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Systemic Health Considerations in the Endodontic Patient and Geriatric Endodontics

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CHAPTER OUTLINE

Health and Medical History, 23

The Systemic Health Assessment of the Endodontic Patient, 24

Physical Examination: Vital Signs, 24

Systemic Considerations, 24

Diabetes Mellitus, 26

Hypertension, 26

Risk for Osteoradionecrosis or Osteonecrosis of the Jaw, 26

Viral Infections, 26

Sickle Cell Anemia, 27

Smoking, 27

Genetic Predisposition, 27

Presentation of Endodontic Disease in the Older Adults, 28

Anatomy, 29

Pulp Response, 29

Root Canal Treatment, 31

Healing After Surgery, 34

Identifying Patients for Referral, 34

LEARNING OBJECTIVES

After reading this chapter, the student should be able to:

1. Recognize the various ways in which endodontic pathosis and systemic disease interact and some of the mechanisms of such interactions.
2. Identify general consideration for the safe management of the endodontic patient with systemic disease.
3. Identify the effects of diabetes mellitus, smoking, genetic predisposition, irradiation, sickle cell disease, and viral infections on the pathogenesis of endodontic pathosis and endodontic treatment outcomes.
4. Determine the potential for acute and chronic endodontic infections to cause or contribute to systemic disease.
5. Discuss the prognosis of the endodontic treatment in relation to the systemic condition.
6. Identify age changes in the anatomy and physiology of the older dental pulp and periapical tissues, as well as differences in pathogenesis of disease and response to treatment.
7. Identify factors that complicate case selection and discuss the differences in treatment between older and younger patients.
8. Identify those elderly patients who should be considered for referral.

Health and Medical History

Successful dental management of a patient with extensive medical history depends on a thorough evaluation of the patient and on determining the diagnosis and treatment plan that takes risks

and benefits into consideration. It is essential to determine and identify modifications to the dental treatment for a medically complex patient. Thorough discussion of the dental management and risk assessment of medically complex patients is beyond the scope of this chapter. However, some of the common illnesses will

be explained. In patients with serious disorders, referral to an endodontic specialist may be appropriate. Specialist care is generally more expedient and offers better prevention and management of treatment complications (see [Chapter 6](#)).

The Systemic Health Assessment of the Endodontic Patient

In the review of the medical history and during clinical examination and treatment of the endodontic patient, the clinician needs to be keenly aware of specific areas in which systemic health affects the management of the patient. Importantly, endodontic patients should be managed in a manner that assures their safety, comfort, and well-being during and after the procedure (see *Endo-Medical History Video 2.1*).

Patients should be asked whether they have received prior endodontic treatment and how they view and feel about this form of dental treatment. Previous experiences or information that patients have from other sources may render them especially anxious about this procedure. Many patients have severe apprehension about having endodontic treatment, and their care may need premedication, sedation, or other auxiliary methods that facilitate the experience for them. Occasionally, especially in the case of children, moderate to deep sedation or general anesthesia may be the only practical approach to treating them.

Endodontic patients especially should be asked about the history of chronic pain of any type. These patients are at an increased risk of postoperative and of persistent pain, and this aspect should be reviewed with them during the informed consent process (see [Chapter 5](#)).

Endodontic treatment involves the effective use of local anesthesia (see [Chapter 8](#)), adjunctive analgesics, and antibiotics. Therefore complete history of cardiovascular, endocrine, respiratory, hepatic, and renal systems should be obtained. Preoperative vital signs, such as blood pressure, pulse, and respiration, should be recorded. Occasionally, preoperative glycemia (blood glucose measurement or glycated hemoglobin [HbA_{1c}]) are needed to assess the control of glycemia for diabetics or the need for referral to a physician in patients at high risk of diabetes (see *video 2.2 for A_{1c} Now Measurement*). International normalized ratio (INR) is required for the patient on Coumadin (warfarin), especially before surgical treatment. The INR is a standardized way of expressing the prothrombin time test (PT). Heparin is an anticoagulant that will prolong partial thromboplastin time, activated PTT (PTT, aPTT). Detailed lists of medications, allergies, previous hospitalizations, medical and surgical treatments, and previous untoward reactions should be collected. Like any dental procedure that results in risk of bacteremia, the risk of infective endocarditis or of late artificial joint infection should be identified, and appropriate antibiotic coverage should be instituted whenever indicated according to current guidelines. The American Dental Association has recently provided guidelines for the use of systemic antibiotics for endodontic patients (see https://ebd.ada.org/en/evidence/guidelines/antibiotics-for-dental-pain-and-swelling?utm_source=EBDsite&utm_content=guidelines for guidelines).

Allergies to specific materials or reagents used in endodontics are rare. Reports of hypersensitivity to gutta percha, amide-based local anesthetic agents, sodium hypochlorite, and nickel (present in nickel titanium files) should be considered in the treatment of the endodontic patient. Consultations with a medical specialist in hypersensitivity reactions should be made before treatment decisions are made. Referral to an endodontist would be indicated for management of patients with true allergy to any endodontic materials.

Physical Examination: Vital Signs

Vital signs are an important component of patient treatment and give the health care provider information regarding the current medical status of that patient (see [Chapter 4](#)). Blood pressure, heart rate, respiratory rate, and temperature should be recorded. In some cases, fasting blood glucose and/or the values of HbA_{1c} are recorded or documented, too (see *video 2.2 of A_{1c} Now Measurement*). This information helps the clinician better understand the patient's physiological state.

Systemic Considerations

Dentists are members of the health team whose role ultimately is to ensure that the patient's health, including oral health, is maintained at an optimal level. Over the past two to three decades, the close relationship between oral health and systemic health has gained much attention, and many advances in this area have been achieved. In the early part of the 20th century, endodontic infections were thought to be a focus of infection that may lead to a variety of ailments and chronic diseases in the body. Although the systemic spread of acute oral infections is clear, recent objective research has identified compelling associations between systemic disease and chronic oral infections, including endodontic infections. The available evidence on the relationship between endodontic pathosis and systemic disease is presented here.

Endodontics and Systemic Disease

With regard to the relationship between endodontic pathosis and systemic disease, the practitioner needs to be aware of three factors: systemic diseases that mimic endodontic pain or periapical radiolucency (see [Chapters 4 and 5](#)), systemic diseases that may accelerate or potentiate pulpal pathosis or influence treatment outcomes, and conditions in which the endodontic infection may initiate or contribute to an infection in a distant site or another systemic disease.

Systemic Diseases That May Influence Endodontic Pathosis or Its Treatment

Certain systemic conditions were reported to be associated with pathogenesis of endodontic lesions in a recently published systematic review.¹ Specifically the authors found that there was a moderate risk for and association of cardiovascular disease and diabetes with endodontic pathosis. In another systematic review, the authors investigated the interaction of systemic disease with endodontic healing and reported that certain systematic diseases are associated with endodontic healing.² Patients with medical conditions that compromise their immune response may have a less favorable endodontic treatment outcome. Though the mechanism or pathway for this interaction remains speculative at this time, it is critical to note that the patient's medical condition is preemptive to his or her dental care and prognosis.

Endodontic Disease May Initiate or Contribute to Systemic Diseases

The oral cavity is the first component of the digestive system and has a large component of the human microbiome (as noted in [Chapter 1](#)). The diversity of microorganisms in the mouth is related to its exposure to dietary and environmental factors and to the unique characteristics of the oral environment. Deleterious effects of these microorganisms are prevented by an intact mucosal lining, which is

capable of a formidable immune response, and by oral hygiene measures that limit the progression of oral microbial biofilms. The dental pulp is protected from bacteria by intact enamel and dentin, whereas the periodontium is protected by periodontal attachment and sulcular epithelium. With marginal periodontitis or pulpal pathosis, these barriers are absent, and the oral microflora may have free access to the periodontium or periapical tissues; in this way, microorganisms that are normally commensals become pathogenic.

Acute Endodontic Infections

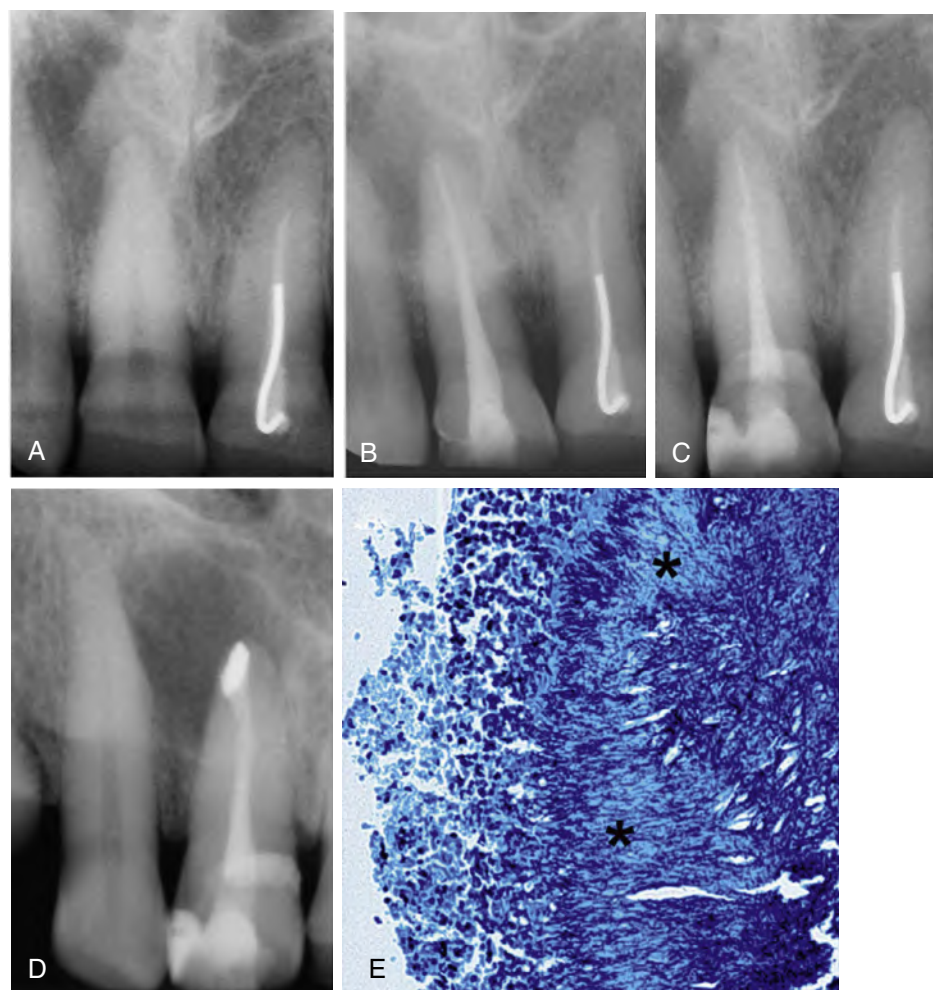
There is no doubt that bacteria from acute endodontic infections can cause bacteremia and can migrate to local lymph nodes and fascial spaces. Case reports have documented the association of acute endodontic infections with brain abscess,³⁻⁵ mediastinitis,^{6,7} and fatal necrotizing fasciitis.⁸ In fact, researchers reported that about 8000 patients in the United States are hospitalized annually for periapical abscesses, some of whom have comorbid conditions such as diabetes or hypertension.⁹ Therefore it is essential for the practitioner to obtain adequate diagnostic data for patients with acute endodontic infections and to evaluate their progress carefully, in case they need referral for management in a hospital setting. Patients

with abscesses should have their temperature measured, and they must be evaluated for lymphadenopathy, malaise, and fascial space infection. These patients should receive prompt and complete elimination of local irritants, including drainage of the swelling. Those with a fascial space infection (cellulitis) also should be treated with adjunctive antibiotics and, most important, should be monitored carefully until their condition improves (see [Chapter 9](#)).

Chronic Endodontic Infections

The evidence for the presence of bacteria in periapical lesions and their escape systemically in chronic endodontic infections is less conclusive. Animal^{10,11} and human^{12,13} studies show that this is infrequent in primary lesions ([Fig. 2.1](#)). Studies have found that the number of bacteria in persistent periapical lesions after unsuccessful treatment may be much higher.^{14,15} Teeth with chronic apical abscesses and sinus tracts have been reported to have very complex bacteriologic conditions with biofilm attached to the outer root surfaces in 17 out of 24 teeth.¹⁶

One way to investigate this potential for bacteria in chronic infections to travel from the endodontic environment to participate in the pathogenesis of systemic disease is to determine the



• **Fig. 2.1** Periapical Actinomycosis. **A**, Preoperative radiograph shows tooth #8 presenting with signs of pulp necrosis and chronic apical abscess. **B**, Root canal treatment was completed. **C**, Recall in 6 months revealed a persistent sinus tract. **D**, Root-end surgery was completed, and tissues were submitted for biopsy. **E**, Biopsy result revealed actinic filaments (*) surrounded by a severe inflammatory reaction. (Courtesy Dr. Blythe Kaufman.)

epidemiologic associations between the two forms of disease. One report associated periapical lesion-years (the number of years with a periapical lesion) and incident coronary heart disease in men younger than age 40.¹⁷ Another study of patients with myocardial infarction (MI) reported a significantly higher number of patients with missing teeth and teeth with periapical lesions in the MI group compared with controls.¹⁸ An additional large cohort study of male health professionals showed that the presence of coronary heart disease was significantly associated with the presence of one or more root canal–treated teeth (as a marker of pulpal and periapical disease).¹⁹ In a systematic review of longitudinal cohort studies, the authors reported a moderate risk of causation.²⁰ However, they raised questions about the interrelationship of these different diseases, warranting further animal and human studies. Interventional studies would be required to prove causation, and those are clearly difficult to perform, given the ethical issues involved.

Diabetes Mellitus

Diabetes mellitus is one of the most significant chronic diseases that affects humans worldwide. In the United States about 30.3 million people, or 9.4% of the U.S. population, had diabetes in 2015. This total included 30.2 million adults age 18 or older, or 12.2% of all U.S. adults. About 7.2 million of these adults had diabetes but were not aware that they had the disease or did not report that they had it.²¹ Diabetes is not curable, and it has serious complications, including cardiovascular disease, neuropathy, renal disease, blindness, limb amputations, and periodontal disease.

Health care practitioners generally know that diabetics have a higher prevalence of teeth with periapical lesions.^{1,22–25} The longitudinal treatment outcome is generally not different for diabetics and nondiabetics.^{26,27} However, if the outcomes of cases with and without preoperative periapical lesions are separated, a notable difference is observed. In cases with preoperative lesions, diabetics are significantly less likely to have successful treatment than do nondiabetics, especially when controlling for several other confounding factors.^{28,29}

People with diabetes may have compromised healing, particularly those with higher glycemic rates and with preoperative endodontic infection, for several reasons. These individuals may select for specific microorganisms that may be more virulent.³⁰ They may have a variant of inflammatory cells, such as monocytes, characterized by excessive secretion of inflammatory mediators, including bone resorptive cytokines, that are critical for the development of periapical lesions.³¹ The increased glycemia may also spontaneously result in excessive production of advanced glycation end products (AGEs). AGEs interact with their receptors (RAGEs), resulting in the production of bone resorptive mediators, which may lead to persistence of the periapical lesions.³²

Hypertension

Hypertension is a sign of cardiovascular disease that may indicate a variety of underlying conditions and comorbidities, including diabetes. Hypertension appears to be associated with reduced survival (meaning continued presence of the tooth in the mouth) of endodontically treated teeth. In a study of the Indian Health Service in two U.S. states, 4500 patients were examined.³³ It was found that patients who had diabetes and/

or hypertension had a significantly reduced chance of retention of endodontically treated teeth within a period of 10 years. In another cohort that included more than 49,000 teeth followed for about 2 years, researchers found that the presence of diabetes and/or hypertension resulted in significant reduction in tooth retention.³⁴ It is noteworthy, however, that the study of tooth survival in the absence of exact endodontic diagnosis and assessment of periapical health is confounded by the fact that diabetes and cardiovascular diseases are also associated with periodontal disease, which may have played an important role in the loss of these teeth.

Risk for Osteoradionecrosis or Osteonecrosis of the Jaw

Patients who have undergone radiation therapy for the treatment of malignancies in the craniofacial area are at risk of osteoradionecrosis at the site of a surgical procedure such as tooth extraction. Therefore many of these patients have teeth that would ordinarily not be amenable to treatment but that are retained with endodontic treatment to avoid the risk of osteoradionecrosis. A report documented the treatment outcome in 22 patients treated endodontically after having received 50 Gy irradiation in the area within the preceding 6 months.³⁵ After a mean of 19 months, successful treatment was found in 91% of the patients, which was consistent with treatment averages for normal patients in other studies. However, treatment of patients who have undergone radiation therapy is frequently complicated by fibrotic tissues that do not permit adequate mouth opening (Fig. 2.2). About 66 to 70 Gy of radiotherapy has been reported to result in progressive decrease in pulp vitality testing and electric pulp testing at 12 months.³⁶ Also, dry mouth results in recurrent caries, compromising the prognosis.

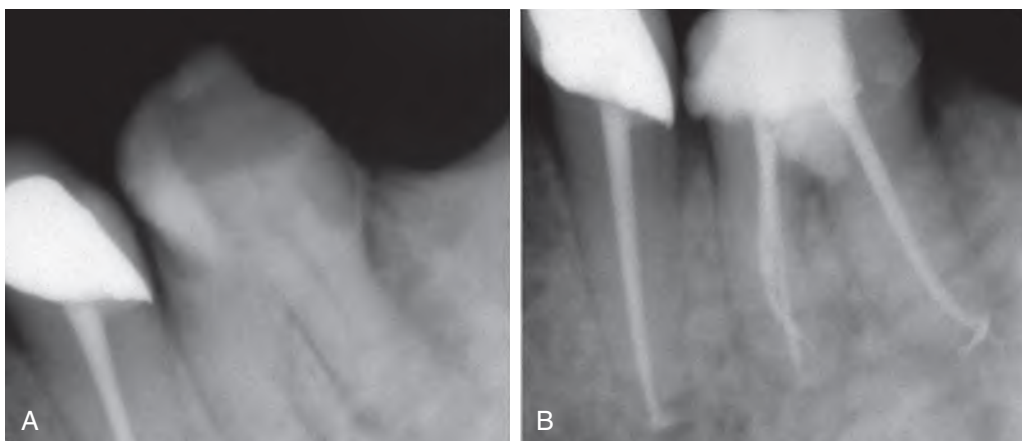
Over the past decade, it has been recognized that patients undergoing bisphosphonate therapy may be at risk for bisphosphonate-related osteonecrosis of the jaw (BRONJ). This risk is greater in patients receiving intravenous (IV) bisphosphonates, particularly if more than one agent is used simultaneously, and the risk increases with the duration of bisphosphonate use and with surgical procedures, such as extractions.³⁷ Although rare, BRONJ may occur after endodontic treatment³⁸ or endodontic surgery.³⁹ When nonsurgical endodontic treatment is performed on a patient receiving IV bisphosphonates, care should be taken not to injure the soft tissue. For example, the clamps should be carefully placed to avoid injury to the soft tissues and alveolar bone⁴⁰.

Oral bisphosphonates pose a much lower risk of BRONJ. Endodontic outcomes are not different between patients taking oral bisphosphonates and other patients.⁴¹

Viral Infections

HIV/AIDS

When the human immunodeficiency virus (HIV) was first identified, practitioners were concerned that patients with HIV infection would be so compromised that severe complications would ensue with endodontic disease and/or endodontic treatment, particularly in patients whose cluster of differentiation 4 (CD4+) cell count had dropped below 200/mL. However, a cohort study of patients with acquired immune deficiency syndrome (AIDS) who had received various oral health procedures documented that the patients did not



• **Fig. 2.2** A compromised case of an older adult patient who had had a hemimandibulectomy on the right side to treat oral cancer, together with radiation therapy; that treatment resulted in severe restriction in mouth opening. The patient could open her mouth only about 15 mm at the incisors, making the introduction of radiographic sensors, mirrors, and dental instruments very difficult. **A**, A poor-quality preoperative radiograph shows a previous restoration that compromised pulp health and led to a periradicular lesion. **B**, Treatment was attempted to prevent osteoradionecrosis and save the tooth for function. Complications arose in the furcation area, because the clinician was unable to use the mirror and the handpiece together for access preparation.

appear to suffer any undue pain or infection with endodontic treatment.⁴² In addition, 1 year after treatment, no difference was seen in the outcomes of treatment between patients who were HIV positive and those who were not infected with the virus.⁴³

Herpes Viruses

There are many different types of herpes viruses that affect humans. These types include varicella zoster virus (VZV), which causes herpes zoster infection; human herpes viruses (HHV1-8); human cytomegalovirus (HCMV); and Epstein-Barr virus (EBV).

Herpes zoster infections frequently represent a diagnostic dilemma, because after the herpetic blisters heal, the patient may suffer from postherpetic neuralgia, which mimics endodontic pain. Careful documentation of the medical history and diagnostic tests should help the practitioner identify this condition and make the right decisions and/or referrals. However, herpes zoster infection may also induce spontaneous pulpal pathosis.⁴⁴⁻⁴⁸

Periapical lesions in patients infected with HCMV and/or EBV, but not herpes simplex viruses, may be larger and more painful. In addition, irreversible pulpitis or acute endodontic infections may be associated with a higher incidence of EBV or the HHV pathogens.^{49,50} However, it is not yet conclusively known whether the viral association potentiates the development of more aggressive forms of endodontic pathosis or whether the findings of the small studies and case reports available were merely coincidental. One systematic review has not identified significant associations between HCMV or EBV and symptomatic endodontic pathosis.⁵¹

Sickle Cell Anemia

Sickle cell anemia is characterized by a congenital abnormality of red blood cells that results in deficient oxygenation of the blood. A milder form of the disease, known as *sickle cell trait*, results from homozygous transmission of the affected gene. Oral findings of

sickle cell anemia include the radiographic “stepladder” trabecular pattern of bone, enamel hypomineralization, calcified canals, increased overbite, and overjet.⁵² An older case series showed the spontaneous development of pulpal pathosis in some noncarious teeth in patients with sickle cell anemia.⁵³ More recently, it was shown that patients with sickle cell anemia have a significantly higher incidence of orofacial pain than controls and have pulp necrosis in 6% of their teeth that have no other apparent etiologies in comparison with none in the controls.⁵⁴

Smoking

The oral health problems of smoking, including the increase in periodontal disease, mucositis, and oral premalignant and malignant lesions, have been well documented. Recently, there has been an interest in the association of smoking with pulpal and periapical diseases. Smoking is also associated with a high prevalence of periapical lesions⁵⁵⁻⁵⁷ and with incident root canal treatment as a marker of pulpal and periapical diseases.⁵⁸ The incidence of root canal treatment (as a marker of endodontic disease and its treatment) was also increased with the duration of smoking and reduced in smokers who stopped smoking more than 9 years before the evaluation time. Smoking was also shown to increase the incidence of pain and/or swelling after endodontic surgery.⁵⁹ Smoking has been reported to change the immunoregulatory function of the cytokines and chemokines in dental pulps.⁶⁰ In addition, smokers tend to have more postsurgical infections than do nonsmokers.⁵⁹

Genetic Predisposition

Several gene polymorphism associations have been made with endodontic treatment outcomes. Thus interleukin (IL)-1 β allele 2 was found to be associated with reduced healing after endodontic treatment.⁶¹ Gene polymorphism in IL-1 β , IL-6, and IL-8 have been reported to be associated with apical periodontitis.^{62,63}

It is noteworthy, however, that these associations do not prove causation and that studies with large sample sizes are needed to confirm these initial findings.

• BOX 2.1 Review Study Questions

- Why is it important to be familiar with the patient's medical history?
 - Most patients require antibiotic treatment. Thus the clinician needs to premedicate most patients.
 - Most patients are in pain and need to be premedicated with antibiotics, analgesics, and narcotics.
 - As with any invasive procedure, there is a high prevalence for bacteremia.
 - The clinician needs to be keenly aware of the patient's systemic health as it affects the dental management.
- Reports of hypersensitivity to gutta percha, amide-based local anesthetic agents, sodium hypochlorite, and nickel (present in nickel titanium files) have been reported, but it is rare.
 - True
 - False
- Diabetes has which of the following complications:
 - Neuropathy
 - Liver dysfunction
 - Blood disorder
 - Hepatitis
- There are several reasons why diabetics may have compromised healing. All the following are reasons except one. Which one is the EXCEPTION?
 - Impaired immunologic cells
 - More virulent microorganisms
 - Variant inflammatory cells
 - Reduced glycemia
- What dose of radiotherapy has been reported to result in progressive decrease in pulp vitality testing and electric pulp testing at 12 months?
 - 10 to 20 Gy
 - 30 to 40 Gy
 - 50 to 55 Gy
 - 66 to 70 Gy

Presentation of Endodontic Disease in the Older Adults

Endodontic considerations in older adult patients are similar in many ways to those in younger patients, but there are some notable differences.

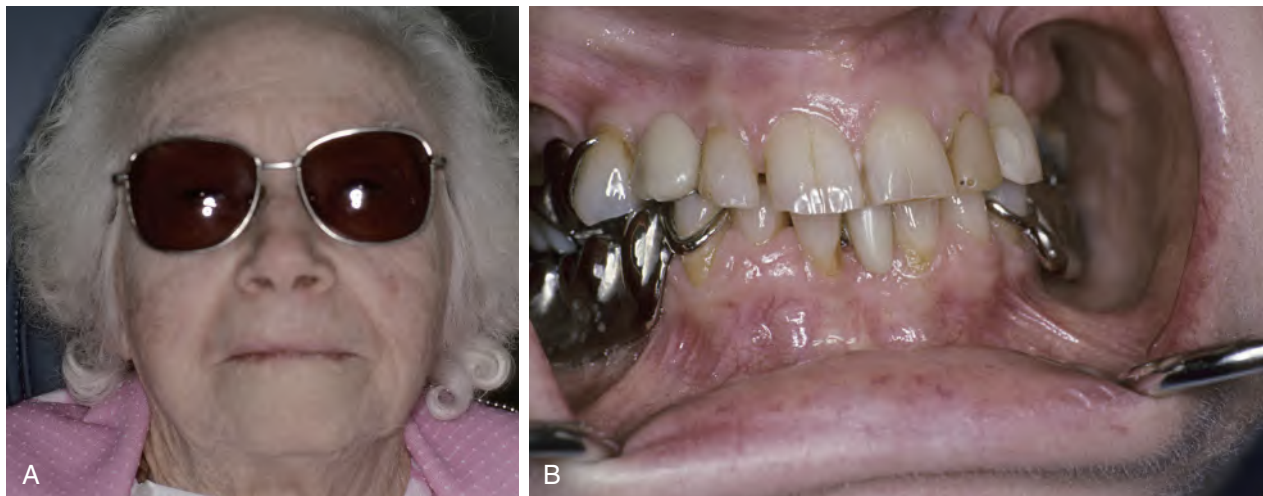
The number of persons age 65 or older in the United States exceeds 39 million, and they are expected to comprise 20% of the population by 2020. Their dental needs will also continue to increase.⁶⁴⁻⁶⁶ More older adult patients will not accept tooth extraction unless there are no alternatives.⁶⁷ They have a high utilization rate of dental services.⁶⁸ The expectations for dental health parallel their demands for quality medical care. An even more important consideration is that these dentitions will continue to experience caries⁶⁹ and decades of dental disease, in addition to restorative⁶⁵ and periodontal procedures specifically⁷⁰ (Fig. 2.3). These factors all have compound adverse effects on the pulp and periapical and surrounding tissues (Fig. 2.4). In other words, the more injuries inflicted, the greater the likelihood of irreversible disease, and thus the greater the need for treatment. The number of older adult endodontic patients is increasing and will continue to do so.⁷¹

The combination of an increase in pathosis and dental needs, coupled with greater expectations, has resulted in more endodontic procedures among aging patients (Fig. 2.5). Furthermore, expanded dental insurance benefits for retirees and more disposable income have made complex treatment more affordable.⁷² Other means will likely be available to finance the costs of oral health care in the future.⁷³

Endodontic considerations in older patients include physical, biologic, medical, and some psychologic differences from young patients, in addition to treatment complications.

Physical Limitations

If a patient cannot be suitably reclined or if the mouth opening is limited, referral should be considered.



• **Fig. 2.3** **A**, This 87-year-old woman has Alzheimer's disease. **B**, Her dentition shows diverse problems caused by many years of disease, restorations, and oral and systemic changes. Diagnosis is challenging, and the dentition will be difficult to restore to acceptable function and esthetics, particularly in a patient with mental impairment.



• **Fig. 2.4** Cervical External Resorption Exposing the Pulp. A free-end removable partial denture has settled posteriorly, exerting pressure on the gingiva and inducing inflammation and root resorption. (From Walton RE: Endodontic considerations in the geriatric patient, *Dent Clin North Am* 41(4):795–816, 1997.)



• **Fig. 2.5** Restorations, caries, and time have resulted in dentin formation. The first premolar shows calcific metamorphosis (a very small pulp space is present). The second premolar has dentin formation (arrow) in response to recurrent caries. Both are difficult to treat and restore. (From Walton RE: Endodontic considerations in the geriatric patient, *Dent Clin North Am* 41(4):795–816, 1997.)

Restorative Considerations

Severe caries or fractures from trauma may render the tooth difficult to isolate or restore.

Biologic Considerations

Biologic considerations are both systemic and local. In the older patient, systemic or local changes unique to endodontics are not different from those for other dental procedures. Similarly, the response of the pulp and periapical tissues is not markedly different.

Anatomy

Pulp Chamber

As a tooth ages, pulp chamber space decreases. Chamber size and pulp stones, in addition to the extent of calcifications in the canal system, must be considered.

Canal Calcification (Calcific Metamorphosis)

Secondary and perhaps tertiary dentin formation leads to narrowing of the canals, sometimes to an extent that they are not visible radiographically (Figs. 2.6 and 2.7).

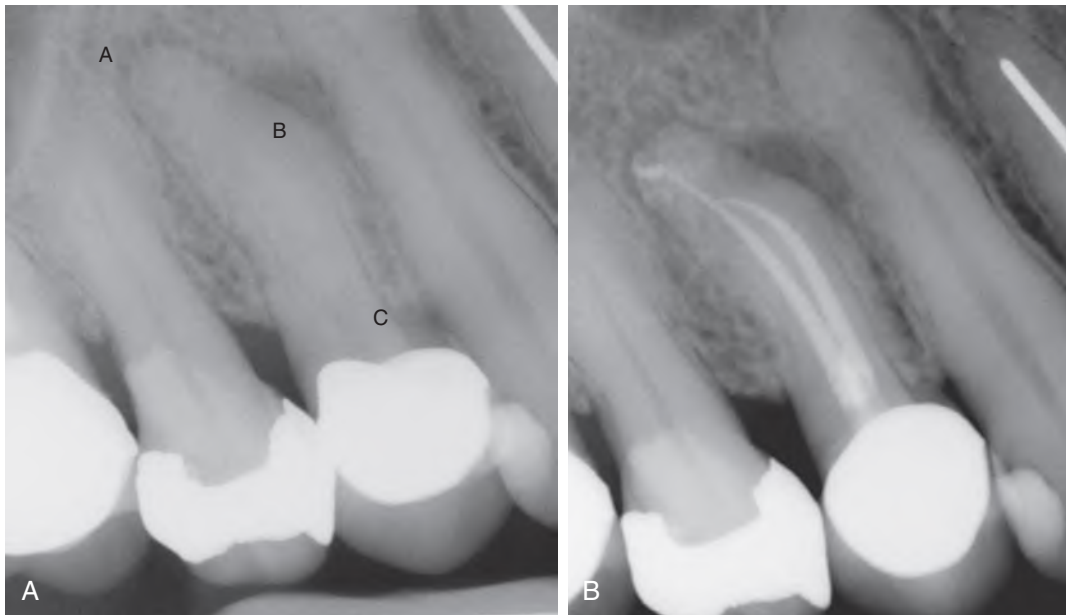
Calcifications include denticles (pulp stones) and diffuse (linear) calcifications.⁷⁴ Pulp stones tend to be found in the coronal pulp, and diffuse calcifications are found in the radicular pulp. It has

been speculated that the nidi of calcification arise from degenerated nerves or blood vessels, but this has not been proved. Another common speculation is that pulp stones may cause odontogenic pain; however, this is not true. Pulp stones were shown to increase in patients with cardiovascular disease and those on statins.⁷⁵

Pulp Response

Changes With Age

Two considerations are important in age-related changes in pulp response: (1) structural (histologic) changes that take place as a function of time and (2) tissue changes that occur in response to irritation from injury. These changes tend to have similar appearances in the pulp. In other words, injury may prematurely “age” a pulp. Therefore an “old” pulp may be found in a tooth of a younger person (e.g., a tooth that has experienced caries, restorations, etc.). Whatever the etiology, these older (or injured) pulps react somewhat differently than do younger (or uninjured) pulps. The aging pulp may be less resistant to injury, although this may be due to the cumulative effect of irritation, which increases with age, rather than the effect of age. Stem cells were shown to be present in periapical tissues of older adults.⁷⁶ This is not necessarily the case with the young immature tooth (open apex) in which pulps have indeed been shown to be more resistant to injury. There is a theory that pulps in older teeth may in fact be *more* resistant because of decreased permeability of dentin.⁷⁷ However, this resistance to injury in old teeth has not been proved.⁷⁸ Therefore the



• **Fig. 2.6** **A**, Periapical radiolucency (**A**) and mesial radiolucency in the apical third (**B**). The canals are calcified, the root is narrow, and there is a hint of a significant mesial concavity in the coronal third (**C**). The tooth is also crowned, which increases access complexity. This is considered a high-risk case. **B**, Postoperatively, the mesial radiolucency resulted from the buccal root exiting several millimeters shorter than the palatal root, with a significant distal curvature. The practitioner must be prepared to manage the unexpected should problems arise during treatment.



• **Fig. 2.7** Pulp chamber and root canals show calcific metamorphosis; this situation is rated as extreme risk.

dental pulp in older patients require more care in preparation and restoration; this response to irritation is probably the result of a history of previous irritation rather than age per se.

Chronologic Versus Physiologic

Does a pulp in an older individual react differently to injury compared with pulp in a younger individual? This question has not been answered definitively. A previously injured pulp (from caries, restoration, and so on) in a younger person probably has *less*

resistance to injury than an undamaged pulp in an older individual. At a histologic level, there are some consistent changes in the older pulps and in irritated pulps.

Structural

The pulp is a dynamic connective tissue. With age, there are changes in cellular, extracellular, and supportive elements. There is a decrease in cells, including both odontoblasts and fibroblasts. There are also fewer supportive elements (i.e., blood vessels and nerves).^{79,80} Fewer and smaller vessels result in a decrease in blood flow in the pulp; the significance of this decrease is unknown. Capillaries show somewhat degenerative changes in the endothelium with age.⁸¹ There is presumably an increase in the percentage of space occupied by collagen but less ground substance.⁸²

Dimensional

In general, pulp spaces progressively decrease in size and often become very small,⁸³ a phenomenon known as *calcific metamorphosis* or pulp canal obliteration.⁸⁴ Dentin formation may be accelerated by irritation from caries, trauma, abrasion, restorations, and periodontal disease and is not uniform. For example, in molar pulp chambers there is more dentin formation on the roof and floor than on the walls.⁷⁹ The result is a flattened (disk-like) chamber (Fig. 2.8).

Nature of Response to Injury

The older patient does tend to have more severe pulpal reactions to irritation than the reactions that occur in the younger patient. The reason for these differences is not fully understood, but the more severe reactions probably result from a lifetime of cumulative injuries.



• **Fig. 2.8** Disk-like Chamber (arrow). The chamber is flattened because of dentin formation on the roof and floor. These chambers and canals are a challenge to locate. (From Walton RE: Endodontic considerations in the geriatric patient, *Dent Clin North Am* 41(4):795–816, 1997.)

Irritation

There are reasons for pulp pathosis after restorative procedures. First, the tooth may have experienced several injuries in the past. Second, the tooth is likely to have undergone more extensive procedures that involve considerable tooth structure, such as crown preparation. Multiple potential injuries are associated with a full crown, such as foundation placement, bur preparation, impressions, temporary crown placement (temporary crowns may leak), cementation, and unsealed crown margins. The cause of final demise, or “coup de grâce,” of a pulp that is already stumbling along may be that final restoration.

Systemic Conditions

There is no conclusive evidence that systemic or medical conditions directly affect (decrease) pulp resistance to injury. One proposed condition is atherosclerosis, which has been presumed to directly affect pulp vessels⁸⁵; however, the phenomenon of pulpal atherosclerosis could not be demonstrated.⁸⁶ There may be differences among patients due to gene polymorphism that lead to faster or slower pulp necrosis. For example, one study showed that two heat shock protein gene variations were significantly associated with whether deep carious lesions were related to the presence of vital pulp versus a periapical lesion.⁸⁷

Periapical Response

Little information is available on changes in bone and soft tissues with age and how these changes might affect the response to irritants or to subsequent healing after removal of those irritants. There is some indication that relatively little change occurs in periapical cellularity, vascularity, or nerve supply with aging.⁸⁸

Therefore it is unlikely that there are significantly different periapical responses in older patients compared with younger individuals.

Additional Considerations

In treatment planning for older patients, the tendency is to plan according to anticipated longevity.⁸⁹ It is natural to assume that procedures need not be as permanent because the patient may not live very long. The concept that treatment should not outlast the patient is not accepted by many elder patients, who desire health care equivalent to that rendered to younger patients. Esthetic and functional concerns may not differ.

Root Canal Treatment

Treatment Considerations

Time Required

On average, longer appointments are necessary to accomplish the same procedures in older adult patients, for the reasons discussed earlier.

Anesthesia

Primary Injections

The need for anesthesia is somewhat less in older patients with pulp necrosis and an increased risk to local anesthetic toxicity.⁹⁰ It is necessary for vital pulps but is often unnecessary for pulp necrosis, obturation appointments, and retreatments. Older patients tend to be less sensitive and are more likely to prefer procedures without anesthetic. Also, they tend to be less anxious and therefore have a higher threshold of pain. Although there are no differences in effectiveness of anesthetic solutions, various systemic problems or medications may preclude the use of vasoconstrictors.

Supplemental Injections

Intraosseous, periodontal ligament (PDL), and intrapulpal forms of anesthesia are effective adjuncts if the primary anesthesia is not adequate. Certain cardiac conditions may preclude the use of epinephrine, particularly with the intraosseous and PDL techniques. The duration of anesthesia is considerably decreased without a vasoconstrictor, and reinjection during the procedure may be required.

Procedures

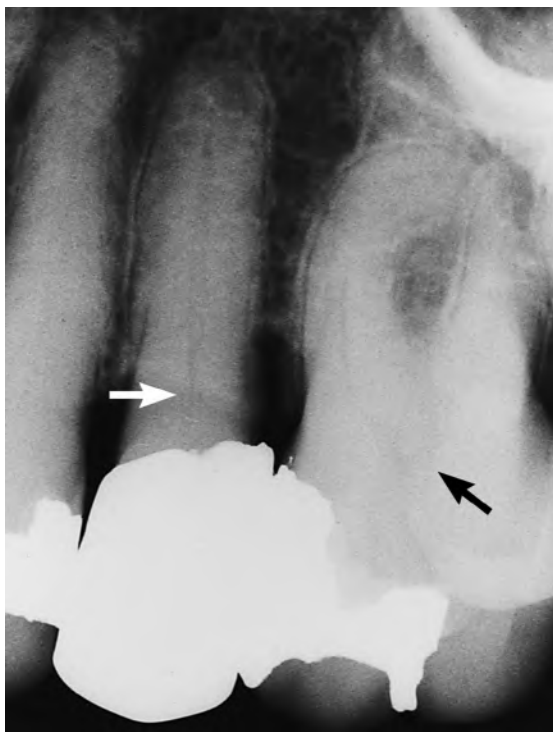
Isolation

Isolation is often difficult because of subgingival caries or defective restorations. However, placement of a rubber dam is imperative and often requires ingenuity (see [Chapter 13](#)).

Access Preparation

Achieving good access that enables the clinician to locate and then negotiate canal orifices is challenging in older teeth because of the internal anatomy ([Fig. 2.9](#)). Radiographs are helpful. A slightly larger, rather than a too small, access opening is preferable, particularly through large restorations such as crowns. Magnification is also helpful, either from a microscope or from other visual aids.

A supererupted tooth, as a result of caries or restoration, has a short clinical crown, requiring a less deep access preparation. The distance from the reference cusp to the chamber roof should be measured on the bur radiographically. A very small or invisible chamber may be an indication to begin the access without the



• **Fig. 2.9** Age, caries, and restorations have resulted in small chambers (arrows). Either would be a challenge to access, and referral should be considered.

rubber dam; this helps the clinician parallel to the long axis of the tooth (Fig. 2.10). Once the canal has been located, the rubber dam is immediately placed, before working length radiographs are made.

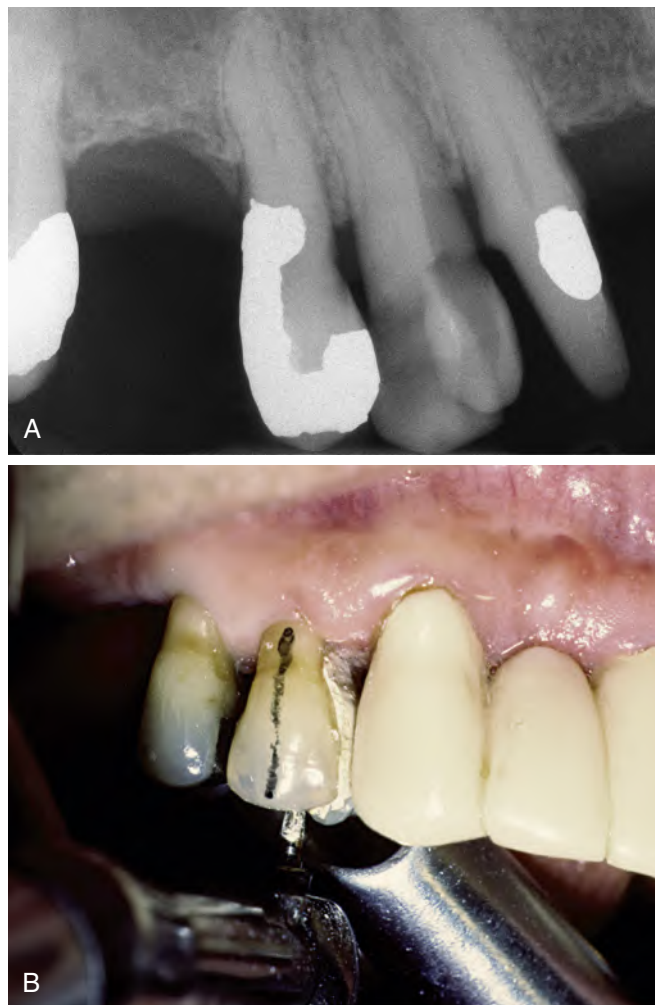
Locating canal orifices is often fatiguing and frustrating for both the clinician and the patient. Although a reasonable time should be allocated for this, there is a limit. It may be best to stop and have the patient return for another appointment. Often the canals are readily located at a subsequent visit. This circumstance also is a time to consider a referral because imaging with cone beam computed tomography (CBCT) and/or another procedure, such as surgery, may be indicated.

Working Length

There are some differences in working length for the older patient.⁹¹ Because the apical foramen varies more widely (Fig. 2.11) than in the younger tooth and because of the decreased diameter of the canal apically, it is more difficult to determine the preferred length.⁹² In teeth of any age, materials and instruments are best confined to the canal space. One millimeter short of the radiographic apex is the preferred working and obturation length⁹³; this length should be decreased if an apical stop is not detected. Electronic apex locators are also useful, particularly when there is difficulty obtaining adequate working-length radiographs.⁹⁴

Cleaning and Shaping

A common challenge is a much smaller canal that requires more time and effort to enlarge. A very small canal may be more easily negotiated and initially prepared with a lubricant, such as glycerin, RC-Prep, or Glyde. This process may be used through two or three smaller sizes of files to facilitate enlargement and to reduce the risk of binding and separation. The same principles of débridement and adequate shaping are followed. Glide path 0.02 taper instruments such as PathFiles or ProGlider (Sirona/Dentsply) may be helpful in these situations (see Chapter 14).



• **Fig. 2.10** A, The first premolar is tilted and has a “receded” pulp chamber. B, Aids in orientation during access. The preparation is initiated without the rubber dam in place. A pencil mark is placed on the crown to guide the bur in the long axis of the root. (From Walton RE: Endodontic considerations in the geriatric patient, *Dent Clin North Am* 41(4):795–816, 1997.)

Intracanal Medicaments

Intracanal medicaments are not useful, with the exception of calcium hydroxide. This chemical is antimicrobial, inhibits bacterial growth between appointments, and possibly reduces periapical inflammation.⁹⁵ Its use is indicated if the pulp is necrotic and the canal preparation is essentially complete.

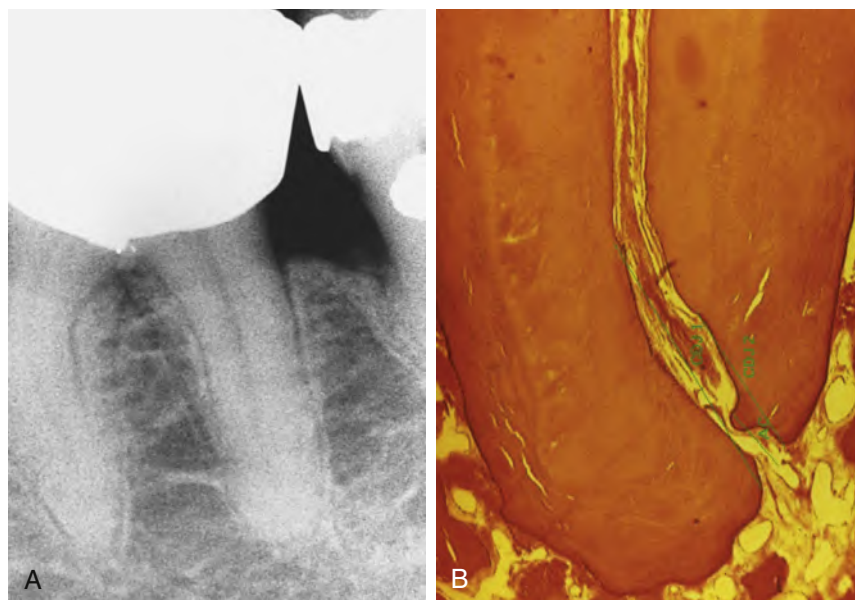
Obturation

There is no demonstrated preferred approach, although cold-lateral and warm-vertical gutta-percha obturations are the most commonly used and their use the best documented.

Effect of Restoration

In general, the larger and deeper the restoration, the more complicated the root canal treatment would be. The old tooth is more likely to have a full crown. There are two concerns when there is a crown: (1) potential damage to retention or components of the crown and (2) blockage of access and poor internal visibility.

The porcelain-fused-to-metal (PFM) crown is more common than a full metal crown and creates additional problems. Porcelain may fracture or craze during access preparation. This problem is minimized by using burs specifically designed to prepare through



• **Fig. 2.11** Variability in Apical Foramen Location. **A**, The foramen is not visible radiographically. **B**, Histologically, the distal root shows the foramen to be well short of the apex. (From Walton RE: Endodontic considerations in the geriatric patient, *Dent Clin North Am* 41(4):795–816, 1997.)



• **Fig. 2.12** Access Through a Porcelain-Fused-to-Metal Crown. The outline is large for visibility. Also, the preparation does not extend to the porcelain to avoid fracture of the porcelain. (From Walton RE: Endodontic considerations in the geriatric patient, *Dent Clin North Am* 41(4):795–816; 1997.)

porcelain,⁹⁶ combined with slow cutting and copious use of water spray. Occlusal access is wide (Fig. 2.12). Metal should not be removed after the chamber has been opened to prevent metal shavings from entering and blocking canals. Access through a PFM or gold crown (either anterior or posterior) that is to be retained is best permanently repaired with amalgam. Anterior nonmetallic crowns may be repaired with composite.

Retreatment

Factors that lead to failure tend to increase with age; thus retreatment is more common in older patients. Retreatment at any age is often

complicated and should be approached with caution; these patients should be considered for referral. Retreatment procedures and outcomes are similar in older and younger teeth (see Chapter 19).

Endodontic Surgery

Considerations and indications for surgery are similar in older adult and younger patients. These indications include incision for drainage, periapical procedures, corrective surgery, root removal, and intentional replantation. Overall, the incidence of most of these factors increases with age. Small nonnegotiable canals, resorptions, and canal blockages occur more often with age. Perforation during access or preparation, ledging, and instrument separation are related to restorative and anatomic problems.

Medical Considerations

Medical considerations may require consultation and are a concern but generally do not contraindicate a surgical approach.⁹⁷ This contraindication is particularly true when extraction is the alternative; surgery is often less traumatic.

Excessive hemorrhage during or after surgery is a concern; many older adult patients are receiving anticoagulant therapy. Interestingly, recent studies examined bleeding patterns in oral surgery patients taking low-dose aspirin⁹⁸ and prescribed anticoagulants.⁹⁹ The findings were that anticoagulant therapy should not be altered and that hemorrhage was controllable by local hemostatic agents.¹⁰⁰ Consultation with the physician and maintenance of the INR at the 2- to 3-unit range are appropriate in these cases. It is important to note that patients undergoing anti-thrombotic therapy, patients with previous history of MI, patients with history of renal disease, or patients with severe asthma should not receive nonsteroidal antiinflammatory drugs.¹⁰¹

Biologic and Anatomic Factors

Bony and soft tissues are similar and respond the same in older and younger patients. There may be somewhat less thickness of overlying soft tissue; however, alveolar mucosa and gingiva seem to be



• **Fig. 2.13** Postsurgical Ecchymosis. Root-end surgery of a maxillary lateral incisor resulted in widespread migration of hemorrhage into the tissues, with resultant discoloration. This is not an uncommon occurrence in older adult patients. No treatment is indicated, and the problem resolves in 1 to 2 weeks.

structurally similar. Anatomic structures, such as the sinuses, floor of the nose, and location of neurovascular bundles, are essentially unchanged. Often, periodontal and endodontic surgery must be combined. In addition, crown-to-root ratios may be compromised because of periodontal disease or root resorption.

Healing After Surgery

Hard and soft tissues heal as predictably in older patients as they heal in younger ones, although somewhat more slowly.¹⁰²⁻¹⁰⁴ Post-surgical instructions should be given both verbally and in writing to minimize complications. If the patient has cognitive problems, instructions are repeated to the person accompanying the patient. Even very old patients have good healing, provided they follow posttreatment protocols and have no underlying immunologic problems. Ice and pressure (in particular) applied over the surgical area reduce bleeding and edema and minimize swelling. Overall, older patients experience no more significant adverse effects from surgery than do younger patients. Outcomes depend more on oral hygiene than on age, as has been shown in periodontal surgery patients.¹⁰⁵

One problem that seems to be more prevalent in older patients is ecchymosis after surgery. This is hemorrhage that often spreads widely through underlying tissue and commonly presents as discoloration (Fig. 2.13). Patients are informed that this may occur and that it should not be a concern. Normal color may take 1 to 2 weeks or longer to return. In addition, the discoloration may go through different color phases (purple, red, yellow, green) before disappearing.

• BOX 2.2 Study Questions

6. All the following are changes that occur in the pulp with age except one. Which one is the EXCEPTION?
 - a. Decreased vascular elements
 - b. Increase in numbers of fibroblasts
 - c. Decrease in numbers of odontoblasts
 - d. Increase in occurrence of calcifications
7. Which of the following statement is true regarding calcifications in the pulp space?
 - a. Pulp stones are found frequently in the radicular pulp.
 - b. Pulp stones are associated with odontogenic pain.
 - c. Calcification increases with both age and irritation.
 - d. Diffuse calcifications are mostly commonly found in the pulp chamber.
8. With age, which of the following describes the dimensional changes in the pulp space?
 - a. Pulp space progressively decreases in size in occlusal-apical dimension.
 - b. Pulp space decreases primarily in a mesiodistal dimension.
 - c. The volume remains the same.
 - d. Pulp space increases in size in response to irritation; hence called *inflammation*.
9. Epinephrine should be used with caution particularly in patients with
 - a. Hepatic disease
 - b. Renal disease
 - c. Cardiovascular disease
 - d. Diabetes
10. Working length determination in older adult patients may be more difficult because of which of the following?
 - a. Increased bone density, making radiographs harder to interpret
 - b. Increased cementum deposition, modifying the apical anatomy
 - c. Differences in tissue electrical resistance, making apex locators less accurate
 - d. Patient's inability to withstand and sit still for radiograph

ANSWERS

Answer Box 2

- 1 d. The clinician needs to be keenly aware of the patient's systemic health as it affects the dental management.
- 2 a. True
- 3 a. Neuropathy
- 4 d. Reduced glycemia
- 5 d. 66 to 70 Gy
- 6 b. Increase in numbers of fibroblasts
- 7 c. Calcification increases with both age and irritation
- 8 a. Pulp space progressively decreases in size in occlusal-apical dimension
- 9 c. Cardiovascular disease
- 10 b. Increased cementum deposition, modifying the apical anatomy

Identifying Patients for Referral

The AAE Endodontic Case Difficulty Assessment Form and Guidelines is a great tool for decision-making regarding case selection. In general, those patients with complex medical history, serious illness, or disability (American Society of Anesthesiologists Classes 3–5) should be referred. On that list, there are also those patients who are difficult to anesthetize, uncooperative, have limitation in opening, have extreme gag reflex that has compromised past dental care, and/or have severe pain or swelling.

Other considerations include difficult diagnosis, extreme curvature of the roots, extensive pretreatment modification required for rubber dam isolation, significant deviation from normal tooth due to crown morphology to root morphology, indistinct canal morphology, extensive resorption, concurrent severe periodontal disease, cracked teeth, and endodontic surgery.

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Video 2.1: Endo-Medical History Video
Video 2.2: A1C Now Measurement