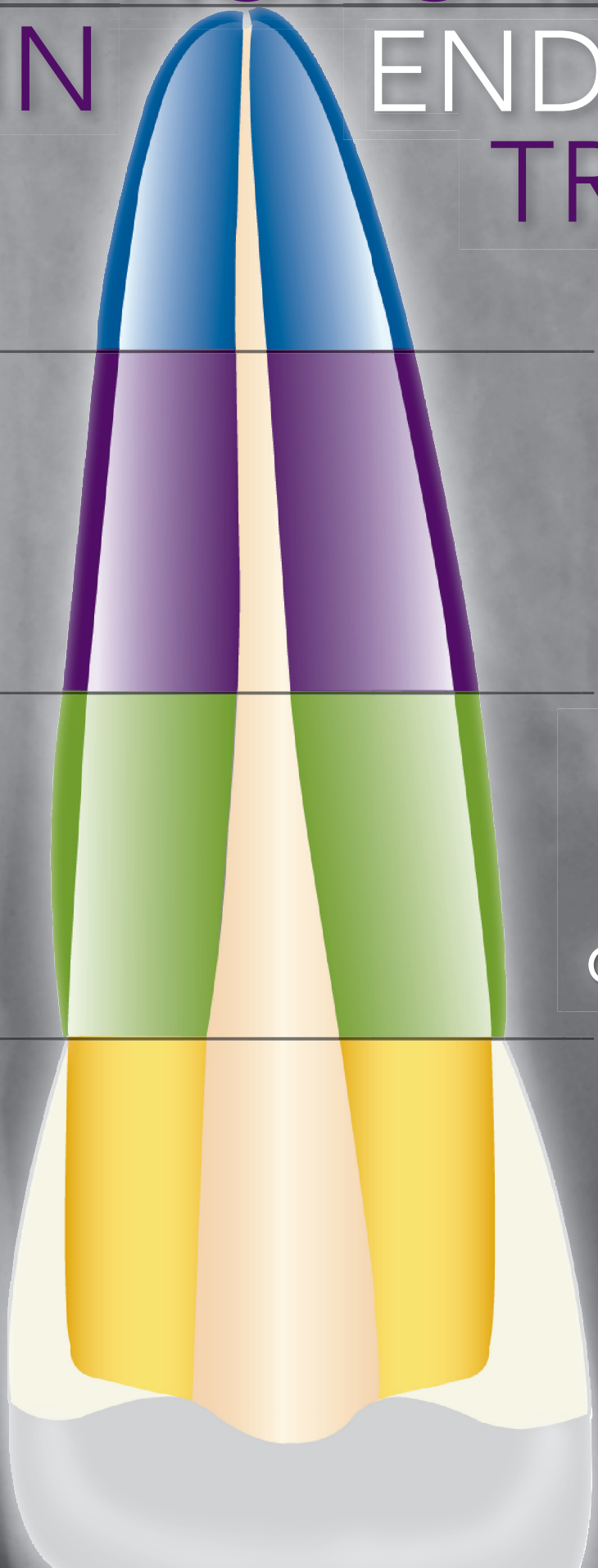
# PRACTICAL LESSONS IN ENDODONTIC TREATMENT



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Practical Lessons in Endodontic Treatment

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# Contents

## PART THREE *Preparation for Treatment*



## PART FOUR *Canal Instrumentation: Shaping, Disinfection, and Case Management*

## PART FIVE *Endodontic Obturation*



## PART SIX *Emergency and Adjunctive Endodontic Procedures*

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# Preface

Contemporary endodontic therapy is based on a sound scientific foundation, but its clinical success is largely dependent on how well clinicians access, clean, shape, disinfect, and seal root canals. This text is first and foremost a practical manual, not a reference book. While we refer to the literature as necessary to corroborate and/or reinforce concepts with scientific evidence, we focus on the essential, practical strategies for providing reliable nonsurgical endodontic care to patients.

Traditional endodontic textbooks often overwhelm readers with the amount of theoretical information presented. In this book, every effort has been made to provide straightforward discussions that emphasize key concepts. Following the tradition of this book's popular predecessor, *Practical Lessons in Endodontic Surgery* (Quintessence), we have adopted an easy-to-use, workbook approach to nonsurgical root canal therapy. Each lesson presents a different component of endodontic therapy and includes simple step-by-step clinical procedures and concise tips and recommendations. Readers will find helpful solutions to myriad endodontic challenges.

With more than of 150 years of combined experience both in developing and teaching graduate endodontic programs and in managing private practices, we have had ample opportunity to critically assess and validate all the procedural changes and technologic improvements demonstrated in the text. We have integrated the latest clinical concepts and technologies with tried-and-true strategies in the diagnosis, treatment planning, and execution of endodontic therapy. Our goal is to assist dentists and their support staffs in the implementation of technologic and procedural recommendations that simplify daily routine, build confidence and skill, enhance treatment outcomes, and make root canal treatment more rewarding, profitable, and fun.

We wish to thank our families for their advice, understanding, and encouragement during the preparation of this manuscript and throughout the countless hours in editing and organization of the text. Few projects of this scope are achieved without the selfless devotion of family. It is to our families that we fondly dedicate this book.

# PART ONE

# Examination and Diagnosis

# LESSON 1

# Medical Evaluation and Antibiotic Precautions

## OBJECTIVE

To identify and respond to health issues that might compromise endodontic therapy.

## OFFICE POLICY

A patient must complete a comprehensive medical/dental questionnaire before any dental treatment is initiated (Fig 1-1). It is the responsibility of the attending doctor to:

- Ascertain the responder's authority to make the patient's health care decisions if the responder to the questionnaire is someone other than the patient.
- Question the significance of all *yes* responses in the questionnaire.
- Ask the patient if any new medical problems have arisen since the last appointment.
- Verify the date of the patient's last appointment. No questionnaire should be considered valid if 1 year or more has passed since the patient's last appointment.

## HEALTH HISTORY

**Patient Name:** _____ **Birth Date:** _____

**I. CIRCLE APPROPRIATE ANSWER** (leave blank if you do not understand question):

1. Yes No Is your general health good?
2. Yes No Has there been a change in your health within the last year?
3. Yes No Have you been hospitalized or had a serious illness in the last three years?
   If YES, why? _____
4. Yes No Are you being treated by a physician now? For what? _____
   Date of last medical exam _____ Date of last dental exam _____
5. Yes No Have you had problems with prior dental treatment?
6. Yes No Are you in pain now?

**II. HAVE YOU EXPERIENCED:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 7. | Yes | No | Chest pain (angina)? | 18. | Yes | No | Dizziness? |
| 8. | Yes | No | Swollen ankles? | 19. | Yes | No | Ringing in ears? |
| 9. | Yes | No | Shortness of breath? | 20. | Yes | No | Headaches? |
| 10. | Yes | No | Recent weight loss, fever, night sweats? | 21. | Yes | No | Fainting spells? |
| 11. | Yes | No | Persistant cough, coughing up blood? | 22. | Yes | No | Blurred vision? |
| 12. | Yes | No | Bleeding problems, bruising easily? | 23. | Yes | No | Seizures? |
| 13. | Yes | No | Sinus problems? | 24. | Yes | No | Excessive thirst? |
| 14. | Yes | No | Difficulty swallowing? | 25. | Yes | No | Frequent urination? |
| 15. | Yes | No | Diarrhea, constipation, blood in stools? | 26. | Yes | No | Dry mouth? |
| 16. | Yes | No | Frequent vomiting, nausea? | 27. | Yes | No | Jaundice? |
| 17. | Yes | No | Difficulty urinating, blood in urine? | 28. | Yes | No | Joint pain, stiffness? |

**III. DO YOU HAVE OR HAVE YOU HAD:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 29. | Yes | No | Heart disease? | 40. | Yes | No | AIDS? |
| 30. | Yes | No | Heart attack, heart defects? | 41. | Yes | No | Tumors, cancer? |
| 31. | Yes | No | Heart murmurs? | 42. | Yes | No | Arthritis, rheumatism? |
| 32. | Yes | No | Rheumatic fever? | 43. | Yes | No | Eye diseases? |
| 33. | Yes | No | Stroke, hardening of arteries? | 44. | Yes | No | Skin diseases? |
| 34. | Yes | No | High blood pressure? | 45. | Yes | No | Anemia? |
| 35. | Yes | No | Asthma, TB, emphysema, other lung diseases? | 46. | Yes | No | VD (syphilis or gonorrhea)? |
| 36. | Yes | No | Hepatitis, other liver disease? | 47. | Yes | No | Herpes? |
| 37. | Yes | No | Stomach problems, ulcers? | 48. | Yes | No | Kidney, bladder disease? |
| 38. | Yes | No | Allergies to drugs, foods, medications, latex? | 49. | Yes | No | Thyroid, adrenal disease? |
| 39. | Yes | No | Family history of diabetes, heart problems, tumors? | 50. | Yes | No | Diabetes? |

**IV. DO YOU HAVE OR HAVE YOU HAD:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 51. | Yes | No | Psychiatric care? | 56. | Yes | No | Hospitalization? |
| 52. | Yes | No | Radiation treatments? | 57. | Yes | No | Blood transfusions? |
| 53. | Yes | No | Chemotherapy? | 58. | Yes | No | Surgeries? |
| 54. | Yes | No | Prosthetic heart valve? | 59. | Yes | No | Pacemaker/defibrillator? |
| 55. | Yes | No | Artificial joint? | 60. | Yes | No | Contact lenses? |

**V. ARE YOU TAKING:**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 61. | Yes | No | Recreational drugs? | 63. | Yes | No | Tobacco in any form? |
| 62. | Yes | No | Drugs, medications, over-the-counter supplements? | 64. | Yes | No | Alcohol? |

Please list: _____
_____

**VI. WOMEN ONLY:**

65. Yes No Are you or could you be pregnant or nursing? 66. Yes No Taking birth control pills?

**VII. ALL PATIENTS:**

67. Yes No Do you have or have you had any other diseases or medical problems NOT listed on this form?

If so, please explain: _____
_____

*To the best of my knowledge, I have answered every question completely and accurately. I will inform my dentist of any change in my health and/or medication.*

Patient's signature: _____ Date: _____

**RECALL REVIEW:**

1. Patient's signature: _____ Date: _____
2. Patient's signature: _____ Date: _____
3. Patient's signature: _____ Date: _____



**Fig 1-1** Example of a comprehensive Health History Form.

# INACCURATE QUESTIONNAIRE

It is the responsibility of the attending doctor to be constantly aware of hidden signs of disease(s) that may be unknown to the patient or accidentally or intentionally withheld by the patient, such as:

- Fire red (flushed) or ashy pale (pallor) skin color and/or ankle and leg swelling that might indicate an undiagnosed cardiac problem, such as high blood pressure or congestive heart failure, or severe alcoholism.
- A yellowish or bronze skin color that might indicate liver, kidney, or endocrine impairment.
- Facial blemishes, gingival and/or palatal sores, and exposed needle marks that might indicate the patient is an alcohol or drug abuser and as such could be a carrier of hepatitis or a sexually transmissible disease.
- Facial varicosities that might indicate drug and alcohol abuse that could interfere with the dynamics (intensity and duration) of a local anesthetic.

Dentists should also be alert to patients seen on an emergency basis where the offending tooth has all the appearances of having been treated multiple times in the past, such as an excessively large endodontic access opening and overly aggressive canal enlargement. This may very well indicate that the patient is seeking emergency treatment only to acquire a prescription for pain medication. This situation is even more suspicious when the patient requests a specific pain medication.

Whatever the circumstances, a physician consultation request is always an option (see Physician Release Form, Fig 10-1).

# RISK FACTOR CONCERNS

Based on the responses to both written and verbal questioning, patients should be mentally categorized into risk levels, and the treatment decision(s) should be based on the demands of that risk. The most serious and dangerous threat to a patient following a dental procedure is infective endocarditis (IE), which is more commonly called *bacterial endocarditis*.

## Etiology

Bacteria enter the bloodstream (bacteremia), lodge on abnormal heart valves or other damaged heart tissue, and stimulate an infection of the inner lining of the heart. Only certain bacteria are prone to cause IE, and those microorganisms are normally found in the mouth and upper respiratory system.

## Who is at risk

According to the American Heart Association (AHA), the American Dental Association (ADA), the Infectious Diseases Society of America (IDSA), and the Pediatric Infectious Diseases Society (PIDS), anybody is subject to IE, and IE is just as likely to occur from an everyday activity as it is from a dental procedure (AHA, *Circulation*, April, 2007).

## Prevention

Use of a prophylactic regimen of antibiotics can help prevent IE.

### *Caution*

According to the AHA, the risk of taking preventive antibiotics often outweighs the benefits. As such, the AHA does not recommend the injudicious use of broad prophylactic regimens of antibiotics for every patient.

### *The AHA conclusion*

Prophylactic antibiotics should be reserved for moderate- to high-risk patients who might experience the gravest outcomes (eg, death) if left unprotected. The AHA guidelines are based on its comprehensive risk factor studies and are not intended to represent the standard of care for dentistry or to be a substitute for a dentist's clinical judgment (Table 1-1).

**Table 1-1** AHA recommendations of prophylactic antibiotic regimens for IE

| Situation | Agent | Regimen |
|---|---|---|
| Standard: For the general population | Amoxicillin | Adults: 2.0 g, children: 50 mg/kg<br>Sig: orally 1 h before procedure |
| For patients unable to take medication orally | Ampicillin | Adults: 2.0 g, children: 50 mg/kg<br>Sig: IM or IV 30 minutes before procedure |
| For patients with a penicillin allergy | Clindamycin | Adults: 600 mg<br>Sig: orally 1 h before procedure |

IM = intramuscular; IV = intravenous; Sig = write on label.

# RISK LEVELS

## Negligible risks

The AHA does *not* recommend prophylactic antibiotics for patients that present to the office with the following conditions:

### *Cardiac conditions*

- Repaired congenital heart defects
- Innocent heart murmurs
- History of rheumatic fever but no valve disease
- Coronary graft beyond a 6-month healing period
- Mitral valve prolapse, without valvar regurgitation
- Kawasaki syndrome, without valvar regurgitation
- A cardiac pacemaker/defibrillator (intravascular or epicardial)

### *Over-the-counter blood thinners*

Patients taking over-the-counter blood thinners, such as aspirin, do not normally present a problem for routine endodontic procedures. Local coagulate methods, including pressure, epinephrine pellets (Epidri, Pascal), ferric sulfate products such as Stasis (Gingi-Pak) and Cut-trol (Icthys Enterprise), and calcium sulfate, are usually satisfactory in controlling hemorrhage even when the endodontic procedure involves a surgical intervention.

### *Pregnancy*

- To avoid the possibility of inducing labor, endodontic care during the first trimester should be performed on an emergency basis only, and the treatment procedure and chair time at that appointment should be kept to a minimum.
- If the endodontic treatment is an elective procedure, it is wise to perform the service when the patient is in the second trimester.
- Antibiotics should be used sparingly, sedatives should be avoided, and the quantity of a vasoconstrictor used during treatment should be kept to a minimum.

### *Apprehension and anxiety*

- Additional appointment time will be required to thoroughly explain the need and reasons for the endodontic procedure(s).
- Once it becomes apparent the patient is excessively fearful of the procedure, it is wise to suggest the use of a mild preoperative sedative.
- The use of rubber dam must be carefully and thoroughly explained, and to reduce the possibility of a sudden claustrophobic panic attack, the eyes and nose (airway) must be kept clear at all times.
- Though reassurance throughout the procedure will have a calming effect, the doctor and the assistant must be ever prepared for a patient's sudden, even violent body and hand movements provoked by the stress of the procedure.

### *Neurologic issues*

Epilepsy, palsy, Parkinson disease, facial and head tics, dementia, or the convulsive and/or emotionally disturbed patient.

- These patients are best served by prescribing appropriate preoperative sedatives or hypnotics, not prophylactic antibiotics.
- The doctor and assisting staff must be on constant alert for sudden patient movement(s) that could cause an inadvertent procedural accident.
- Referral is always an option.

## Moderate risk

The AHA *does* recommend a prophylactic regimen of antibiotics for the following risk conditions:

### *Cardiac impairment*

- Acquired valvar dysfunction (eg, rheumatic heart disease)
- Cardiomyopathy
- Mitral valve prolapse with valvar regurgitation and/or thickened leaflets

### *Prescription blood thinners*

Patients on prescribed blood thinners such as Coumadin (Bristol-Myers Squibb) or any other warfarin-related drug are at moderate risk with routine endodontic and restorative procedures. As such, it is incumbent upon the attending doctor to make sure the international normalized ratio (INR) number is greater than 2.5 at the time an endodontic procedure is initiated! Do not take patients at their word for the prothrombin time (PT) number unless they show you a document of the date and test result.

The anticoagulant therapy of a Coumadin patient should never be discontinued without the permission of the patient's attending physician. As such, a Coumadin patient's physician should be contacted and asked to respond to the following questions before any treatment is initiated:

> I am planning to do a (routine/surgical) endodontic procedure on (patient's name). I understand you have (patient's name) on Coumadin therapy (warfarin). Do you know this patient's current INR count, or do you wish to test this patient at this time? If you discontinue the patient's Coumadin therapy, how many days should I wait until I can continue with my treatment plan?

An account of the verbal consultation (physician's name and phone number, date, time, responses to all questions, advice, and course and direction of action) should be recorded in the patient's chart. For even greater liability protection, a follow-up written response from the physician should be requested (see Physician Release Form, Fig 10-1).

### *Bleeding disorders*

- Hemophilia, leukemia, neutropenia, and leukopenia; consult (both orally and in writing) with the attending physician. The missing factor(s) in a patient with hemophilia must be determined and replaced before any treatment is initiated.
- Treatment is best performed in a hospital setting, where an ample supply of blood is available and an emergency transfusion can be administered.
- Referral is always an option.

### *Respiratory conditions*

Asthma, emphysema, severe bronchitis, smoker's cough, history of miner's (black) lung disease, tuberculosis, or lung cancer.

- Prescribing a mild sedative and keeping the length of treatment time short can help minimize the threat of a patient's hyperventilating and becoming anoxic during treatment (see lesson 6).
- Every effort should be made to keep the patient's airway open throughout the procedure. This is particularly true when applying and maintaining a rubber dam.
- Oxygen should be available at all times and administered whenever a patient's breathing becomes noticeably stressed.
- A physician should clear any patient having a history of tuberculosis or having had a lung removed before treatment is initiated.

### *Infectious diseases*

- Patients with a known infectious disease require a physician consultation, barrier control, and appropriate (physician-prescribed) antibiotics.
- All office personnel involved in the treatment of such patients should be current with their hepatitis A and B inoculations (see lesson 12).

### *Immunologic disorders: Mononucleosis, Epstein-Barr*

- The attending physician should be consulted, and an appropriate physician-prescribed antibiotic regimen should be administered.
- These patients are most receptive to treatment early in the day when they are least tired.

### *Endocrine imbalances*

Addison disease, hypothyroidism, hyperthyroidism.

- The attending physician should be consulted.
- Appropriate physician-prescribed sedatives and/or antibiotics should be administered.

### *Uncontrolled diabetes*

- The attending physician should be consulted.
- An appropriate physician-prescribed antibiotic regimen should be administered.
- The patient and the doctor should be aware that, depending on the severity of the diabetes, response to treatment (healing) could be delayed.

### *Hepatitis and HIV*

- The attending physician should be consulted.
- The doctor and all attending office personnel should be current with their hepatitis A and B vaccinations.
- The doctor and the assisting staff must strictly adhere to the universally accepted infection-control protocol.
- An accidental "stick(s)" to a doctor, patient, or staff member demands immediate attention; the wound site must be washed with soap and rinsed with alcohol, Betadine (Purdue Pharma), or hydrogen peroxide. The stick incident must be recorded in both the patient's chart and the employee file (see lesson 12).

### *Osteoradionecrosis*

Because the loss of vascularity inhibits a normal inflammatory response, which in turn impairs healing, a positive prognosis for endodontic treatment cannot be expected or offered.

## High risk

The AHA *does* recommend a prophylactic regimen of antibiotics for patients who present to the office with a medical condition(s), the gravity of which presents the greatest of risks (ie, death). The following conditions demand a physician consultation and strict adherence to the AHA recommendations for preventing IE:

### *Severe cardiac impairment*

- Severe hypertension. The danger of this condition lies in the possibility of sudden stroke or a cardiovascular crisis (eg, uncontrollable hemorrhage during treatment).
- A recent (within 12 months) myocardial infarct. With this situation, there is a danger of stress-related relapse, coagulant antagonisms, or hemorrhage during the procedure.
- A history of bacterial endocarditis.
- Prosthetic cardiac valves, including bioprosthetic and homograft valves.
- Complex cyanotic congenital heart disease (eg, single ventricle states, transposition of the great arteries, tetralogy of Fallot).
- Surgically constructed systemic pulmonary shunts or conduits.
- Most congenital cardiac malformations other than those listed for moderate- and negligible-risk patients.
- Acquired valvar dysfunction (eg, rheumatic heart disease).
- Mitral valve prolapse with valvar regurgitation and/or thickened leaflets.

## Controversial risks

- Judgment, the dentist's choice: Antibiotic treatment decisions for endodontic cases are often based on the subjective opinion of the treating dentist—that is, evaluation of the patient's medical and dental history, clinical signs and symptoms, advice from the patient's physician, personal interpretation of the literature, recommendations of the ADA and AHA, and even past experience(s).
- The recommendation of the ADA Division of Science and the AHA: "To reduce the risk of bacterial endocarditis the dentist should administer antibiotics to heart patients undergoing endodontic therapy where instrumentation goes beyond the apex or when apical surgery is necessary."
- Conclusion: It is the prerogative of the attending dentist to prescribe an antibiotic regimen for a patient if he or she considers the reason to prescribe the drug is in the best interest of the patient and the rationale behind the decision is justifiable and defensible.

### *Prosthetic joint replacement*

In 2003, an expert panel convened by the ADA, the American Academy of Orthopaedic Surgeons (AAOS), and infectious disease specialists updated their 1997 recommendations and concluded:

- Prophylactic antibiotic therapy is not indicated for patients with pins, plates, or screws, nor is it routinely indicated for most dental patients with total joint replacements.
- Prophylactic antibiotic therapy is advisable for a small number of patients who may be at risk of experiencing a hematogenous total joint infection. They are those with:
  - Inflammatory arthropathy (eg, rheumatoid arthritis, systemic lupus erythematosus)

– Disease-, drug-, or radiation-induced immunosuppression
– Insulin-dependent (type I) diabetes
– A history of prior prosthetic joint infections
– Physical weakness, feebleness, and malnourishment
– Hemophilia

### *Drug interactions*

Today, clinicians have the monumental task not only of being aware of the actions and reactions of the plethora of Food and Drug Administration (FDA)–cleared drugs but also of understanding the chemical interactions of the nonapproved FDA herbal medicine supplements. As such, the Patient's Medical Questionnaire must be specific with regard to asking patients to include both prescription and nonprescription over-the-counter supplements.

For instantaneous information regarding the mode of action and biologic effects (synergisms and antagonisms) of all drugs, a current issue of the *Physicians' Desk Reference* (PDR), or a computer Internet drug link should be referenced:

- For prescription drugs: http://www.rxlist.com/script/main/hp.asp; http://clinicalpharmacology.com
- For a review of diseases: http://library.dialog.com/bluesheets/html/bl0304.html
- For nutraceuticals: http://www.nutraceuticalsworld.com; http://www.ana-jana.org/

## LEGAL PERSPECTIVES REGARDING THE USE OF ANTIBIOTICS

The courts recognize that each professional is entitled to and responsible for his or her own treatment decisions as long as the decision is based on sound principles that are reasonable, defensible, and in the best interest of the patient. However, the courts also recognize that patients have the right to make decisions regarding their own health and welfare, and those rights may at times conflict with the dentist's rights. The following examples represent such situations.

### Case 1: Physician vs dentist recommendation

The patient brings a recommendation for premedication from his or her physician, and the dentist disagrees with the physician. Should the dentist ignore the recommendation or simply defer to the physician's judgment? "Neither approach is prudent," says Kathleen M. Todd, JD, Associate General Counsel, Division of Legal Affairs, ADA, and she supports her position as follows: "It is incumbent upon the dentist to inform the patient of all reasonable treatment options and to make sure the patient clearly understands the risks and benefits of each."

Of particular importance in this case would be an explanation of how and why his or her recommendation(s) might differ from that of the physician. However, if after the case is presented the patient insists the dentist follows the physician's advice, Todd states: "The greatest risk for the dentist would be to go against his or her better judgment." As such, the dentist is under no obligation to render a treatment that he or she feels is not in the patient's best interest. To avoid being accused of abandonment, a referral to another practitioner would be the best solution. All of the discussions, explanations, and decisions should be recorded, signed, and included in the patient's record.

### Case 2: Patient refusal to follow dentist's recommendation

The dentist prescribes a regimen of antibiotics for a patient. After the case is presented, the patient refuses to take the medication. Todd states that it is incumbent upon the dentist to clearly explain to the patient that, in his or her opinion, "not taking the prescribed antibiotics places the patient at grave risk of experiencing a bacterial endocarditis." If the patient still chooses not to take the recommended antibiotics, the best solution is to refer the patient to another practitioner. All of the discussions, explanations, and decisions should be recorded, signed, and included in the patient's record.

Do no harm. Of greatest risk is performing a service for a patient that compromises one's beliefs and integrity. A referral is always a preferable option.

# LESSON 2

# Clinical Examination and Assessment of an Endodontic Patient

## OBJECTIVE

To collect and evaluate examination data for the purpose of reaching a diagnosis and developing a treatment plan.

## INTRODUCTION

The success of any endodontic treatment plan depends on the health of the pulp and periradicular bone. To determine those conditions, a thorough, systematic, and standardized clinical and radiographic evaluation regimen must take place. Though this lesson focuses on the specifics of comprehensive examination of a patient who is experiencing a nonemergency pulpal or periradicular problem that is not immediately diagnosable, there are times when the urgency of treatment requires immediate attention.

# TREATMENT REQUIRING IMMEDIATE ATTENTION

## Traumatic pulp exposure

In this type of case, the patient was involved in an accident that fractures the crown of a tooth (teeth) and exposes the pulp(s). Once the superficial bleeding is arrested, the pulp exposure is obvious, and if the visual and radiographic examination reveals no further damage, the treatment options will be pulp cap, pulpotomy, or pulpectomy and concomitant root canal therapy. However, though few diagnostic tests are needed to determine the treatment plan, the records (for potential litigation purposes) of a trauma case must include a comprehensive assessment of the patient:

- A review of the patient's past and present health history
- The patient's physical condition at the time he or she arrived at the office (ie, indication[s] of other bodily injury)
- A review of the patient's past dental history to determine if there had been a prior injury to this tooth (teeth) that might affect prognosis
- A clinical evaluation and description of the appearance and condition of the soft (facial and mucosal) and hard (alveoli and bone) tissues approximating the injured tooth (teeth)
- A detailed explanation of the accident

The patient should be advised to see a physician. If the patient already has seen a physician, the physician's name, address, and phone number, and the date and time the patient was seen also should be recorded.

At this time, it is incumbent upon the dentist to discuss and explain in depth the treatment procedures that may be required at this visit, those procedures that will be necessary at a later date(s), the prognosis of the proposed treatment plan, other available options, the fact that a final restoration will be required sometime in the future (possibly by someone else), and an estimation of the fee(s). If the dental trauma from the accident involves more than the coronal aspect of the tooth (teeth) (eg, root fracture, alveolar or jaw fracture or displacement, lip and facial lacerations, uncontrollable bleeding), there is always the option to refer the patient to an oral surgeon or to the hospital emergency room.

All patient (guardian) and doctor comments, particularly about time frames and fees, should be recorded, and if the patient (guardian) agrees to the treatment plan, a consent to treat must be in writing and signed by all parties. Once the dentist has legal and binding informed consent, the treatment may ensue.

## Inadvertent operative incident

During the course of excavating an extensively decayed tooth, the pulp might be exposed.

### *Best-case scenario*

The clinical and radiographic evaluation of a carious tooth indicates or suggests that the pulp might be exposed during excavation. The patient is informed of the potential problem, and the treatment options—including a pulp cap, pulpotomy, pulpectomy and root canal therapy, or extraction—are thoroughly discussed (see lessons 36, 37, and 38). The benefits, prognosis, future treatment needs, and fees are carefully explained. A treatment plan is mutually agreed upon, and consent is given to proceed (see lesson 10).

### *Worst-case scenario*

The possibility that the pulp might be exposed during the excavation has not been preliminarily discussed with the patient, in which case treatment must be interrupted or aborted if and when the exposure occurs. The options, benefits, and fees must now be discussed at a cost of valuable office time, and the patient, under stress, is forced to make a decision that she or he may reconsider, regret, and challenge at a later time. The alternative is for the dentist to make a treatment decision without the patient's approval and permission. Both resolutions are expensive, time-consuming, and lend themselves to latent liability questions about consent, rights, and fees.

## Emergency patient

The third situation involves a patient who is in pain and/or swollen who has either called for an appointment or walked into the office seeking immediate endodontic attention.

# EXAMINATION SEQUENCE FOR THE ENDODONTIC PATIENT

The remainder of this lesson concentrates on the sequential phases of a comprehensive examination and assessment process that leads to a diagnosis and appropriate endodontic treatment plan.

## Phase 1: Triage

Since the efficient use of production time is important to a successful practice, the evaluation of a patient should begin at the time a patient calls or visits the office. Beyond asking routine personal questions for the legal record (eg, name, address, phone number) (see lesson 5), a trained receptionist asking a series of specific questions can gather enough prediagnostic information not only to judge the urgency of the situation (work in today, see tomorrow, schedule at the earliest opportunity, seek advice from the doctor) but also to estimate the amount of chair time needed to provide the service. The following Triage Form (Table 2-1) is offered as a guide; with it the receptionist should be able to accommodate the patient, keep the office on schedule, and avoid the stress and chaos associated with falling behind and making scheduled patients wait!

## Phase 2: Initial office visit

By reviewing the triage form, asking leading and meaningful questions about signs and symptoms, and listening intently to the verbal descriptors of a patient's problem in a compassionate manner, the doctor not only demonstrates personal concern for the patient's welfare and establishes a rapport that will set the tone for the balance of treatment, he or she also learns to separate differentials that help lead to a diagnosis.

## Phase 3: Evaluating the patient's medical and dental history

Any health condition(s) mentioned on the medical history form that might influence the outcome of treatment should be questioned and the responses noted in the patient's record. If doubt exists with regard to health issues, the situation should be brought to the patient's attention and counseling sought from the family physician(s) before initiating treatment. Reviewing the dental history with the patient may expose reasons for the symptoms, including a recent restorative procedure, a prior endodontic or periodontal treatment, trauma, or perhaps even a medical treatment such as a sinus scope or radiation therapy.

## Phase 4: Interpreting the patient's pain—Listen, listen, listen!

The presence, location, and patient description of pain are crucial. If the pain is focused, the patient can not only pinpoint the arch but also, as a result of past and present thermal sensitivity, point directly to the offending tooth. A few specific tests can quickly and easily confirm a diagnosis.

If the inflammatory by-products of a necrotic tooth have built internal (pulpal) pressure sufficient to elevate the tooth in the socket, the patient will be able to pinpoint the offending tooth by biting down. Therefore, the diagnosis may only require the doctor to instruct the patient to bite down on a specifically placed orangewood stick or Tooth Slooth (Professional Results) to pinpoint the problem. The Tooth Slooth is an excellent instrument to test specific cusps when a coronal fracture is suspected. A few tests can quickly and easily confirm a diagnosis.

If the patient claims the pain is vague and diffuse, the doctor may be able to target only the arch. In instances of referred pain (eg, a nonodontogenic malignant metastasis, sinus inflammation, cavitational osteomyelitis), the patient must be questioned about the painful experiences and the sequences and episodes that have led to this appointment: Does the pain wake you up at night? Is there any one area in the mouth that seems to be more of a problem? How long and how often have you had this pain? Does any medication relieve the pain? Have you seen other doctors? What were their recommendations? Numerous differentials should be considered, and none should be excluded until all of the facts accumulated over the entire examination have been collated and assessed.

Since there is never any justification to initiate a treatment plan until the patient and the doctor agree on the origin of the pain, your choices are to offer the patient compassion; to admit the diagnosis cannot be confirmed at this time; and to suggest the patient return in several days or weeks to repeat the tests at which time, hopefully, the problem will have localized. You may also consider referring the patient.

**Table 2-1** Sample triage form*

| Question | Answer | Response |
|---|---|---|
| 1. Are you presently in pain? | NO | The receptionist is free to make an appointment on a day that is convenient for both the patient and the doctor. |
| | YES | The receptionist should proceed to question 2. |
| 2. Is the tooth sensitive to cold or heat? | YES | This indicates the pulp is most likely alive (vital), and treatment will require the use of an anesthetic. The receptionist should proceed to questions 3, 7, and 4, in that order. |
| | NO | This indicates the tooth is possibly necrotic, in which case the receptionist should proceed to questions 5, 6, 7, and 4, in that order. |
| 3. On a scale of 1 to 10, with 10 being the worst, what would you judge your pain? | 0–4 | Being sensitive to cold or heat at this level indicates a mild pulpitis. If there is no time available on this day, an appointment within the next 24 to 72 hours should be satisfactory. The receptionist may, with the doctor's permission, recommend that the patient take two acetaminophen or ibuprofen every 6 hours. |
| | 5–10 | Being sensitive to cold or heat at this level indicates an irreversible (acute) pulpitis. It would be best for the patient to be seen that day. To determine the amount of appointment time needed, the receptionist should proceed to question 4. |
| | | For the possibly necrotic tooth (no sensitivity to cold or heat), pain level is less important than are the responses to questions 5 and 6, and the receptionist should proceed to these questions next. |
| 4. Is the tooth that is hurting a front or a back tooth? | FRONT | For an anterior tooth, the patient and doctor will probably need a 30- to 40-minute appointment. |
| | BACK | For a posterior tooth, the patient and doctor will probably need a 45- to 60-minute |
| 5. Are you swollen and/or do you have a fever, and is the particular tooth tender when you bite on it? | YES | If the patient is swollen, a particular tooth is tender to bite on, and the patient has a fever, the patient is suffering from an active acute periapical inflammation and needs to be seen that day. The receptionist should proceed to question 6 to determine the urgency and to question 4 to determine the time needed. |
| | NO | Indicates a chronically infected tooth and, if no time is available that day, an appointment (time to be determined by question 4) within the next 24 to 72 hours should be satisfactory. |
| 6. Please describe exactly where you are swollen. | If the swelling is located in... | •The upper posterior part of the face in front of the ear, it could mean a maxillary molar infection that is draining into the temporal/pterygomandibular space(s), which places the brain (via the plexus) in peril (possible brain abscess).<br>•The face around and/or under (possibly shutting) the eye, it could indicate an infraorbital-space infection caused by a diseased canine or premolar. Drainage via the unshunted angular vein is critical (possible cavernous sinus thrombosis).<br>•Under the chin, the tongue, or the posterior part of the lower jaw, it could be caused by any mandibular tooth. Drainage into one or all of the deep submental, submandibular, and/or sublingual spaces could raise the tongue, close off the airway (Ludwig angina), and require an emergency tracheotomy.<br>•If any patient calls with a swelling as described above, it is essential the receptionist advise the doctor of the infection location. The patient should be seen immediately or referred. |
| 7: Has this tooth ever had a root canal? | NO | The receptionist may make an appointment based on the conditions previously mentioned in questions 1 through 6. |
| | YES | If it is a retreatment, just opening the tooth without establishing patency will be ineffective. The options are to access, negotiate a file to the apex, incise the swelling, trephine the bone, insert a wick drain, and prescribe an appropriate antibiotic (see lesson 35), or to refer the patient. |

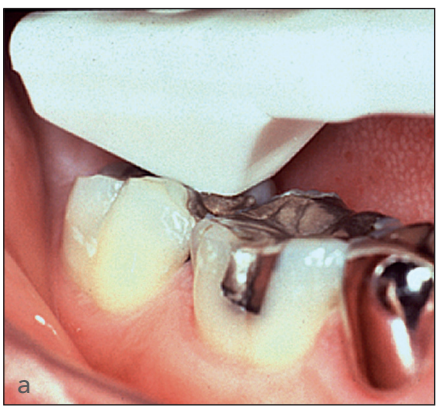
*Referral is a viable option with regard to the management and treatment of any emergency case.

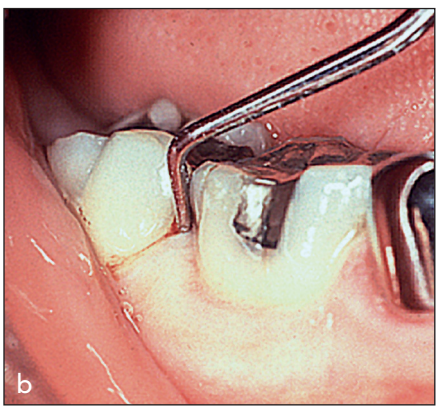
**Fig 2-1** Intraoral swelling and abscess originating from a mandibular incisor.

**Fig 2-2** Extraoral sinus tract draining from a mandibular left molar.

**Fig 2-3** Extraoral swelling in the submental area.

**Fig 2-4** *(a)* Diagnosis of a cracked cusp in a mandibular right molar using a Tooth Slooth. *(b)* Periodontal probing confirms a deep vertical pocket associated with the tooth seen in Fig 2-4a.




## Phase 5: Visual and palpation examination of intraoral soft tissue

The mucosal and facial tissues should be palpated to determine the center of the inflammation and/or the spread of infection and tenderness. All findings and differentials must be recorded. Look for bumps, lumps, enlarged lymph nodes, and so forth (Fig 2-1). The buccal and lingual mucosa and gingival tissues must be visually inspected, preferably under magnification, in search of a draining sinus tract (fistula). If a sinus tract is discovered, a No. 35 gutta-percha cone or larger should be inserted into the tract and a radiograph taken to trace and confirm the source of the infection (ie, periodontal or endodontic) (Fig 2-2).

A swollen gingival crest and papillae (hyperplastic granulation tissue) that spontaneously bleed upon touch may be indicative of long-term irritation from poor oral hygiene, periodontal pocket drainage, crown or root fracture, caries, poor restorative margins, food packing, or a more serious nonodontogenic medical problem such as anemia, leukemia, or hemophilia. The patient's facial features should be observed and evaluated for asymmetry, swelling, redness, and indications of nerve damage (eg, stroke, Bell palsy, amyotrophic lateral sclerosis, severe alcoholism) (Fig 2-3).

Periodontal pocket depths may indicate more than periodontal disease; a long narrow one-sided deep pocket could indicate a vertical root fracture or a diseased lateral canal (Fig 2-4).

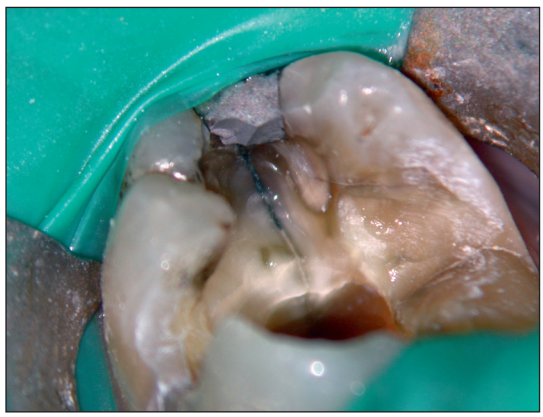


**Fig 2-5** Patient presented in pain with multiple suspect teeth. Removal of the restoration in a mandibular molar revealed a crack across the floor of the chamber. Observation through a microscope showed the crack directed down the distal canal. (Image courtesy of Dr Brett A. Rosenberg, Jupiter, FL.)

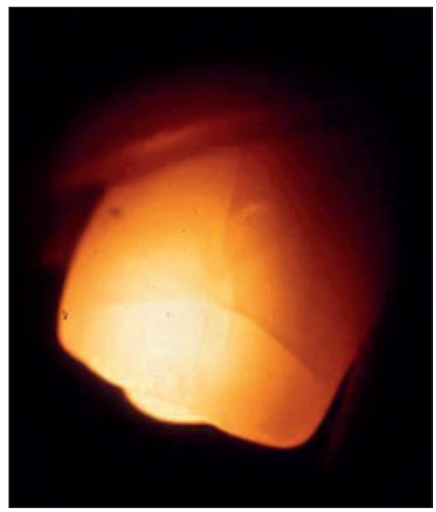


**Fig 2-6** Transillumination of a recently traumatized incisor demonstrating deep and superficial cracks in the enamel.

## Phase 6: Examination of superficial intraoral hard tissue

Each tooth within the proximity of the suspected problem tooth as well as the problem tooth itself should be examined under intense illumination and magnification to detect cracks, leaking restorations, caries, and so forth (Fig 2-5). All findings and differentials must be recorded. Painting the tooth surface with methylene blue helps define fracture lines, decay, and the defective borders of restorations. New caries detection devices help identify the presence and depth of nonvisible caries.

A deep red, rust, blue, or black discoloration of the crown is a positive indication that the microcirculation of the pulp has ruptured (probably due to trauma) and the trapped intrachamber blood is in a stage of degeneration. If such discoloration is present, the patient should be questioned about recent or past injuries. If a traumatic injury is admitted to or is suspected, the involved jawbone and dental alveoli (teeth) should be grasped and gingerly forced lingually and buccally to ascertain mobility to either confirm or eliminate reattachment.

It is always wise to check occlusion, particularly when the patient is complaining of pain in the vicinity (quadrant) of a tooth that has been recently restored.

## Phase 7: Transillumination of the hard tissue

A gray, blue, or black color might indicate a blood infiltrate and hemostasis within the pulp chamber and the dentinal tubules or a corroding metallic restoration. A yellow or brown reflection from an unrestored crown often represents a past trauma or physiologically mineralized, nonpathologic obliteration of the root chamber and canal.

Pharmacologically affected (ie, tetracycline-stained) teeth may vary in color from yellow to black, and their drug fluorescence and etiology may be verified by using an ultraviolet light or a Wood lamp. Transillumination (in lieu of a microscope) not only exposes crazes and cracks but also aids in identifying their depths (Fig 2-6). All findings and differentials must be recorded.

## Phase 8: Clinical testing

The electric pulp test is the standard sensitivity test used to determine the presence or absence of vital pulp tissue (Fig 2-7). The electric testing systems are only reliable in determining if the tooth is vital or necrotic. The data gathered with


**Fig 2-7a** Electric pulp tester (SybronEndo).

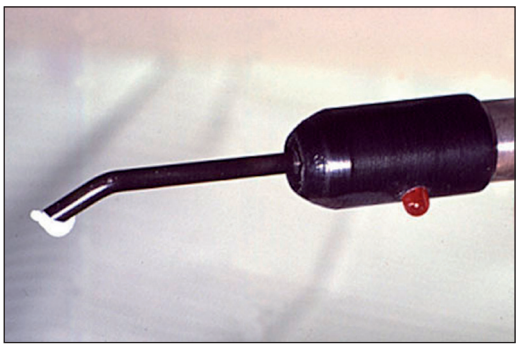


**Fig 2-7b** Electrode with toothpaste as conductant.

**Fig 2-7c** Electrode placed on the tooth.

**Fig 2-7d** Patient holds the electrode to complete the circuit. Release by the patient will interrupt the current, giving the patient complete control over the stimulus.

these systems (particularly when the target tooth has been restored) are best supported with other corroborating information. However, several factors influence the tests' accuracy and reliability, such as the presence of newly and/or heavily restored teeth (large amalgams and gold or ceramic crowns), pulp-capped teeth, and recently injured (subluxated) teeth. Though the results of these tests may not always provide all the pieces of the puzzle, each patient's response is extremely relevant when added to all the other examination data collected, collated, recorded, and evaluated.

## *Cold test*

### Materials

- Endo-Ice (Coltène Whaledent) or SuperCold 134 Plus (MG Chemicals) copiously sprayed onto a cotton tip, or ice probe

### Technique

For optimal results, spray the end of a cotton tip with the cryogenic liquid (Fig 2-8) or use an ice probe (Fig 2-9), and place the tip on the labial or buccal surface of the tooth at the estimated level of the pulp horn (highest density of nerve


**Fig 2-8a** Endo-Ice refrigerant liquid.

**Fig 2-8b** The refrigerant is sprayed on a cotton pledget.

**Fig 2-8c** Ice crystals form, providing an extremely cold testing source.

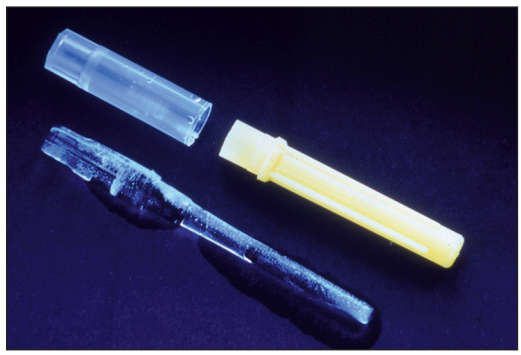


**Fig 2-9a** Freezing water inside a needle cover is an efficient way to make an ice probe.

**Fig 2-9b** Ice probe applied to a tooth.

fibers). The patient's subjective response to pulp testing should be evaluated carefully to differentiate a true positive response from a false anxiety-produced response (anticipation). To ensure accuracy, one must establish a baseline and separate real results from those that are imagined. You may accomplish this by alternating different patterns (tooth sequences) throughout the test as you compare the responses of the target tooth with those of the adjacent teeth and even at times with the contralateral teeth.

### Interpretation

If the patient experiences slight intermittent pain, the pulp is likely healthy and/or is experiencing a potential reversible pulpitis after a recent filling or injury. The low-threshold A-δ fibers of the pulp respond to acute cold. However, because the vessels of this pulp are not severely damaged (beyond repair), the sensation is gone seconds after the stimulus is removed. This tooth should be reevaluated in 30 to 60 days.

When testing patients who are experiencing pulpal pain (as in pulpitis-induced toothaches), all the main types of sensory fibers (A-β, A-δ, and C-fibers) are inflamed, and the application of cold further provokes these fibers, causing the patient to experience a sharp pain that is followed by a lingering dull pain. This tooth requires endodontic therapy.

When testing patients who are in an advanced (mixed and acute) stage of degenerative pulpitis, the tissue of the canal may be inflamed while the coronal pulp chamber may be necrotic. In such cases, cold reduces the tissue temperature and intrapulpal pressure and relieves the pain. However, within minutes of removing the cold, the temperature and pres-


**Fig 2-10a** Dental Stopping (Hygenic) can be heated to provide a thermal source of heat.

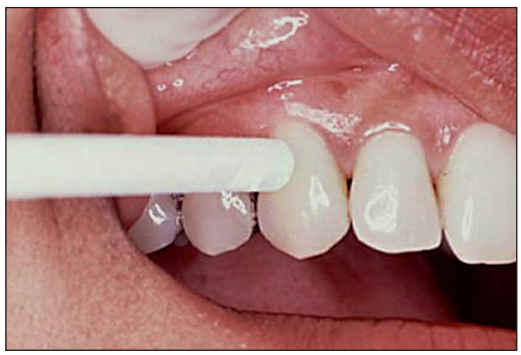


**Fig 2-10b** Heated gutta-percha stopping applied to a tooth.

sure quickly increase (due to body temperature), and the acute pain returns. This tooth requires endodontic therapy. This form of pulpitis is representative of the so-called hot tooth, and the operator should be aware that it may be difficult to gain a working level of anesthesia.

A tooth that does not respond to thermal or electric stimuli is totally mineralized (stimulated by an injury), or its pulp is necrotic. Radiographs can reveal the true extent of the mineralization and/or periapical involvement (ie, expanded lamina dura or radiolucency).

### *Heat test*

It is difficult to test a tooth with heat. Hot water and hot drinks have been suggested, but for those sources to be hot enough to get a reliable response, the patient's safety would be jeopardized. As an alternative, heat may be applied directly to the tooth by touching a hot (150°F to 200°F) Buchanan System B Heat Plugger (SybronEndo) to the tooth or using heated gutta-percha stopping. If there is no response, the tooth is most likely necrotic (Fig 2-10). If there is a response and it lingers after the stimulus is removed, it indicates irreversible inflammation of the high-threshold C-fibers. Either way the tooth needs endodontic therapy.

## Phase 9: Selective anesthesia

When a patient experiences pain and cannot identify which arch is involved, the use of selective anesthesia can be enormously helpful. Anesthetizing the maxillary teeth is easier as each tooth has branches from the superior alveolar nerve that can be numbed in sequence until there is an absence of pain. If the pain continues unabated, a mandibular block must be considered. With the advent of the intraosseous injection technique using X-Tips (X-Tip Technologies), it is possible to inject segments of the jaw and by so doing to anesthetize just one to three teeth at a time in the mandible (see lesson 14).

In cases where the administration of selective anesthesia in the maxilla or mandible does not relieve the pain, you must consider the possibility of referred pain of nondental origin.

## Phase 10: Radiographic examination

*Never make a diagnostic decision based on a single radiograph. Always evaluate at least two views that have been taken from different angles.* A quality bitewing radiograph provides the following information: *(1)* the extent and depth of caries, *(2)* the extent and depth of a restoration, and *(3)* the depth of restorative material in the pulp chamber, which may indicate a possible pulp exposure and pulp cap. In addition to confirming the information learned from a bitewing, a quality periapical radiograph reveals pulp recession and secondary dentin, alveolar bone loss (crestal, furcation, horizontal, vertical, lateral, periapical), root fractures, resorption, the number of roots and canals, canal complexity, widening of the periodontal ligament, apical or lateral radiolucencies or radiopacities, and evidence of previous endodontic treatment.

Avoid the superimposition (proximity) of roots by using the buccal object rule, or SLOB rule (same lingual, opposite buccal), to locate which root is closer to the film or sensor. When dealing with anatomic landmarks such as the mandibular canal and the sinus floor, in contrast, it is better to assess the proximity of the apices with those landmarks, which

can be viewed with a panoramic radiograph or a computed tomography (CT) image.

Considering the reduction in radiation and the ability to use zoom and color for diagnosis, one must seriously contemplate investing in a digital imaging system.

The availability of three-dimensional cone beam computed tomography (CBCT) at a significantly lower radiation dose than medical CT makes it the imaging method of choice in difficult situations where anatomy or pathosis is obscure. CBCT scans are being utilized more and more by university clinicians, oral and maxillofacial surgeons, and radiologists. A detailed account of which radiographs are most appropriate and guidelines for their interpretation are available in lesson 3. The Endodontic Form (see Fig 4-1) that is currently used at the Arthur A. Dugoni School of Dentistry, University of the Pacific, is an organized method of recording diagnostic values accumulated during the examination process.

# LESSON 3

# Radiographic Examination and Interpretation

## OBJECTIVE

To recognize, identify, and interpret anatomic structures and endodontically related pathosis.

## INTRODUCTION

Preoperative radiographs are an indispensable part of the diagnosis and assessment of endodontic situations. When combined with the clinical findings, a final diagnosis is almost always assured.

*Note:* In multirooted teeth or teeth with obliterated root canals, it is necessary to have more than one preoperative radiograph to determine all necessary anatomic landmarks and dental morphologies. These should include a bitewing radiograph and a second periapical film taken from a different horizontal angle (either mesial or distal).