alternative consists of eugenol, benzocaine, and balsam of Peru. Alternatively, a gauze dressing impregnated with equal amounts of zinc oxide, eugenol, tetracycline, and benzocaine may be used.

**50. What substances should never be placed into a healing socket?**

They are petrolatum-based compounds and tetracycline powder.

**51. If perforation into the maxillary sinus occurs during extraction of a maxillary tooth, what surgical maneuvers and postoperative instructions help prevent the formation of an oroantral fistula?**

- Watertight closure of the extraction site
- No nose blowing or using a straw
- Antibiotics to prevent infection in the sinus
- Decongestants to decrease swelling of the nasal mucosa and allow normal drainage through the sinus ostium

**52. Describe pain control after extraction.**

For most patients, adequate control of postoperative pain is obtained with nonsteroidal anti-inflammatory drugs (NSAIDs). Evidence has shown that postoperative pain can be minimized if the first dose of NSAIDs is administered immediately after the procedure. No evidence indicates that preoperative administration of NSAIDs favorably alters the postoperative course. For patients unable to take NSAIDs because of allergies, ulcer disease, or other contraindications, various narcotic analgesics are available. Patients taking these agents must be cautioned about drowsiness and concurrent use of alcohol or other medication. Persistent postoperative pain (>2 days) is not typical, and patients should be instructed to call if they have prolonged discomfort, which may indicate infection or another complication.

**53. What percentage of patients request pain medication after third molar removal?**

It is 90%.

**54. Which teeth are most commonly impacted?**

The most commonly impacted teeth are the third molars and maxillary canines.

**INFECTIONS AND ABSCESSSES****55. What are the major sources of odontogenic infections?**

The two major sources of odontogenic infection are periapical disease, which occurs as a consequence of pulpal necrosis, and periodontal disease.

**56. What are the three clinical stages of odontogenic infection?**

1. Periapical osteitis occurs when the infection is localized within the alveolar bone. Although the tooth is sensitive to percussion and often slightly extruded, there is no soft tissue swelling.
2. Cellulitis develops as the infection spreads from the bone to adjacent soft tissue. Subsequently, inflammation and edema occur, and the patient develops a poorly localized swelling. On palpation, the area is often sensitive, but the sensitivity is not discrete.
3. Suppuration then occurs and the infection localizes into a discrete fluctuant abscess.

**57. What are the significant complications of untreated odontogenic infection?**

- Tooth loss
- Spread to the cavernous sinus and brain
- Spread to the neck with large vein complications
- Spread to potential fascial spaces with compromise of the airway
- Septic shock

**58. What are the principles of therapy for odontogenic infections (as defined by Peterson)?**

1. Determine the severity of the infection.
2. Evaluate the state of the host defense mechanisms.
3. Determine whether the patient should be treated by a general dentist or a specialist.

4. Treat the infection surgically.
5. Support the patient medically.
6. Choose and prescribe the appropriate antibiotic.
7. Administer the antibiotic properly.
8. Evaluate the patient frequently.

**59. What is the treatment of choice for an odontogenic abscess?**

The treatment of choice for an odontogenic abscess is incision and drainage, which may be accomplished in one of three ways: (1) exposure of the pulp chamber, with extirpation of the pulp; (2) extraction of the tooth; or (3) incision into the soft tissue surface of the abscess. Antibiotic therapy is indicated in the presence of fever or lymphadenopathy.

**60. How are incision and drainage of soft tissue best performed?**

Local anesthesia should be administered first. Care must be taken not to inject through the infected area and spread the infection to noninvolved sites. Once adequate anesthesia has been obtained, an incision should be placed at the most dependent part of the swelling. The incision should be wide enough to facilitate drainage and allow blunt dissection through the periosteum down to bone. After irrigation, a drain (e.g., iodoform gauze, rubber) should be placed to maintain the patency of the wound. Postoperative instructions should include frequent rinses with warm saline, appropriate pain medication and, when indicated, antibiotic therapy. The patient should be instructed to return for follow-up evaluation in 24 hours and the drain advanced or removed.

**61. When infection erodes through the cortical plate, it does so in a predictable manner. Which factors determine the location of infection from a specific tooth?**

- Thickness of bone overlying the tooth apex  
The thinner the bone, the more likely it is to be perforated by spreading infection.
- The relationship of the site of bony perforation to muscle attachments to the maxilla or mandible.

**62. State the usual site of bone perforation, relationship to muscle attachment, determining muscle, and site of localization for each tooth for odontogenic infections.**

See Table 11-1.

**Table 11-1.**

INVOLVED TEETH	USUAL SITE OF PERFORATION OF BONE	RELATION OF PERFORATION TO MUSCLE ATTACHMENT	DETERMINING MUSCLE	SITE OF LOCALIZATION
<b>Maxilla</b>				
Central incisor	Labial	Below	Orbicularis oris	Labial vestibule
Lateral incisor	Labial (palatal)*	Below	Orbicularis oris	Labial vestibule (palatal)
Canine	Labial	Below	Levator anguli oris	Oral vestibule
	Labial	(above)	Levator anguli oris	(canine space)
Premolars	Buccal	Below	Buccinator	Buccal vestibule
Molars	Buccal	Below	Buccinator	Buccal vestibule
	Buccal (palatal)	Above	Buccinator	Buccal space (palatal)

*Continued*

Table 11-1—cont'd

INVOLVED TEETH	USUAL SITE OF PERFORATION OF BONE	RELATION OF PERFORATION TO MUSCLE ATTACHMENT	DETERMINING MUSCLE	SITE OF LOCALIZATION
<b>Mandible</b>				
Incisors	Labial	Above	Mentalis	Labial vestibule
Canine	Labial	Above	Depressor anguli oris	Labial vestibule
Premolars	Buccal	Above	Buccinator	Buccal vestibule
First molar	Buccal	Above	Buccinator	Buccal vestibule
	Buccal	Below	Buccinator	Buccal space
Second molar	Lingual	Above	Mylohyoid	Sublingual space
	Buccal	Above	Buccinator	Buccal vestibule
	Buccal	Below	Buccinator	Buccal space
	Lingual	Above	Mylohyoid	Sublingual space
Third molar	Lingual	Below	Mylohyoid	Submandibular space
	Lingual	Below	Mylohyoid	Submandibular space

\*Parentheses indicate rare occurrences.

Adapted from Laskin DM, Adelman HB: *Oral Surgery*. In Levy S (ed): *Dentist's handbook of office and hospital procedures*. Chicago, Yearbook Medical Publishers, 1963.

### 63. What is osteoradionecrosis?

Osteoradionecrosis occurs after radiation therapy. It is usually noted in the mandible of patients who have received treatment for head and neck cancer and have a preexisting dental infection. Thus, the frequency is higher in dentate patients compared with edentulous patients. Prevention of osteoradionecrosis involves the elimination of infected teeth before the initiation of radiation therapy. The patient who receives radiation to the head and neck remains at risk for osteoradionecrosis.

### 64. What are the indications for hospitalization of patients with infection?

- Fever > 101° F (38° C)
- Dehydration
- Trismus
- Marked pain
- Difficulty with breathing or swallowing
- Leukocytosis (white blood cells [WBCs] > 10,000)
- Shift of WBCs to the left (increased immature neutrophils)
- Significant and/or spreading swelling
- Elevation of the tongue
- Bilateral submandibular swelling
- Neurologic changes
- Systemic disease known to modify the patient's ability to fight infection
- Need for parenteral antibiotics
- Inability of patient to comply with traditional treatment
- Need for drainage

### 65. What are the indications for antibiotic therapy in orofacial infection?

- Evidence of systemic involvement, such as fever, leukocytosis, malaise, fatigue, weakness, lymphadenopathy, or increased pulse
- Infection that is not localized but extending or progressing
- No response to standard surgical intervention
- Increased risk for endocarditis or systemic infection because of cardiac status, immune status, or systemic disease



**66. What are fascial space infections?**

Fascial spaces potentially exist between fascial layers and may become filled with purulent material from spreading orofacial infections. Spaces that become directly involved are termed *spaces of primary involvement*. Infections may spread to additional spaces.

**67. What are the primary maxillary fascial spaces?**

They are the canine, buccal, and infratemporal.

**68. What are the primary mandibular fascial spaces?**

They are the submental, submandibular, buccal, and sublingual.

**69. What are the secondary fascial spaces?**

Masseteric	Superficial and deep temporal
Pterygomandibular	Lateral pharyngeal
Retropharyngeal	Prevertebral

**70. What is Ludwig's angina?**

Ludwig's angina is bilateral cellulitis affecting the submandibular and sublingual spaces. Patients develop marked brawny edema, with elevation of the floor of the mouth and tongue that results in airway compromise.

**71. What is cavernous sinus thrombosis?**

Cavernous sinus thrombosis may occur as a consequence of the hematogenous spread of maxillary odontogenic infection via the venous drainage of the maxilla. The lack of valves in the facial veins permits organisms to flow to and contaminate the cavernous sinus, thus resulting in thrombosis. Patients present with proptosis, orbital swelling, neurologic signs, and fever. The infection is life-threatening and requires prompt and aggressive treatment consisting of elimination of the source of infection, drainage, parenteral antibiotic therapy, and neurosurgical consultation.

**72. What is the antibiotic of choice for odontogenic infection?**

Penicillin is the drug of choice; 95% of bacteria causing odontogenic infections respond to penicillin. For most infections, a dose of penicillin VK, 500 mg every 6 hours for 7 to 10 days, is adequate; 5% to 7% of the population, however, is allergic to penicillin.

**73. What are alternative antibiotics for patients who are allergic to penicillin?**

They are clarithromycin, clindamycin, and azithromycin.

**74. Despite the advent of numerous new antibiotics, penicillin remains the drug of choice for odontogenic infections. Why?**

- It is bactericidal, with a narrow spectrum of activity that includes the most common pathogens associated with odontogenic infection.
- It is safe; the toxicity associated with penicillin is low.
- It is cheap.

**75. List the major side effects associated with clindamycin.**

- |                               |                            |
|-------------------------------|----------------------------|
| • Diarrhea and abdominal pain | • Rash                     |
| • Nausea and vomiting         | • Pseudomembranous colitis |

**76. What factors govern the selection of a particular antibiotic?**

- |               |                          |
|---------------|--------------------------|
| • Specificity | • Cost                   |
| • Toxicity    | • Ease of administration |

**77. When should cultures be used for odontogenic infection?**

- Infection in immunocompromised patients (e.g., from cancer chemotherapy, diabetes mellitus, immunosuppressive drugs)
- Before changing antibiotics in a patient who has failed to respond to empiric therapy
- Before initiating antibiotic therapy in a patient who demonstrates signs of systemic infection

**78. Why may antibiotic therapy fail?**

- Lack of patient compliance
- Failure to treat the infection locally
- Inadequate dose or length of therapy
- Selection of wrong antibiotic

- Presence of resistant organisms
- Nonbacterial infection
- Failure of antibiotic to reach infected site
- Inadequate absorption of antibiotic, as when tetracycline is taken with milk products

**79. Does the initiation of antibiotic therapy obviate the need for surgical intervention in a patient with an infection?**

No. Failure to eliminate the source of infection through surgical intervention ultimately results in the failure of other forms of therapy.

## DENTAL TRAUMA

**80. What are the most important questions to ask when evaluating a patient with acute trauma?**

1. How did the injury occur?
2. Where did the injury occur?
3. When did the injury occur?
4. Was the patient unconscious, or did the patient have nausea, vomiting, or headache after the accident?
5. Was there prior injury to the teeth?
6. Is there any change in the occlusion?
7. Is there any thermal sensitivity of the teeth?

Also, review of the medical history of the patient.

**81. Discuss the primary assessment and management of the patient with trauma.**

The initial assessment and management of the traumatized patient are centered on identification of life-threatening problems. The three most significant aspects are the following; (1) establishing and maintaining an airway; (2) providing adequate ventilation; (3) evaluating and supporting the cardiopulmonary system; and (4) controlling external hemorrhage. The patient should be assessed and treated for shock.

**82. What are the methods of choice for evaluation of the pediatric patient with trauma?**

History and physical examination are the mainstays for evaluating the pediatric patient with trauma. The clinician should determine the cause of the trauma, type of injury, and direction from which it occurred. In the case of a younger child, it is helpful if an adult witnessed the traumatic event. Physical examination should determine the child's mental state, facial asymmetry, occlusion, and vision. The radiographic evaluation of choice is computed tomography (CT).

**83. What are the four best ways for a patient to preserve a recently avulsed tooth until he or she is seen by a dentist?**

The four best ways for a patient to preserve a recently avulsed tooth are as follows: (1) replace it immediately into the socket from which it was avulsed; (2) place it in the mouth, under the tongue; (3) place the tooth in milk; or (4) place the tooth in Hank's medium.

**84. How should an avulsed tooth be managed?**

1. Whenever possible, avulsed teeth should be replaced into the socket within 30 minutes of avulsion. After 2 hours, associated complications such as root resorption increase significantly.
2. The tooth should not be scraped, extensively cleaned, or sterilized because these procedures will damage the periodontal tissues and cementum. The tooth should be gently rinsed with saliva only.
3. The tooth should be placed in the socket with a semirigid splint for 7 to 14 days.

**85. What should be included in the clinical evaluation of the traumatized dentition?**

Mobility testing	Electric pulp testing
Percussion sensitivity	Soft-tissue evaluation

**86. Describe the injuries involving the supporting structures of the dentition.**

**Concussion:** injury to the tooth that may result in hemorrhage and edema of the periodontal ligament, but the tooth remains firm in its socket. Treatment is occlusal adjustment and soft diet.

**Subluxation:** loosening of the involved tooth without displacement. Treatment is the same as for concussion.

**Intrusion:** tooth is displaced apically into the alveolar process. If root formation is incomplete, treatment involves allowing the tooth to re-erupt over several months; if root formation is complete, the tooth should be repositioned orthodontically. Pulpal status must be monitored because pulpal necrosis is frequent in the tooth with an incomplete root and almost 100% in the tooth with complete root formation.

**Extrusion:** tooth is partially displaced out of the socket. Treatment involves manually repositioning the tooth into the socket and splinting in position for 2 to 3 weeks. A radiographic examination should be performed after 2 to 3 weeks to rule out marginal breakdown or initiation of root resorption.

**Lateral luxation:** tooth is displaced horizontally, therefore resulting in fracture of the alveolar bone. Treatment involves gentle repositioning of the tooth into the socket followed by splinting for 3 weeks. A radiographic examination should be performed after 2 to 3 weeks to rule out marginal breakdown or initiation of root resorption.

**Avulsion:** total displacement of the tooth out of the socket. Rapid reimplantation is the ideal treatment. The tooth should be held by the clinical crown and not by the root. Rinse the tooth in saline, and flush the socket with saline. Replant the tooth, and splint in place with a semirigid splint for 1 week. Place the patient on antibiotic therapy. Assess the patient's tetanus prophylaxis status and treat appropriately. If the apex is closed, a calcium hydroxide pulpectomy should be initiated when the splint is removed. If the tooth cannot be replanted immediately, placing it in Hank's medium, milk, or saliva aids in maintaining the vitality of the periodontal and pulpal tissues. Follow-up radiographic examinations should be performed at 3 and 6 weeks and at 3 and 6 months.

#### 87. What are the types and characteristics of the resorption phenomenon that may follow a traumatic injury?

**Inflammatory external and internal resorption** occur when necrotic pulp has become infected, leading to resorption of the external surface of the root or the pulp chamber and/or canal. Immediate treatment with a calcium pulpectomy is indicated to arrest the process.

**Replacement resorption** occurs after damage to the periodontal ligament results in contact of cementum with bone. As the root cementum is resorbed, it is replaced by bone, resulting in ankylosis of the involved tooth.

#### 88. When can these forms of resorption be detected radiographically?

It is possible to detect periapical radiolucencies that indicate internal and external resorption after 3 weeks. Replacement resorption may be detected after 6 weeks.

#### 89. Why should radiographs of the soft tissue be included in evaluation of a patient with dental trauma?

It is not uncommon for fragments of fractured teeth to puncture and embed themselves into the oral soft tissue. Clinical examination is often inadequate to detect these foreign bodies.

#### 90. When a lip laceration is encountered, what part of the lip is the most important landmark and the first area to be reapproximated?

The vermilion border, the area of transition of mucosal tissue to skin, is evaluated and approximated first. An irregular vermilion margin is unaesthetic and difficult to correct secondarily.

#### 91. How should a small avulsion of the lip be managed?

Avulsions can be treated with primary closure if no more than 25% of the lip is lost. The tissue margins should be excised so that the wound has smooth, regular margins.

#### 92. How should a full-thickness, mucosa to skin laceration of the lip be closed? Which layers should be sutured?

A layer closure ensures optimal cosmetic and functional results. First, 5-0 nylon sutures are placed at the vermilion cutaneous junction. The muscle layer, subcutaneous layer, and mucosa layer are closed with 4-0 resorbable sutures; then the skin layer is closed with 5-0 or 6-0 nylon sutures.

**93. How should a facial laceration that extends into dermis or fat be closed?**

Wounds that extend into dermis or fat should be closed in layers. The dermis should be closed with 4-0 absorbable sutures and the skin closed with 5-0 or 6-0 nonabsorbable sutures.

**94. Why is a layered closure important?**

A layered wound closure reestablishes anatomic alignment and avoids dead space, thus reducing the risk of infection and scar formation. Closure of the muscle and subcutaneous tissue layers minimizes tension in the skin layer and allows eversion of the skin edges, which results in the most aesthetic scar.

**95. What structures are at risk when a facial laceration occurs posterior to the anterior margin of the masseter muscle and inferior to the level of the zygomatic arch?**

The buccal branch of the facial nerve and parotid gland duct are at risk with lacerations in this position. When such a laceration is encountered, facial nerve function must be tested, along with salivary flow from the parotid duct.

**96. What is a dentoalveolar fracture? How is it treated?**

A dentoalveolar fracture is a fracture of a segment of the alveolus and tooth within that segment. This fracture usually occurs in anterior regions. Treatment consists of reduction of the segment to its original position or best position relative to the opposing dentition because it may not be possible to determine the exact position before injury. The segment is then stabilized with a rigid splint for 4 to 6 weeks.

**97. What is the Le Fort classification of fractures?**

**Le Fort I.** This is a horizontal segmented fracture of the alveolar process of the maxilla.

**Le Fort II.** This is a unilateral or bilateral fracture of the maxilla, in which the body of the maxilla is separated from the facial skeleton and the separated portion is pyramidal in shape. The fracture may extend through the body of the maxilla down the midline of the hard palate, through the floor of the orbit, and into the nasal cavity.

**Le Fort III.** This is a fracture in which the entire maxilla and one or more facial bones are completely separated from the craniofacial skeleton (also called craniofacial dysjunction).

**98. Describe the Ellis classification of dental fractures.**

**Class I.** Enamel only

**Class II.** Dentin and enamel

**Class III.** Dentin, enamel, and pulp

**Class IV.** Whole crown

**99. Describe the management of each of these fractures.**

**Class I.** Enameloplasty and/or bonding

**Class II.** Dentin coverage with calcium hydroxide and bonded restoration or reattachment of fractured segment

**Class III.** Pulp therapy via pulp capping or partial pulpotomy

**Class IV.** If the fracture is supragingival, remove the coronal segment and perform appropriate pulp therapy, then restore. If the fracture is subgingival, remove the coronal segment, perform appropriate pulp therapy, and then reposition the remaining tooth structure coronally, orthodontically, or surgically. The surgical approach results in loss of pulpal vitality and therefore requires a pulpectomy.

**100. What are the most likely signs and symptoms of a mandibular body or angle fracture?**

- Alteration in occlusion
- A step or change in the mandibular occlusal plane
- Lower lip numbness
- Mobility at the fracture site
- Pain at the fracture site
- Bleeding at the fracture site or submucosal hemorrhage

**101. How is a displaced fracture of the mandibular body or angle treated?**

A displaced mandibular fracture is treated by open reduction and rigid internal fixation. Arch bars are placed on the teeth or intermaxillary fixation are placed in the bone and used

with intermaxillary wires or elastics to establish the preoperative occlusion. This procedure involves exposing the mandible through an incision, reducing the fracture, and fixing the fracture segments with rigid plates and screws. In many cases, rigid internal fixation can be used to avoid prolonged intermaxillary fixation.

**102. What are the two causes of mandibular fracture displacement?**

Mandible fractures are displaced by the force that causes the fractures and by the muscles of mastication. Depending on the orientation of the fracture line, the attached muscles may cause significant displacement of the segments.

**103. Are most fractures of the mandibular condyle treated by closed or open reduction?**

Most fractures of the mandibular condyle are treated by closed reduction. Treatment usually consists of 1 to 3 weeks of intermaxillary fixation followed by mobilization and close follow-up. In adults fracture dislocation of the condyle can be treated with open reduction and fixation of the bony segments with rigid fixation.

**104. What radiographs are used to diagnose mandibular fractures?**

- CT scan
- Panoramic radiograph
- Occlusal radiograph
- Mandibular series
- Lateral oblique views
- Posteroanterior view
- Towne's view

**105. What are the likely signs and symptoms of a zygomatic fracture?**

- Pain over zygomatic region
- Numbness in the infraorbital nerve distribution
- Swelling in the zygomatic region
- Depression or flatness of the zygomatic prominence
- Nasal bleeding
- Submucosal hemorrhage or ecchymosis
- Subconjunctival hemorrhage or ecchymosis
- Submucosal or subconjunctival emphysema
- Palpable step at the infraorbital rim (emphysema)
- Exophthalmos
- Diplopia
- Unequal pupil level

**106. Which radiographs are used to evaluate and diagnose zygomatic fractures?**

CT scan

**107. Which bones articulate with the zygoma?**

- Frontal bone
- Sphenoid bone
- Maxillary bone
- Temporal bone

**108. How may mandibular function be affected by a fracture of the zygoma or zygomatic arch?**

A depressed zygoma or zygomatic arch fracture can impinge on the coronoid process or temporalis muscle, causing various degrees of hypomobility.

**109. Define neurapraxia.**

Neurapraxia is the mildest form of nerve injury and denotes a localized conduction block along a nerve. Axonal continuity is maintained, and nerve conduction proximal and distal to the lesion is preserved. No treatment other than documentation of the area of injury is required. Recovery is generally rapid, and impulse conduction is complete within weeks.

**110. Define axonotmesis.**

Axonotmesis denotes sufficient damage to disrupt the continuity of axons within the connective tissue of the peripheral nerve. Conduction block is complete and distal axon degeneration follows the injury. Prognosis is good because of the continuity of the supportive connective tissue and basement membrane.

**111. What is neurotmesis?**

The most severe type of injury is neurotmesis. Complete anatomic severance of the peripheral nerve occurs, and no recovery is expected without surgical coaptation of the ends of the fibers. Proximal and distal degeneration is present.

## LOCAL ANESTHESIA

### 112. What are the major classifications of local anesthetics used in dentistry?

Classification of local anesthetics is based on the molecular linkage between hydrophilic and lipophilic groups of the molecule. The amides, such as xylocaine and mepivacaine, are the most commonly used class of local anesthetics and, for the most part, have replaced esters, such as procaine.

### 113. Do all local anesthetics used in dentistry have the same duration of action?

No. Long-lasting local anesthetics, such as bupivacaine-epinephrine (Marcaine), provide surgical grade anesthesia about three times longer than generally used anesthetics, such as lidocaine.

### 114. What is the role of pH in determining the effectiveness of a local anesthetic?

Anesthetic solutions are acid salts of weak bases and have a pH in the range of 3.3 to 5.5. For the molecule to be active, the uncharged base must be available. If the tissue into which the solution is placed has a pH lower than the anesthetic solution, dissociation does not occur, and the amount of active base available is not adequate for a substantial anesthetic effect. A clinical example of this phenomenon is the injection of local anesthesia into an area of infection.

### 115. What are the advantages of including epinephrine in a local anesthetic solution?

There are two major advantages of including epinephrine in local anesthesia: (1) because epinephrine is a vasoconstrictor, it helps maintain an optimal level of local anesthesia at the site of injection and thus reduces permeation of the drug into adjacent tissue; and (2) the vasoconstrictive properties of epinephrine also result in reduced intraoperative bleeding.

### 116. How significant is the concentration of epinephrine in local anesthetic solutions in affecting their hemostatic properties?

No difference in the degree or duration of hemostasis has been noted when solutions containing epinephrine concentrations of 1:100,000, 1:400,000, or 1:800,000 were compared. Five minutes should be allowed for epinephrine to achieve its maximal effect.

### 117. Which nerves are anesthetized using the Gow-Gates technique?

- |                            |                           |
|----------------------------|---------------------------|
| 1. Inferior alveolar nerve | 4. Auriculotemporal nerve |
| 2. Lingual nerve           | 5. Buccal nerve           |
| 3. Mylohyoid nerve         |                           |

### 118. Describe the best types of injections of local anesthesia for extractions of the following teeth.

Maxillary lateral incisor	Infiltration at apex Infiltration of buccal soft tissue Nasopalatine block
Maxillary first molar	Infiltration at apex Infiltration over mesial root and over apex of maxillary second molar
Mandibular canine	Inferior alveolar block Lingual nerve block
Mandibular second molar	Inferior alveolar block Lingual nerve block Buccal block

### 119. What are the symptoms and treatment for inadvertent injection of the facial nerve during the administration of local anesthesia?

The muscles of facial expression are paralyzed. The condition is temporary and self-limiting. However, the patient's eye should be protected because closure of the eye on blinking may be limited.

### 120. How does a hematoma form after the administration of a local anesthetic? How is it treated?

Hematoma may occur when the needle passes through a blood vessel and results in bleeding into the surrounding tissue. Posterosuperior alveolar nerve blocks are usually associated

with hematoma formation, although injection into any area, particularly a foramen, may have a similar result. Treatment of hematoma includes direct pressure and immediate application of ice. The patient should be informed of the hematoma and reassured. In healthy patients, the area should resolve in about 2 weeks. In patients at risk for infection, hematomas may act as a focus of bacterial growth. Consequently, such patients should be placed on an appropriate antibiotic.

**121. What are the reasons for postinjection pain after the administration of a local anesthetic?**

The most common causes of postinjection pain are related to injury of the periosteum, which results from tearing of the tissue or from deposition of solution beneath the tissue.

**122. What causes blanching of the skin after the injection of local anesthesia?**

Arterial spasms caused by needle trauma to the vessel may result in sudden blanching of the overlying skin. No treatment is required. Epinephrine causes vasoconstriction.

**123. What is the toxic dose of most local anesthetics used in dentistry? What is the maximal volume of a 2% solution of local anesthetic that can be administered?**

The toxic dose for most local anesthetics used in dentistry is 300 to 500 mg. The standard carpule of local anesthetic contains 1.8 mL of solution. Thus, a 2% solution of lidocaine contains 36 mg of drug ( $2\% \text{ solution} = 20 \text{ mg/mL} \times 1.8 \text{ mL} = 36 \text{ mg}$ ). Ten carpules or more are in the toxic range.

**124. What is the most common adverse reaction to local anesthesia? How is it treated?**

Syncope is the most common adverse reaction associated with the administration of a local anesthetic. Almost 50% of the medical emergencies that occur in dental practice fall into this category. Syncope typically is the consequence of a vasovagal reaction. Treatment is based on early recognition of a problem; the patient often feels uneasy, queasy, sweaty, or lightheaded. The patient should be reassured and positioned so that the feet are higher than the head (Trendelenburg position); oxygen is administered. Tight clothing should be loosened, and a cold compress should be placed on the forehead. Vital signs should be monitored and recorded. Ammonia inhalants are helpful for stimulating the patient.

## POSTOPERATIVE MANAGEMENT AND WOUND HEALING

**125. What are the principal components of postoperative orders?**

- Diagnosis and surgical procedure
- Patient's condition
- Allergies
- Instructions for monitoring of vital signs
- Instructions for activity and positioning
- Diet
- Medications
- Intravenous fluids
- Wound care
- Parameters for notification of dentist
- Special instructions

**126. What is dead space?**

Dead space is the area in a wound that is free of tissue after closure. An example is a cyst cavity after enucleation of the cyst. Because dead space often fills with blood and fibrin, it has the potential to become a site of infection.

**127. What are the four ways that dead space can be eliminated?**

1. Loosely suture the tissue planes together so that the formation of a postoperative void is minimized.
2. Place pressure on the wound to obliterate the space.
3. Place packing into the void until bleeding has stopped.
4. Place a drain into the space.

**128. What is postoperative ecchymosis? How does it occur? How is it managed?**

Ecchymosis is a black and blue area that develops as blood seeps submucosally after surgical manipulation. It is a self-limiting condition that looks more dangerous than it actually is. Patients should be warned that it may occur. Although no specific treatment is indicated, moist heat often speeds resolution.

**129. What are the causes of postoperative swelling after an oral surgical procedure?**

Swelling because of edema usually reaches its maximum 48 to 72 hours after the procedure and then resolves spontaneously. It can be minimized by the application of a cold compress to the surgical site at 20-minute intervals on the day of surgery. Beginning on the third postoperative day, moist heat may be applied to swollen areas. Patients should be informed of the possibility of swelling. Swelling after the third postoperative day, especially if it is new, may be a sign of infection, for which patients need appropriate assessment and management.

**130. What is primary hemorrhage? How should it be treated?**

Primary hemorrhage is postoperative bleeding that occurs immediately after an extraction. In essence, the wound does not stop bleeding. To permit clear visualization and localization of the site of bleeding, the mouth should be irrigated thoroughly with saline. The patient's overall condition should be assessed. Once the general site of bleeding has been identified, pressure should be applied for 20 to 30 minutes. Extraneous granulation tissue or tissue fragments should be carefully debrided. If the source of the bleeding is soft tissue (e.g., gingiva), sutures should be applied. If the source is bone, bone wax can be applied. Placement of a hemostatic agent such as a surgical gel in the socket may be followed by the placement of interrupted sutures. The patient should be instructed to bite on gauze for 30 minutes. At the end of that period, coagulation should be confirmed before the patient is dismissed.

A clot may fail to form because of a quantitative or functional platelet deficiency. The former is most readily assessed by obtaining a platelet count. The normal platelet count is 200,000 to 500,000 cells/mm<sup>3</sup>. Prolonged bleeding may occur if it falls below 100,000 cells/mm<sup>3</sup>. Treatment of severe thrombocytopenia may require platelet transfusion. Qualitative platelet dysfunction usually results from aspirin ingestion and is generally measured by determining the bleeding time. A prolonged bleeding time requires consultation with a hematologist.

**131. What is secondary hemorrhage? How is it treated?**

Secondary hemorrhage occurs several days after extraction and may be caused by clot breakdown, infection, or irritation to the wound. The mouth first should be thoroughly irrigated and the source of the bleeding identified. The wound should be debrided. Sources of local irritation should be eliminated. The placement of sutures or a hemostatic agent may be necessary. Patients with infection should be placed on an antibiotic. If local measures fail to stem the bleeding, additional studies, especially relative to fibrin formation, are indicated.

**132. Describe the stages of wound healing.**

The **inflammatory stage** begins immediately after tissue injury and consists of a vascular phase and cellular phase. In the vascular phase, initial vasoconstriction is followed by vasodilation, which is mediated by histamine and prostaglandins. The cellular phase is initiated by the complement system, which acts to attract neutrophils to the wound site. Lymphocytic infiltration follows. Epithelial migration begins at the wound margins.

During the **fibroblastic stage**, wound repair is mediated by fibroblasts. New blood vessels form, and collagen is produced in excessive amounts. Foreign and necrotic material is removed. Epithelial migration continues.

In the **remodeling stage**, the final stage of wound healing, collagen fibers are arranged in an orderly fashion to increase tissue strength. Epithelial healing is completed.

**133. What is the difference between healing by primary and secondary intention?**

In healing by primary intention, the edges of the wound are approximated as they were before injury, with no tissue loss. An example is the healing of a surgical incision. In contrast, wounds that heal by secondary intention involve tissue loss, such as an extraction site.



**134. What are the five phases of healing of extraction wounds?**

1. Hemorrhage and clot formation
2. Organization of the clot by granulation tissue
3. Replacement of granulation tissue by connective tissue and epithelialization of the wound
4. Replacement of the connective tissue by woven bone
5. Recontouring of the alveolar bone and bone maturation

**IMPLANTOLOGY****135. What are dental implants?**

Dental implants are devices placed into bone to act as abutments or supports for prostheses.

**136. Describe the bone-implant interface found in osseointegrated implants.**

Osseointegrated (osteointegrated) implants interface directly with the bone, resulting in a relationship that mimics ankylosis of a tooth to bone. Osseointegrated implants are made of titanium.

**137. What are the requirements for successful implant placement?**

- Biocompatibility
- Mucosal seal
- Adequate transfer of force

**138. The surgical placement of most osseointegrated implants can require two steps. What are they? How long is the period between them?**

The first step is the actual placement of the implant. Implants can be covered with soft tissue during the time that they integrate with bone. This process takes between 3 to 6 months. After this period, a second surgical procedure is performed, during which the implant is exposed. Some brands of implants are not buried during the period of osseointegration, and therefore do not require a second surgical procedure.

**139. Describe the major indications for the consideration of implants as a treatment alternative.**

- Resorption of the alveolar ridge or some other anatomic consideration does not allow for adequate retention of a conventional removable prosthesis.
- The patient is psychologically unable to deal with a removable prosthesis.
- There is a medical condition for which removable prostheses may create a risk, such as a seizure disorder.
- The patient has a pronounced gag reflex that does not permit the placement of a removable prosthesis.
- There is loss of posterior teeth, particularly unilaterally.
- Adjacent teeth are without decay or extensive restoration.

**140. What are the major contraindications for the placement of implants?**

- Pathology within the bone
- Limiting anatomic structures, such as the inferior alveolar nerve or maxillary sinus
- Unrealistic outcome expectations from patient
- Poor oral health and hygiene
- Patient's inability to tolerate implant procedures because of a medical or psychological condition
- Inadequate quantity or quality of bone

**141. What is the prognosis of osseointegrated implants placed into an edentulous mandible? Maxilla?**

According to studies with implants developed by Branemark, the stability of implant-supported continuous bridges for a 5- to 12-year period was 100% in the mandible and 90% in the maxilla.

**142. What are the steps in the assessment of patients prior to implant placement?**

- Medical and dental history
- Clinical examination
- Radiographic examination

**143. Which radiographic studies are used for patient assessment before implant placement?**

For many implant cases, panoramic and periapical radiographs provide adequate information relative to bone volume and location of limiting anatomic structures. In some cases, CT may be especially useful for providing information relative to multiplanar jaw configuration.

**144. During preparation of the implant recipient site, what is the maximal temperature that should develop at the drill-bone interface?**

To prevent necrosis of bone, a maximal temperature of 104° F (40° C) has been recommended. This is achieved through the use of copious external or internal saline irrigation and low-speed, high-torque drills. In the final step of implant site preparation, the drill rotates at a speed of only 10 to 15 rpm.

**145. What is the best way to ensure proper implant placement and orientation?**

Careful pretreatment evaluation and preparation by both the surgeon and restoring dentist are critical. A surgical stent fabricated to the specifications of the restoring dentist is extremely helpful. Lack of pretreatment communication and planning may result in implants that are successfully integrated but impossible to restore.

**146. Do any data suggest that osseointegration of implants may occur when implants are placed into an extraction site?**

Some data suggest that placement of an implant into an extraction site may be successful, especially if the implant extends apically beyond the depth of the extraction site. Conventional treatment, however, consists of a period of 3 months from extraction to implant placement.

**147. What anatomic feature of the anterior maxilla must be evaluated before placement of an implant in the central incisor region?**

The incisor foramen must be carefully evaluated radiographically and clinically. Variations in size, shape, and position determine the position of maxillary anterior implants. Fixtures should not be placed directly into the foramen.

**148. Which anatomic site is the most likely to yield failed implants?**

Implants placed in the maxillary anterior region are the most likely to fail. Because short implants are more likely to fail than longer implants, the longest implant that is compatible with the supporting bone and adjacent anatomy should be used.

**149. Do definitive data support the contention that implanted supported teeth should not be splinted to natural teeth?**

This issue is controversial, but available data refute the claim that bridges with both implant and natural tooth abutments do more poorly than bridges supported only by implants.

**150. Is there any reason to avoid the use of fluorides in implant recipients?**

Yes. Acidulated fluoride preparations may corrode the surface of titanium implants.

**151. Do implants need periodic maintenance once they are placed?**

Like natural teeth, poorly maintained implants may demonstrate a progressive loss of supporting bone, which may result in implant failure. Aggressive home care is necessary to ensure implant success. Plastic-tipped instruments are available for professional cleaning.

**152. What is the most common sign that an implant is failing?**

Mobility of the implant is regarded as an unequivocal sign of implant failure.

**PAIN SYNDROMES AND TEMPOROMANDIBULAR JOINT DISORDERS****153. What is trigeminal neuralgia?**

Trigeminal neuralgia, or tic douloureux, results in severe lancinating pain in a predictable anatomic location innervated by the fifth cranial nerve. The pain typically is of short

duration but extremely intense. Stimulation of a trigger point initiates the onset of pain. Possible causes include multiple sclerosis, vascular compression of the trigeminal nerve roots as they emerge from the brain, demyelination of the gasserian ganglion, trauma, and infection.

**154. Discuss the treatment of trigeminal neuralgia.**

Drug therapy is the primary treatment for most forms of trigeminal neuralgia. Neurontin and antiepileptic drugs are used most often. If drug therapy fails, surgical intervention may be necessary. Surgical options include rhizotomy and nerve decompression.

**155. What symptoms are associated with TMJ disorders?**

TMJ disorders are characterized by the presence of one or more of the following:

- Preauricular pain and tenderness
- Limitation of mandibular motion
- Noise in the joint during condylar movement
- Pain and spasm of the muscles of mastication

**156. What are the two most common joint sounds associated with TMJ disorders? How do they differ?**

Clicking and crepitus are the two most common joint sounds associated with TMJ disorders. Clicking is a distinct popping or snapping sound; crepitus is a scraping continuous sound. Sounds are best distinguished by use of a stethoscope.

**157. What are the components of evaluation of the patient with TMJ symptoms?**

Evaluation of the patient with TMJ symptoms should include a detailed history of the problem, thorough physical examination, and appropriate radiographic and imaging studies.

**158. What should be included in the physical examination of the patient with TMJ symptoms?**

- Gross observation of the face to determine asymmetry
- Palpation of the muscles of mastication
- Observation of mandibular motion
- Palpation of the joint
- Auscultation of the joint
- Intraoral examination of the dentition and occlusion

**159. What are the parameters for normal mandibular motion?**

The normal vertical motion of the mandible results in 50 mm of intraincisor distance. Lateral and protrusive movement should range to approximately 10 mm.

**160. What radiographic and imaging studies are of value in evaluating the TMJ?**

A panoramic radiograph is a baseline screening radiograph. However, to identify bony disease of the joint and surrounding structures, CT studies provide the most definitive information. Magnetic resonance imaging (MRI) is the technique of choice to evaluate soft tissue changes (disc displacement) within the joint.

**161. What is the likelihood that a patient with TMJ symptoms will demonstrate identifiable pathology of the joint?**

Only 5% to 7% of patients presenting with TMJ symptoms have identifiable pathology of the joint. Based on this frequency, it clearly makes sense to proceed initially with conservative reversible treatment.

**162. What is the most common disorder associated with the TMJ?**

Myofascial pain dysfunction (MPD) is the most common clinical problem associated with the TMJ.

**163. What is the cause of MPD?**

The cause of MPD is multifactorial. Functional, occlusal, and psychological factors have been associated with its onset. Fortunately, most cases are self-limited.

**164. What occlusal factors may contribute to MPD?**

Clenching and bruxism may be associated with MPD because they may result in muscle spasm. Lack of posterior occlusion, which results in changes in the relationship of the jaws, also is a potential cause. The placement of restorations or prostheses that alter the

occlusion may cause MPD directly or indirectly through the patient's attempt to accommodate changes in the vertical dimension.

**165. What patient group is at highest risk for MPD?**

Of patients with MPD, 70% to 90% are women between the ages of 20 and 40 years.

**166. What are the diagnostic criteria for myofascial pain syndrome?**

1. Tender areas in the firm bands of the muscles, tendons, or ligaments that elicit pain on palpation
2. Regional pain referred from the point of pain initiation
3. Slightly diminished range of motion

**167. What signs and symptoms are associated with MPD?**

Patients with MPD may have some or all of the following:

- Pain on palpation of the muscles of mastication
- Pain on palpation of the joint
- Pain on movement of the joint
- Altered TMJ function, including trismus, reduced opening, and mandibular deviation on opening
- Joint popping, clicking or crepitus
- Stiffness of the jaws
- Facial pain

**168. What radiographic findings are associated with MPD?**

None. Radiographic studies of the joints of patients with MPD have failed to demonstrate the presence of pathology.

**169. Describe the treatment approach to MPD.**

Because most cases of MPD are self-limiting, a conservative reversible approach to intervention is recommended. Patients should be informed of the condition and its frequency in the overall population (patients always feel better knowing that they have something that is "going around," rather than some rare exotic disease) and then reassured. Mobility of the joint should be minimized. A soft diet, limited talking, and elimination of gum chewing should be recommended. Moist heat, applied to the face, is often helpful in relieving muscle spasms. Muscle relaxants (e.g., cyclobenzaprine [Flexeril]) can be prescribed. Pain symptoms generally respond to NSAIDs. For patients with evidence of occlusal trauma or abnormal function, fabrication of an occlusal appliance may be helpful.

**170. Why is heat applied to the face used in the treatment of facial muscle and TMJ pain?**

1. To reduce muscle spasm and myofascial pain
2. To stimulate removal of inflammatory byproducts
3. To induce relaxation and sedation
4. To increase cutaneous blood flow

**171. What are the contraindications for using superficial heat to treat facial pain?**

1. Acute infection
2. Impaired sensation or circulation
3. Noninflammatory edema
4. Multiple sclerosis

**172. What is the function of ultrasound in the therapy of myofascial pain?**

Ultrasound provides deep heat to musculoskeletal tissues through the use of sound waves. It is indicated for treatment of muscle spasm or contracture, inflammation of the TMJ, and increased sensitivity of the joint ligament or capsule. It is contraindicated in areas of acute inflammation, infection, cancer, impaired sensation, or noninflammatory edema. Ultrasound is typically administered by a physical therapist.

**173. What is internal derangement of the TMJ?**

Although internal derangement refers to disturbances among the articulating components within the TMJ, it is generally applied to denote changes in the relationship of the disc and the condyle.

**174. What are the main categories of internal derangement?**

- Anterior displacement of the disc with reduction  
Here, the meniscus is displaced anteriorly when the patient is in a closed-mouth position but reduces to its normal position on opening. Patients experience a click on opening and closing.
- Anterior displacement of the disc without reduction (also called a closed lock)
- Disc displacement with perforation

**175. What are the common symptoms of internal derangement?**

- Pain, generally in the preauricular area and usually constant, increasing with function
- Earache
- Tinnitus
- Headache
- Joint noise
- Deviation of the mandible on opening

**176. What imaging technique is useful for the diagnosis of internal derangement?**

MRI is the imaging technique of choice for evaluating soft tissue changes of the joint.

**177. What is the treatment of internal derangement?**

Initial treatment should be similar to that for MPD, and has been found to be beneficial for a number of patients, particularly those with anterior disc displacement with reduction. Surgical intervention may be required for patients who do not respond to conservative therapy.

**178. What are the most common causes of ankylosis of the TMJ?**

Infection and trauma are the most common causes of ankylosis caused by pathologic changes of joint structures. Severe limitation of TMJ function may also be caused by non-TMJ factors, such as contracture of the masticatory muscles, tetanus, psychogenic factors, bone disease, tumor, or surgery.

**179. Are tumors of the TMJ common?**

No. Tumors of the joint itself are rare. However, benign connective tumors are common, including osteomas, chondromas, and osteochondromas. Benign and malignant tumors also may affect structures adjacent to the joint, thereby affecting TMJ function.

**180. What is the effect of radiation therapy on the TMJ?**

Patients receiving radiation therapy for the treatment of head and neck cancer may experience fibrotic changes of the joint. Consequently, they have difficulty with opening the TMJ. Exercise may help minimize such functional changes.

**181. What is the effect of orthodontic therapy on the development of TMJ dysfunction?**

The results of many well-controlled scientific studies have revealed no causal relationship between orthodontics and TMJ dysfunction.

**182. What about extraction therapy?**

Again, the results of several well-controlled studies offer no support to the contention that extraction therapy may precipitate TMJ disorders.

**183. What degenerative diseases can affect the TMJ?**

Osteoarthritis, rheumatoid arthritis, and psoriatic arthritis may affect the TMJ. Over time, radiographs may demonstrate degenerative changes of joint structures. Often, patients have a history of one of these conditions elsewhere in the body.

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# INFECTION AND HAZARD CONTROLS

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## 1. What is the difference between infection control and exposure control?

Infection control encompasses all recommendations, policies, and procedures to prevent the spread of infection and/or the potential transmission of disease. Exposure control refers to recommendations, policies, and procedures for preventing exposures to potentially infective microbial agents.

## 2. Where do the recommendations come from?

These recommendations come from the Centers for Disease Control and Prevention (CDC): The most current recommendation on infection control in dental settings are “Guidelines for Infection Control in Dental Health Care Settings” (2003) and can be accessed at <http://www.cdc.gov/oralhealth/infectioncontrol/guidelines/index.htm>.

## 3. What is the difference between OSHA and CDC?

The U.S. Safety and Health Administration (OSHA) was established in 1970 for the sole purpose of protecting the health and safety of all workers. OSHA mandated through its General Duty Clause that “Each employer must ‘furnish to each of his employees, employment and a place of employment, which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.’”

In May 1989 OSHA issued draft regulations to address an increasing concern regarding occupational exposure to blood and other infectious body fluids (29 CFR Part 1910.1030; Bloodborne Pathogens Standard), and finalized the rule on December 6, 1991. When issuing the final rule, OSHA’s administrator said: “Today we are providing full legal force to universal precautions—employers and employees must treat blood and certain body fluids as if infectious. Meeting these requirements is not optional. It’s essential to prevent illness, chronic infection and even death.”

The Needlestick Safety and Prevention Act passed in 2000, requiring revisions to the Bloodborne Pathogens Standard. These revisions required employers provide engineered sharps injury protection devices when available. The CDC is the public health authority in the United States. The CDC makes recommendations to protect health and safety. These are based on current scientific information and are updated as necessary. The CDC monitors disease trends and investigates them to protect the health of the public.

CDC is an advisory agency and OSHA is a regulatory agency. OSHA regulations are directed at employers to protect employees, whereas the CDC develops guidelines designed to protect workers and patients.

## 4. Why are infection control and prevention important?

Dental health care workers and patients are exposed to various pathogens in a dental facility. There is potential contact with blood and other fluids, contaminated surfaces, and items and persons harboring transmissible pathogens. There are appropriate procedures that can minimize the risk of transmission and spread of disease.

## 5. What are the principles of infection prevention and control?

The CDC has developed four major principles to control the spread of infectious diseases from workers to patients, from patients to workers, and between patients. These principles are:

1. Take action to stay healthy.
2. Avoid contact with blood or other body fluids.
3. Limit the spread of contamination.
4. Make objects safe for use.

### 6. What are the major strategies of infection control?

- Immunizations
- Engineering controls
- Work practice controls
- Administrative controls

### 7. What are the major mechanisms whereby diseases are transmitted?

Disease may be transmitted by direct contact with the source of microorganisms (e.g., percutaneous injury, contact with mucous membranes, nonintact skin, or infective fluids, excretions, or secretions) and by indirect contact with contaminated environmental surfaces or medical instruments and aerosols.

### 8. What is aerosolization?

Aerosolization is a process whereby mechanically generated particles (droplet nuclei) remain suspended in the air for prolonged periods and may be capable of contributing to **airborne transmission** of disease, even at considerable distances from the source. Aerosols are airborne particles in the range of 5 to 10 mm in diameter and are capable of being inhaled and penetrating the bronchial tree to the alveoli of the lungs. In contrast, larger particles may be airborne in the sense that they travel through the air, but only for short times and distances; they are too large to be inhaled. They do not play a role in airborne transmission of disease per se, but may contribute to **direct transmission** (e.g., if they are from an infected source and contact a susceptible host in the mucous membranes of the eyes, nose, or mouth) or **indirect transmission** of disease (e.g., when they fall out onto horizontal surfaces and are subsequently transferred to the proper portal of entry into a susceptible host by hand or finger contamination). It is important to recognize the actual meaning of the term *true aerosol* because effective strategies for protecting against aerosol transmission of disease versus diseases transmitted by splash, spatter, and perhaps contaminated surfaces are significantly different.

### 9. What barriers may be used to block these routes of transmission?

A surgical mask or an appropriate face shield provides some degree of protection from contact with larger airborne particles such as splash and spatter. Surgical masks were neither designed nor intended to protect the worker from true aerosols (see question 8). Surgical masks and protective eyewear help prevent mucous membrane exposures. Clinic attire and gloves offer skin contact protection. The basic idea is to put a barrier between exposed areas of the body and microbe-laden materials.

In regard to tuberculosis (TB), a surgical mask is not the appropriate barrier for the prevention of transmission of airborne organisms such as *Mycobacterium tuberculosis* found in droplet nuclei. The National Institute for Occupational Safety and Health (NIOSH) recommends a number of engineering controls when treating patients with active TB, including a negative air pressure room, special air filtration within the room, and use of a personal respirator.

### 10. What precautions should be taken when treating a patient with suspected or confirmed tuberculosis in a dental office?

Patients with suspected or confirmed active TB should not be treated in a typical dental setting. Treatment should be deferred until they are no longer infectious or, if emergency treatment must be provided, it should be done in a setting equipped with airborne infection isolation rooms.

### 11. What does OSHA require in a written exposure control plan?

OSHA requires at least the following elements:

1. The employer's "exposure determination," which identifies at-risk employees
2. An implementation schedule and discussion of specific methods of implementing requirements of the OSHA Bloodborne Pathogens Standard
3. The method for evaluating and documenting exposure incidents
4. Noting that consideration was given to the use of safety devices, as evidenced by staff evaluation and determination of whether they were feasible for use in the practice

### 12. How often must a written exposure control plan be reviewed?

OSHA's Bloodborne Pathogens Standard requires an annual review of a written exposure control plan. The plan must be reviewed and updated after any changes in knowledge, practice, personnel, guidelines, or regulations that may affect occupational exposure.



**13. Are there any revisions to the exposure control plan (ECP)?**

OSHA revised some requirements for the ECP in the Needlestick Safety and Prevention Act of 2000. There has always been a requirement to review and update the ECP annually. This update and review must now include changes in technology that eliminate or reduce exposure to bloodborne pathogens. Therefore, the plan should document consideration and implementation of appropriate safety devices designed to eliminate or minimize occupational exposure. This documentation must include evidence that employees who use the devices have had input into the identification, evaluation, and selection of the devices.

**14. What is an exposure incident?**

According to OSHA, an exposure incident is any reasonably anticipated eye, skin, mucous membrane, or parenteral contact with blood or other potentially infectious fluids during the course of one's duties. In more general terms, an exposure incident is an occurrence that puts one at risk of a biomedical or chemical contact or injury on the job.

**15. What should be included in the procedure for evaluating an exposure incident?**

At least the following factors should be considered in evaluating an exposure incident:

1. Where the incident occurred in terms of physical space in the facility
2. Under what circumstances the exposure occurred
3. Engineering controls and work practices in place at the time of the exposure, including the use of a safety device
4. Policies in place at the time of the incident
5. Type of exposure and severity of the injury
6. Any information available about the source patient
7. The presence of visible blood on the device

**16. How does OSHA define a "source individual" in the context of an exposure incident?**

The standard defines a source individual as any individual, living or dead, whose blood or other potentially infectious materials may be a source of occupational exposure.

**17. Are students covered by OSHA standards?**

In accordance with the Occupational Safety and Health Act of 1970, OSHA jurisdiction extends only to employees and does not cover students if they are not considered to be employees of the institution. If, however, the student is paid by the institution, he or she becomes an employee. Regardless of employee status, most aspects of the OSHA Bloodborne Pathogens Standard are considered to be standards of practice for all health care workers and are designed to prevent the potential transmission of disease. Therefore, the safe practices and procedures outlined in the standard should be followed by all health care workers.

**18. How do you determine who is at risk for a bloodborne exposure?**

The first step is to conduct a risk assessment, which begins by evaluating the tasks that are always done, sometimes done, and never done by an employee. If any one task carries with it an opportunity for contact with any potentially infective (blood or blood-derived) fluid or if a person may, even once, be asked to do a task that carries such an exposure risk, that employee is at risk and must be trained to abate or eliminate risk.

**19. Can the receptionist help out in the clinic?**

The receptionist can help out only if he or she has been trained to work in a manner that reduces risk of an exposure incident, understands the risk, and has received (unless otherwise waived) the hepatitis B vaccine or demonstrates immunity from past infection.

**20. What is an engineering control?**

This term refers to industrial hygiene and is used by OSHA for technologically derived devices that isolate or remove hazards from the work environment. The use of engineering controls may reduce the risk of an exposure incident. Examples include ventilation systems, ergonomic design of equipment and furnishings, and safety devices.

**21. Give examples of engineering controls used in dentistry.**

A needle-recapping device is an engineering control, as is a sharps container. These items are designed to isolate sharps, wires, and glass. A rubber dam, which serves as a barrier between the operator and potentially infective patient fluids, is also an engineering control

because it reduces aerosols and splashing and spattering of large droplets during dental procedures. A newer engineering control in the dental setting is safety devices.

**22. What is an SESIP?**

SESIP is an acronym for sharps with engineered sharps injury protection. It refers to a non-needle sharp or needle device with a built-in safety feature or mechanism that effectively reduces the risk of an exposure incident.

**23. Where is the most reasonable location for a sharps container?**

To be most effective in reducing the hazard associated with nonreusable sharps, the container should be placed in a site near where the sharps are used and not in a separate area that requires transport or additional handling.

**24. What needle-recapping devices are acceptable?**

First, any recapping must be done with a mechanical device or technique that uses only one hand (scoop technique). Such techniques ensure that needles are never pointed at or moved toward the practicing health care worker or other workers, either on purpose or accidentally. Newer, self-sheathing anesthetic syringes and needle devices do not require any movements associated with recapping.

**25. What is a work practice control? How does it differ from an engineering control?**

Work practice controls are determined by behavior, rather than technology. Quite simply, a work practice control is the manner in which a task is performed. Safe work practice controls sometimes require changing the manner in which a task is performed to reduce the likelihood of an exposure incident. For example, in recapping a needle, whether or how you use a device is the work practice. Something as simple as how you wash your hands is also a work practice control.

**26. What is the most appropriate work practice control in cleaning instruments?**

Probably the best technique for cleaning instruments is to use an ultrasonic cleaner or instrument washer because of its potential to reduce percutaneous injuries. If these are not available, the work practice is to select one or two instruments at a time with gloved hands, hold them low in the sink under running water, and scrub them with a long-handled brush. Essentially, the strategy is to clean reusable instruments and items in a manner that minimizes hand contact.

**27. What should a proper hand washing agent be expected to accomplish?**

At a minimum, it should do the following: (1) provide good mechanical cleansing of skin; (2) have the capacity to kill a variety of microorganisms if used in a surgical setting; (3) have some residual antimicrobial effect to prevent regrowth of resident bacteria and fungi when used for surgical hand washing; and (4) be dispensed without risk of cross-contamination among workers.

The major concern, exclusive of surgery, is the transient flora on workers' hands. The primary idea is to wash off the flora, not just kill them in situ with an antimicrobial agent. In surgery, antimicrobial products are the standard of care to address the health care worker's resident flora, which multiply under the glove. Surgical hand washing is used when a direct intent of the medical procedure is to break soft tissue.

**28. When should a dental health care worker wash and dry hands before gloving? When should he or she use an antiseptic hand rub agent?**

CDC Guidelines are outlined in Table 12-1. Hand hygiene recommendations are specific to the type of procedure to be performed (e.g., clean technique or surgical procedure).

**29. Can dental charts be contaminated? How can you reduce the risk of cross-contaminating dental charts?**

A dental chart may be contaminated if it is in an area where it may come into contact with potentially infective fluids. This risk may be minimized if the charts are not taken into a patient or clinical area. If, however, they must be accessible during treatment, they should be appropriately handled with noncontaminated gloves. Overgloves worn on top of clinic gloves for handling records are one possibility. Another is to protect the record with a barrier.

**Table 12-1.** Hand-hygiene Methods and Indications

METHOD	AGENT	PURPOSE	DURATION (MINIMUM)	INDICATION*
Routine handwash	Water and nonantimicrobial soap (e.g., plain soap <sup>†</sup> )	Remove soil and transient microorganisms	15 seconds <sup>§</sup>	Before and after treating each patient (e.g., before glove placement and after glove removal). After barehanded touching of inanimate objects likely to be contaminated by blood or saliva. Before leaving the dental operatory or the dental laboratory.
Antiseptic handwash	Water and antimicrobial soap (e.g., chlorhexidine, iodine and iodophors, chloroxylenol [PCMX], triclosan)	Remove or destroy transient microorganisms and reduce resident flora	15 seconds <sup>§</sup>	When visibly soiled. <sup>¶</sup> Before regloving after removing gloves that are torn, out, or punctured.
Antiseptic hand rub	Alcohol-based hand rub <sup>¶</sup>	Remove or destroy transient microorganisms and reduce resident flora	Rub hands until the agent is dry <sup>¶</sup>	
Surgical antiseptics	Water and antimicrobial soap (e.g., chlorhexidine, iodine and iodophors chloroxylenol [PCMX], triclosan)	Remove or destroy transient microorganisms and reduce resident flora (persistent effect)	2-6 minutes	Before donning sterile surgeon's gloves for surgical procedures <sup>††</sup>
	Water and non-antimicrobial soap (e.g., plain soap <sup>†</sup> ) followed by an alcohol-based surgical hand-scrub product with persistent activity		Follow manufacturer instructions for surgical hand-scrub product with persistent activity <sup>¶**</sup>	

\* (7,9,11,13,113,120-123,125,126,136-138).

<sup>†</sup>Pathogenic organisms have been found on or around bar soap during and after use (139). Use of liquid soap with hands-free dispensing controls is preferable.

<sup>§</sup>Time reported as effective in removing most transient flora from the skin. For most procedures, a vigorous rubbing together of all surface of premoistened lathered hands and fingers for  $\geq 15$  seconds, followed by rinsing under a stream of cool or tepid water is recommended (9,120,123,140,141). Hands should always be dried thoroughly before donning gloves.

<sup>¶</sup>Alcohol-based hand rubs should contain 60%-95%, ethanol or isopropanol and should not be used in the presence of visible soil or organic material. If using an alcohol-based hand rub, apply adequate amount to palm of one hand and rub hands together, covering all surfaces of the hands and fingers, until hands are dry. Follow manufacturer's recommendations regarding the volume of product to use. If hands feel dry after rubbing them together for 10-15 seconds, an insufficient volume of product likely was applied. The drying effect of alcohol can be reduced or eliminated by adding 1%-3% glycerol or other skin-condition agents (123).

<sup>\*\*</sup>After application of alcohol-based surgical hand-scrub product with persistent activity as recommended, allow hands and forearms to dry thoroughly and immediately don sterile surgeon's gloves (144,145). Follow manufacturer instructions (122,123,137,146).

<sup>††</sup>Before beginning surgical hand scrub, remove all arm jewelry and any hand jewelry that may make donning gloves more difficult, cause gloves to tear more readily (142,143), or interfere with glove usage (e.g., ability to wear the correct sized glove or altered glove integrity).

From Centers for Disease Control and Prevention. *Guidelines for Infection Control in Dental Health-Care Settings—2003*. MMWR 2003;52(No. RR-17):(15).

## PERSONAL PROTECTIVE EQUIPMENT

- 30. What type of gloves should be worn for different procedures and tasks?**  
The type of glove must first provide appropriate hand protection for the anticipated exposures, such as biologic, chemical, and/or physical (sharp). Next, within each procedure or exposure category, there are choices of materials based on several factors, including personal health compatibility (allergies and fit).
- 31. How do you determine what types of personal protective equipment (PPE) you should use?**  
The selection of PPE should be based on the type of exposure anticipated and the quantity of blood, blood-derived fluids, or other potentially infective materials that might reasonably be expected in the performance of one's duties. With normal use, the material should prevent passage of fluids to skin, undergarments, or mucous membranes of the eyes, nose, or mouth.
- 32. Do gloves provide protection from a sharps exposure?**  
They provide protection to a limited degree, at best. Some studies indicate that the mechanical action of a sharp passing through the glove may reduce the microbial load. However, even heavy-duty utility gloves do not block penetration. In addition, blunt instruments pose injury risks for the dental health care worker and patient.
- 33. Does clinic attire (lab coats) protect one from potentially infective fluids?**  
The intent of clinic attire is to prevent potentially infective fluids from reaching skin, especially nonintact skin, which can serve as a portal of entry for pathogenic organisms. Putting an effective barrier, such as a lab coat, between the body and these fluids reduces the risk of infection. Such garments are contaminated and should not be worn outside the clinic area.
- 34. Should clinic attire be long- or short-sleeved?**  
Because the OSHA standards are performance-based, the dental health care worker must determine whether the procedure is likely to result in contact with patient fluids or materials. If the answer is yes, the potential contact area should be covered.
- 35. How do you determine whether eyewear is protective?**  
The best way is to read the standards of the American National Standards Institute (ANSI). These describe protective eyewear as impact-resistant, with coverage from above the eyebrows down to the cheek and solid side shields to provide peripheral protection. The eyewear should protect not only from fluids but also from flying debris that might be generated during a dental procedure.
- 36. Is a surgical mask needed under a face shield?**  
Yes, it is needed, unless the face shield has full peripheral protection at the sides and under the chin. The mask protects the dental health care worker from splashes and spatters to the nose and mouth.
- 37. What type of protection do most masks used in dental offices offer?**  
The masks used in dental offices do not provide definable respiratory protection; their primary design is to protect the patient. However, the physical barrier certainly protects covered areas from droplet scatter generated during treatment. If respiratory protection is indicated, masks must be certified for respiratory protection. Read the product label.
- 38. How long can a mask be worn?**  
One can wear a mask until it becomes wet, torn, or somehow compromised. At a minimum, a new mask must be worn for each patient. Limited research indicates that the duration for use is about 1 hour for a dry field and 20 minutes for a wet field.
- 39. What is the purpose of heavy duty utility gloves?**  
Heavy duty utility gloves, such as those made of nitrile rubber, should be worn whenever contaminated sharps are handled. They are worn for safe pickup, transport, cleaning, and packing of contaminated instruments. They also should be used for housekeeping procedures such as surface cleaning and disinfection. Routine cleaning and disinfection are

necessary because the gloves also become contaminated. They should not be worn when handling or contacting clean surfaces or items.

**NOTE:** Examination gloves are not appropriate for instrument cleaning or reprocessing or any housekeeping procedure (Table 12-2).

#### 40. What is irritant dermatitis?

It is a nonallergic process that damages superficial layers of skin. It is mainly caused by contact that challenges the skin tissue.

#### 41. What are its symptoms?

In general, the top layer of the skin becomes reddened, dry, irritated, or cracked.

#### 42. What causes of dermatitis are associated with health care workers' hands?

Nonallergic irritant dermatitis is the most common form of adverse reaction. It is often caused by the following: (1) contact with a substance that physically or chemically damages the skin, such as frequent antimicrobial hand washing agents on sensitive skin; (2) failure to rinse off chemical antiseptic completely; (3) excessive exposure to water; and (4) failure to dry hands properly and thoroughly.

#### 43. What common types of hypersensitivity symptoms are caused by latex gloves and other latex items?

1. **Cutaneous anaphylactic reaction** (type I hypersensitivity) typically develops within minutes after an allergic individual comes into direct contact with allergens via tissues or mucous membranes (donning latex examination or surgical gloves) or is exposed via aerosolization of allergens. Natural rubber latex proteins adhering to glove powder particles can remain suspended in the air for prolonged periods after gloves are placed on the hands and when new boxes of gloves are opened. Wheal and flare reaction (e.g., urticaria, hives) may develop, along with itching and localized edema. Coughing, wheezing, shortness of breath, and/or respiratory distress may occur, depending on the person's degree of sensitization. Type I hypersensitivity can be life-threatening; appropriate medical supplies (e.g., epinephrine) should always be immediately available.
2. **Contact dermatitis** (delayed type IV hypersensitivity) is characterized by a several-hour delay in the onset of symptoms and a reaction that peaks in 24 to 48 hours. This slow-forming, chronic inflammatory reaction is well demarcated on the skin and is surrounded by localized erythema. Healing may take up to 4 days, with scabbing and sloughing of affected epithelial sites.

#### 44. What should be done for health care workers who develop symptoms or reactions that may be caused by latex hypersensitivity?

The first step is to determine that you are dealing with a true reaction to latex. The most common type of hand dermatitis is actually nonspecific irritation and not an immunologic response. Nonspecific irritation can have a similar appearance to a type I or IV reaction but often results from improper hand care, such as not drying hands completely before putting on gloves. In addition, allowing dry hands to go untreated, especially during colder seasons, may lead to development of chapped broken areas in the epithelium.

**Table 12-2.** How to Select Task-appropriate Gloves

FOR THIS TASK:	USE THIS GLOVE:
Contact with body, as during surgery	Sterile surgical gloves
Routine intraoral procedures, routine contact with mucous membranes	Nonsterile examination gloves
Nonclinical care or treatment procedures, such as processing radiographs and writing in a patient record	Copolymer gloves or overgloves
Contact with chemical agents, contaminated sharps, and other potential exposure incidents not related to patient treatment	Heavy-duty utility gloves

Definitive diagnosis through clinical and laboratory tests by a qualified health care professional is necessary. Specific treatment and latex avoidance recommendations must be followed by the latex-sensitive or allergic health care worker. Accommodations in products selection and work environment may be required in order for the health care worker to return to work safely. In an alert to health professionals in 1991, the U.S. Food and Drug Administration (FDA) also suggested that persons with severe latex sensitivity should wear a medical identification bracelet in case they require emergency medical care and are unable to alert hospital personnel.

**45. What risk factors are associated with latex allergy?**

- Frequent exposure to latex
- Frequent catheterization
- History of surgery
- Spina bifida
- Allergies to certain food, such as bananas, avocados, kiwi fruit, and chestnuts

**46. What are the official recommendations for protection of health care workers with ongoing exposure to latex?**

NIOSH recommends the following steps for worker protection:

1. Use nonlatex gloves for activities that are not likely to involve contact with infectious materials (e.g., food preparation, routine housekeeping and maintenance).
2. When appropriate barrier protection is necessary, choose powder-free latex gloves with reduced protein content.
3. When wearing latex gloves, do not use oil-based hand creams or lotions unless they have been shown to reduce latex-related problems.
4. Frequently clean work areas contaminated with latex dust.
5. Frequently change the ventilation filters and vacuum bags in latex-contaminated areas.
6. Learn to recognize the symptoms of latex allergy—skin rashes and hives; flushing and itching; nasal, eye, or sinus symptoms; asthma; and shock.
7. If you develop symptoms of latex allergy, avoid direct contact with latex gloves and products until you see a physician experienced in treating latex allergy.
8. Consult your physician about the following precautions:
  - Avoid contact with latex gloves and products.
  - Avoid areas in which you may inhale the powder from latex gloves worn by others.
  - Wear a medical alert bracelet.
9. Take advantage of all latex allergy education and training provided by your employer. See the NIOSH website ([www.NIOSH.gov](http://www.NIOSH.gov)) for updated information.

**47. A patient reports a latex allergy and says that if a glove touches her, she will break out. What type of glove should be used in place of latex?**

There are nonlatex (synthetic) gloves which provide appropriate barrier protection and reduce concern for an allergic response. However, depending on the severity of the allergy, more serious responses may occur merely in the presence of latex. You may wish to consult with the patient's allergist for additional recommendations.

**48. Why are lanolin hand creams contraindicated with glove use?**

The fatty acids in lanolin break down the latex, causing wicking. This same process can cause a buildup of film on the hands.

## BLOODBORNE INFECTIONS AND VACCINATION

**49. What are universal precautions?**

Universal precautions, a concept of infection control, assume that any patient is potentially infectious for a number of bloodborne pathogens. Blood, blood-derived products, and certain other fluids that are contaminated with blood are considered infectious for human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), and other bloodborne pathogens. Standard Precautions are procedure-specific, not patient-specific.

In dentistry, saliva is normally considered to be blood-contaminated. The basic principle and implementation of this concept is that gloves (and other PPE, as appropriate) should be worn “*universally* with *all* patients, i.e., without regard to whether a particular patient’s bloodborne infection state is known.”

#### 50. What are Standard Precautions?

In 1996, the CDC developed new guidelines that combined the major components of universal precautions and body substance isolation into one set of precautions known as Standard Precautions. According to the Oral Health Division of the CDC, they are similar to universal precautions in that they are designed to reduce the risk of transmission of pathogens from recognized and unrecognized sources of infection to other patients and to health care workers. Standard Precautions apply to blood, body fluids, secretions, and excretions (except sweat), regardless of whether they contain blood, to nonintact skin and mucous membranes. Standard Precautions should be used in the care of all patients, regardless of their infectious status. This expanded set of precautions teaches simply that “if it’s a wet body substance and it doesn’t belong to you, wear your gloves and other PPE as appropriate to avoid direct contact with it while delivering health care to the patient.”

#### 51. What is the chain of infection?

The chain of infection refers to the prerequisites for infection (by direct or indirect contact). The chain of infection must include the following:

- A susceptible host
- A pathogen with sufficient infectivity and numbers to cause infection
- An appropriate portal of entry to the host (e.g., a bloodborne agent must gain access to the bloodstream, whereas an enteric agent must enter the mouth [digestive tract])
- A reasonably efficient physical mode of pathogen transfer from source to host

#### 52. Which factor is easiest to control—agent, host, or transmission?

Agent and host are more difficult to control than transmission. Standard Precautions are directed toward interrupting the transfer of microorganisms from patient to health care worker, and vice versa.

#### 53. What is one of the single most important measures to reduce the risk of transmission of microorganisms?

Hand hygiene, such as hand washing, is one of the most important measures in reducing the risk of transmission of microorganisms. Hands should *always* be thoroughly washed between patients, after contact with blood or other potentially infective fluids, after contact with contaminated instruments or items, and after removal of gloves. Gloves also play an important role as a protective barrier against cross-contamination and reduce the likelihood of transferring microorganisms from health care workers to patients and from environmental surfaces to patients. A cardinal rule for safety is never to touch a surface with contaminated gloves that will subsequently be touched with ungloved hands.

#### 54. Is exposure synonymous with infection?

No. An exposure is a contact that has a reasonable potential to complete the chain of infection and result in disease of the host. Infection occurs when the exposure leads to transmission of the pathogen.

#### 55. What are hepatitis B and delta hepatitis?

Hepatitis B is one of most common reportable diseases in the United States. HBV is transmitted through blood or blood-contaminated body fluids. It is highly transmissible because of the large numbers of virus in the blood of infected persons (about 100 million/mL). Delta hepatitis is caused by a defective virus (hepatitis D virus [HDV]) that relies on HBV for its pathogenicity and can infect only in the presence of HBV. HBV and HDV co-infection, however, results in a fulminant course of liver disease. Hepatitis D is very rarely seen in the United States but may be encountered when traveling to certain countries. If successfully vaccinated against HBV, one cannot contract HDV.

**56. Why is hepatitis B vaccination so important?**

HBV is the major infectious occupational hazard to health care workers. Transmission has been documented from providers to patients, and vice versa. In 1982, a vaccine became available to provide protection from HBV infection. The first-generation vaccine was plasma-derived, but the vaccine in current use is genetically engineered. The safety and efficacy of the vaccine are well established, and there is no current recommendation for booster doses. Furthermore, protection from HBV also confers protection from HDV.

**57. If you are employed in a dental practice, who pays for the HBV vaccine—you or your employer?**

If an employee may be exposed to blood or other potentially infectious fluids during the course of work, it is the obligation of the employer to offer and pay for the series of vaccinations. According to OSHA regulations, the vaccine series must be offered to all at-risk employees within 10 working days of hire or reassignment to the position with occupational exposure to blood. A hepatitis B surface antibody titer test (referred to as anti-HBs or HBsAb) is recommended 1 to 2 months after completion of the vaccine series to verify that the health care worker is protected. Because this is a U.S. Public Health Service (USPHS) recommendation, the employer is expected to pay the cost of the titer test.

**58. What if I refuse the vaccination?**

In most states, you have a right to refuse the vaccination. You should realize, however, that without the HBV vaccination series or evidence of previous infection, you remain at risk for acquiring HBV infection. Because OSHA considers the HBV vaccination one of the most important protections that a health care worker can have, the agency requires the employee to sign a waiver if the vaccination is refused. Only after the employee has been informed of the safety and efficacy of the vaccine and the potential consequences of not receiving the vaccine can they sign the declination form. The language used in the declination must be that which is specified in the OSHA Bloodborne Pathogens Standard. If an employee with occupational exposure to blood declines the vaccine and later decides to accept it, the employer must still pay the cost of the vaccination series.

**59. What is the risk of acquiring HBV infection from a percutaneous exposure to blood known to be infected with HBV?**

The risk of becoming infected with HBV varies with the presence or absence of HBsAg. If the source is e antigen-positive, the risk of 22% to 30%; if the source is e antigen-negative, the risk is 1% to 6%. This risk is for an unprotected, nonvaccinated health care worker.

**60. What is the risk of HIV transmission associated with percutaneous and/or mucous membrane exposures to blood known to be HIV-positive?**

The risk is about 0.3% (1/300) for percutaneous and about 0.09% (1/900) for mucous membrane exposures. Many factors, however, influence the likelihood of transmission (see question 66). Accumulated data from studies involving health care worker exposures suggest a 0.2% to 0.4% risk of HIV infection, with the worst case scenario of a severe percutaneous injury involving exposure to blood from a terminal HIV patient.

**61. How can percutaneous injuries be prevented?**

Use devices with engineered safety features designed to prevent injuries such as self-sheathing needles, blunt suture blades, other safe disposable needle systems, and the use of appropriate sharps containers.

Use safer work practices that avoid hand contact with sharps, such as not debriding an instrument by hand with gauze but rather by using a single-hand technique, such as cotton rolls taped to a bracket tray or use of a commercial safe wipe device. Also, when handling sharps, use caution not to come into contact with the sharp instrument, such as not recapping a syringe or disengaging needles from a reusable syringe by hand.

**62. What are the elements of a postexposure management program?**

1. Wound management
2. Exposure reporting and documentation
3. Medical follow-up



**63. How do you assess the risk of infection?**

The risk of infection is assessed by type of exposure, body substance involved, and source evaluation. Assessing the type of exposure determines whether it is percutaneous, mucous membrane, nonintact skin, or a bite resulting in blood exposure. Risk also depends on the type of body fluid, with blood or bloody fluid being a higher risk. Caution should also be used for potentially infectious fluid or tissue. In terms of the source evaluation, consideration must be given to the presence of HBsAg, presence of HCV antibody, and/or the presence of HIV antibody. If the source status is unknown, a community or practice assessment is indicated.

**64. What is appropriate wound management?**

1. Cleaning the wound with soap and water
2. Flushing mucous membranes with water

**NOTE:** Bleeding the wound or the use of bleach or caustic agents is not recommended.

**65. Are any of these injuries preventable?**

Yes. Data indicate that many reported injuries were preventable. In the event of a device failure, an injury may not have been preventable. Device failures should be reported to the FDA MedWatch program.

**66. What is the major factor in the prevention of bloodborne pathogen transmission in health care settings?**

Although engineering controls are a major factor in reducing the risk of an exposure, work practice controls have the greatest impact on preventing bloodborne disease transmission. Over 90% of the injuries leading to disease transmission have been associated with syringes and sharp instruments. Injuries also may be prevented by engineering controls, particularly the use of safer medical devices. A safe device will not prevent an injury unless it is properly used. The overall message is to maintain consistent levels of attention and take personal care (Box 12-1).

**BOX 12-1. Recommendations for Managing Occupational Blood Exposures**

Establish written protocols for management of occupational exposures (these are based on the most current USPHS guidelines):

- Review periodically.
- Provide training to personnel—prevention and response to occupational exposures.
- Identify a qualified healthcare provider who is familiar with the most current USPHS postexposure management recommendations, antiretroviral therapy, bloodborne disease transmission, and the OSHA Bloodborne Pathogens Standard; will ensure prompt evaluation, treatment, management, and follow-up of occupational exposures; and will provide necessary counseling.

Provide immediate care to the exposure site:

- Wash wounds and skin with soap and water.
- Flush mucous membranes with water.

Immediately report the exposure to the infection control coordinator who should:

- Initiate referral to a qualified health care professional.
- Complete necessary reports.

Include the following information in the postexposure report:

- Date and time of exposure
- Details of the procedure being performed: where and how the exposure occurred; type of device involved; how and when during its handling the exposure occurred
- Details of the exposure: type and amount of fluid or material; severity of the exposure
- Details about the exposure source (HBV, HCV, HIV): if the source was infected with HIV—note the stage of disease, history of antiretroviral therapy, and viral load, if known
- Details about the exposed person (e.g., hepatitis B vaccination, vaccine-response status)
- Details about counseling, postexposure management, and follow-up

*From Centers for Disease Control and Prevention. Updated U.S. Public Health Service Guidelines for the Management of Occupational Exposures to HBV, HCV, and HIV and Recommendations for Postexposure Prophylaxis. MMWR 2001;50(No. RR-11).*

**67. If I injure myself while working on a patient or using contaminated instruments from an identifiable patient, can someone call the patient's personal physician for additional medical history information?**

In almost all states, a written informed consent is necessary before a physician can release information on a patient. Obtaining information without this consent may be a violation of the Health Insurance Portability and Accountability Act (HIPAA) or other state laws. The situation may be discussed with the source patient to ask for consent to obtain additional information about his or her health. Regardless of the answer, an appropriate health care professional should evaluate you as soon as feasible if the injury warrants this.

**68. What treatment options are available to a health care worker who has been exposed to HBV?**

The health care worker may consider having a hepatitis B antibody titer to determine HBV serostatus. However, treatment should be initiated within 24 hours. If the health care worker was not vaccinated against HBV or does not have demonstrable antibody titer against hepatitis B surface antigen (anti-HBsAg), hepatitis B immunoglobulin (HBIG) should be administered as soon as possible. The HBV vaccination series should be initiated at the same time. An exposed health care worker may also need to consider the possibility that HIV and/or HCV exposure may have occurred simultaneously.

The efficacy of HBV postexposure prophylaxis (PEP) is based on perinatal data. These data indicate that if multiple doses of HBIG alone or the vaccine series alone is given within 1 week, the prevention of HBV infection is 70% to 75%. If a combination of HBIG and the vaccine series is administered, the efficacy increases to 85% to 95%.

**69. How effective is the HBV vaccine?**

Anti-HBs titers decline in 30% to 50% of adults within 8 to 10 years after vaccination. However, it is believed that the immune memory remains intact indefinitely after immunization. Chronic infection has rarely been documented in vaccine responders.

**70. Describe postexposure follow-up for HBV.**

The major elements are baseline evaluation and testing of the exposed health care worker, consideration of treatment options, and follow-up testing and counseling, as indicated. If the exposed person has been vaccinated but the vaccine response is unknown, test for anti-HBs. If, however, the exposed health care worker has not been vaccinated, or if the response is known, baseline testing is not necessary.

For health care workers who receive the HBV vaccine, follow-up testing for anti-HBs is indicated at 1 to 2 months after the last dose. If however, HBIG was also administered, the vaccine response cannot be ascertained until 3 to 4 months. If the source is not infected, follow-up is not necessary.

**71. When must a percutaneous exposure (e.g., needlestick) be reported to OSHA?**

Any occupational exposure or injury must be recorded on OSHA or the practice's forms if it is work-related, required medical evaluation and/or follow-up, or resulted in seroconversion. There are some specific exceptions for small employers. Seroconversion as the result of occupational exposure also should be reported to the appropriate state agencies and the CDC.

**72. If I am a hepatitis B carrier, can I continue work that involves patient contact?**

You may continue clinical care as long as you adhere strictly to Standard Precautions. Only clinicians performing the most invasive of surgical procedures should consult with an expert panel to determine whether work restrictions are indicated.

**73. What is hepatitis C?**

HCV is a single-stranded RNA virus isolated in 1989. Much like hepatitis B, HCV may be transmitted via contact with HCV-infected blood. There are major differences between HCV and HBV. A large majority of individuals who contract HCV will develop chronic HCV infection. HCV is rarely implicated in health care-related transmissions, but there have been some cases documented in which HCV was transmitted to patients or clinicians. Cases of patient to patient transmission have been associated with a lack of good infection control practices, including improper instrument sterilization and mishandling of multidose medications.

**74. How is HCV transmitted? What are the implications for health care workers?**

HCV is a bloodborne disease and is spread primarily via a parenteral route; sexual and maternal-fetal (vertical) transmission are minor modes of viral passage. Health care workers should follow Standard Precautions, as indicated. HCV has not been found to be efficiently transmitted by occupational exposure, although it has been documented. The prevalence among health care workers is about 1% to 2% (less than in the adult general population) and 10 times lower than for HBV infection. The average risk is 1.8% after a percutaneous injury from an HCV-positive source.

**75. What other information about HCV is important for health care workers?**

1. No postexposure prophylaxis is available. However, medical follow-up for an exposure is important and should be considered an immediate medical concern. The exposed worker can be tested for possible prior exposure to HCV and monitored for early signs of seroconversion.
2. No vaccine is available.
3. Health care workers should be educated about risk and prevention.
4. Policies about testing and follow-up should be established.
5. There are no current recommendations for restriction of practice for HCV-infected health care workers.
6. Risk of transmission from health care worker to patient appears low.
7. Appropriate control recommendations for the prevention of bloodborne disease transmission should be followed.

**76. Does the CDC have specific policy recommendations for follow-up after percutaneous or permucosal exposure to HCV-positive blood?**

As of July 4, 1997, the CDC recommended that minimal policies should include the following:

1. For the source, baseline testing for antibody to HCV (anti-HCV)
2. For the person exposed to an anti-HCV-positive source, baseline and follow-up testing (e.g., 6 months) for anti-HCV and alanine aminotransferase (ALT) activity
3. Confirmation by supplemental anti-HCV testing of all anti-HCV results reported as repeatedly reactive by enzyme immunoassay (EIA)
4. Recommendation against postexposure prophylaxis with immunoglobulin or antiviral agents (e.g., interferon)
5. Education of health care workers about the risk for and prevention of bloodborne infections, with routine updates to ensure accuracy

**77. In the absence of postexposure prophylaxis, what other issues should be considered?**

The CDC recommends consideration of at least six issues in defining a protocol for the follow-up of health care workers occupationally exposed to HCV:

1. Limited data suggest that the risk of transmission after a needlestick is between that for HBV and HIV. Data for other routes of exposure are limited or nonexistent.
2. Newer generation tests, including rapid tests, are available and have a higher sensitivity and specificity than earlier tests.
3. The risk of transmission by sexual and other exposures is not well defined; all anti-HCV-positive persons should be considered potentially infectious.
4. There are new therapies for treating acute and chronic HCV that have proven to be effective. Therefore, monitoring for disease is important so that if transmission has occurred, treatment can be instituted at an early stage. There is evidence that newer treatment protocols have cleared HCV, but the long-term outcomes have not been established.
5. Costs associated with follow-up are a consideration.
6. A postexposure protocol should address medical and legal implications, such as counseling about an infected health care worker's risk of transmitting HCV to others, therapy decisions, and individual worker concerns.

**Table 12-3.** Potential Transmission Risks to Health Care Workers

<b>PATHOGEN</b>	<b>CONCENTRATION IN SERUM OR PLASMA (/mL)</b>	<b>TRANSMISSION RATE AFTER NEEDLESTICK INJURY (%)</b>
HBV	1,000,000-100,000,000	6.0-30.0
HCV	10-1,000,000	1.8
HIV	10-1,000	0.3

**78. What are the elements of postexposure management for HCV?**

As with other bloodborne exposures, baseline testing and follow-up testing and counseling are necessary. If the source patient is HCV-positive, the exposed health care worker should be tested for anti-HCV and ALT. If the source is not infected, baseline testing is not necessary. However, if the source is unknown, the risk of infection must be assessed to determine the indicated follow-up.

**79. What if the source is HCV-positive?**

If the source is HCV-positive, test for anti-HCV and ALT at baseline and 4 to 6 months after the exposure. For earlier diagnosis of HCV infection, an HCV-RNA test may be done at 4 to 6 weeks. Positive results should be confirmed with a supplemental Western blot confirmatory test. Note that there is a rapid test (screening) for HCV.

**80. What is the relationship between viral load and potential rate of transmission to health care workers for HBV, HIV, and HCV?**

See Table 12-3.

**81. Have there been reports of transmission of HCV from health care workers to patients?**

There have recently been reports of transmission in dental facilities. Past reports in the United States involved transmission from a cardiac surgeon to at least three patients. According to the CDC, the genetic match was “almost perfect” between the surgeon and the patients. The CDC further indicated that such transmissions are “exceedingly rare.”

**82. What are the guidelines for postexposure management for occupational exposure to bloodborne pathogens?**

In June 2001, the CDC updated and revised recommendations for HIV (2013) and the guidelines for HIV postexposure management (PEM) to occupational bloodborne exposures to reflect new information and considerations. This document also consolidated recommendations for post-exposure prophylaxis (PEP) for HBV and follow-up monitoring guidance for HCV.

Since 1998, the FDA has approved new antiretroviral (ARV) agents, and more is known of the safety and efficacy of PEP. In light of the newer classes of drugs and new drugs within classes, the CDC updated their guidelines in 2005 to discuss other PEM options. There was also concern over increased resistance, as well as when not to use PEP, such as for low-risk exposures. In 2013, the Society for Healthcare Epidemiology of America (SHEA) issued updated USPHS guidelines for the treatment of occupational exposures to HIV including recommendations for post-exposure prophylaxis (PEP). This updates all previous guidelines, but the principles of management remain the same. In December of 2013, CDC published updated guidance for Hepatitis B post exposure management, *CDC Guidance for Evaluating Health-Care Personnel for Hepatitis B Virus Protection and for Administering Postexposure Management*.

**83. What is included in their summary of recommendations?**

- PEP is recommended when occupational exposures to HIV occur.
- The source patient status should be determined, when possible.
- PEP should be started as soon as possible and continued for 4 weeks.

- PEP regimens should include three or more ARV drugs.
- There are situations for which expert consultation is indicated.
- Follow-up should include counseling, baseline testing, and monitoring for drug toxicity and begin at 72 hours postexposure. This is especially important if additional information becomes known about the source patient.
- The use of the newer fourth-generation combination HIV-p24 antibody test allows for testing to be concluded at 4 months, rather than 6 months.

**84. What factors are associated with an increased risk of HIV transmission after a percutaneous injury?**

The risk for HIV infection after an exposure to blood known to be infected with HIV is increased if the exposure is to a larger quantity from the source, as indicated by either or both of the following:

1. Visible blood on the device
2. A procedure that involved a needle being directly placed into a vein or artery

Risk is also increased if the source has terminal illness, possibly meaning a higher titer of virus in the blood. Studies have demonstrated that more blood is transferred if the injury is deep and if hollow bore needles are used.

**85. What is the rationale for HIV PEP?**

The rationale behind the use of PEP is based on the concept that infection can be prevented or ameliorated by the use of ARVs. There are indications that if ARVs are given early, the pathogenesis may be affected because systemic infection does not occur immediately. There is a window of opportunity during which ARVs may modify or prevent replication. There is also evidence from human and animal studies that specific agents may work if used appropriately. In addition, retrospective studies of exposed health care workers demonstrated that the use of zidovudine (ZDV; Retrovir) after an occupational exposure was associated with an 81% reduction in risk of seroconversion. Early treatment is most effective; therefore, an occupational exposure to HIV is an urgent medical concern.

**86. What is the primary recommendation from SHEA for PEP after an HIV exposure?**

Of primary importance is that the regimen can be tolerated, which eliminates the need to determine the number of drugs; it also expands the possible range of the regimen of ARVs to consider. Furthermore, monitoring the exposed worker for toxicity allows for earlier treatment of side effects or modification in the regimen.

**87. What ARVs are FDA-approved and appropriate for HIV PEP under the new guidelines?**

Currently, there are six classes of ARVs approved to treat HIV infection. The choice of an ARV from these classes is based on the knowledge of HIV infection and on which are most appropriate for PEP, with considerations for tolerability, toxicity, and source experience. It is important to note again that regardless of the regimen, the duration of PEP is 4 weeks.

**88. What is the most frequently recommended PEP regimen in the new guidelines?**

The USPHS now recommends emtricitabine (FTC) plus tenofovir, which can be taken as a combination (Truvada). Raltegravir (RAL) should be the other agent in the regimen, thereby constituting a three-drug regimen. Again, a qualified health care provider (QHP) would make the decision of what to offer as PEP. There are alternatives available that a QHP might recommend.

**89. Have adverse effects been reported about the use of ARVs?**

Studies indicate that about 50% of health care workers report some adverse symptoms, such as nausea, malaise, and headache, and about 33% discontinue use because of adverse symptoms. This consideration is important in designing a regimen that can be tolerable. More serious side effects have been reported, but are rare. The new guidelines emphasize the importance of a regimen that can be adhered to, and tolerability is one aspect. It is critical that the full 4-week course be completed.

**90. What is the concern about resistance?**

Resistance remains a concern in the use of ARVs because of source information about resistance or the potential resistance or cross-resistance associated with one or more of the agents used for PEP. There are tests for resistance, as well as more choices for ARVs. Drug resistance is among those issues for which expert consultation is advised. PEP should not be delayed if this consultation is not immediately available because the regimen may be modified if new information becomes available.

**91. For what other situations with PEP is expert consultation indicated?**

Pregnancy and breast-feeding are situations for which expert consultation is indicated. However, the decision to offer PEP should be the same as for anyone experiencing an occupational exposure, because HIV transmission is a risk to the mother and fetus. A qualified health care provider should seek expert consultation for ARV selection and monitoring.

**92. In what other situations is expert consultation advised?**

Expert consultation is advised if there is a delay in medical follow-up (later than 24 to 36 hours after exposure), if the source is unknown and the injury is significant, if resistance is known or suspected to the recommended drug regimen, and if toxicity or adverse symptoms occur.

**93. How long must PEP be taken?**

The current recommendation is a 4-week regimen.

**94. Do ARVs prevent occupational infection?**

PEP does not prevent all occupational infections. There have been at least 21 reports of ARVs failing to prevent infection in health care workers. Factors that may influence failure include ARV resistance, treatment interruption (too short a duration), delayed initiation of treatment, a high titer or inoculum exposure, or host factors. Following current infection control recommendations and using safer needle devices are the primary means of preventing occupationally acquired HIV infection. However, if an exposure occurs, the risk of infection is usually low; when warranted, taking drugs as soon as possible (within 2 hours) after exposure may reduce the risk further.

**95. Has the risk of seroconversion increased?**

No, the risk remains the same as in previous reports, which is that a low risk may be modified by the use of PEP. The new recommendations, which call for use of rapid testing or fourth-generation testing, allow for prompt treatment by a qualified health care provider. This health care provider should be aware of the classes of ARVs available, risk of drug resistance, the ARVs of choice for PEP, and the follow-up protocol.

**96. Are there factors that affect the risk of occupational transmission of HIV?**

The CDC has described these factors and the average risk of transmission. The risk after a percutaneous exposure to blood known to contain HIV remains at 0.3%, for mucous membranes it is 0.09%, and for noncontact skin it is estimated to be lower than that for mucous membrane exposures.

**97. How does an undetectable viral load affect transmission?**

An undetectable viral load may not remove the risk, so PEP (see earlier) and follow-up testing are indicated.

**98. Does the severity of exposure determine PEP?**

It is no longer recommended that severity determine the number of drugs offered in a PEP regimen. Currently, three or more ARVs are recommended for all occupational exposures. The determination would be made by a qualified health care provider.

**99. If I am offered PEP and decide to take it, what type of follow-up should I expect?**

Whether or not you choose to accept a PEP regimen, you should at least have medical follow-up, including testing and counseling. In addition, SHEA recommends that follow-up within 72 hours of exposure be provided to afford an opportunity for more counseling and/or explanation of the exposure and PEP regimen and to determine whether PEP is

indicated if new information becomes available or if a modification in the regimen should be considered. This is also an opportunity to review and treat any side effects and be aware of possible adverse events.

**100. What other type of counseling would be expected?**

First, psychological counseling relative to the trauma one may experience from an occupational exposure should be sought. In addition, there should be counseling about avoiding secondary transmission, such as the use of barrier protection during sex, refraining from donations of blood or tissue, and concerns relative to pregnancy and breast-feeding. Other discussions would include drug toxicity reactions, drug interactions with prescribed or over-the-counter medications and supplements and, of utmost importance, the need to adhere to the prescribed regimen. Exposed workers should be made aware of the signs and symptoms of acute HIV infection and should report them immediately.

**101. What about follow-up testing?**

HIV testing should occur at baseline (time of exposure), 6 weeks, 12 weeks, and 6 months. Testing may be discontinued at 4 months if the fourth-generation combination HIV-p24 antibody test was used. If the source was co-infected with HCV, testing intervals may be prolonged. Other blood assays will also be included.

**102. What if I am not exposed, but have questions?**

The National Clinicians' Postexposure Prophylaxis hotline (PEPLINE) is an excellent resource (888-448-4911). Another resource is the FDA MedWatch program (<http://www.fda.gov/Safety/MedWatch/>; 800-322-1088).

**103. Does the employer have to pay for ARVs?**

OSHA has made no official statement. However, because OSHA relies on the most current USPHS recommendations, the agency may expect the employer to pay for the chemoprophylactic regimen. This rapidly evolving area may change further as the USPHS reviews its recommendations, which are based on surveillance studies demonstrating that ARV therapy is beneficial if taken immediately after a significant exposure incident. PEP may be covered by the employer-provided worker's compensation insurance. This varies, depending on the carrier, and the worker compensation company should be consulted to determine if coverage is included.

**104. What is a prudent course for postexposure chemoprophylaxis?**

It is important to discuss the postexposure management options in advance of an exposure incident. The discussion should include the potential risk associated with various injuries, source patient factors, selection of a health care professional, and availability of ARVs, if indicated.

**105. Has HIV seroconversion been documented among dental health care workers as the result of an occupational exposure?**

No, not as of June 2014. There have been voluntary reports to the CDC of 57 health care workers with documented seroconversion.

**106. Have any dental health care workers possibly seroconverted for HIV as the result of an occupational exposure?**

Yes. As of June 2014, about six dental health care workers (of 138 health care workers) have been reported to the CDC as possible cases of occupational transmission.

**107. What is the difference between a documented occupational transmission and a possible occupational transmission of HIV?**

The difference is in the testing. A documented occupational transmission requires that the exposed health care worker be tested for HIV at the time of the incident and that the baseline test be negative. If HIV seroconversion occurs after a designated time, it is considered to be the result of the exposure incident. In the possible category, HIV-positive health care workers have been found to be without identifiable behavioral or transfusion risk. Each reported percutaneous exposure to blood or body fluids or laboratory solutions containing HIV, but HIV seroconversion specifically resulting from an occupational exposure was not documented. There was no baseline testing at the time of the incident to prove that the health care worker was HIV-negative before the incident.

- 108. What is the purpose of baseline testing after an occupational exposure incident?**  
Baseline HIV antibody, HBV, and/or HCV testing allows the health care professional who evaluates the exposed worker to determine whether any subsequently diagnosed disease was acquired as the result of the exposure incident. Blood is tested soon after the injury has occurred to determine the health care worker's HBV and/or HIV serologic status. Note that the availability of rapid HIV testing (for types 1 and 2) and HCV testing provides results in 20 minutes. Furthermore, there are newer generation HIV tests, which can detect infection in the acute stages.
- 109. Can an employee refuse baseline testing?**  
An employee may decline testing or choose to delay testing of collected blood for 90 days. If a delay is chosen, the blood must be drawn but not tested until consent is given.
- 110. If I consent to baseline blood collection, but not testing, then what?**  
If the employee consents to testing of the baseline sample within 90 days, it should be done as soon as possible. If consent is not given within the 90 days, the sample may be discarded.
- 111. What is the difference between confidential and anonymous HIV testing?**  
Confidential testing with consent means that the test results become part of your confidential medical record and cannot be released without your consent and in accordance with state laws. The test results are linked to your name, even if only in your medical record. Anonymous testing refers to a system whereby test results are linked to a number or code and not to a name. Therefore, you are the only one who will know the results; they will not be part of your medical record. Whether a coded result will suffice as evidence of baseline testing for the purposes of documenting an exposure incident has not been challenged. If you are reluctant to have any HIV test information in your medical record, but are concerned about documenting an incident, you may wish to consider baseline blood collection at an anonymous and confidential test site. Have the anonymous sample tested, and store the confidential sample for not more than the 90 days allowed. Thus, you have time to consider testing and an opportunity to find out whether you are seronegative.
- 112. Who pays the cost of HIV testing?**  
The employer is responsible for the cost of HIV testing under the obligation to provide medical evaluation and follow-up of an exposure incident.
- 113. Is the employer responsible for costs associated with treatment of disease if transmission occurs?**  
No. The employer is not expected to pay the costs associated with long-term treatment of disease, only for the immediate evaluation and PEP, as prescribed by OSHA in accordance with USPHS recommendations.
- 114. What is a sharps injury log?**  
A sharps injury log is used to record percutaneous injuries from contaminated sharps. The log must be maintained to ensure confidentiality. At a minimum, the log should contain the following:  
  1. Type and brand of device involved
  2. Work area where the incident occurred
  3. Explanation of how the incident occurred
- 115. How long must an employer maintain employee medical records?**  
The employer must maintain employee medical records for the duration of employment plus 30 years in accordance with OSHA's Standard on Access to Employee Exposure and Medical Records (29 CFR 1910.20). An employer may contract with the health care professional to maintain the records as long as they are accessible to OSHA.
- 116. Who selects the health care professional for postexposure evaluation and follow-up?**  
The employer has the right to choose the health care professional who will treat exposure incidents. This HCP should be qualified to evaluate, treat, counsel, monitor, and test the exposed worker (Table 12-4).



**Table 12-4.** Postexposure Evaluation and Follow-up Requirements After Exposure Incident

EMPLOYEE	EMPLOYER	HEALTH CARE PROFESSIONAL (HCP)
Reports incident to employer	Directs employee to HCP—sends to HCP copy of standard	Evaluates exposure incident Arranges for testing of exposed employee and source patient (if not already known)
	Job description of employee	Notifies employee of results of all testing
	Incident report (e.g., route)	Provides counseling
	Source patient's identity and HBV, HIV status (if known) and other relevant medical	Provides postexposure prophylaxis; evaluates reported illnesses (above items are confidential)
	Documents events on OSHA 200 and 101 (if applicable)	
	Receives HCP's written opinion	Sends (only) written opinion to employer—documentation that employee was informed of evaluation results and need for any further follow-up
Receives copy of HCP's written opinion	Provides copy of HCP's written opinion to employee (within 15 days of completed evaluation)	Determines whether HBV vaccine is indicated and if vaccine was received

Adapted from U.S. Safety and Health Administration (OSHA): *Enforcement procedures for the occupational exposure to bloodborne pathogens, 2001*. [https://www.osha.gov/pls/oshaweb/owadisp.show\\_document?p\\_table=DIRECTIVES&p\\_id=2570](https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=2570). Accessed May 14, 2014.

### 117. Does the employer have an obligation to former employees?

OSHA's standard on bloodborne pathogens requires immediate medical evaluation and follow-up of an employee. If an employee leaves the practice, the employer is no longer obligated to meet the obligations in the standard.

### 118. Does the employer have any obligation to temporary workers under OSHA standards?

The responsibility to protect temporary workers from workplace hazards is shared by the agency that supplies a temporary worker. The agency is required to ensure that all workers have been vaccinated and are provided with follow-up evaluations. The contracting employer is not responsible for vaccinations and follow-up unless the contract specifies it. However, the contracting employer is expected to provide gloves, masks, and other PPE.

Note that this can depend on the nature of the relationship between the temporary worker and referring agency. Some do not have an employee–employer relationship, but act only as a referring agent (receiving some type of fee for the referral), and others employ the temporary workers and assign them to requesting employers. In the first case, the agency has little obligation to provide such things as training or vaccination; in the latter case, the obligation is greater but the person hiring the temporary worker must provide site-specific training.

### 119. How accurate is the HIV antibody test?

At 6 months after an exposure incident, the current serum test has the ability to detect the presence of HIV antibody with 99.9% accuracy. After 1 year, it is 99.9999% accurate. In addition to the traditional serum test, a saliva collection system is available. The accuracy

of the saliva test is reported to be comparable to that of the serum test. The FDA has approved rapid HIV tests that require one drop of blood or a saliva sample and can produce results in 20 minutes. These tests can detect HIV types 1 and 2.

**120. What concerns are raised by the rapid test?**

There were questions about whether the test was to be approved for use in physician's offices and public health clinics rather than laboratories. Because rapid HIV tests are Clinical Laboratory Improvement Amendments of 1988 (CLIA)–waived they may be used in nonlaboratory settings, such as a dental clinic.

**121. What should you recommend to a health care worker who has been potentially infected with HIV?**

The first step is to have immediate medical follow-up, including testing and counseling services. Early medical intervention is most important in light of the multidrug combinations for anti-HIV therapy. In addition, it is important to consult state guidelines for HIV-HBV–infected health care workers, your professional association, or a legal advocate.

**122. Have there been any recent reports of HBV transmission from dentists to patients?**

Since 1987, there have been no reports of HBV transmission from a dentist to a patient. From 1970 to 1987, nine clusters were reported, in which HBV infection was associated with dental treatment by an infected dental health care worker. Reasons for the current lack of reports of HBV transmission may include the following:

1. Increased adherence to Standard (universal) Precautions
2. High compliance with HBV vaccination among dental health care workers
3. Reporting bias, incomplete reporting, or failure to correlate HBV transmission with previous dental treatment

Factors that enhanced the transmission of HBV in the past included failure to use gloves routinely during patient care, failure to receive HBV vaccination, noncompliance with universal precautions, and inability to detect disease in dental health care workers. In at least two of the cases of dentist to patient transmission, there were no identifiable breaches in infection control.

## INSTRUMENT REPROCESSING AND STERILIZATION

**123. What is a single-use patient care item?**

A single-use patient care item is an item used on one patient and discarded after that use. Many dental products have become available that are labeled as single use. Items labeled as *single use* or *disposable* are not intended to be reprocessed or used for more than one patient. Examples of single-use patient care items include the following:

- Saliva ejector
- Disposable air-water syringe tips
- Disposable impression trays
- Disposable needles
- Single-use dental burs

**124. Can a disposable saliva ejector be reprocessed and reused?**

No. It is a single-use item that is impossible to reprocess adequately and should be discarded after a single use.

**125. How must a reusable air-water syringe tip be reprocessed?**

There are reusable air-water syringe tips and disposable single-use tips. The only acceptable method of reprocessing a reusable tip is first to thoroughly clean the tip, followed by wrapping and packaging, and then sterilizing with steam under pressure, dry heat, or unsaturated chemical vapor.

**126. Should contaminated reusable patient care items be placed in a holding solution prior to cleaning?**

No. A holding solution or presoak is only necessary when items cannot be cleaned in a reasonable time. The purpose of a holding solution is to keep debris moist on the instruments to facilitate cleaning. Holding solutions should consist of a noncorrosive detergent

and water. Disinfectants are unnecessary, and most immersion disinfectants require cleaning prior to immersion. Many of the immersion disinfectant products can actually act as fixatives of proteinaceous materials (organic molecules) in tissue and blood, making cleaning more difficult.

**127. Why is an automated method of cleaning reusable patient care items recommended, rather than hand scrubbing?**

Cleaning should precede all disinfection and sterilization processes; it should involve removal of debris and organic and inorganic contamination. Removal of debris and contamination is achieved by scrubbing with a surfactant, detergent, and water or by use of an automated process (e.g., ultrasonic cleaner, washer disinfecter) using chemical agents. If visible debris, inorganic or organic, is not removed, it will interfere with microbial inactivation and can compromise the disinfection or sterilization process. After cleaning, instruments should be rinsed with water to remove chemical or detergent residue. Splashing should be minimized during cleaning and rinsing. Before final disinfection or sterilization, instruments should be handled as though they were contaminated.

Considerations in selecting cleaning methods and equipment include the following:

- Efficacy of the method, process, and equipment
- Compatibility with items to be cleaned
- Occupational health and exposure risks.

Use of automated cleaning equipment (e.g., ultrasonic cleaner, washer disinfecter) does not require presoaking or scrubbing of instruments and can increase productivity, improve cleaning effectiveness, and decrease workers' exposure to blood and body fluids. Use of automated equipment can be safer and more efficient than manually cleaning contaminated instruments.

**128. Is a thermal washer disinfecter an acceptable substitute for ultrasonic cleaning of dental instruments?**

Yes. Washer disinfecters and washer decontaminators that have been cleared for marketing by the FDA are a suitable alternative to ultrasonic cleaning. Household dishwashers, however, are not acceptable for health care applications. Dishwashers and other household appliances have not been evaluated by the FDA to guarantee adherence to the strict operating parameters that health care applications demand.

**129. What is the difference between sterilization and disinfection?**

Sterilization is a process capable of killing all forms of microorganisms on an instrument or surface, including high numbers of highly resistant bacterial spores, if present. Disinfection is the process of destroying pathogenic organisms, but not necessarily all organisms.

**130. What are methods of sterilization common for dentistry?**

They include saturated steam, saturated chemical vapor, dry heat—rapid transfer, dry heat—convection, ethylene oxide gas, and chemical immersion.

**131. What are the types of heat-based sterilization methods?**

1. Steam under pressure, or autoclaving, is the most widely used method. There are two categories of autoclaves: (1) gravity displacement; and (2) class B (pre-post vacuum).
2. Dry heat sterilization involves placing instruments in a dry heat sterilizer cleared for marketing as a medical device by the FDA. Instruments must remain in the unit for a specified period of heating at a required temperature.
3. Unsaturated chemical vapor sterilization uses a proprietary chemical solution, which, when heated under pressure, forms a sterilized vapor phase, with a low concentration of water.

**NOTE:** Manufacturer's directions for each sterilizer must be followed closely.

**132. What are some considerations in the selection of a sterilizer?**

Consider the practice setting size and types of instruments and devices used. You may need more than one type of sterilizer to accommodate needs. The size of the practice, instrument inventory, and space considerations are important factors in the decision making process.

**133. What is an elementary doctrine in choosing a method of sterilization?**

Do not disinfect or cold-sterilize what you can sterilize with a heat-based process. “Don’t dunk it; cook it.” If an item or instrument is heat-stable, it should be heat-sterilized. No other methods (e.g., gases, liquids) have equivalent economy, potency, and safety assurance.

**134. According to the Spaulding classification, what are critical, semicritical, and noncritical items?**

See Table 12-5.

**135. How are critical and semicritical items treated after use?**

If reusable, all heat-stable critical and semicritical instruments should be sterilized with a heat process. In dentistry, almost all reusable patient care items are heat-stable. If a critical item is not heat-stable, it should be replaced with one that is.

**Table 12-5.** Spaulding Classification of Surfaces

PARAMETER	DESCRIPTION	EXAMPLES	DISEASE TRANSMISSION RISK	REPROCESSING TECHNIQUE†
Critical instruments	Pointed/sharp Penetrates tissue Blood present	Needles Cutting instruments	High	Sterile, disposable Heat sterilization
		Implants		
Semicritical instruments	Mucous membrane or broken skin contact	Medical “scopes” Nonsurgical dental instruments	Moderate	Heat sterilization High-level disinfection
		Specula		
		Catheters		
Noncritical instruments	Unbroken skin contact	Face masks Clothing Blood pressure cuffs Diag electrodes	Low	Sanitize (no blood) Intermediate-level disinfection (blood present)
		Environmental surfaces		
Medical equipment	Indirect contact	Knobs, handles x-ray machine Dental units	Moderate to low	
Housekeeping	No contact	Floors, walls, countertops	Least	

\*This table incorporates the expansion of Spaulding’s classic “critical, semicritical, noncritical” surface classification.

†Because the vast majority of, if not all, dental instruments are heat-stable, they should be sterilized using a heat-based method (e.g., autoclaving). High-level disinfection using liquid chemical or sterilant germicides is not the current standard of practice in dentistry.

Adapted from Farero MS, Bond WW: *Chemical disinfection of medical and surgical instruments*. In Block SS, editor: *Disinfection, sterilization, and preservation*, ed 5, Philadelphia, Lippincott Williams & Wilkins, 2001, pp 881–917.

**136. To what does the term *cold sterilization* refer in dentistry?**

In dentistry, cold sterilization refers to the past practice of immersion (liquid chemical) disinfection used for reprocessing reusable semicritical instruments or items for patient care. The practice was not sterilization *per se* and is no longer considered appropriate for reprocessing heat-stable medical instruments. Almost every reusable dental instrument in current use is heat-stable and should be appropriately cleaned, wrapped, and sterilized between uses with a heat-based, biologically monitored process, such as a steam autoclave. Accordingly, the near-universal heat stability of dental instruments creates little justification or economic benefit for the use of other low-temperature sterilization procedures (e.g., with gases, such as ethylene oxide or vapor phase hydrogen peroxide).

**137. What is the appropriate use of an immersion sterilant solution in a dental operatory or laboratory?**

To sterilize something using an FDA-cleared, immersion chemical sterilant requires procedures such as meticulous precleaning of the item, total immersion (no bubbles anywhere) for possibly up to 10 or more hours in (preferably) fresh solution at the indicated temperature, aseptic retrieval of the item with sterile forceps (preferably in a laminar flow safety cabinet to minimize extraneous contamination), thorough rinsing with sterile water, drying with sterile towels (workers wearing sterile gloves), and packaging in a sterile container, unless the item is used immediately. The practical probability of delivering a truly sterile item (probability of contamination of 1 in 1 million, impossible to validate or confirm by postprocess sampling and culturing) to the patient under such circumstances is almost nil. For high-level disinfection of a heat-sensitive item using a similar procedure (the chemical agent is the same as for sterilization), the only change in the process is significantly less time of exposure to the liquid chemical agent (minutes instead of hours).

Whatever the target case (sterilization or high-level disinfection), before purchasing and using any chemical agent for these purposes, workers should perform a careful inventory of instruments or devices appropriate for being reprocessed using a cold or low-temperature procedure. Furthermore, recognizing the toxic nature and use patterns of these agents (especially the liquid chemicals that require the use of trays or other open containers of the product), workers should closely follow the label-directed procedures for agent containment, worker protection, and agent disposal. Under no circumstance should this class of chemical be used for any purpose other than what is listed on the product label. For example, a glutaraldehyde-based sterilant-disinfectant (or any other immersion-type liquid chemical agent in that class) is never appropriate for wipe downs of environmental surfaces, no matter the perceived level or type of contamination. These chemicals have little use in dentistry.

**138. What is the function of a glass bead sterilizer?**

The glass bead sterilizer has historically been used during endodontic procedures to decontaminate endodontic files while they are used on the same patient. It is not a sterilizer, and this designation is a long-standing misnomer in FDA classification.

These devices have been recalled by the FDA for submission of supplemental data to substantiate or refute its classification as sterilizers. Use only FDA-cleared medical devices for sterilization, and follow the manufacturer's instructions for correct use.

**139. What is flash sterilization?**

In general, the CDC recommends that all reusable patient care items be packaged or wrapped for sterilization and remain packaged until the point of use.

- Flash sterilization, not termed *immediate-use sterilization*, is sterilizing items that are unwrapped or unpackaged.
- Immediate-use sterilization is a method for sterilizing unwrapped patient care items for immediate use.

The time required for an unwrapped sterilization cycle depends on the type of sterilizer and type of item (i.e., porous or nonporous) to be sterilized. The unwrapped cycle in tabletop sterilizers is preprogrammed by the manufacturer to a specific time and temperature setting and can include a drying phase at the end to produce a dry instrument, with much of the heat dissipated. If the drying phase requirements are unclear, the operation

manual or manufacturer of the sterilizer should be consulted. If the unwrapped sterilization cycle in a steam sterilizer does not include a drying phase, or has only a minimal drying phase, items retrieved from the sterilizer will be hot and wet, making aseptic transport to the point of use more difficult. For dry heat and chemical vapor sterilizers, a drying phase is not required.

Unwrapped sterilization should be used only under certain conditions:

- Thorough cleaning and drying of instruments precede the unwrapped sterilization cycle.
- Mechanical monitors are checked and chemical indicators used for each cycle.
- Care is taken to avoid thermal injury to dental health care personnel (DHCP) or patients.
- Items are transported aseptically to the point of use to maintain sterility

Because all implantable devices should be quarantined after sterilization until the results of biologic monitoring are known, unwrapped or flash sterilization of implantable items is not recommended.

Critical instruments that are sterilized unwrapped should be transferred immediately using aseptic technique from the sterilizer to the actual point of use. Critical instruments should not be stored unwrapped. Semicritical instruments that are sterilized unwrapped on a tray or in a container system should be used immediately or within a short time. When sterile items are open to the air, they will eventually become contaminated. Storage, even temporary, of unwrapped semicritical instruments is discouraged because it permits exposure to dust, airborne organisms, and other unnecessary contamination before use on a patient. A carefully written protocol for minimizing the risk of contaminating unwrapped instruments should be prepared and followed.

#### 140. What is the best way to reprocess a dental handpiece?

Manufacturer's instructions should be followed. The instructions are specific to the manufacturer and model of the handpiece. The manufacturer's instructions for use verify that a handpiece is heat-stable and should be sterilized between each patient use. The manufacturer's instructions for use should also describe the steps for presterilization maintenance (e.g., cleaning, lubrication) and the most appropriate heat treatment method. All high- and slow-speed dental handpieces manufactured since the late 1980s are heat-stable; older handpieces, if still in working condition, may be modified to withstand heat sterilization. If not so modified, their use should be discontinued and they should be replaced with heat-stable handpieces.

#### 141. Which federal agency is responsible for regulating high- and slow-speed dental handpieces?

The FDA, Center for Devices and Radiological Health, Office of Device Evaluation, Dental and Medical Services Branch, in accordance with the Safe Medical Devices Act, clears medical devices, including sterilizers, for marketing. The user, however, must be aware that clearance to market proves neither efficacy nor manufacturer's claims.

#### 142. What is the minimal temperature required for sterilization by an autoclave?

It is 250° F (121° C). Follow the manufacturer's instructions for time, temperature, and pressure parameters.

#### 143. What are some advantages and disadvantages of sterilization by steam heat under pressure (e.g., an autoclave)?

##### Advantages

- Rapid process
- Does not require special ventilation
- Does not involve use or disposal of chemical agents; uses only distilled water
- Highly reliable when properly maintained and used according to manufacturer's instructions

##### Disadvantages

- Instrument cutting surfaces of carbide steel may become dulled if packages are not thoroughly dry on removal from the sterilizer.
- Carbide steel items may corrode and become dulled if packages are not thoroughly dry on removal from the sterilizer.

**144. In a forced air, dry heat oven preheated to 320° to 338° F (160°-170° C), how long does it take to sterilize instruments?**

Sterilization is achieved in 2 hours in a properly working unit. However, additional time may be necessary for cool down before metal items can be used.

**145. What are some advantages and disadvantages of dry heat sterilizers?**

**Advantages**

- They do not dull or otherwise corrode instruments.
- They are equivalent to a steam autoclave in germicidal potency in a completed cycle.

**Disadvantages**

- The cycle time is long.
- Most plastics, paper, and fabrics char, melt, or burn and cannot be sterilized in this manner.

**146. What packaging material is compatible with autoclaves?**

The most suitable material for use in an autoclave is one that the steam can penetrate—for example, paper or certain plastics. It is best to read the manufacturer's instructions and follow them precisely.

**147. What packaging material cannot be used in dry heat sterilizers?**

The manufacturer's instructions specify that you cannot use most plastic pouches or wraps and paper wraps commonly used for steam autoclaves. They melt or burn at high temperatures.

**148. What packaging material is compatible with unsaturated chemical vapor sterilizers?**

The manufacturer's instructions make clear that perforated metal trays and paper are suitable for use in chemical vapor sterilizers. The vapor must be able to penetrate the material. Chemical vapor sterilizers also rely on high levels of heat and pressure for efficacy.

**149. What is an easy method to demonstrate that sterilization conditions have been reached in a cycle?**

External process indicators (on the outside of the instrument package or wrap) and internal chemical indicators or integrators (inside each package of instruments) demonstrate that some conditions to achieve sterilization were reached.

**150. What is the definition of sterile?**

The state of sterility is an absolute term—an item is sterile or it is not sterile. Sterility is the absence of all viable life forms; the term reflects a carefully designed and monitored process used to ensure that an item has a very low probability of being contaminated with anything at time of use. For surgical instruments, this probability is 1 in 1 million—that is, a sterility assurance level (SAL) of  $10^{-6}$ .

**151. What are the most common reasons for sterilization failure in an autoclave?**

- Inadequate precleaning of instruments
- Improper maintenance of equipment
- Cycle time too short and/or temperature too low
- Improper loading or overloading
- Incompatible packaging material
- Interruption of a cycle to add or remove items

**NOTE:** A number of investigations have found that the most frequent cause of sterilizer failure is human error.

**152. What types of sterilization monitoring are available?**

1. Mechanical, electronic
2. Chemical indicators (color change integrators)
3. Biologic indicators (spore tests)

**153. What is a mechanical or electronic control?**

These devices involve observation of gauges and indicators on the sterilization equipment (cycle monitors). They measure time, temperature, and pressure, for example.

#### 154. What is the difference between chemical indicators and biologic indicators (spore) monitors?

Biologic indicators use nonpathogenic bacterial spores to verify that spore bacteria are killed. They more precisely reflect the potency of the sterilization process by directly measuring death of high numbers of highly resistant, but nonpathogenic, bacterial endospores. Simple chemical indicators merely reflect that the temperature of sterilization has been reached. Other chemical indicators (e.g., integrators) are more sophisticated and demonstrate time and temperature during the process. Chemical indicators, internal and external, use sensitive chemicals to assess physical conditions (e.g., time, temperature) during the sterilization process.

Although chemical indicators do not prove that sterilization has been achieved, they allow for the detection of certain equipment malfunctions and can help identify procedural errors. External indicators applied to the outside of a package (e.g., chemical indicator tape, special markings) change color rapidly when a specific parameter is reached, and they verify that the package has been exposed to the sterilization process. Internal chemical indicators should be used inside each package to ensure that the sterilizing agent has penetrated the packaging material and has reached the instruments inside. A single-parameter internal chemical indicator provides information regarding only one sterilization parameter (e.g., time or temperature). Multiparameter internal chemical indicators are designed to react to two or more parameters (e.g., time and temperature, or time, temperature, and the presence of steam) and can provide a more reliable indication that sterilization conditions have been met. Multiparameter internal indicators are available only for steam sterilizers (autoclaves).

#### 155. What are the different types of chemical indicators?

The 2008 CDC guidelines recommended that chemical indicators be affixed on the outside of each package to show that the package has been processed through a sterilization cycle, but these indicators do not prove that sterilization has been achieved. Preferably, a chemical indicator also should be placed on the inside of each pack to verify sterilant penetration. Chemical indicators are usually heat- or chemical-sensitive inks that change color when one or more sterilization parameters (e.g., steam time, temperature, and/or saturated steam) are present. Chemical indicators have been grouped into six classes based on their ability to monitor one or multiple sterilization parameters (see later). If the internal and/or external indicator suggests inadequate processing, the item should not be used. An air removal test (e.g., Bowie-Dick test) must be performed daily in an empty dynamic air removal sterilizer (e.g., class B prevacuum steam sterilizer) to ensure air removal.

Specifically, a comprehensive guide to steam sterilization and sterility assurance in health care facilities Amendment 3 ANSI/AAMI ST79 has described the different classes of chemical indicators as follows:

- Class 1 (process indicators)—chemical indicators intended for use with individual units (e.g., packs, containers) to indicate that the unit has been exposed to the sterilization process and to distinguish between processed and unprocessed units.
- Class 2 (Bowie-Dick test indicators)—chemical indicators intended for use in a specific test procedure (e.g., the Bowie-Dick test used to determine if air removal has been adequate in a steam sterilization process).
- Class 3 (single-variable indicators)—chemical indicators designed to react to one of the critical variables and intended to indicate exposure to a sterilization process at a stated value of the chosen variable.
- Class 4 (multivariable indicators)—chemical indicators designed to react to two or more of the critical variables and intended to indicate exposure to a sterilization process at stated values of the chosen variables.
- Class 5 (integrating indicators)—chemical indicators designed to react to all critical variables, with the stated values having been generated to be equivalent to, or exceed, the performance requirements given in the ISO 11138 series for Biological Indicators (BIs), which are also sometimes referred to as biologic spore tests.
- Class 6 (emulating indicators)—chemical indicators designed to react to all critical variables of specified sterilization cycles, with the stated values having been generated from the critical variables of the specified sterilization process.

ANSI/AAMI/ISO 11140-1 refers to these indicators as cycle verification indicators. See [Table 12-6](#).



Table 12-6.

ANSI/AAMI/ISO 11140-1:2005	FDA GUIDANCE FOR INDUSTRY AND FDA STAFF*	FDA CONSENSUS STANDARD RECOGNITION	COMMENTS
Class 1—process indicators	Process indicators	Process indicators	Considered equivalent
Class 2—indicators for use in specific tests	Air removal indicators	Indicators for use in specific tests	No differences
Class 3—single-variable indicators	Not included	Class not part of consensus standard recognition by FDA	N/A
Class 4—multivariable indicators	Process indicators or chemical integrators	Not included	Some class 4 devices that can meet the recommended performance standards of the FDA and demonstrate substantial equivalence to a legally marketed chemical indicator may also be able to meet the performance requirements of a class 4 multivariable indicator.†
Class 5—integrating indicators	Chemical integrators	Class not part of consensus standard recognition by FDA	Some class 5 devices that can meet the recommended performance standards of the FDA and demonstrate substantial equivalence to a legally marketed chemical indicator may also be able to meet the performance requirements of a class 5 integrating indicator.†
Class 6—emulating indicators	Chemical integrators	Emulating indicators	Some class 6 devices that can meet the recommended performance standards of the FDA and demonstrate substantial equivalence to a legally marketed chemical indicator may also be able to meet the performance requirements of a class 6 emulating indicator.†

\*At the date of this publication, FDA recognition of chemical indicators is limited to class 1 process indicators, class 2 indicators for use with special tests, and chemical integrators, which have resistance characteristics consistent with guidelines from the U.S. Food and Drug Administration (FDA): *Premarket notification [510(k)] submissions for chemical indicators*, 2003. [http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/Guidance Documents/ucm072613.htm](http://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/GuidanceDocuments/ucm072613.htm). Accessed May 14, 2014.

Also see ANSI/AAMI/ISO 15882 for information on the selection, use, and interpretation of chemical indicators. See also 10.5.2.

†As defined in ANSI/AAMI/ISO 11140-1:2005. *Sterilization of health care products—chemical indicators. Part 1: general requirements*, American National Standards Institute. Adapted from American National Standards Institute (ANSI): *Chemical indicator classifications: AAMI/ANSI ST79, amendment 3*, ANSI, 2012, pp 233-235.

**156. What should be done if the spore test is positive?**

The CDC Guidelines for Infection Control in Dental Health Care Settings (2003) recommended the following in the case of a positive spore test:

1. Remove the sterilizer from service and review sterilization procedures (e.g., work practices, use of mechanical and chemical indicators) to determine whether operator error could be responsible
2. Retest the sterilizer by using biologic, mechanical, and chemical indicators after correcting any identified procedural problems.
3. If the repeat spore test is negative, and mechanical and chemical indicators are within normal limits, put the sterilizer back in service.

The following are recommended if the repeat spore test is positive:

1. Do not use the sterilizer until it has been inspected or repaired or the exact reason for the positive test has been determined.
2. Recall, to the extent possible, and reprocess all items processed since the last negative spore test.
3. Before placing the sterilizer back in service, rechallenge the sterilizer with biologic indicator tests in three consecutive empty chamber sterilization cycles after the cause of the sterilizer failure has been determined and corrected.

Maintain sterilization records (mechanical, and chemical, biologic) in compliance with state and local regulations.

**157. Which nonpathogenic organisms are used for biologic monitoring sterilization for each type of sterilization method?**

For autoclaves and chemical vapor sterilizers, *Geobacillus stearothermophilus* (formerly *Bacillus stearothermophilus*) spores are used. For dry heat and ethylene oxide units, *Bacillus atrophaeus* (formerly *Bacillus subtilis*) is used. Placement of the monitor in a load is critical; the manufacturer's instructions should be followed closely.

**158. How often should biologic monitoring of sterilization units be performed?**

- The 2003 CDC guidelines recommended monitoring sterilizers at least weekly by using a biologic indicator with a matching control (biologic indicator and control from same lot number).
- The 2008 CDC guidelines recommended use of "biologic indicators to monitor the effectiveness of sterilizers at least weekly with an FDA-cleared commercial preparation of spores intended specifically for the type and cycle parameters of the sterilizer." Also, if a sterilizer is used frequently (e.g., several loads per day), daily use of biologic indicators allows earlier discovery of equipment malfunctions or procedural errors and thus minimizes the extent of patient surveillance and product recall needed in the event of a positive biologic indicator. Each load should be monitored if it contains implantable objects. If feasible, implantable items should not be used until the results of spore tests are known to be negative.
- ANSI/AAMI ST79 recommended the use of biologic indicators "within process challenge devices for routine sterilizer efficacy monitoring at least weekly, but preferably every day that the sterilizer is in use," along with every load that contains an implantable device.
- ARON recommended that "biological indicators should be used to monitor sterilizer efficacy. Efficacy monitoring should be performed at least weekly and preferably daily."

At a minimum, according to the CDC, biologic monitoring of sterilization units should be done on a weekly basis (Box 12-2; Table 12-7).

**159. How should sterile packs of patient care items be stored?**

All sterile and disposable patient care items should be in enclosed storage areas that are clean and dry. Packages containing sterile supplies should be inspected before use to verify barrier integrity and dryness. Although some health care facilities continue to date every sterilized package and use shelf life practices, other facilities have switched to event-related practices. This approach recognizes that the product should remain sterile indefinitely unless an event causes it to become contaminated (e.g., torn or wet packaging).

**BOX 12-2. Indications for More Frequent Biologic Monitoring of Sterilization Units**

1. If the equipment is new and being used for the first time
2. During the first operating cycle after a repair
3. If there is a change in packaging material
4. If new employees are using the unit or being trained in use of the equipment or procedure for monitoring
5. After an electrical or power source failure
6. If door seals or gaskets are changed
7. If cycle time and/or temperature is changed
8. Waste not to be processed in an instrument sterilizer
9. For all cycles to render infectious waste as noninfectious, as mandated by state law\*
10. If the method of biologic monitoring is changed

\*This may not apply in all states; contact the appropriate agency.

Even for event-related packaging, at a minimum, the date of sterilization should be placed on the package and, if multiple sterilizers are used in the facility, the sterilizer used should be indicated on the outside of the packaging material to facilitate the retrieval of processed items in the event of a sterilization failure. If packaging is compromised, the instruments should be recleaned, packaged in new wrap, and sterilized again.

**HANDLING AND DISPOSAL OF DENTAL WASTE****160. What constitutes regulated medical waste?**

Regulated medical waste includes, but is not limited to, items such as blood-soaked gauze or cotton rolls, tissue, extracted teeth (without amalgam) and contaminated sharps. Contaminated sharps must be segregated and placed into an approved, color-coded or labeled, spillproof and leakproof container. This container must be puncture-resistant and should be as close as possible to the area where sharps waste is generated. Containers should be considered as full when they are 75% full to avoid injury in overfilled containers. Regulated waste must be in labeled containers (biohazard label), and the transport and disposal must be by a licensed medical waste hauler. Again, a log of waste removal and receipts should be part of the record keeping.

**161. What are the categories of medical waste?**

There are two categories—nonregulated medical waste, which is not assumed to be infectious and can be disposed of in the regular trash, and regulated medical waste, which may pose a risk of infection during handling and disposal. Sharps must be handled according to disposal recommendations for sharps. It is important to note that although teeth are biologic waste, they are hazardous waste if they contain amalgam because of the toxic nature of amalgam. Hazardous waste must be managed differently.

**162. How should regulated medical waste be managed?**

There should be a written waste management program that defines regulated waste according to CDC recommendations and federal, state, or local laws. These require that appropriate containers be used that are properly labeled and leakproof. A color-coded (red) or labeled (biohazard warning) container may be used for nonsharp medical waste.

**163. Who regulates dental waste?**

OSHA regulates how the waste is handled in a dental facility by employees to ensure that they are protected from potential hazards associated with the waste. Federal, state, and local laws govern the disposal itself.

**164. What is the intent of the Resource Conservation and Recovery Act (RCRA) of the U.S. Environmental Protection Agency (EPA)?**

The intent of the RCRA is to hold the generator of a hazardous waste responsible for its ultimate disposal or treatment and for any clean-up costs associated with improper disposal. Each dentist, therefore, is responsible for ensuring proper disposal of waste, and improper disposal by an unscrupulous company is ultimately the responsibility of the dentist.

**Table 12-7.** Recommendations for Routine Use of Biologic Monitoring (Spore Tests)

SOURCE	DOCUMENT TITLE	RECOMMENDATION
CDC	Guidelines for infection control in dental health-care settings, 2003.	“Monitor sterilizers at least weekly by using a biological indicator with a matching control (i.e., biological indicator and control from same lot number).”
CDC	Guideline for disinfection and sterilization in healthcare facilities, 2008.	“Use biologic indicators to monitor the effectiveness of sterilizers at least weekly with an FDA-cleared commercial preparation of spores intended specifically for the type and cycle parameters of the sterilizer.”
Association for the Advancement of Medical Instrumentation	Comprehensive guide to steam sterilization and sterility assurance in health care facilities.	“Biological indicators should be used within process challenge devices for routine sterilizer efficacy monitoring at least weekly, but preferably every day that the sterilizer is in use.”
American Dental Association	Infection control recommendations for the dental office and the dental laboratory.	“Biological monitors should be used routinely to verify the adequacy of sterilization cycles. Weekly verification should be adequate for most dental practices.”
<b>References for Historical Purposes</b>		
CDC	CDC guideline for handwashing and hospital environmental control, 1985.	“All sterilizers should be monitored at least once a week with commercial preparations of spores intended specifically for the type of sterilizer.”
CDC	Recommended infection-control practices for dentistry, 1993.	“Proper functioning of sterilization cycles should be verified by the periodic use (at least weekly) of biologic indicators (i.e., spore tests).”
CDC	Recommended infection-control practices for dentistry.	“The adequacy of sterilization cycles should be verified by the periodic use of spore-testing devices (e.g., weekly for most dental practices).”

**NOTE:** In March 2004, the ADA ([www.ada.org](http://www.ada.org)) decided not to publish a separate set of dental infection-control guidelines and encouraged all dental health-care personnel to follow appropriate infection control procedures as described in the 2003 CDC guidelines.

**Sources:**

Centers for Disease Control and Prevention (CDC): *Guidelines for infection control in dental health-care settings—2003*. *Recomm Rep* 2003;52(RR-17):1–66; <http://www.cdc.gov/oralhealth/infectioncontrol/guidelines/index.htm>.

Healthcare Infection Control Practices Advisory Committee: *Guideline for disinfection and sterilization in healthcare facilities*, 2008. [www.cdc.gov/hicpac/Disinfection\\_Sterilization/toc.html](http://www.cdc.gov/hicpac/Disinfection_Sterilization/toc.html); [www.aami.org](http://www.aami.org); <http://www.aami.org/publications/standards>

Association for the Advancement of Medical Instrumentation (AAMI), American National Standards Institute (ANSI): *Comprehensive guide to steam sterilization and sterility assurance in health care facilities*, Arlington, VA, Association for the Advancement of Medical Instrumentation, 2008; ANSI/AAMI ST79 2010, Amendments 1 and 2, 2011 and Amendments 3, 2012; [http://marketplace.aami.org/eseries/PDFDocs/st79a3\\_1208.pdf](http://marketplace.aami.org/eseries/PDFDocs/st79a3_1208.pdf).

American Dental Association’s Council on Scientific Affairs and Council on Dental Practice. *Infection control recommendations for the dental office and the dental laboratory*. *J Am Dent Assoc* 127:672–680, 1996.

Garner JS, Favero MS. *CDC guideline for handwashing and hospital environmental control*, 1985: *Infect Control* 7:231–243, 1986; CDC: *Recommended infection-control practices for dentistry*, 1993. *MMWR Recomm Rep* 1993;42(RR-8):1–12; CDC: *Recommended infection-control practices for dentistry*. *MMWR Morb Mortal Wkly Rep* 1986;35:237–242.

**165. What is potentially infective waste?**

It is waste contaminated by patient material and should be handled and disposed of accordingly.

**166. Does the term *contaminated* refer to wet or dry materials, or both?**

Contaminated refers to both wet and dry materials. For example, HBV can remain viable in dried materials for at least 7 days and perhaps longer. However, HBV is easily killed by moderate levels of heat or by a wide variety of chemical germicides, including low-level germicides.

**167. Is all contaminated waste potentially infective waste?**

No, but all infective waste is contaminated by definition. Some contaminated waste, although it contains potential pathogens, may not be of sufficient quantity or type to pose a reasonable threat of infection transmission.

**168. What is toxic waste?**

Toxic waste is capable of causing a poisonous effect.

**169. What is hazardous waste?**

This is waste that may pose a risk to individuals or the environment; it is regulated according to the type of hazardous waste, such as chemicals and materials. Hazardous waste is not necessarily biologic waste, but it can be. Toxic waste is a type of hazardous waste that may have a poisonous effect.

**170. What are some examples of hazardous waste?**

Some examples are spent fixer, lead foil, and amalgam. Although each is a hazardous waste and must be handled using proper PPE, their disposal is not the same. Therefore, it is necessary to segregate all waste, including medical waste, at chairside to ensure that it is disposed of properly.

**171. Is all hazardous waste toxic?**

No. It may not have a poisonous effect.

**172. If potentially infective waste is autoclaved, must you biologically monitor the cycle?**

If you use heat sterilization equipment to treat potentially infective waste, most state regulations mandate that you must biologically monitor each waste load to ensure that the cycle was successfully completed. Each load must be labeled with a date and batch number so that if a sterilization failure occurs, the load can be retreated. Although required by many states, the merits of or necessity for this degree of monitoring is highly controversial among experts.

**173. How is waste discarded?**

Nonregulated medical waste may be disposed of with the general waste. Regulated medical waste disposal is governed by the EPA and possibly by state or local laws. Hazardous waste requires using a waste hauler with an appropriate license to dispose of or reclaim the materials depending on their nature. The U.S. Department of Transportation also has jurisdiction over waste haulers. All waste transported for disposal should be entered into a specific waste log, and receipts from the hauler should be part of record keeping procedures.

**174. Can blood be discarded in the sewer system?**

If it is a sanitary sewer system and allowed by law, then blood can be discarded into the system. As with any other task that carries a risk of exposure, appropriate PPE should be worn.

**175. What method should be used to dispose of potentially infective items such as gauze, extracted teeth, masks, and gloves?**

Blood-soaked gauze, extracted teeth, and any other material contaminated by patient fluids, saliva, or blood should be considered potentially infective waste and disposed of according to federal, state, or local law. Masks, provided that they are not blood-soaked, can be disposed of as ordinary trash. Contaminated gloves should be disposed of as potentially infective waste.

**176. What is the most appropriate method for disposal of used needles and sharps?**

Although needles may be recapped by a one-hand technique or mechanical device, they should not be bent or broken or otherwise manipulated by hand. An appropriate sharps container should be used for disposal of all spent sharps and needles.

**177. What is household waste?**

Household waste is nonregulated and should be disposed of according to local requirements or regulations.

**DENTAL WATER QUALITY****178. Is there concern about the microbial biofilm known to populate dental unit water lines?**

Biofilm contamination of dental unit water lines (DUWLs), although not a new phenomenon, has received widespread attention from the media and scientific community. Numerous products are available that will control the growth of biofilm and proliferation of microorganisms present in DUWL. There are also test kits available to monitor the water quality of dental units. The American Dental Association has released a statement recognizing the microbial levels in DUWLs are not acceptable for the delivery of health care, and urging improvement of the amplified microbiologic quality of water through research, product development, and training. Other organizations, such as the CDC and Organization for Safety and Asepsis Procedures (OSAP), have issued guidelines for DUWLs. Current CDC guidelines recommend DUWL be maintained to ensure they meet the drinking water standard of no more than 500 colony forming units per mL of water.

**179. Have there been any documented cases of infection or disease in dental health care workers from microorganisms in DUWLs?**

Some published reports have suggested increased exposure of dental health care workers to *Legionella* bacteria from aerosolized DUW. DUW from an unmaintained dental unit may contain literally millions of bacteria and fungi per milliliter, many of them potential clinical pathogens. The lack of specific epidemiologic studies has prevented accurate assessment of the potential effect on public health. There has been one reported death of a patient linked to contaminated DUWL. To date, however, a major public health problem has not been identified.

**180. What is biofilm?**

Microbial biofilms are found almost anywhere that moisture and a suitable solid surface for bacterial attachment exist. Biofilms consist primarily of naturally occurring, slime-producing bacteria and fungi. These form microbial communities in the DUWL along the walls of small-bore plastic tubing in dental units that deliver coolant water from high-speed dental handpieces and air-water syringes. As water flows through the microbial matrix, some microorganisms may be released. Dental plaque is the best-known example of a biofilm.

**181. Where do the microorganisms come from?**

The vast majority are indigenous to house water mains. Patient microorganisms may be transient “tourists” in the biofilm.

**182. What conditions facilitate biofilm formation?**

Low numbers of microbes continually enter the DUWLs. They can be affected by nutrients in the incoming water, stagnation in the tubing, and the low flow rate near tubing walls. In addition, the small inside diameter of DUWLs results in a large surface-to-volume ratio, which presents optimal conditions for the growth of biofilm microorganisms, especially when the water sits stagnant.

**183. What are some suggested control measures?**

You can use independent reservoirs, chemical treatment, filtration, sterile water delivery systems, or combinations of these. The primary and perhaps most effective measure is routine monitoring (culturing), coupled with a regimen of chemical disinfection of the lines. Other strategies include improvement of the incoming water quality (e.g., sterile water in independent water reservoirs, heating, ultraviolet irradiation, filtering, constant low-level chemical treatment of incoming tap water) and controlling the microbial levels in the output water (e.g., filters).

**184. What is the purpose of flushing water lines?**

Current recommendations are to flush water lines for at least 3 minutes at the beginning of the clinic day and for at least 15 to 20 seconds between patients. This process does not

remove biofilm, but it may transiently lower the levels of free-floating microorganisms in the water. Control of water line contamination requires a number of steps, such as chemical disinfection of the lines, sterile water source, specific filtration system in the water line, or a combination of these treatments. Only a chemical disinfection regimen done on a routine basis will remove or control biofilm formation. Filters, for example, remove only the free-floating microorganisms that originate from the biofilm.

### 185. What is the purpose of an antiretraction valve?

Its purpose is to prevent aspiration of patient material into water lines, thereby reducing the risk of transmission of potentially infective fluids or patient material from one patient to another.

### 186. What should be done with the water supply on a dental unit when local health authorities issue a boil water notice after the quality of the public water supply is compromised?

Use of the dental unit should be stopped if it is attached to the public water supply or if tap water is used to fill the bottle of an isolated water supply to the unit. Immediately contact the unit manufacturer for instructions on flushing and disinfecting the water lines. The use of house water should not resume until the boil water notice is lifted by the local authorities.

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# DENTAL PUBLIC HEALTH

*Edward S. Peters and Lin Li*

*If you do not have oral health, you're simply not healthy.*

—C. Everett Koop, former U.S. Surgeon General

## PUBLIC HEALTH PROMOTION

### 1. What is the definition of public health in its broadest sense?

The World Health Organization defines public health as “all organized measures (whether public or private) to prevent disease, promote health, and prolong life among the population as a whole.”

### 2. What are the three tenets of public health?

1. A problem exists.
2. Solutions to the problem exist.
3. The solutions to the problem are applied.

### 3. Public health efforts are usually directed toward acute problems, such as infectious disease, or chronic diseases, such as cancer. What public health strategies are similar for these and most other diseases?

1. Surveillance
2. Intervention
3. Evaluation

### 4. What constitutes a public health problem?

A public health problem usually fulfills three criteria of the public, government, or public health authorities:

1. A condition or situation exists that is a widespread actual or potential cause of morbidity or mortality.
2. Costs to community and to individuals are great.
3. Effective methods available to prevent, alleviate or cure.

### 5. Describe the current infection control recommendations.

Recommendations for infection control undergo frequent revision, and the reader is urged to refer to the most up to date source. For current recommendations, please check the CDC's Division of Oral Health website, <http://www.cdc.gov/oralhealth/>.

The principles behind infection control involve **exposure control**, which refers to personal protective barriers such as gloves, masks, eye protection or face shield, and gowns. In addition, **heat sterilization** of all dental equipment, including handpieces, is required. Finally, the **handling and disposal** of all potentially infectious material must be properly performed (see Chapter 12).

### 6. Describe the U.S. Occupational Safety and Health Administration (OSHA) and its role in dental practice.

The mission of OSHA is to ensure the safety and health of U.S. workers. As part of the Department of Labor, OSHA and the states that operate OSHA-approved state plans establish guidelines and standards to promote worker safety and health that apply to every workplace, including medical and dental offices. The work practice control, engineering control, and personal protective equipment regulations are examples of OSHA safety topics that have a direct impact on dental infection control. The regulations designed to protect the dental health care worker often translate into increased safety for the dental patient.

### 7. What are primary, secondary, and tertiary prevention?

**Primary prevention** involves health services that provide health promotion and protection, with the goal of preventing the development of disease. Examples are community-based fluoridation for caries prevention and smoking cessation programs.

**Secondary prevention** includes services that are provided once the disease is present to prevent further progression. These services include dental restorations and oral cancer screening.

**Tertiary prevention** services are provided when disease has advanced to the point where loss of function or life may occur. Definitive surgery or radiation therapy to treat oral cancer and extractions of diseased teeth to eliminate infection are examples.

### 8. What is health promotion?

Health promotion is a set of educational, economic, and environmental incentives to support behavioral changes that lead to better health.

### 9. How has health promotion been achieved in dentistry?

Examples of health-promoting activities include community fluoridation and sealant programs. On the individual level, health promotion is encouraged through oral hygiene procedures.

### 10. Define health disparities.

The National Institutes of Health has defined health disparities as the “differences in the incidence, prevalence, mortality, and burden of diseases and other adverse health conditions that exist among specific population groups in the United States.” Health disparities may occur because of various reasons, such as poverty, unequal access to health care, lower educational attainment, racism, social networks, geographic location (neighborhoods), and social stigma.

### 11. How do disparities affect oral health?

There are substantial differences in oral health concerning clinical conditions, awareness of treatment options, treatment recommendations, and treatment received by different socioeconomic and ethnic groups. Examples of existing disparities in oral health include the following:

- Childhood caries are highly prevalent among racial and ethnic minorities and those in poor, rural, and immigrant groups.
- Persons in a lower socioeconomic position and minorities have more periodontal disease, more advanced periodontal disease, and faster progression of disease.

### 12. Give examples of community-based dental public health programs geared toward school children.

These are school-based fluoride delivery, dental screening, hygiene instruction, and sealant placement.

### 13. Before the implementation of any community-based program, the process of planning and evaluation is necessary. What are the basic steps involved in planning for a program?

Planning involves making choices to achieve specific objectives. Thus, a planner should review a list of alternative programs, assess the effectiveness and feasibility of the program under consideration, examine the community to determine if the program is needed, and initiate the process to implement the program.

### 14. What skills must someone have before managing dental public health programs?

The implementation of a public health program requires such skills as planning, marketing, communications, human resources management, financial management, and quality assurance.

### 15. Differentiate among need, demand, and utilization of oral health services.

**Need** can be defined as the quantity of dental treatment that expert opinion deems necessary for people to achieve the status of being dentally healthy. **Demand** for dental care is expressed by patients who wish to receive dental treatment. **Utilization** is expressed as the proportion of the population that visits a dentist.

### 16. What factors influence the need and demand for oral health services in the United States?

Demographic and other variables influence the use of dental services. Most notably, these include gender, age, socioeconomic status, race, ethnicity, geographic location, medical

health, and presence of insurance. Women use more dental services than men, although the reasons are unclear. Dental visits are most frequent for patients in their late teenage years and early adulthood, with a gradual tapering of visits with increasing age. Socioeconomic status is directly related to the use of dental services. There are fewer dental visits by patients of lower socioeconomic status and nonwhite and Hispanic populations.

**17. The utilization of health care has been explained through behavioral models. One model demonstrates how variables influence the utilization of health care from the individual's perspective. What factors play a role in explaining a person's health care utilization?**

1. **Predisposing factors**, such as the following: (1) demographic variables (e.g., gender, age); (2) societal variables (e.g., education, job); and (3) health beliefs (e.g., how susceptible to disease the person believes that he or she is, how serious he or she believes the consequences of the disease to be).
2. **Enabling factors**, which allow the services to be used, such as personal income, community resources, and accessibility to health care.
3. **Need factors**, which determine how the services should be used (e.g., presence of disease).

**18. What is the prevalence of smokeless tobacco use among adolescent males and females?**

Surveys indicate that in 2011, 7.7% of high school students (male, 12.8%; female, 2.2%) and 2.2% of middle school students (male, 3.0%; female, 1.4%) were current smokeless tobacco users. It is important to note the wide geographic variability in the rates. The Northeast experiences the lowest usage, and the highest reported use is in the South.

**19. What risks are associated with smokeless tobacco?**

Smokeless tobacco increases the risk of developing oral cancer. It contains nicotine and is as strongly addictive as cigarettes. The use of smokeless tobacco leads to the development of leukoplakia in mucosal areas in which the tobacco is placed. There is about a 5% chance of leukoplakia becoming cancerous. Leukoplakia may resolve with early cessation of smokeless tobacco use. In addition, smokeless tobacco is also associated with increased tooth decay, tooth loss, and periodontal disease.

**20. What is meant by the term *acidogenic*?**

Particular foods have the ability to reduce the pH of plaque when consumed and are considered to be acidogenic. The reduction in pH is considered a necessary condition for the development of caries. Such foods contain a high proportion of refined sugars (e.g., candy, soda).

**21. Describe how the benefits of fluoride were first discovered.**

In the early 1900s, Dr. Frederick McKay, having recently graduated from dental school, moved to Colorado, where he observed an unusual blotching of tooth enamel in many of his patients. This pattern was localized to communities that obtained their drinking water from artesian wells. He also observed that this blotching was associated with decreased caries activity. Eventually, fluoride was identified as the responsible agent. This finding led to fluoridation trials demonstrating that artificial fluoride prevents dental caries.

**22. Water fluoridation is one of the few public health measures that save more money than they cost. Why is water fluoridation so cost-effective?**

Fluoridation is a low-cost, low-technology procedure that benefits an entire community. It requires no patient compliance and is therefore easy to administer. The major costs are associated with the initial equipment purchase; later costs are for maintenance and fluoride supplies. The average cost for a community to fluoridate its water is estimated to range from approximately \$0.50/year/person in large communities to approximately \$3.00/year/person in small communities. For most cities, every \$1 invested in water fluoridation saves \$38 in dental treatment costs.

**23. What are the major mechanisms of action for fluoride in caries inhibition?**

1. The topical effect of constant infusion of a low concentration of fluoride into the oral cavity is thought to increase remineralization of enamel.
2. Fluoride inhibits glycolysis in which sugar is converted to acid by bacteria.
3. During tooth development, fluoride is incorporated into the developing enamel hydroxyapatite crystal, which reduces enamel solubility.

**24. What percentage of the U.S. population is served by community systems providing optimal levels of fluoridated water?**

Over 73% of the total U.S. population has an optimally fluoridated water supply.

**25. What is the recommended level of fluoride in the water supply?**

The U.S. Public Health Service sets the optimal fluoride level at 0.7 to 1.2 ppm.

**26. At what policy level is the decision to fluoridate the water supply made?**

Local governments make the decision. However, seven states have laws requiring water fluoridation.

**27. A parent of a 6-year-old child asks about fluoride supplementation. The child weighs 20 kg and lives in a fluoride-deficient area, with less than 0.3 ppm of fluoride ion in the drinking water. What do you recommend?**

You should prescribe sodium fluoride, 1-mg tablets, to be chewed and swallowed at bedtime.

**28. What are the recommended fluoride supplementation dosages for children?**

Tablets are available in doses of 1.0 and 0.5 mg for children and toddlers. For infants, supplemental fluoride is available as 0.125-mg drops (Table 13-1).

**29. What are alternatives to systemic fluoride supplementation (e.g., tablets)?**

- Topically applied gels of 2.0% NaF, 0.4% SnF, 1.23% acidulated phosphate fluoride (APF)
- Varnishes
- Prophylactic pastes or pumice
- Mouth rinses of 0.2% NaF weekly, 0.05% NaF daily, 0.1% SnF daily
- Daily dentifrice

The fluoride supplementation can be self-applied or professionally applied. The professionally applied fluorides are more concentrated than the self-applied fluorides and therefore are not needed as frequently. For patients with a high caries risk, the American Dental Association (ADA) recommends fluoride varnish applications at 3- to 6-month intervals for those younger than 6 years, fluoride varnish or gel applications at 6-month intervals for those age 6 to 18 years, and fluoride varnish or gel applications at 3- to 6-month intervals for those older than 18 years.

**30. In prescribing fluoride supplementation, what tradeoffs must be considered?**

The benefit of caries reduction must be considered against the risk of fluorosis. Fluorosis occurs with the presence of excessive fluoride during tooth development and causes discoloration of tooth enamel. Affected teeth appear chalky white on eruption and later turn brown. This risk is especially important during the development of the incisors in the second to third years. To avoid this problem, you must assess the fluoride content of the drinking water before dispensing fluoride supplementation. The fluoride in water, along with any supplemental fluoride, must not exceed 1 ppm. If 1 ppm is exceeded, the probability that fluorosis may develop increases as the fluoride concentration increases.

**31. Where is ingested fluoride absorbed?**

Eighty percent of absorption occurs in the upper gastrointestinal tract.

**Table 13-1. Supplemental Fluoride Dosage Schedule**

AGE	Concentration of Fluoride Ion in Drinking Water (ppm)		
	<0.3	0.3-0.6	>0.6
0-6 mos	0	0	0
6 mo to 3 yr	0.25 mg/day	0	0
3-6 yr	0.50 mg/day	0.25 mg/day	0
6-16 yr	1 mg/day	0.50 mg/day	0

**32. What are the manifestations of fluoride toxicity?**

The ingestion of 5 g or more of fluoride in an adult results in death within 2 hours if the person does not receive medical attention. In a child, ingestion of a single dose greater than 400 mg results in death caused by poisoning in about 3 hours. Doses of 100 to 300 mg in children cause nausea and diarrhea.

**33. How much fluoride is contained in an average 4.6-ounce tube of toothpaste?**

Sodium monofluorophosphate or sodium fluoride toothpaste contains approximately 1.0 mg of fluoride/g of paste. Therefore, a 4.6-oz tube of toothpaste contains 130 mg of fluoride. A level of 435 mg of fluoride consumed in a 3-hour period is considered fatal for a 3-year-old child—only a little over three tubes of toothpaste need to be consumed to reach a fatal level.

**34. What is the rationale behind the use of pit and fissure sealants in caries prevention?**

Occlusal surfaces, particularly fissures, have not experienced as rapid a decline in the incidence of caries as proximal surfaces because fluoride's protective effect is confined to smooth surfaces only. It has been observed that sealing the fissures from the oral environment prevents the development of occlusal caries. Sealants should be part of an early preventive program for protecting permanent molars.

**35. What proportion of U.S. children has received dental sealants?**

Of U.S. children, 30% of those age 6 to 11 years and 38% of adolescents age 12 to 19 years have received dental sealants. In addition, 39 states report having dental sealant programs to extend this service to the neediest children.

**36. Describe evidence-based dentistry (EBD) and its three important domains.**

Evidence-based dentistry is an approach to practice, an approach to making clinical decisions, and the provision of personalized dental care based on the most current scientific knowledge. The practice of EBD is based on the following:

1. The best available scientific evidence
2. A dentist's clinical skill and judgment
3. Each individual patient's needs and preferences.

**37. What are the recommended sources when searching for clinical evidence?**

- PubMed
- TRIP Database
- DARE (Database of Abstracts of Reviews of Effectiveness)
- National Guideline Clearinghouse
- Cochrane Library
- ADA's EBD website

**38. Do dentists have an obligation to report child abuse?**

Yes. Dentists are morally, ethically, and legally obligated to report a suspected case of child abuse. Reports should be made to the local department of social services, although this may vary from state to state.

**39. Where is the dentist's code of ethics found?**

The ADA has established a code of ethics that describes dentistry's responsibility to society. The code is published in the *Journal of the American Dental Association*. It deals with issues of patient care, fees, practice guidelines, advertising, and referrals. The ADA Principles of Ethics and Code of Professional Conduct can be found at the ADA's website, <http://www.ada.org/en/about-the-ada/principles-of-ethics-code-of-professional-conduct/>.

**40. What does the ADA Code of Ethics state about the removal of dental amalgam to prevent mercury toxicity?**

"The removal of amalgam restorations from the non-allergic patient for the alleged purpose of removing toxic substances from the body, when such treatment is performed solely at the recommendation of the dentist, is improper and unethical."

**41. How does the Americans with Disabilities Act affect dentists?**

- Dentists cannot deny anyone care because of a disability.
- Offices must undergo architectural changes to allow access for the disabled.
- Employees are protected against dismissal because of a disability.
- Offices must accommodate disabled workers so they can perform jobs.



## EPIDEMIOLOGY AND BIOSTATISTICS

### 42. Define epidemiology.

Epidemiology is the study of the distribution and frequency of disease or injury in human populations and the factors that make groups susceptible to disease or injury.

### 43. Differentiate between incidence and prevalence.

**Incidence** is the number of new cases of disease occurring within a population during a given period. It is expressed as a rate,  $(\text{cases})/(\text{population})/(\text{time})$ .

**Prevalence** is the proportion of a population affected with a disease at a given point in time—  $(\text{cases})/(\text{population})$ .

**Example:** A dentist counts the number of patients presenting to the office with newly diagnosed periodontal disease in a 6-month period. Of the 100 people who came to the office, 10 had periodontal disease. The incidence rate is calculated as  $10/100$  in 6 months, or  $0.2/\text{year}$ . The range for incidence rates is from 0 to  $\infty$ . The prevalence of periodontal disease may be obtained by counting all patients with periodontal disease in the same period—that is, if 50 of 100 patients have periodontal disease, the prevalence is 50%. Remember, incidence is a rate and requires a unit of time, whereas prevalence is a proportion and is expressed as a percentage of the population.

### 44. What is meant by test sensitivity and specificity? How are they calculated?

Frequently, dentists wish to know if disease is present and may use some diagnostic test to arrive at an answer. In dentistry, the most frequently used test is radiography. Dental radiographs are imperfect in that they do not distinguish all diseased from disease-free surfaces. Sensitivity and specificity are measures that describe how good the radiograph is in such differentiation.

**Sensitivity** measures the proportion of persons with the disease who are correctly identified by a positive test (true-positive [TP] rate). **Specificity** measures the proportion of persons without disease who are correctly identified by a negative test (true-negative [TN] rate). Sensitivity and specificity are inversely proportional; as the specificity of a test increases, the sensitivity decreases. An ideal test would have both high specificity and sensitivity, yet tradeoffs can be made, depending on the condition being tested. Sensitivity and specificity can be calculated from a  $2 \times 2$  table (Table 13-2). Sensitivity =  $(TP/TP) + FN$ ; specificity =  $(TN/FP) + TN$  (FN is false-negative).

### 45. What is meant by positive predictive value (PPV)?

The PPV reflects the proportion of persons who have the disease, given that they test positive. It measures how well the test predicts the presence of a given disease. The PPV is calculated from a  $2 \times 2$  table:

$$PPV = (TP/TP) + FP$$

This calculation takes into account the prevalence of disease.

### 46. What is meant by negative predictive value (NPV)?

The NPV indicates the proportion of persons who do not have the disease, given that they test negative. It measures how many of test negatives are true negatives. The NPV is calculated from a  $2 \times 2$  table:

$$NPV = (TN/TN) + FN$$

Positive and negative predictive values are directly related to the prevalence of the disease in the population. Assuming that all other factors remain constant, the PPV will increase with increasing prevalence and NPV will decrease with increasing prevalence.

Table 13-2.

	WITH DISEASE	WITHOUT DISEASE
Test positive	True-positive (TP)	False-positive (FP)
Test negative	False-negative (FN)	True-negative (TN)

**47. What does the *P* value represent?**

It means the probability that the observed result or something more extreme occurred by chance alone. Therefore, a *P* value of 0.05 indicates that there is only a 5% likelihood that the result observed was caused by chance alone. Traditionally, a *P* value of 0.05 is considered statistically significant. If the *P* value is more than 0.05, chance cannot be ruled out as an explanation for the observed effect. It is important to remember that chance can never be ruled out absolutely as an explanation for the observed results. A statistically significant result indicates that chance is not likely.

**48. What is relative risk? Odds ratio?**

The **relative risk** measures the association between exposure and disease. It is expressed as a ratio of the rate of disease among exposed persons to the rate among unexposed persons. Relative risk estimates the strength or magnitude of an association. The calculation of relative risk requires incidence rates, which are provided by cohort studies.

The **odds ratio** provides an estimate of the relative risk in case-control studies; because disease has already occurred, the incidence of disease cannot be determined.

**49. How do the mean, median, and mode differ?**

The three terms are measures of central tendency and are used to provide a summary measure to characterize a group of people. The **mean** represents the average. It is calculated by adding together all the observations and then dividing by the total number of measurements. The mean takes into account the magnitude of each observation and, as a result, is easily affected by extreme values. The **median** is defined as the middlemost measurement (50th percentile)—that is, half the observations are below it and half are above. Therefore, the median is unaffected by extreme measures. The **mode** is the most frequently used observation.

**50. Which of the following is most appropriate to test for differences between the means of two groups—ANOVA, *t*-test, or chi-square?**

A *t*-test is used to compare the means between two groups. The ANOVA, or analysis of variance, compares the means in more than two groups. The chi-square test is used to show differences in proportions.

**51. Confidence intervals are often provided when data are reported. What do they indicate?**

Confidence intervals (CIs) represent the range within which the true magnitude of the effect lies with a certain degree of certainty. For example, a relative risk of 2.1 may be reported with a 95% CI (1.5, 2.9). This indicates that the study determined the relative risk to be 2.1 and that we are 95% certain that the true relative risk is not less than 1.5 or more than 2.9. If the 95% CI includes the null value (1.0), the result is not statistically significant.

**52. Compare cross-sectional, case-control, and cohort studies.**

**Cross-sectional studies** are a type of descriptive epidemiologic study in which the exposure and disease status of the population are determined at a given point. For example, the caries status of U.S. adults age 45 to 65 years in 1992 may be determined by a national dental survey and examination.

**Case-control and cohort studies** are analytic epidemiologic studies. In **case-control studies**, participants are selected on the basis of disease status. The “cases” are persons who have the disease of interest, and the control group consists of persons similar to the case group except that they do not have the disease of interest. Information about exposure status is then obtained from each group to assess whether an association exists between exposure and disease.

In **cohort studies**, participants are selected on the basis of exposure status. Study participants must be free of the disease of interest at the time the study begins. Exposed and nonexposed participants are then followed over time to assess the association between exposure and specific diseases.

**53. Which type of study—cohort, case-control, retrospective, or clinical trial—most closely resembles a true experiment?**

In a clinical trial, the investigator allocates the participants to the exposure groups of interest and then follows the groups over time to observe how they differ in outcome. This method most closely resembles an experiment.

#### 54. Define clinical trial, the major types of clinical trials, and their purpose.

Clinical trial is a research study to answer specific questions about vaccines or new therapies or new ways of using known treatments. The National Institutes of Health (NIH) has classified clinical trials into five types:

1. *Treatment trials*: To test experimental treatments, new combinations of drugs, or new approaches to surgery or radiation therapy. For example, in dentistry, treatment trials are commonly used to test new dental restorative materials, implants, and treatment for dry mouth.
2. *Prevention trials*: To look for better ways to prevent disease in people who have never had the disease or to prevent a disease from returning. These approaches may include medicines, vaccines, vitamins, minerals, or lifestyle changes. Prevention trials are frequently carried out in dental caries prevention.
3. *Diagnostic trials*: To find better tests or procedures for diagnosing a particular disease or condition. Using different methods to assess the level of the clinical attachment and bone support in the diagnosis of periodontitis is an example of a diagnostic trial.
4. *Screening trials*: To test the best way to detect certain disease or health conditions. A clinical trial to evaluate the effectiveness of different screening strategies for oral cancer is an example of screening trial.
5. *Quality of life trials* (or supportive care trials): To explore ways to improve the comfort and quality of life for individuals with chronic illnesses. A dental trial that investigates clinical effectiveness and quality of life for conventional dental treatment compared to an alternative intervention is an example of quality of life trial.

#### 55. Discuss the importance of blinding and randomization in experimental studies.

Randomization and blinding are two methods of reducing bias in research studies. In a **randomized study**, all participants have an equal likelihood of receiving the treatment of interest. For example, patients are randomly assigned to two groups, one of which receives a particular treatment and the other, placebo. Several techniques are available to ensure randomization of the study participants. In a **double-blind study**, both the investigator observing the results and the participants are unaware of which individuals are assigned to which group. One means of achieving a blinded study is the use of placebos.

#### 56. Distinguish between split-mouth and crossover designs.

In **split-mouth studies**, different treatments are applied to different sections of the mouth. The effects of treatment must be localized to the region receiving the treatment. In **crossover studies**, patients serve as their own control and receive treatments in sequence—treatment A and then treatment B—and the disease course is compared between the two periods. The disease under investigation must be assumed to be stable during the period of treatment.

#### 57. What is the difference between interexaminer and intraexaminer reliability?

The validity of an examination depends on the reliability of the examiner. Intraexaminer reliability refers to the ability of a single examiner to record the same findings in the same way over time. Interexaminer reliability refers to the ability of different examiners to record the same finding in the same way.

#### 58. List and describe the most commonly used dental indices.

Measurements of dental caries are made with the **DMF index**. The DMF is an irreversible index and is used only with permanent teeth. *D* represents decayed teeth, *M*, missing teeth, and *F*, filled teeth. The DMF index can be applied to teeth (DMFT) or surfaces (DMFS). The DMFT score may range from 0 to 32, whereas the DMFS score may range from 0 to 160. The primary dentition uses the **def index**, where *d* represents decayed teeth, *e*, extracted teeth, and *f*, filled teeth.

Gingivitis is most commonly scored with the **gingival index** of Loe and Silness. It grades the gingiva on the four surfaces of each tooth. Each area receives a score from 0 to 3, where 0 = normal gingiva, 1 = mild inflammation, no bleeding on probing, 2 = moderate inflammation, and 3 = severe inflammation, ulceration, and spontaneous bleeding.

#### 59. What has been occurring in regard to the prevalence of caries in the United States?

The prevalence of caries has declined in children during the 20th century. Results of the National Health and Nutrition Examination Surveys (NHANES) during the 1970s and 1980s indicated that the prevalence of caries decreased significantly in the United States.

Data from NHANES, 1988 to 1994 and 1999 to 2004, also suggested that dental caries continues to decrease in the permanent dentition of youths and adolescents. However, the prevalence of dental caries in the primary dentition for youths age 2 to 5 years increased from 1988 to 1994 to 1999 to 2004. This increase was accompanied by a greater number of dental surfaces restored between 1988 and 1994 and 1999 and 2004. Elsewhere, the caries rate is also declining. A decline in adult caries is not as evident because most adults grow up before the decline starts. The use of fluoridation has received the most credit for the decline.

**60. How would you interpret the following statement, “Half of today’s schoolchildren have never had a cavity.” Is this statement accurate?**

The 50% estimate is overly optimistic because it ignores caries in the primary dentition. In fact, 50% of children have had caries by the time they are 8 years old. Also, most of the research methods used to assess caries prevalence have relied entirely on visual means and omitted radiographs. As a result, most caries studies underestimate the true burden of disease. Eighty-five percent of U.S. children experience decay by the time they are 17 years old. Low-income groups exhibit more dental disease and more delay in treatment than those with higher incomes.

**61. What factors make a person susceptible to dental caries?**

1. Host with susceptible tooth (mineral)
2. Agent—acid-producing bacteria (e.g., *Streptococcus mutans*)
3. Environment—dental plaque (from sucrose)
4. More recently some individuals also now include the dimension of time

**62. What did the Vipeholm study reveal about the effect of diet on dental decay?**

This study, conducted in a mental institution in Vipeholm, Sweden, is considered unethical and will not be repeated. The study divided patients into groups who received different doses of sugars. The sugars differed in amount, form, frequency, and whether they were consumed between meals. The most significant finding of the study was that the form and frequency of sugar consumption were most related to the occurrence of dental caries—that is, frequent consumption of sticky sugars increased the occurrence of dental caries.

**63. What can you tell the parents of a toddler to aid in the prevention of caries?**

Sugars are the most cariogenic foods, and the consumption of sugars between meals is associated with a marked increase in caries, whereas consumption of sugars with meals is associated with a much smaller increase. To prevent caries, avoid free sugars in bottle feeds, ensure optimal fluoride levels in water, and restrict intake of sugars.

**64. Root caries is seen predominantly in what patient population?**

It is seen primarily in older adults. The rising incidence of root caries can be attributed to the aging of the population in industrialized societies and the fact that most adults are retaining more teeth. Increased gingival recession with exposure of root surfaces leads to the development of root caries.

**65. What is the prevalence of periodontal disease?**

Gingivitis and periodontitis are universally prevalent; in most countries, more than 70% of all adults are affected. Some data suggest that there is no difference in the prevalence of periodontitis between developing and developed countries. The World Health Organization (WHO) reported that severe periodontitis affects 10% to 15% of adults worldwide, regardless of the country’s economic state, oral hygiene, or availability of dental care.

**66. What is a common factor in caries and periodontal disease?**

The presence of dental plaque is a causative agent in both diseases.

**67. What is the prevalence of malocclusion in the United States?**

Malocclusion is the third highest dental public health problem worldwide, surpassed only by dental caries and periodontal diseases. Approximately 60% of those in the United States have mild to severe malocclusion. Over 30% of white youths, 11% of Mexican Americans, and 8% of blacks report receiving treatment. Severe malocclusion is observed more frequently in blacks. Treatment is much more frequent in higher income groups; only 5% of those in the lowest income group and 10% to 15% of those in intermediate income groups report being treated.

**68. What types of problems are associated with malocclusion?**

- Psychosocial problems—facial appearance affects expectations, self-esteem
- Problems of oral functions and temporomandibular joint dysfunction (TMD)
- Greater susceptibility to trauma, periodontal disease, and tooth decay

**69. How common are oral cancers?**

Oral cancer accounted for 2% to 4% of all cancers diagnosed annually in the United States. It was estimated that 42,440 Americans (30,220 men; 12,220 women) would be diagnosed with oral cancer and 8,390 would die of cancer of the oral cavity and pharynx in 2014.

**70. What are the risk factors?**

Studies of oral cancer have identified smoking and use of other forms of tobacco as the primary risk factors. Alcohol consumption is also a risk factor that may act as a promoter with tobacco. The combination of heavy smoking and alcohol consumption increases the risk of oral cancer 30-fold. In addition, more recently, the human papilloma virus (HPV), particularly HPV16 and HPV18, has been implicated as a risk factor for oral and oropharyngeal cancers, especially in younger, nonsmoking, oral cancer patients.

**HEALTH POLICY****71. Differentiate between licensure and registration.**

Licensure is granted through a government agency to those who meet specified qualifications to perform given activities or claim a particular title. Registration is a listing of qualified individuals by a governmental or nongovernmental organization.

**72. What are the types of supervision for allied dental personnel, as defined by the ADA?**

1. **Indirect:** The dentist diagnoses a condition and then authorizes dental personnel to carry out treatment while the dentist remains in the office.
2. **Direct:** The dentist diagnoses a condition, authorizes treatment, and evaluates the outcome.
3. **General:** General supervision is defined by practice acts within each state and may require that the dentist be available but not necessarily on the premise or site where care is delivered.

**73. What are the basic components of the dental care delivery system?**

A delivery system is a means whereby health care is provided to a patient. It consists of four main components: (1) organizational structure in which doctors and patients come together; (2) how health care is financed and paid for; (3) supply of health care personnel; and (4) physical structures involved in the delivery of care.

**74. To what does quality assurance refer?**

Quality assurance is the process of examining physical structures, procedures, and outcome as they affect the delivery of health care. It consists of assessment to identify inadequacies, followed by implementation of improvements to correct the inadequacies and reassessment to determine whether the improvements have been effective.

**75. Define structure, process, and outcome as they relate to quality assurance.**

**Structure** refers to the layout and equipment of a facility. Included are items such as the building, equipment, and record forms. **Process** involves the services that the dentist and auxiliary personnel perform for patients and how skillfully they do so. **Outcome** is the change in health status that occurs as a result of the care delivered.

**76. How do cost-benefit and cost-effectiveness analyses differ?**

Cost-effectiveness and cost-benefit analyses are similar yet distinct techniques to help allocate resources to maximize objectives. **Cost-benefit analysis** requires that all costs and benefits be expressed in dollar terms to provide a measure of net benefit. **Cost-effectiveness analysis** uses alternative measures to value effectiveness. Objections to valuing life in terms of dollars led to the use of cases of disease prevented, life-years gained, or quality-adjusted life-years. The result is a cost-effectiveness ratio that expresses the cost per unit of effectiveness.

**77. What is adverse selection?**

Adverse selection occurs when people at high risk for an illness are the predominant purchasers of insurance, especially when the risk for illness and the premium are based on a low-risk population. Thus, high-risk people are attracted to the insurance by its low rates, which allow them to avoid payments for a likely illness.

**78. What is moral hazard?**

Patients with insurance demand more medical care than patients who have to pay the cost themselves.

**79. What is a community rating?**

The premiums charged to all insurance subscribers are the same, regardless of individual risk and who pays for medical care. Community rating spreads the cost out, allowing those who are less healthy to afford medical care, but it can create higher costs for those who are healthy. The cost ultimately falls on the general public.

**80. What are the different financing mechanisms for dental care?**

Dentistry is financed mainly through fee-for-service self-pay; 56% of all dental expenses are paid out of pocket by the patient. Payment to the dentist by an organization other than the patient is called third-party payment. Third-party payers represented by private insurance pay about 33% of total dental expenses, followed by government-financed or public programs (e.g., Medicaid, U.S. Department of Veterans Affairs).

**81. What is capitation payment?**

HMO premiums are usually made on a capitation basis—that is, HMO providers receive a given fee per enrollee, regardless of how much or little care is delivered.

**82. Explain the differences among IPA, PPO, and HMO.**

All three represent managed-care practices. Managed care refers to forms of insurance coverage in which utilization and service patterns are monitored by the insurer, with the aim of containing costs. An HMO (health maintenance organization) is usually a self-contained, staff model practice in which no distinction is made between the providers of insurance and providers of health care. HMO premiums are paid on a capitation basis. In contrast, IPA (independent practice association) and PPO (preferred provider organization) represent groups of doctors who practice in the community and are distinct from the insurance provider. However, the insurance agency contracts with the providers for discounted rates and may refer patients to these providers exclusively. If a patient chooses to go to a different provider from the one recommended by the insurance company, the patient may face a financial penalty, such as an additional charge.

**83. How do managed care arrangements differ from the traditional model of dental care?**

Traditional medical and dental care has been paid on a fee-for-service basis. The patient chooses any provider in the community, and the insurance company usually pays a certain percentage of the charge. In the current era of cost-consciousness, many insurance companies are modifying or eliminating this model altogether. Fee-for-service usually provides no incentive for the patient or provider to contain costs. It is no longer widely in use.

Most people today have some type of managed care insurance. Managed care organizations supervise the financing of medical and dental care delivered to members. To be cost-effective, they buy services in bulk for many members at a time and also provide members with a list of doctors from which to choose and lists of laboratories where tests can be performed. Even doctors are provided with lists of medicines from which to choose. Different plans have different restrictions on choice.

**84. How do Medicaid and Medicare differ?**

**Medicare**, an entitlement fund, was created to provide health insurance to those 65 years of age and older, certain disabled groups, and people with certain kidney diseases. Medicare has two parts, an institutional or hospital portion (Part A) and a noninstitutional portion, or physician services (Part B). Part A has no premium, but Part B is supplemental and voluntarily purchased. Medicare does not provide dental care.

**Medicaid** is a means-tested program to provide health insurance to poor people eligible for welfare assistance programs. Medicaid covers hospital and physician costs without a premium or copayment. Medicaid is required by federal law to provide dental services to children. However, adult dental services are optional, and the decision whether to provide dental care is determined at a state level.

### 85. Which agency administers Medicare funds?

The Health Care Financing Administration (HCFA), a federal agency, is responsible for funding Medicare. It determines how much providers will be paid and what services are covered.

### 86. How are the funds for Medicaid provided?

Medicaid is a joint federal and state program with federal guidelines that allow states some flexibility in which services are provided and who is eligible. The federal government provides states with matching dollars.

### 87. What percentage of the gross national product (GNP) is spent on health care?

In 2011, 17.9% of the GNP was spent on health care. The GNP represents the total production in the United States.

### 88. What percentage of all U.S. health care expenditures is for dental care?

In 2010, approximately 4% (\$104.8 of \$2594 billion) of all U.S. health care expenditures was for dental services, and it was estimated to increase to \$179.8 billion in 2021.

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# c0014 LEGAL ISSUES AND ETHICS

*Elliot V. Feldbau and Bernard Friedland*

## s0010 LEGAL ISSUES

### p0010 1. What general principles of law apply to dental practice?

p0020 U.S. law is outlined under principles of criminal and civil law; the latter is divided into contract and tort law. Most legal issues related to dental practice involve civil wrongs or torts—that is, wrongful acts or injuries, not involving breach of contract, for which an individual can bring a civil action for damages.

p0025 Malpractice is part of the law of negligence, which constitutes one type of tort. A malpractice suit based on the law of negligence alleges that the dentist failed to employ the care and skill of the average qualified practitioner. It further alleges that the failure to employ the required care and skill was the “proximate cause” of the patient’s injury. Malpractice is considered an unintentional tort. It is normally covered by dental malpractice insurance.

p0030 Informed consent cases used to be based on the theory of assault and battery, but today they are considered no differently from other malpractice cases.

p0035 Invasion of privacy, an intentional tort, results when a patient’s image or name is used by a dentist for personal gain, such as in advertising. Discussing a patient by name without permission, with persons other than the clinical staff, also may be construed as a violation of the privacy implied by the doctor-patient relationship.

### o0015 2. Under the law, how is the relationship between doctor and patient interpreted?

p0045 The law defines the doctor-patient relationship under the principles of contract law. The terms are usually implied but may be expressed. On accepting a patient for care, the dentist is obliged to do the following: (1) maintain confidentiality; (2) complete care in a timely and professional manner; (3) ensure that care is available in emergency situations or in the absence of the dentist; and (4) be compensated for treatment by the patient. Of interest, the contract is termed *binding* at the earliest point of contact—that is, the moment when a telephone call is placed to the dentist may be interpreted as the point of consummation of the contract unless the dentist refuses to consider the caller for care or does not realize that the caller is a patient.

### o0020 3. May a dentist dismiss a patient after beginning a treatment?

p0055 There are four ways to terminate the dentist-patient relationship: (1) the patient may inform the dentist that he or she no longer wishes to be cared for by the dentist; (2) the treatment has run its course; (3) the dentist and patient mutually agree that the patient will no longer be treated by the dentist; and (4) the dentist terminates the relationship.

p0060 Perhaps an example best clarifies the second way. Suppose a patient is referred to an endodontist for treatment of tooth #9. Once the endodontist has completed treatment and any necessary follow-up, the dentist-patient relationship is terminated. In this case, the dentist is under no obligation to treat the patient at any time in the future. A possible exception may be if future treatment is needed for tooth #9. In cases involving 3 and 4, the dentist should avoid the risk of being liable for abandonment by notifying the patient of his or her decision in writing, providing the telephone number of the local dental society that the patient may call for a referral, and offering to provide emergency treatment for a reasonable (depending on the circumstances) period of time.

### o0025 4. What is considered adequate informed consent?

p0070 A dentist must disclose to a patient the risks and benefits of a procedure, alternative treatments, and the risks and benefits of no treatment. Informed consent is not required in writing but may be helpful.

p0075 U.S. courts use one of two measures to determine whether the dentist satisfied the informed consent requirement. A minority of states apply the standard that disclosure is

adequate if the dentist has given the patient information that the “average qualified practitioner” would ordinarily provide under similar circumstances. A majority of states require a dentist to disclose to a patient in a reasonable manner all significant medical and dental information that the dentist possesses or reasonably should possess; the patient uses this information to decide to undergo or refuse a proposed procedure.

- o030  
p0085 **5. When may the issue of informed consent be bypassed?**  
In an emergency, consent is implied. Such an emergency exists when treatment cannot be postponed without jeopardizing the life or well-being of the patient, and the patient is unable to grant consent because of physical impairment.
- o0035 **6. Who is responsible if a dental hygienist performs prophylactic treatment without proper premedication on a patient who develops subacute bacterial endocarditis after relating a history of rheumatic fever and heart valve replacement on his or her medical form?**  
p0095 Under the legal principle of *respondeat superior* (“let the master answer”), the employees of a dentist, and the dentist, may be sued for negligence (deviating from the standard of care) or other issues of malpractice or battery during the course of their employment.
- o0040  
p0105 **7. Does a missed diagnosis or failure of treatment constitute negligence?**  
An incorrect diagnosis does not necessarily constitute negligence. Because of the many judgments involved in dental practice, it is considered unrealistic to expect that a dentist be 100% correct. The plaintiff must demonstrate injury because of the dentist’s failure to diagnose properly before there are grounds for negligence. Furthermore, it must be shown that the dentist failed to exercise the applicable standard of care.  
p0110 If the outcome of treatment is bad (e.g., a failed endodontic treatment because of a separated instrument), negligence is not necessarily supported if the appropriate standard of treatment is employed. However, if a dentist promises to effect a specific cure, bring about a particular result, or complete a procedure with no residual problems and fails to fulfill the promise, a lawsuit may be filed on the basis of breach of contract rather than negligence.
- o0045 **8. When should a patient be referred?**  
p0120 A patient should be referred under the following circumstances:  
o0050 1. When there is a question of appropriate treatment  
o0055 2. When periodontal treatment not routinely performed by the general dentist is indicated  
o0060 3. When periodontal disease is advanced, with severe bone loss  
o0065 4. When shared responsibility is desirable for complex multidisciplinary cases  
o0070 5. When complex care is required for medically compromised patients  
o0075 6. When the patient is refractory to treatment or unstable, with a well-documented history of previous treatment failures
- p0155 **9. What are common reasons for patients to sue?**  
o0085 1. Lack of informed consent—patient does not know the specific nature and/or complications of treatment  
o0090 2. Failure to refer—for example, treating advanced periodontal disease with only scalings  
o0095 3. Failure to treat or diagnose adequately  
o0100 4. Abandonment  
p0185 If the patient was dismissed for nonpayment of services, the dentist must show that other avenues were tried, such as small claims court or collection agencies. The dentist should document the reason for the dismissal and make a referral source and any necessary emergency care available for a period of 60 days. Communications to the patient should be through a registered letter.  
o0105 5. Guarantees by doctor or staff  
o0110 6. Poor patient rapport  
o0115 7. Lack of communication  
o0120 8. Poor record keeping  
o0125 9. Issues related to fee collection
- p0215 **10. What is necessary to prove negligence?**  
p0225 Four elements are necessary to prove negligence and win a malpractice suit. The patient must establish the following: (1) a dentist-patient relationship existed (i.e., the dentist owed the

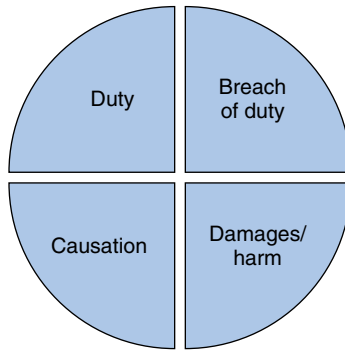


Figure 14-1.

patient the care and skill of the average qualified practitioner); (2) the dentist breached his or her duty by failing to exercise the level of care and skill of the average qualified practitioner; (3) the patient suffered injury; and (4) a connection exists between the dentist's breach of duty and the patient's injury (causation) (Fig. 14-1).

o0135 11. What are grounds for revocation of a dental license?

p0235 Criminal convictions involving fraud and deception in prescribing drugs, gross immorality, or conviction of a felony under state law are grounds for revocation, usually by decision of the state licensing board. A license may also be revoked for a pattern of negligent care or for gross negligence.

o0140 12. What issues may constitute a defense against malpractice?

p0245 In theory, a dentist need not introduce any evidence to prevail in a lawsuit brought by a patient. This is because the patient has the burden of proof. In reality, a dentist will often introduce evidence to refute a patient's assertions. If a dentist is able to refute any of the four elements that a plaintiff patient must prove, the dentist will prevail. In practice, the most hotly contested issue usually revolves around the standard of care. Typically the plaintiff has an expert witness testify on his or her behalf and the dentist has one testify on her or his behalf. The matter of causation is another area that may be hotly contested. Even if a dentist breached the standard of care, that does not mean that the breach resulted in harm to the patient. For example, assume that a patient complains to a dentist that he has had an ulcer for 6 weeks that is not healing and that the dentist responds by saying "Let's wait another month and see what happens." The patient happens to see another dentist a week later who does a biopsy, and the histology shows the lesion to be squamous cell carcinoma. The first dentist should certainly have biopsied an ulcer that has been present for 6 weeks and, by failing to do so, breached the standard of care. However, the 1-week delay in diagnosis would not affect the prognosis; hence, there are no damages, and the plaintiff is unable to prove all four of the required elements to win a tort suit.

o0145 13. Which elements are contained in a complete dental record?

- p0255
- Identification data
  - Medical history, including updated antibiotic regimens for prophylaxis of subacute bacterial endocarditis, effects of medication on birth control pills, and medical consultations as needed
  - Dental history
  - Clinical examination
  - Diagnosis and interpretation of radiographs
  - Treatment plans
  - Progress notes
  - Consent forms for surgical procedures
  - Completion notes
- u0070
- u0075
- u0080
- u0085
- u0090
- u0095
- u0100
- u0105

- p0305 **14. How should records be written and corrections be made?**  
 p0315 All entries require ink or typed notes, not pencil, and errors must be lined out with a single line and initialed, with the substitute entry correcting the error. This procedure guards against any challenge to the reliability of record entries.
- p0320 Practitioners who keep digital records (those who use a computer) should be especially careful. Because it is easy to go back and make changes, one is easily accused of making changes to the record to suit one's needs. Practitioners who use word processing software are well advised to take precautions so that they can prove when the entries were made. Programs that record dates of entry are available but work on different principles. One program allows a person to make changes at any time, but an auditing program keeps track of when each and every keystroke was made. A different program requires one to type a word (e.g., "End") after an entry has been completed. Thereafter, the program does not permit one to go back into previous entries. Changes to the record must be made under a new entry, which should be labeled by the dentist to indicate that it is a modification of the record. Commonly, the word *addendum* is used to label such an entry.

## s0015 **ETHICS**

- p0325 **15. How is the practice of dentistry broadly governed?**  
 p0335 The ethical rules and principles of professional conduct for the practice of dentistry are set forth in the American Dental Association (ADA) publication, *Principles of Ethics and Code of Professional Conduct*, which describes the role of the professional in the practice of dentistry.
- o0160 **16. List the five fundamental Principles that form the foundation of the ADA Code of Ethics.**
- o0165 1. Beneficence—being kind and/or doing good
  - o0170 2. Autonomy—respect of the patient's right of self-decision
  - o0175 3. Justice—the quality of being impartial and fair
  - o0180 4. Non-maleficence—First, do no harm
  - o0185 5. Veracity—telling the truth
- o0190 **17. How does the code define beneficence in the practice of dentistry?**  
 p0375 The dentist is obliged to do the following:
- o0195 1. Give the highest quality of service of which he or she is capable.  
 p0385 This implies that professionals will maintain their level of knowledge by continued skill development.
  - o0200 2. Preserve healthy dentition unless it compromises the well-being of other teeth.
  - o0205 3. Participate in legal and public health-related matters.
- p0400 **18. Who is expected to be responsible for the practices of preventive health maintenance?**
- p0410 The patient is expected to be responsible for his or her own preventive practices. The dentist is responsible for providing information and supportive care (e.g., recall, prophylaxis), but the patient has the ultimate responsibility to maintain oral health.
- o0215 **19. Outline the essential elements implied in the principle of autonomy.**  
 p0420 The principle of autonomy requires respect for the patient's rights in the areas of confidentiality, informed consent for diagnostic and therapeutic services, and truthfulness to the patient. The dentist should work with patients to allow them to make autonomous decisions about their care. The dentist is obliged to provide services for which the patient contracts.
- o0220 **20. How does the dental profession serve justice, according to the code?**  
 p0430 The individual dentist and the profession as a whole are obligated to be just and fair in the delivery of dental services. Self-regulation is a basic tenet of this obligation, as well as calling attention to any social injustices in the allocation of societal resources to the delivery of dental health services.

- o0225 **21. A 29-year-old patient with poor oral hygiene and multiple caries requests full-mouth extractions and dentures. A complete examination reveals a basically sound periodontium and carious lesions that can be restored conservatively. What ethical principles apply to this basic case of neglect without advanced disease?**
- p0440 Respect for the patient's autonomy and requests is evaluated and judged against the duty of the dentist to provide the highest type of service of which he or she is capable. After full disclosure about the long-term effects of edentulism, as well as the costs and benefits of saving teeth, the assessment of the patient's motivation is most important. Saving teeth that will only fall into disrepair through neglect and the patient's lack of commitment to maintain oral health must be considered carefully before a final treatment is elected or rejected.
- o0230 **22. A patient rejects the use of radiographs for examination of his teeth. How should this situation be handled, according to the code?**
- p0450 The dentist's only recourse is to use informed consent about the risks and benefits of an incomplete examination and the possible consequences of such a decision. The respect of the patient's right to choose (autonomy) prevails, even if it generates a negative obligation not to interfere with a patient's choice.
- o0235 **23. An adolescent presents with a suspected lesion of a sexually transmitted disease (STD) and asks that no one, especially his parents, be told. What are the ethical considerations?**
- p0460 The right of autonomy and respect for privacy are overturned by the public health law that requires the reporting of STDs to the health department. Public law is often the determinant in these situations.
- o0240 **24. A patient requests that all her amalgam restorations be replaced. Is this an ethical issue?**
- p0470 It is not unethical to replace amalgams on request. It is considered untruthful, and hence unethical, to make any claim that a patient's general health will be improved or that the patient will rid her body of toxins by replacing amalgam restorations. It is unethical to ascribe any disease to the use of dental amalgam, because no causal relationship has been proved, or to attempt to treat any systemic disease by the removal of dental amalgams.
- o0245 **25. What disciplinary penalties may be imposed on a dentist found guilty of unethical conduct?**
- o0250 1. **Censure**—a disciplinary sentence written to express severe criticism or disapproval for a particular type of conduct or act
- o0255 2. **Suspension**—a loss of membership privileges for a certain period, with automatic reinstatement
- o0260 3. **Probation**—a specified period without the loss of rights in lieu of a suspended disciplinary penalty
- p0495 A dentist on probation may be required to practice under the supervision of a dentist or other individual approved by the dental board.
- o0265 4. **Revocation of license**—absolute severance from the profession
- p0505 **26. For what acts may a dentist be charged with unethical conduct?**
- o0275 1. A guilty verdict for a criminal felony
- o0280 2. A guilty verdict for violating the bylaws or principles of the Code of Ethics
- o0285 **27. To what guiding principle does the ADA's *Principles of Conduct and Code of Professional Ethics* ascribe?**
- p0530 Service to the public and quality of care are the two aspects of the dental profession's obligation to society elaborated in the code.
- o0290 **28. May a dentist refuse to care for certain patients?**
- p0540 It is unethical for a dentist to refuse to accept patients because of race, creed, color, gender, or national origin or because the patient has acquired immunodeficiency syndrome (AIDS) or is infected with the human immunodeficiency virus (HIV). Treatment decisions and referrals

should be made on the same basis as they are made for any patient that the dentist treats. Such decisions should be based only on the need of a dentist for another dentist's skills, knowledge, equipment, or experience to best serve the patient's health needs. A dentist may not be deliberately ignorant to avoid treating certain groups of patients. For example, in the early days of the HIV epidemic, some dentists were afraid to care for HIV-infected patients and predicated their refusal to do so on the fact that they did not know how to practice infection control properly. These arguments did not prevail; dental boards acted against them, and these dentists were told to acquire the education and skills required.

- o0295 29. **May a dentist relate information about a patient's seropositivity for HIV to another dentist to whom he or she is referring the patient?**  
 p0550 The laws that safeguard the confidentiality of a patient's record are not uniform throughout the United States with regard to HIV status. It may be prohibited to transfer this information without the written permission of the patient. As a rule, the treating dentist is advised to seek written permission from the patient before releasing any information to the consulting practitioner. With the stigma associated with HIV having dissipated to a large extent, there has been a move to liberalize the laws with respect to releasing HIV information and to allow a health care practitioner to divulge this information to another treating practitioner. However, at this point, a dentist would be well advised to ascertain the law in his or her state.
- o0300 30. **What is overbilling?**  
 p0560 Overbilling is the misrepresentation of a fee as higher than it is—for example, when a patient is charged one fee and an insurance company is billed a higher fee to benefit the patient's copayment.
- o0305 31. **May a dentist accept a payment from a dental insurance company as payment in full for services and not request the patient's portion?**  
 p0570 It is considered overbilling, and hence unethical, to collect only the third-party payment without full disclosure to the insurance company.
- o0310 32. **May a dentist charge different fees to different patients for the same services?**  
 p0580 It is considered unethical to increase a fee to a patient because the patient has insurance. However, different treatment scenarios and conditions may prevail and dictate different fees, regardless of the form of payment.
- o0315 33. **Is it appropriate to advance treatment dates on insurance claims for a patient who otherwise would not be eligible for dental benefits?**  
 p0590 It is considered false and misleading representation to the third-party payer to advance treatment dates for services not undertaken within the benefit period.
- o0320 34. **What are the standards for advertising by dentists?**  
 p0600 In the United States, the right to advertise is guaranteed by the First Amendment. This right to commercial speech is not as unfettered as that granted to other forms of speech, especially political speech, but it is nevertheless an important right. Advertising is permitted as long as it is not false or misleading in any manner. Infringements of the standards involve statements that include inferences of specialty by a general dentist, use of unearned degrees as titles, or statements stating or implying that the dentist's work is superior to that of others.
- o0325 35. **How may specialization be expressed? What are the standard guidelines?**  
 p0610 To allow the public to make an informed selection between the dentist who has completed accredited training beyond the dental degree and the dentist who has not, an announcement of specialization is permitted. The areas of ethical specialty recognized by the ADA are dental public health, endodontics, oral pathology, oral and maxillofacial radiology, orthodontics, pediatric dentistry, periodontics, prosthodontics, and oral and maxillofacial surgery. Any announcement should read "specialist in" or practice "limited to" the respective field. Dentists making such announcements must have met the educational requirements of the ADA for the specialty.
- o0330 36. **What are the stated guidelines for the name of a dental practice?**  
 p0620 Because the name of a practice may be a selection factor on the patient's part, it must not be misleading in any manner. The name of a dentist no longer associated with the practice may be continued for a period of 1 year.

- o0335 37. **What does the code state about the chemical dependency of dentists?**  
 p0630 It is unethical for a dentist to practice while abusing alcohol or other chemical substances that impair ability. All dentists are obligated to urge impaired colleagues to seek treatment and report first-hand evidence of abuse by a colleague to the professional assistance committee of a dental society. The professional assistance committee is obligated to report noncompliers to the appropriate regulatory boards for licensing review.
- p0635 In the case of some boards, dentists who self-report addiction to a board will often not have any official action taken against them as long as they are in compliance with the board's requirements for seeking treatment. As long as they are not a danger to the public, they may even be allowed to practice while undergoing treatment, albeit sometimes under the supervision of another dentist approved by the board. The professional assistance committee is obligated to report noncompliers to the board.
- o0340 38. **How are problems of interpretation of the *Principles of Ethics* and *Code of Professional Conduct* to be resolved?**  
 p0645 Problems involving questions of ethics should be resolved by the local dental society. If resolutions cannot be achieved, an appeal to the ADA's Council on Ethics, Bylaws, and Judicial Affairs is the next step.
- o0345 39. **Name and explain the basic underlying philosophy of major ethical theories that could be used when trying to resolve issues involving patients and treatment.**  
 p0655 The ADA *Code of Ethics* follows the four principles approach:  
 u0110 • Nonmaleficence—doing no harm  
 u0115 • Beneficence—being kind and/or doing good  
 u0120 • Autonomy—respecting the patient's right of self-decision  
 u0125 • Justice—the quality of being impartial and fair  
 p0680 1. **Teleological (utilitarian) ethics**  
 Actions are judged to be morally good if they achieve a good goal or outcome; consequences, not intentions, are important.
- o0355 2. **Deontologic ethics**  
 The consequences of an action are generally irrelevant to the moral assessment; there are rights that must not be violated.
- o0360 3. **Casualty (case-based reasoning)**  
 This is colloquially referred to as the four boxes approach (Box 14-1).

### BOX 14-1. Ozar's and Sokol's Interactive Model of Dentistry

#### Medical Indications

Consider each medical condition and its proposed treatment. Ask the following questions:

- Does it fulfill any of the laws of medicine?
- With what likelihood?
- If not, is the proposed treatment futile?

#### Patient Preferences

Address the following:

- What does the patient want?
- Does the patient have the capacity to decide? If not, who will decide for the patient?
- Do the patient's wishes reflect a process that is informed? Understood? Voluntary?

#### Quality of Life

Describe the patient's quality of life **in the patient's terms**.

- What is the patient's subjective acceptance of likely quality of life?
- What are the views of the care providers about the quality of life?
- Is quality of life "less than optimal" (i.e., qualitative futility)?

#### Contextual Features

Consider social, legal, economic, and institutional circumstances in the case (e.g., inability to pay for treatment, inadequate social support) that can do the following:

- Influence the decision
- Be influenced by the decision

From <http://depts.washington.edu/bioethx/tools/4boxes.html>. Last accessed June 14, 2014.

- p0715 In this model, the dentist and patient are equal partners; the dentist's "authority" arises from his or her expertise; the patient's, from his or her autonomy.
- o0365 40. **Is it ever permissible for a dentist to undertake treatment that is considered below (outside) the standard of care?**
- p0725 Although one might think it is not permissible for a dentist to undertake treatment considered below (outside) the standard of care, most ethicists agree that there are occasions in which this is permissible. Assume, for example, that a patient asks you to reimplant an avulsed tooth that has been out of the mouth for 2 days. Doing so would clearly violate accepted guidelines for reimplanting avulsed teeth. However, weighing of the risks and benefits of reimplanting the tooth could lead some ethicists to regard undertaking the treatment as ethical, in spite of the guidelines. Good informed consent is essential in these cases.
- p0730 Undertaking treatment outside the standard of care (we prefer to use the word *outside* rather than *below* in these circumstances), the standard of care should not be a common occurrence. It should also be pointed out that not all ethicists agree that it is permissible.

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