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Nonsurgical Retreatment

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CHAPTER OUTLINE

LEARNING OBJECTIVES

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

1. Recognize causes of the initial root canal therapy failure that require nonsurgical endodontic retreatment.
2. Identify if an initial root canal therapy requires additional treatment
3. Identify the treatment options available for teeth that need endodontic retreatment.
4. State the indications and contraindications for nonsurgical endodontic retreatment.
5. Describe how an accurate diagnosis should be made for nonsurgical endodontic retreatment.
6. Discuss the treatment plans for nonsurgical endodontic retreatment.
7. Describe the risks and benefits of nonsurgical endodontic retreatment.
8. Describe techniques and materials used in nonsurgical endodontic retreatment.
9. Discuss restorative options and follow-up care.
10. Discuss the prognosis and outcomes for nonsurgical endodontic retreatment.

Introduction

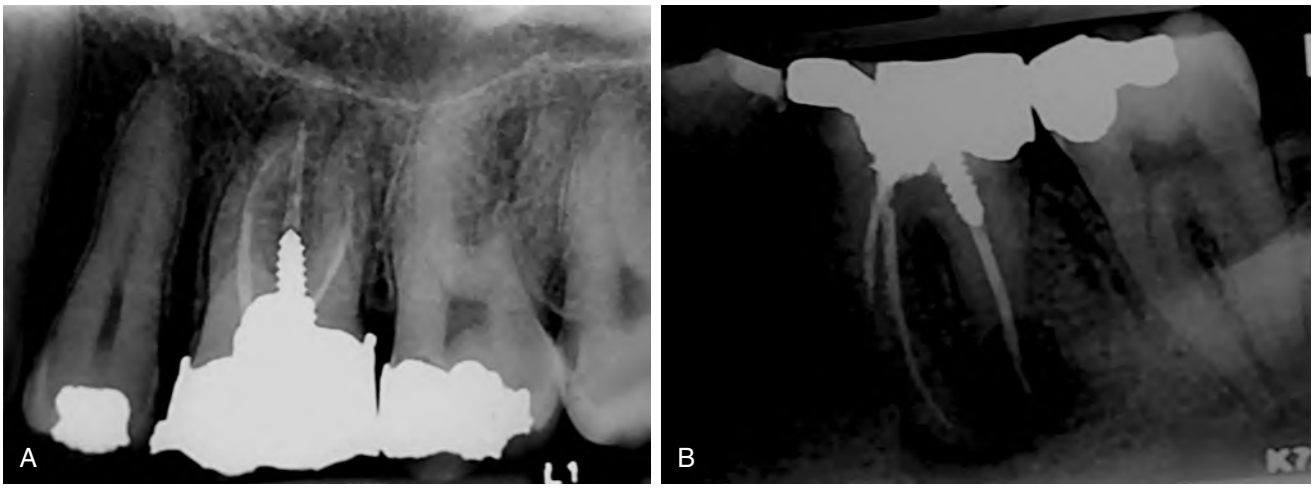
When providing root canal treatment using today's techniques the clinician expects excellent success rates. Modern methodologies and materials have demonstrated this in studies looking at maintaining tooth function and retention.[1,2] Initial root canal therapy, however, does not always result in healing for a multitude of reasons. Failure to adequately disinfect the root canal system may result in nonhealing. Bacteria may persist after initial treatment as a result of areas that were inaccessible to instrumentation and irrigation.[3-6] Causes of treatment failure may include lack of tooth isolation; inadequate cleaning, shaping, and irrigation; and incomplete obturation (Fig. 19.1). In addition to complex anatomic variations in the root canal anatomy, root canal obstructions, including calcifications, can also be a problem[3-5] The reestablishment of root canal infection after initial treatment may also lead to progression of disease.[7-9] This reintroduction of microorganisms is primarily caused by coronal microleakage and recurrent decay.[3,4,9,10] Furthermore, initial treatment may be compromised by long-term use of temporary materials before placement of definitive restorations.[12-14]

Nonhealing after initial nonsurgical root canal therapy may also be related to procedural errors or the presence of biofilms.[11] Procedural errors include perforations, canal transportation, fractured instruments, and ledge formations, all of which can negatively affect the treatment outcome.[3,6]

It is also important to recognize that vertical root fractures (VRF) may sometimes appear as nonhealing lesions. These are longitudinal fractures that occur after root canal treatment and may be related to the weakening of roots from excessive dentin removal or simply from the stresses on teeth from normal function (Video 19.1).[15-17]

Causes of Nonhealing of Initial Root Canal Treatment

A significant reduction or elimination of bacteria in the root canal system after initial endodontic treatment should reduce the presence of periapical periodontitis. The causes of the initial endodontic treatment failure can include inability of the procedure to eradicate bacteria, introduced intraradicular microorganism,[18] extraradicular infection,[19] foreign body reaction,[20] accidental procedures,[21] and nonendodontic related events such as VRF, traumatic injuries, and periodontal disease.[22] Most studies on the unfavorable outcomes of endodontic treatment reported that microorganisms in the root canals or periradicular lesions play a major role in the persistence of apical periodontitis (Fig. 19.2).[8,22-24]



• **Fig. 19.1** **(A)** A patient has had sensitivity to palpation and percussion. Review of the periapical radiograph of the maxillary left first molar is showing the presence of apical pathosis. **(B)** Periapical radiograph of the mandibular left first molar is showing incomplete obturation and large periapical pathosis. The tooth restoration has been fractured and needs a full coverage restoration.

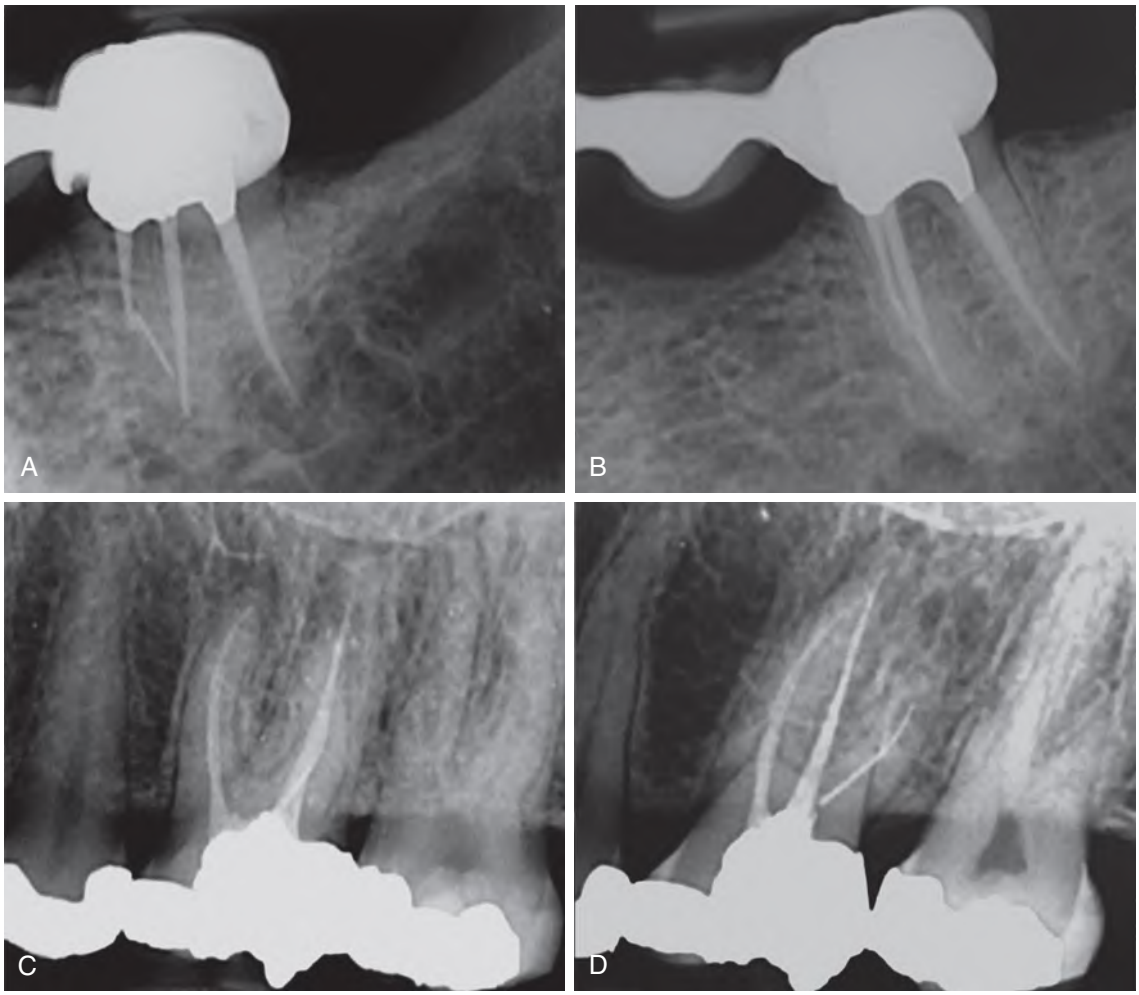
• **Fig. 19.2** **(A)** Preoperative radiograph of the maxillary right second premolar showing a large periapical lesion. **(B)** Sagittal view of CBCT imaging reveals an unfilled canal space apical to the root filling and the periapical lesion extending to the maxillary sinus cavity (*arrow*). **(C)** Coronal view of CBCT imaging reveals complete resorption of maxillary sinus floor on the root (*arrow*). **(D)** Postoperative radiograph showing root canal fillings with MTA. **(E)** Three-month postoperative radiograph showing a reduced periapical lesion. **(F)** Six-month postoperative radiograph showing nice periapical healing. **(G)** Six-month postoperative sagittal view of CBCT imaging reveals both periapical healing and reformation of the maxillary sinus floor (*arrow*). **(H)** Six-month postoperative coronal view of CBCT imaging reveals complete reformation of the maxillary sinus floor (*arrow*).

Diagnosis and Retreatment Options

Diagnosis of a tooth in need of endodontic retreatment should be based on clinical signs and symptoms, radiographic and, when necessary, tomographic interpretations.

Periapical radiographs should be taken in two different horizontal angles to evaluate the quality of obturation, crestal bone level, presence of missed root canals, procedural errors, resorptions, and lateral or periapical radiolucent lesions (Fig. 19.3).

Introduction of cone beam computed tomography (CBCT) to endodontics has had a considerable and positive effect on the diagnosis and treatment planning. However, CBCT images reveal more periapical lesions compared with the two-dimensional conventional radiographic techniques.[25,26] An investigation by Torabinejad et al.



• **Fig. 19.3** Importance of taking preoperative periapical radiograph with different angles. **(A)** Mandibular left second molar shows broken instruments in one of the mesial root canals. **(B)** Different horizontal angle of the same tooth shows a possibility of root canal transportation as well as perforation in the same root. **(C)** Periapical radiography of the maxillary left first molar when taken from distal resulted in superimposition of the distobuccal root over the palatal root. **(D)** Taking the radiograph with a different horizontal angle shows broken instrument in the distobuccal root.

showed that 20% of the teeth with a history of root canal therapy that had no visible radiographic periapical lesions exhibited periapical radiolucencies >1 mm in size when evaluated by CBCT. They cautioned clinicians not to consider all these lesions as treatment failures because the radiolucency might be a previous lesion in its healing phase, persistent periapical disease, or even fibrous scar tissue.[27] They recommended further follow-up as well as a work-up of the case to determine the true nature of these radiolucencies (Fig. 19.4).

Both intraradicular and extraradicular infections might result in nonhealing of root canal treatment. If a periapical radiograph shows adequate root canal therapy, presence of extraradicular infection should also be considered as a reason for failure.[28]

The reason a tooth requires endodontic retreatment should always be confirmed. In addition to performing endodontic retreatment for the failed cases, in some instances, as a result of the fracture of the preexisting restoration, leakage, or unacceptable esthetics, endodontic retreatment should be performed for teeth with inadequate root canal therapy despite the absence of clinical signs or symptoms and radiographic pathosis (Fig. 19.5).

In some cases, dental practitioners might not have a similar treatment plan to manage a tooth with previously failed root canal therapy.[29] Factors such as the practitioners' personal experience, skill, available armamentarium, patients' attitude, and demands for receiving endodontic retreatment might influence the treatment plan. Therefore a dentist would help patients participate in a shared decision-making process through full description of all the treatment options, their risks and benefits, as well as economic advantages and disadvantages. Patients usually attend a dental office when they are in pain and discomfort, need to repair a preexisting restoration, have fractured or traumatized teeth, or need treatment as a result of dental caries. Occasionally, making decisions may be difficult because of conditions that could be genuinely complicated. It would be wise to precisely evaluate each case by clinical and radiographic examinations and, if necessary, refer the patient to a periodontist or a prosthodontist to make sure that the tooth is restorable and maintainable after endodontic retreatment. It is critically important to describe all information in a simple language that is easily understood by the patients.[30] Therefore patients' age, first/second language, and educational background should be considered for better communication.[31,32]

The treatment options in endodontics, when previous root canal therapy is showing signs of failure or when the tooth needs a new permanent restoration, would include nonsurgical root canal

• **Fig. 19.4** An example of working up a case that shows periapical lesion in CBCT image. **(A)** Presence of a large periapical lesion around the maxillary left lateral incisor. **(B)** Root canal treatment of the lateral incisor. **(C)** Periapical healing 2 years after the treatment. **(D)** Presence of a radiolucency around the maxillary lateral incisor in axial view of the tooth that was treated 2 years ago (*white arrow*). No treatment should be performed for this case because the patient is symptom free and the follow-up radiograph showed healing compared with the preoperative radiograph.

• **Fig. 19.5 (A-D)** Endodontic retreatment is needed as a result of unacceptable esthetic and fractured crown in maxillary right central incisors.

retreatment, surgical retreatment, replantation, transplantation, and possible extraction followed by placement of an implant.[33]

Indications for Nonsurgical Endodontic Retreatment

Retreatment is considered the primary procedural option when the tooth exhibits inadequate initial root canal treatment, has palpation and percussion sensitivity, localized swelling, recurrent caries, leaky provisional restorations, and substandard or missing coronal restorations. Radiographic evaluation may show the presence of untreated canals, poor canal obturation with voids, separated instruments, recurrent caries not located during clinical examination, or defective restorations with open margins that can potentially contribute to nonhealing. Any combination of clinical symptoms, radiographic evidence, and other clinical findings may indicate that nonhealing is evident but may also arise without any contribution of the aforementioned conditions.

Contraindications for Nonsurgical Endodontic Retreatment

A major factor to determine the requirement for nonsurgical retreatment is the restorability of the tooth after the necessary removal of preexisting restorative materials. Additional tooth structure may be lost during caries elimination and removal of post and core materials. The restorability decision often requires comprehensive disassembly of preexisting restorations and evaluation of the remaining root canal system. Other factors include the presence of extensive periodontal involvement that weakens tooth support and/or the presence of problematic coronal or radicular fractures. Patients who are not motivated to save the natural tooth are poor candidates for retreatment.

Treatment Planning for Nonsurgical Retreatment

In most instances, nonsurgical root canal retreatment is the first treatment of choice for either overcoming a nonhealing outcome of a previous root canal treatment or correcting a previous inadequate endodontic treatment with no clinical and radiographic signs of failure (Fig. 19.6).[33,34] Moreover, nonsurgical endodontic retreatment is usually preferred to other treatment options because the procedure is less invasive than surgical endodontics, replantation, transplantation, and extraction and replacement with implant.[2]

In addition to the technical challenge of performing endodontic retreatment, other aspects of the treatment should also be considered.[35] Important factors in this respect include cost-effectiveness of the treatment, periodontal status, the remaining tooth structure after removing all caries and preexisting restorations, restorability of the tooth, the total cost of treatment, the need for crown lengthening in order to place a suitable full-coverage restoration, and esthetic and functional conditions.

Cost-effectiveness of a treatment might affect decision-making when there are different treatment options. Both microsurgical endodontic retreatment or nonsurgical endodontic retreatment with a crown are more cost-effective treatments compared with extraction and placement of an implant.[36]

The practitioner should always evaluate periodontal status, restorability, and function of the tooth during the examination visit. The occlusal contacts of the tooth should also be evaluated, particularly if during the previous treatment the occlusal surface of the tooth has been reduced for a long time (Fig. 19.7).

An important aid in treatment planning is to order CBCT before commencing endodontic retreatment.[37] Practitioners should only request CBCT after taking relevant courses and gaining experience and knowledge on interpretation of CBCT images and their limitations.[25] The European Academy of DentoMaxilloFacial Radiology has recommended incorporating courses on CBCT into both undergraduate and postgraduate curricula as well as continuing education programs for dentists and endodontists in order to improve their skills in relation to the interpretation of the tomographic images used in their clinical practice.[38]

Although CBCT could be an important aid for the practitioner, it does not mean it should be ordered for all the endodontic retreatment cases.[39,40] For endodontic retreatment purposes CBCT could be ordered if[25,40,41]:

- Conventional two-dimensional radiography (periapical) did not provide enough information regarding the reason(s) for failure in a tooth that previously received endodontic treatment (Fig. 19.8).
- Conventional two-dimensional radiography (periapical) shows the possibility of complex root canal anatomy in a tooth with a history of endodontic therapy (Fig. 19.9).
- There is possibility of mishaps and overlooked root canal(s) that are not adequately detected by conventional two-dimensional radiography (Figs. 19.9 and 19.10).

Based on standards of care, the dentist should choose whether conventional radiography is sufficient for commencing endodontic retreatment or there is need for more information by ordering CBCT. The practitioner should discuss the risks and benefits of requesting CBCT with the patient and both arrive at a decision either to order the tomography or to only use conventional radiography during treatment planning. Higher radiation dose, higher cost, and lower resolution are disadvantages of CBCT compared with periapical radiography.[42]

There is no unique treatment plan for all the teeth with a history of endodontic therapy and nonhealing periapical lesions.[30] Each case should be evaluated individually and decisions on the treatment plan should be made based on patients' preference, possibility of rendering ideal treatment, and considering the prognosis. Most patients are interested in being active or collaborative in making a decision when teeth have apical periodontitis.[43] Variables should be discussed with patients and a final shared decision should be made.[44]

Risks and Benefits of Retreatment

Like any dental treatment, the risks, benefits, alternative treatments, and the subsequent consequences of choices must always be discussed with the patient. This conversation occurs before commencing treatment and includes an explanation of what the treatment entails, expected treatment time, prognosis, and costs.[36]

Nonsurgical root canal retreatment procedures have numerous potential risks. These include fracture of a porcelain crown during the access procedure, fracture of the root during post removal procedures, and dislodgment of the crown, which may necessitate replacement. In addition, iatrogenic challenges may arise such as extensive removal of tooth structure, canal transportation, creation of ledges, or even perforations.[5,6,45] The separation of an instrument is also possible, which may impede the ability to completely remove obturation materials. These complications potentially affect the retreatment outcome. The benefits of retreatment include the preservation and retention of the patient's natural tooth and the avoidance of more extensive clinical treatment and costs.

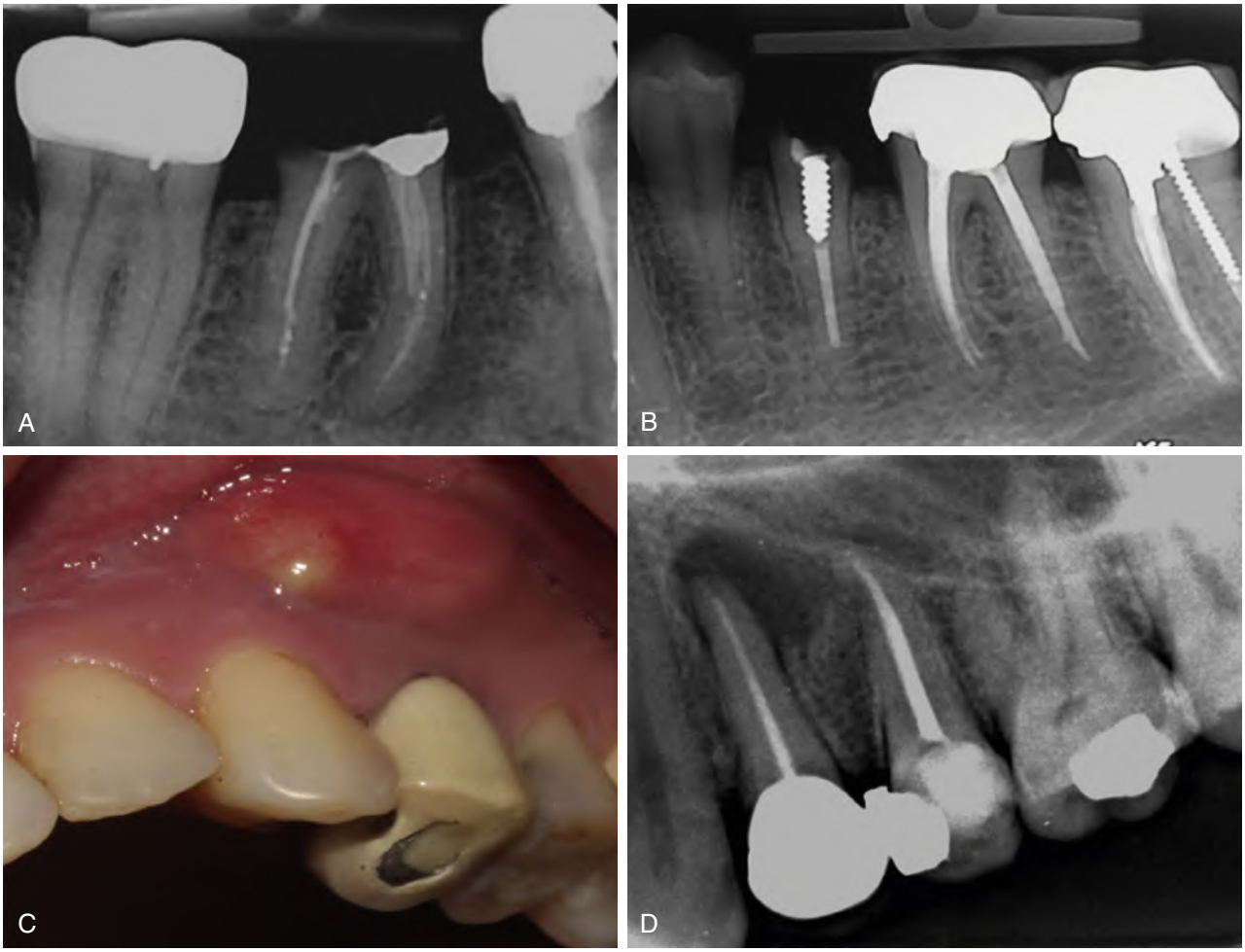
Study Questions

1. Nonhealing of root canal therapy may be caused by:
   a. Inadequate tooth isolation
   b. Inadequate instrumentation
   c. Inadequate obturation
   d. All of the above
2. Radiographic "apical lesions" after root canal therapy may be a result of:
   a. Nonhealing after treatment
   b. Reestablishment of disease
   c. Vertical root fracture
   d. All of the above
3. When should risks benefits and alternatives to treatment be given to a patient?
   a. Before treatment
   b. During treatment
   c. After treatment
4. Which of the following describes a disadvantage of CBCT compared with the conventional radiography?
   a. Higher radiation dose
   b. Higher cost
   c. Lower resolution
   d. All of the above
5. Which of the following is a contraindication for endodontic retreatment?
   a. Absence of coronal restoration
   b. None–restorable crown
   c. Tooth discoloration
   d. A history of soft tissue swelling

Endodontic Retreatment Procedures

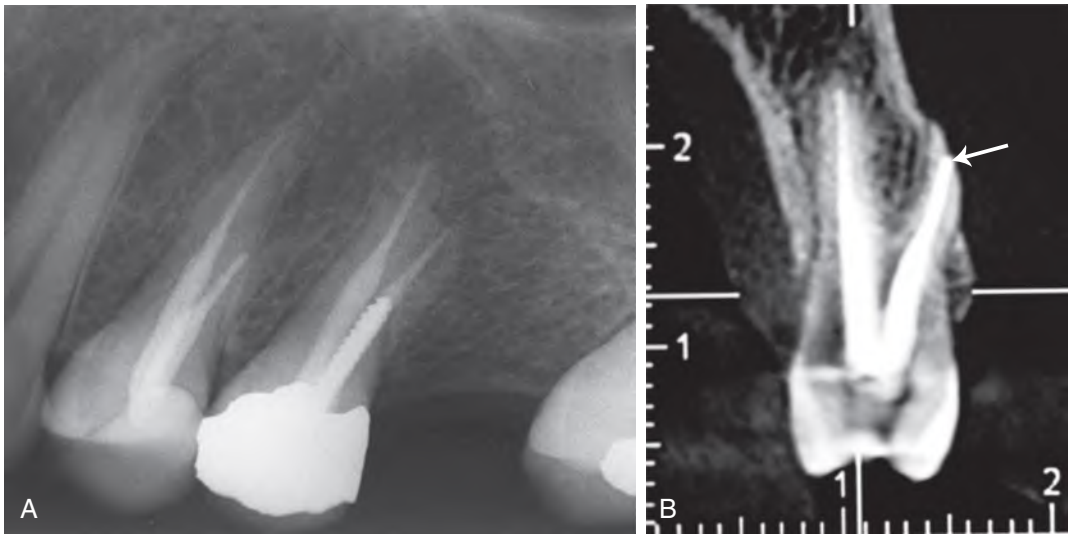
Access Through Full-Coverage or Preexisting Restorations

The decision to remove all the existing restorations during endo-dontic retreatment depends on several factors. In most cases, the practitioner should remove all the existing restorations before commencing the endodontic retreatment procedure because of the possibility of leakage and presence of recurrent caries. In addition, it is reasonable to remove a previous restoration as well as caries before performing endodontic retreatment to determine whether future restoration is possible or not.[46] However, in some instances, the patient might have recently received a suitable restoration and removing it would increase the cost of the treatment. In such a case, providing access cavity through the previous restoration might be recommended (Fig. 19.11). Preserving a crown restoration could also help to improve dental dam isolation and maintain occlusion, with the least alteration in esthetics. However, it might restrict the practitioners' ability to observe cracks, missed root canal(s), and recurrent caries. If a prior restoration of the retreated tooth is amalgam, there would always be a chance of inadvertent pushing of amalgam fragments (induced during access cavity preparation) into the root canal space and blocking the root canal negotiation.



• **Fig. 19.6** Typical cases that need endodontic retreatment because of various reasons. **(A** and **B)** The teeth need endodontic retreatment as a result of fracture of their restorations. **(C** and **D)** Maxillary left first premolar needs endodontic retreatment as a result of failure of the previous root canal therapy.

• **Fig. 19.7** **(A)** Occlusal surface of the mandibular right second molar has been reduced after the previous root canal treatment. **(B)** Occlusal view of the tooth that needs reconstruction. **(C)** No space for placing a full coverage restoration over the tooth.



• **Fig. 19.8** **(A)** Maxillary left second premolar received root canal therapy 2 years ago; however, the patient complained of pain and sensitivity on percussion and palpation since the treatment visit. **(B)** The CBCT image in coronal view showed apical perforation in the buccal root (*white arrow*).

Based on the American Association of Endodontists (AAE) difficulty assessment form,[47] root canal retreatment has been categorized as highly difficult. If the tooth has received a full-coverage crown or is an abutment for a bridge and needs to receive endodontic retreatment, it will definitely increase the difficulty, and it may be wiser to refer the patient to an endodontist. For more information on the subject, the reader should refer to Chapter 6 of this book.

If either a prefabricated or a cast post is present even in a tooth that recently received a restoration, removal of all the existing restorations is highly recommended.

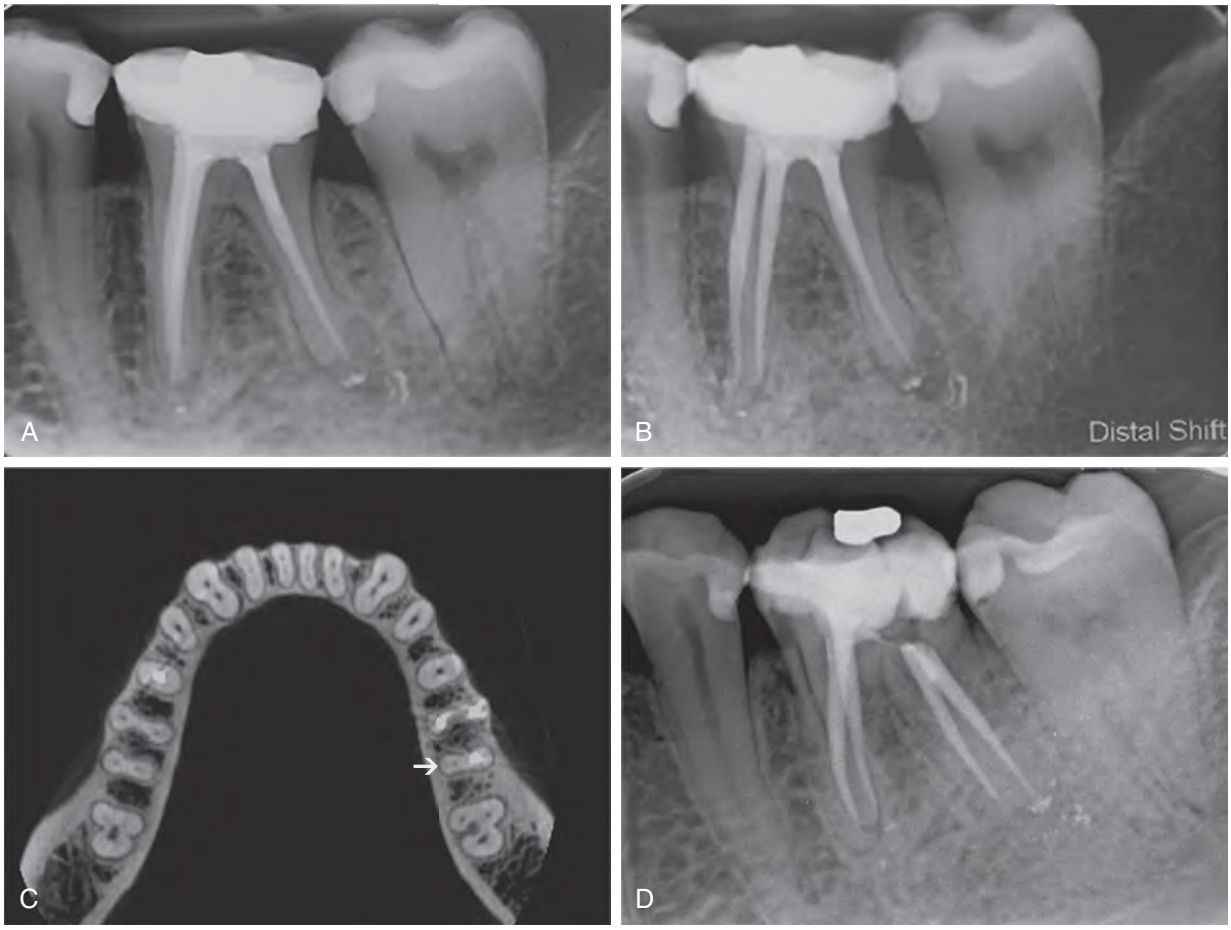
Removal of Existing Restorations

Endodontic treatment outcomes may depend more on the marginal adaptation of the restoration than the quality of root canal fillings.[48,49] Hence, because of the possibility of coronally induced bacterial ingress into the canals, it is essential to remove the preexisting coronal restorations and evaluate the presence of secondary caries and root canal contamination (Fig. 19.12). When a tooth presents with a full coverage restoration, composite resin, or amalgam restoration with recurrent caries, open margins, or loss of marginal integrity, complete removal of the restoration is indicated. In the majority of cases, removal of the full coverage restoration is necessary to see if there is any undetected bacterial contamination.[5,6,50] Disassembly of the preexisting restorations allows inspection for possible recurrent caries and fractures and evaluation of the tooth's restorability.[6,50,51] If coronally induced bacterial ingress is evident, the entire remaining tooth structure should be inspected, including the canals and the pulpal floor. When the remaining coronal structure is assessed as being inadequate, orthodontic extrusion of the root should be considered (see Chapter 21).

Removal of Canal Obstructions

Canal obstructions usually prevent successful negotiation of the root canal system during nonsurgical root canal treatment. Surgical treatment may need to be included to manage these treatment challenges.

Canal obstructions include posts and cores, calcifications of the root canal system, iatrogenic ledges, dentinal debris in the root canal system, fractured instruments, silver points or metallic debris, and some paste materials.[3,5,6] Removals of canal



• **Fig. 19.9** **(A** and **B)** Periapical radiography showed possibility of a complex root canal anatomy in mandibular left first molar. **(C)** CBCT image in axial view showed that the distolingual root had been overlooked *(white arrow)*. **(D)** The tooth received endodontic retreatment.

obstructions are typically complex treatment situations that frequently require extensive operator training and experience to manage. For the benefit of the patient, referral to an endodontist should be considered and offered.[52]

There are basically three approaches to managing intracanal fractured instruments: (1) attempting to remove the instrument nonsurgically or surgically,[53] (2) attempting to bypass the instrument, or (3) preparing and obturating the canal with the fractured instrument.

First, a diagnosis and a treatment plan for instrument retrieval should be made with periapical radiography and CBCT imaging (see Chapter 18).

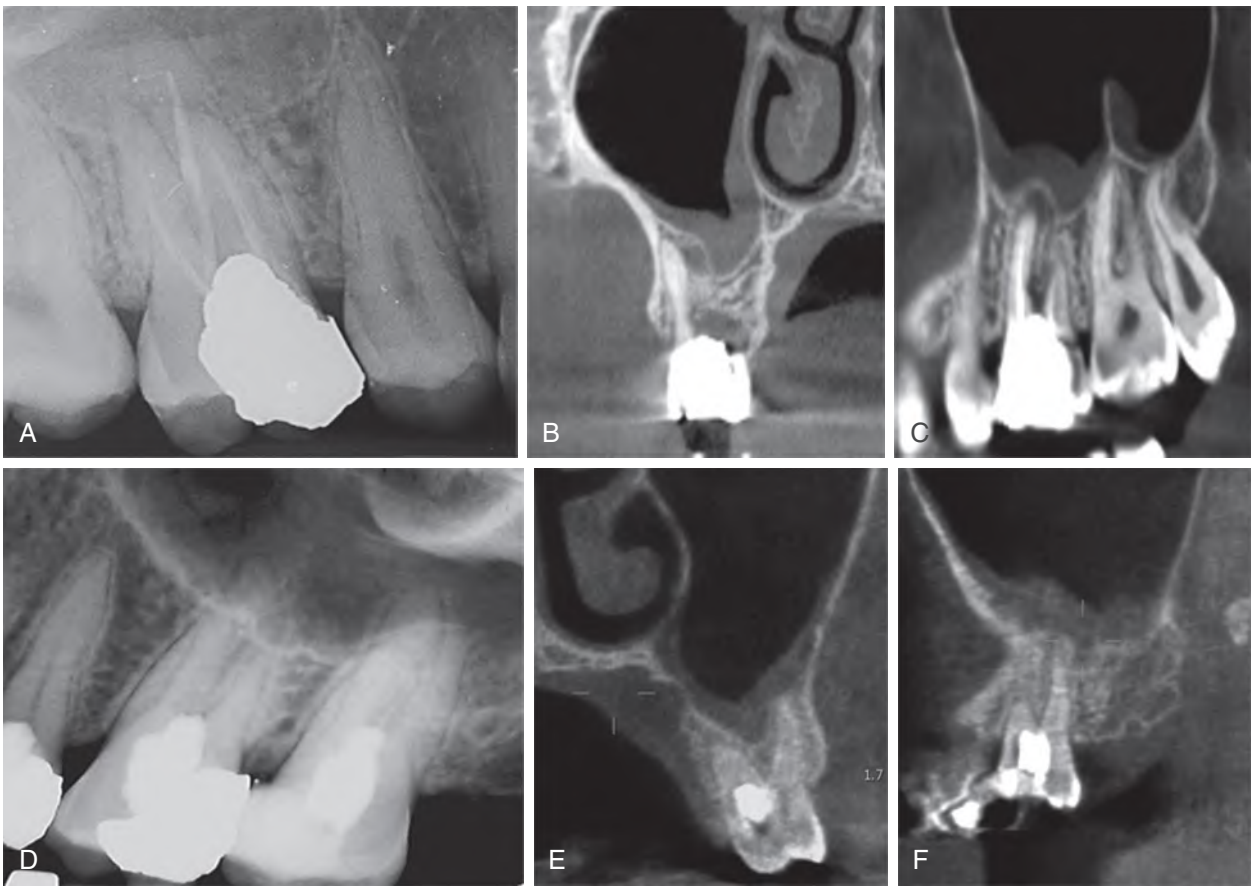
As discussed in Chapter 18, the majority of nickel-titanium (NiTi) rotary instruments fracture in the apical one third of the canals.[54] When a fractured instrument is lodged beyond the curve and extrudes primarily beyond the apical foramen, a surgical approach should be considered because removal sacrifices less valuable structure compared with the nonsurgical approach. A nonsurgical procedure should be initiated if the amount of tooth structure removal after surgery is expected to be greater than a nonsurgical approach.

Bypassing a fractured instrument may not be as successful as removal with ultrasonics,[55,56] and attempts to bypass the instrument may lead to iatrogenic accidents such as ledge formation, perforations, and transportations, particularly in curved canals.[57] In general, bypassing a broken instrument is a technique-sensitive procedure requiring experience, tactile sense, and perseverance by the clinician.[58-68]

When an instrument fractures in the apical one third of the canal in a later stage of canal instrumentation and if an excessive amount of tooth structure must be sacrificed to retrieve it, the separate file should be incorporated as part of the filling material and scheduled for periodic review.[69-72] The sealing ability of the obturation material is not compromised by the presence of a fractured file or other metallic debris.[73]

The use of ultrasonics can effectively remove a fractured instrument when performed under high magnification and illumination.[74-78]

Ledge formation during root canal preparations can be analogous to broken instruments because they can also limit instrumentation in an apical direction. Ledges are typically generated on the outer canal wall when preparation of the curved canal is not maintained (Fig. 19.13).[68] These canal problems typically occur when stainless steel files are not properly precurved to match the canal curvature. Traditional stainless steel files have aggressive cutting tips (pyramidal tips) compared with NiTi files and are apt to straighten canals unless properly precurved, resulting in ledge formation. Root canal transportation and ledging can also occur during preparation if debris accumulation is not consistently removed. It is important to keep the canal wet and constantly irrigate the canal with an irrigation needle smaller than the root canal diameter during instrumentation to avoid debris blockage. Recognition and



• **Fig. 19.10** **(A)** The maxillary right first molar with inadequate root canal therapy showed a possibility of mishap during access cavity preparation. Both CBCT images in coronal **(B)** and sagittal **(C)** views showed trifurcation perforation. **(D)** Maxillary left first and second molars showed the possibility of trifurcation perforation of a previous pulpotomy. No sign of trifurcation perforation was observed on CBCT images in coronal **(E)** and sagittal **(F)** views.

visualization of canal ledges is essential for avoiding perforations and other procedural errors. Studies have shown flexible nonlanded NiTi instruments with noncutting tips produce significantly less apical transportation than landed NiTi instruments or NiTi instruments with cutting tips.[69,70] For more information regarding the ledge management, readers should refer to Chapter 18 of this book.

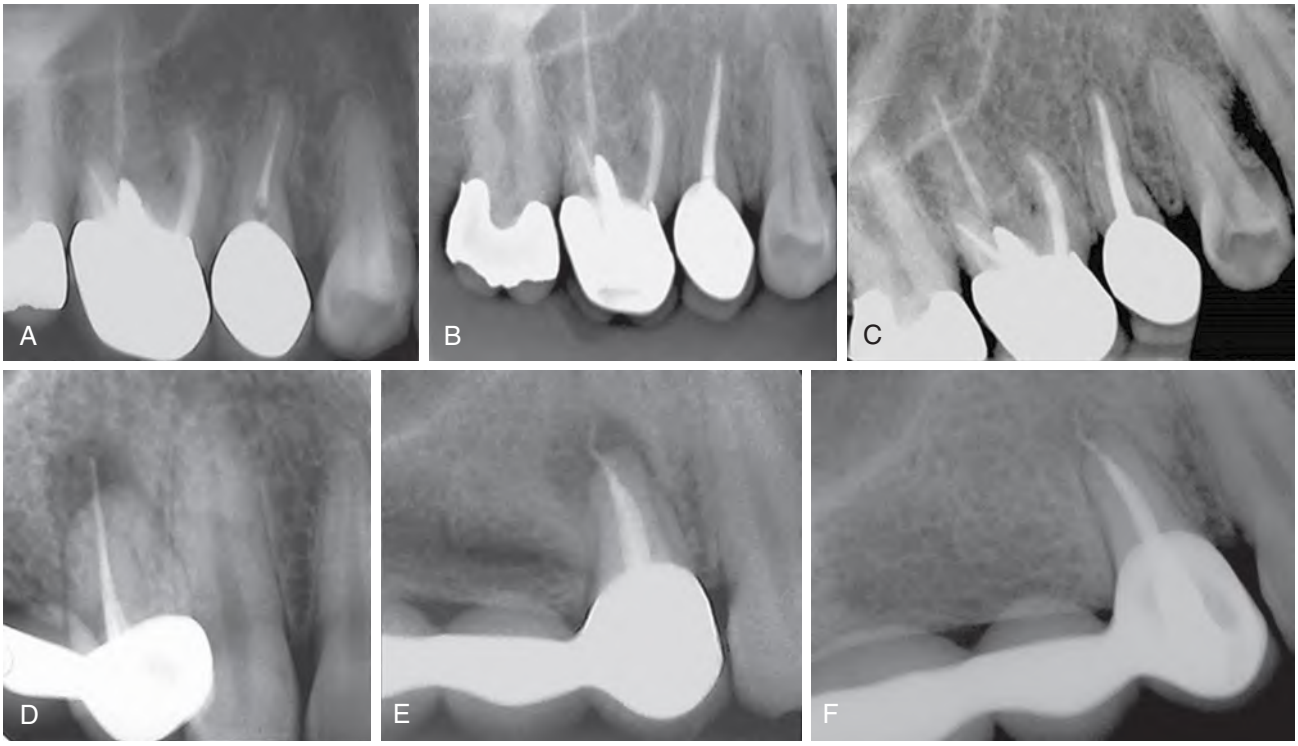
Post and Core Removal

Successful removal of posts and cores during retreatment depends on multiple factors. They include the operator's level of skill, experience, training, and instrumentation selection. Small-diameter long shank carbide burs and ultrasonic systems used in conjunction with the dental operating microscope (DOM) facilitate predictable treatment. Other outcome considerations include the type of core material (cast versus resin or amalgam); the length and diameter of the prefabricated or cast post, post location, post material type (metallic or nonmetallic); and variety of cement or bonding system used to secure the post and core system.[6,45,50] Any number of methods used to remove posts can compromise the existing tooth structure.[45] Some posts may be difficult to remove if they are long, well fitted, or cemented with bonding systems or resin cements (Fig. 19.14). Most posts are essentially straight and can be usually managed using small-diameter long shank carbide burs under the DOM. However, nonmetallic posts such as tooth colored zirconia or fiber posts may be difficult to differentiate from the tooth structure. The small-diameter burs partnered with the DOM allow conservative post removal without sacrificing additional tooth structure (see Fig. 19.14).

In preparation for post removal, the coronal core material must be carefully sectioned and removed incrementally with diamond, zirconia-diamond, transmetal, or carbide burs, and ultrasonic tips to preserve the portion of the post that extrudes coronally from the root canal to facilitate removal of various core materials.[6,45,50]

This procedure is best performed using illumination and magnification to help preserve adjacent tooth structure during the procedure. After core removal, any visible cement surrounding the post can be circumferentially removed using fine ultrasonic tips or flame-tipped diamond burs.[6,71] Loosening of the post should be observed as the ultrasonic activation progresses.

Screw posts can usually be loosened with ultrasonics applied to them in a counterclockwise rotation and picked up with various-sized hemostats or small-tipped forceps or pliers. However, this procedure must be executed with caution because it rapidly generates extremely high temperatures without water coolant. In addition, ultrasonic energy should be delivered in different locations around the exposed portion of the post at intervals lasting no longer than 15 seconds.[6,53,72,73] Ultrasonic tips used without water coolant and placed in contact with posts generate temperature increases of 10°C within 1 minute on the external root surface.[74] If this threshold temperature is reached, heat generation can cause necrosis of periodontal tissues, with possible loss of the tooth and supporting bone.



• **Fig. 19.11** Examples of access cavity preparation with and without preexisting restoration. **(A)** A maxillary right second premolar with a history of recently placed porcelain fused to metal crown being clinically symptomatic. **(B)** The access cavity was prepared through the crown. **(C)** Follow-up radiography 1 year after the treatment showed successful outcome and the tooth was clinically symptom free. **(D)** Maxillary right first premolar was an abutment of a bridge. Because of suitable marginal adaptation of the bridge and favorable esthetic, endodontic retreatment was performed through the full coverage restoration. **(E)** The missed root canal was located. **(F)** Despite unsuccessful effort for removing overextended gutta-percha, periapical radiograph showed that the radiolucent lesion healed 18 months later.

Posts cemented with resin cements and fiber posts are difficult to loosen and remove with ultrasonics.[50] Therefore those posts should be ground down with small-diameter carbide burs under the DOM.

After post removal, any excess cement can be removed using a combination of solvents, rotary or hand instruments, or ultrasonic tips (Video 19.2).[6,45,50]

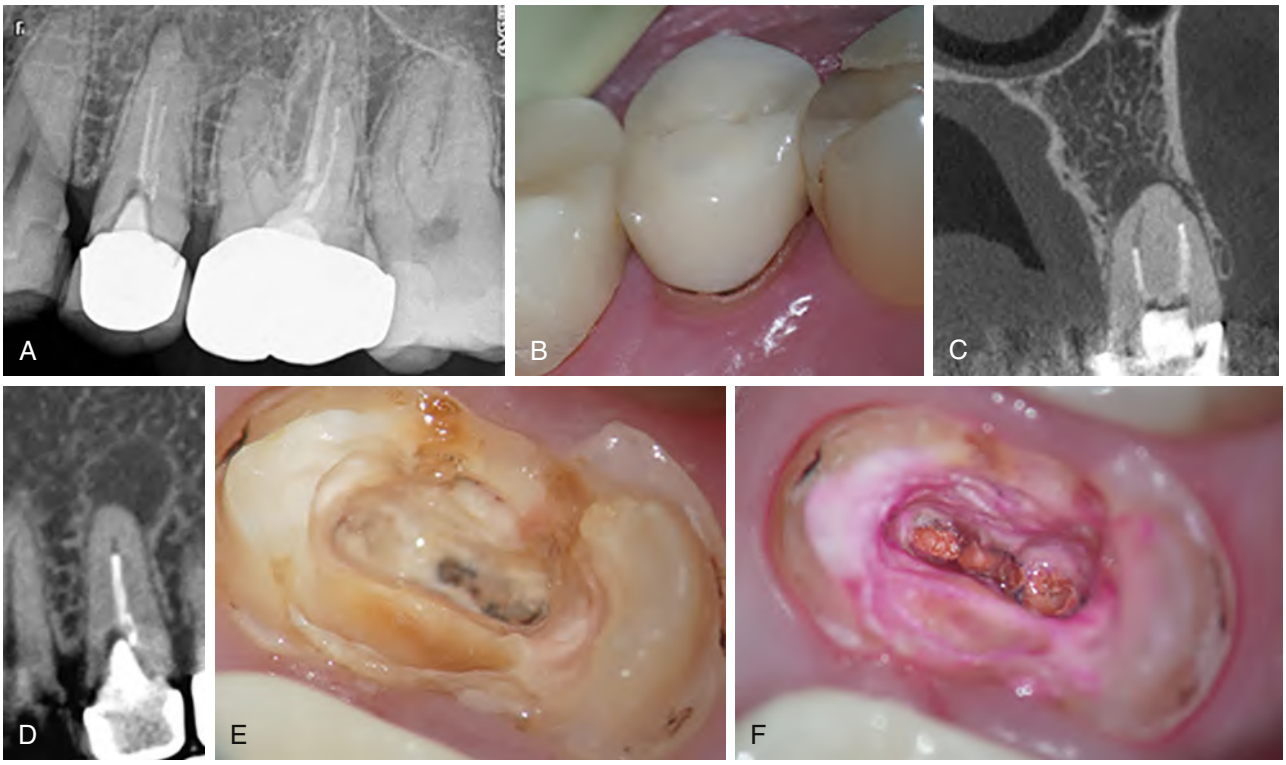
Removal of Gutta-Percha

Gutta-percha is the universally and most commonly used obturation material. Therefore it requires removal more frequently during endodontic retreatment than other materials in order to better prepare a root canal space or improve a canal with an inadequate filling during retreatment. Because biofilms are the primary cause of chronic and recurrent endodontic infections, removal of gutta-percha is essential to successfully retreat the root canal system.[74] This can be accomplished using hand and rotary instruments, ultrasonic instruments, heat systems, or solvents and generally requires a combination of these methods.

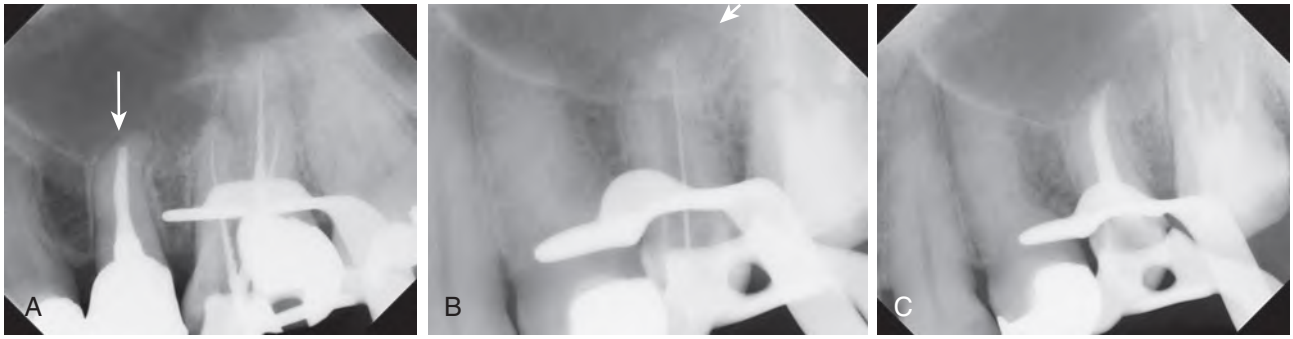
The use of Gates-Glidden burs should probably be limited to the coronal portion of the canal, and excessive force must not be used because of the possible presence of apical root resorption or poorly adapted gutta-percha root fillings, which may result in the material extrusion (Fig. 19.15).[75,76] The most efficient way to remove gutta-percha root fillings is to use ultrasonic and hand instruments under the DOM, followed by rotary instruments (Fig. 19.16). Moreover, chloroform has been reported to be capable of reducing the intracanal levels of *Enterococcus faecalis,* a common microbe detected in endodontic failures.[7,77] However, if chloroform is used during the early stages of gutta-percha removal, more filling material will most likely remain in the canal and may contribute to excess extrusion beyond the apical foramen.[78,79] Xylene, halothane, eucalyptol, eucalyptus oil, carbon disulfide, benzene, and orange oil can also be used for this purpose. Even though they have been shown to be less effective at softening gutta-percha than chloroform, the majority of those solvents do not pose a significant health risk to patients.[80-82] One investigation measured the amount of residual chloroform, halothane, and xylene expressed through the apical foramen during retreatment procedures.[81] It was determined that the amount of each solvent expressed was below the levels that may pose a health concern to patients (Video 19.3).

Removal of Carrier-Based Gutta-Percha Obturators

A popular method of obturation utilizes carrier-based gutta-percha obturators. These devices have a central core of plastic, metal, or other dense material that is coated with gutta-percha. During nonsurgical root canal retreatment, these obturators can be removed using a combination of techniques similar to those for removing posts, silver points, and gutta-percha. Treatment begins by creating a pathway adjacent to the central core to allow an instrument to engage the carrier. Soften the gutta-percha on the surface of the carrier with a heat source or solvent.[83-88] When heat is used to soften the gutta-percha, a thermostatically controlled device, plugger, or endodontic heat carrier heated over an open flame is effective.[87] As increased temperature can damage the surrounding periapical tissues; care should be taken to avoid placing



• **Fig. 19.12** **(A)** Preoperative radiograph showing a wide gap between the coronal restoration and the root with a periapical lesion. **(B)** Intraoral photograph showing poor marginal adaptation of the crown. **(C)** Coronal view of CBCT imaging shows a wide space between the two root canals and the core with a periapical lesion associated with the root. **(D)** Sagittal view of CBCT imaging also shows spaces between the two root canals and the coronal. **(E)** Extensive carious lesions discovered under the coronal restoration. **(F)** Dentin stained with carious detector dye reveals deep carious lesions into the two canals.



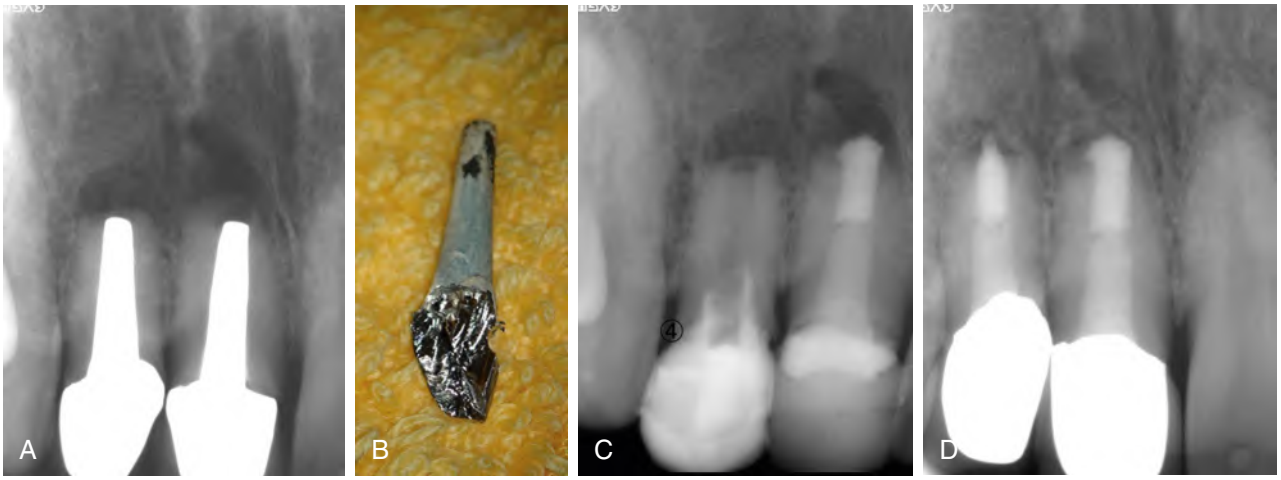
• **Fig. 19.13** **(A)** Preoperative radiograph showing a ledge formation on the outer canal wall in relation to the canal curvature *(white arrow)*. **(B)** Intraoperative radiograph showing a precurved #10 K file in the original pathway after filling the ledged space with MTA *(white arrow)*. **(C)** Postoperative radiograph showing the root filling in the original canal beyond the ledge.

the heated tip in contact with the dentin wall for long periods.[88] Gutta-percha can also be softened using rotary instrumentation at higher speeds (1500 to 2500 rpm), but use of these instruments should be limited to straight canals because the possibility of instrument fracture in a curved canal is high.[89,90]

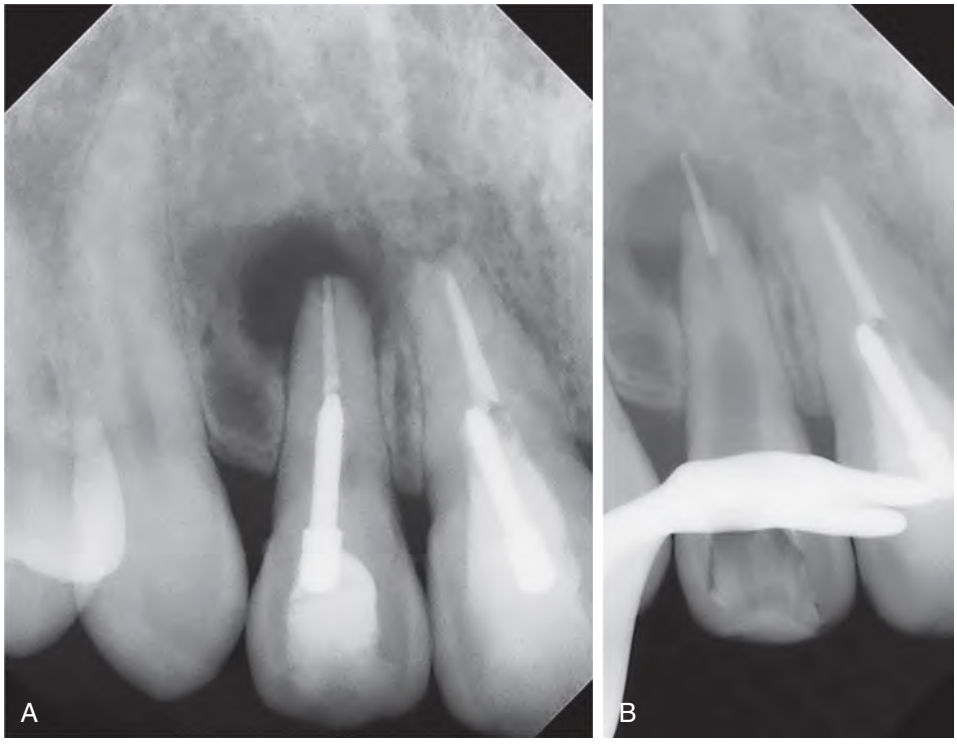
Once a pathway has been created, single or multiple Hedstrom files can be used to engage and remove the carrier.[83,84,86,87] Rotary files may also be used to engage and remove plastic-based carriers. These strategies work better for plastic carriers than for metal-based carriers because of the difficulty of engaging the metal surface with files. Metal carriers are more easily removed using techniques used to remove silver points such as the braided file technique or using modified hemostats, pliers, and ultrasonic instruments. After successful removal of the carriers and gutta-percha, canal preparation and obturation can be completed (Video 19.4).

Removal of Silver Cones (Points)

Silver points are commonly embedded in the build-up core material. Illumination and magnification with the DOM are essential adjuncts during core removal to ensure preservation of the coronal aspect of the silver point.[50,91,92] After removal of the core material, solvents, ultrasonic instruments, or hand files are used to create a



• **Fig. 19.14** **(A)** Preoperative radiograph showing a long cast post placed in the canal of the maxillary right incisor with periapical lesions. **(B)** Removed cast post showing the metal portion that was in the canal looks intact. **(C)** Radiograph taken immediately after the removal of the post shows the untouched dentin wall. **(D)** Twelve-month postoperative radiograph showing periapical healing.

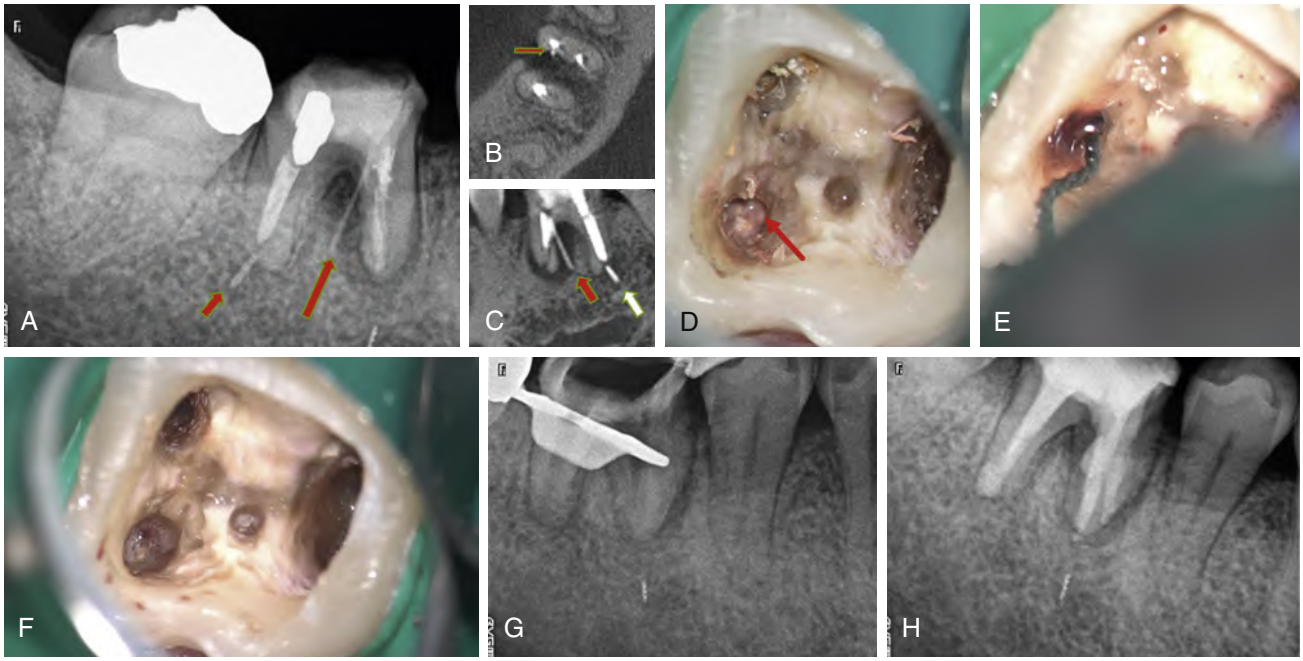


• **Fig. 19.15** **(A)** Preoperative radiograph showing a large periapical lesion. **(B)** Intraoperative radiograph showing the old gutta-percha root filling pushed into the periapical tissues by a #2 GG bur.

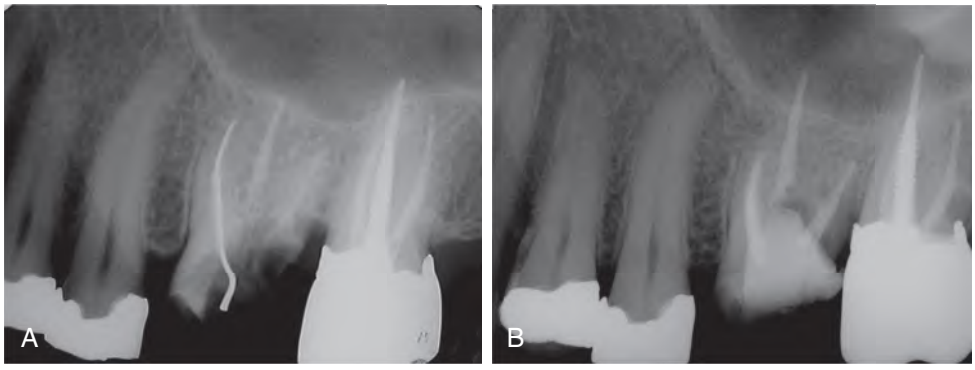
space around the exposed silver point.[92-94] Silver points are soft, and contact with ultrasonic tips or burs can easily cut through them.

The key in removing the silver points is breaking the seal around the silver point. A method for achieving this is by engaging and braiding one or two files around the cone, then applying a force such as ultrasonic energy or leveraging with a hemostat. This energy application facilitates cone removal by rapidly breaking down the cement seal.

The coronal portion of a loosened cone extending from the pulp chamber can then be grasped and pulled from the canal with a variety of devices. These include various types of specialized hemostats, modified or regular Steiglitz forceps, needle holders, gold foil pliers, Caufield silver point retrievers, or splinter forceps.[45,93,94] If the coronal portion of the cone is not present or is accidentally removed during removal of the core material, one or more hand files can be used to engage and extract the cone.[45,80] An alternative method to remove cones in this situation includes flexible metal tubes or needle-sleeve devices that grasp the cone with a file or wire, or bond the cone head using cyanoacrylate glue.[45,80,91,95] These techniques require the use of a trepan bur to trough an access area for the devices. After successful removal of the silver point, cleaning and shaping procedures can proceed (Fig. 19.17). Silver points that cannot be removed may necessitate surgical intervention (Video 19.5).



• **Fig. 19.16** **(A)** Preoperative radiograph showing root fillings extruded into the periapical tissues with periapical lesions (*arrows*). **(B)** Preoperative axial view of CBCT imaging showing the root fillings extruded from the perforation in the mesiobuccal canal (*arrow*). **(C)** Preoperative sagittal view of CBCT imaging showing the root fillings extruded from the perforation in the mesiobuccal canal (*red arrow*) and from the distal canal (*white arrow*). **(D)** Microscopic view showing the perforation in the mesiobuccal canal (*arrow*), which is identical to the axial view of CBCT imaging. **(E)** Microscopic view showing removal of gutta-percha extruded into the periapical tissues from the perforation site with the XP-3D shaper. **(F)** Microscopic view showing removal of all the root fillings was completed. **(G)** Intraoperative radiograph confirms the removal of the root fillings from both the root canals and the periapical tissues. **(H)** Postoperative radiograph showing MTA obturation in all the canals.

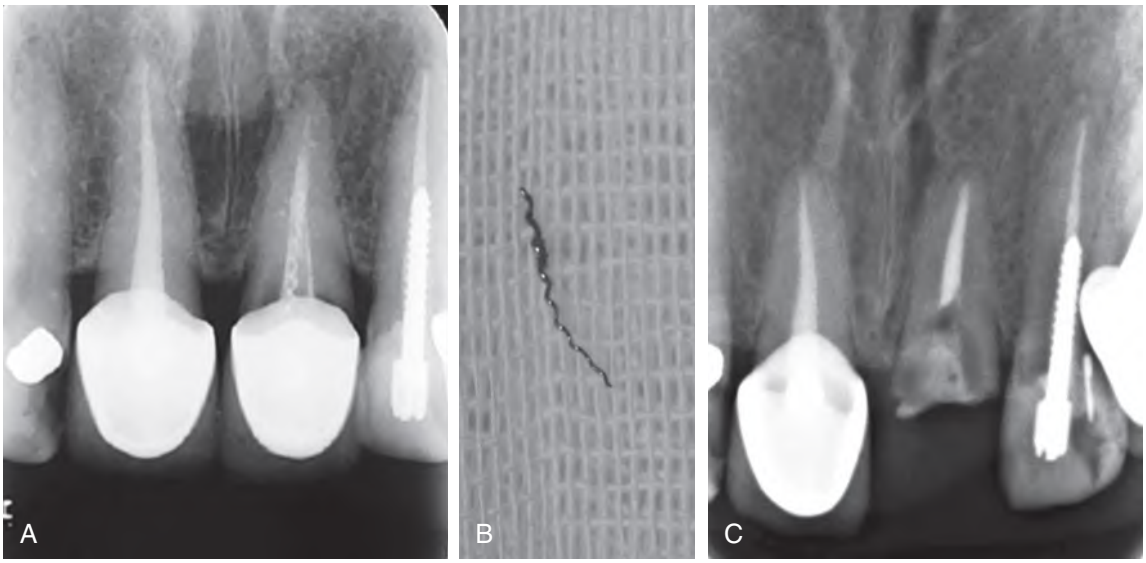


• **Fig. 19.17** **(A)** Mesiobuccal root of a maxillary left first molar has been obturated with a silver cone, whereas the other root canal was filled with gutta-percha. As a result of extensive caries the tooth needed endodontic retreatment. **(B)** The silver point was removed by grasping with Steiglitz forceps and gutta-percha was removed by chloroform and Hedstrom file. All root canals were obturated with gutta-percha and AH26 root canal sealer.

Removal of Soft and Hard Pastes

Soft pastes are easily removed utilizing hand or rotary instruments.[80] Copious irrigation and a crown-down preparation technique are recommended when removing soft materials from the canal system to minimize postoperative flare ups[80] (Fig. 19.18).

Hard-setting pastes are far more challenging to remove. As much of the coronal aspect of the hard paste is removed first with a bur or ultrasonic tip.[50,80,96] If this does not result in an opening up of a canal system, one strategy is to remove 4 mm from the tip of a K-file, creating a sharp edge at the tip so as to better cut into and remove the hardened material.[97] Dental companies now manufacture files with hardened sharp points that can be used to initially penetrate these materials. Perforation and the creation of ledges are potential problems when attempting to remove hardened cements in the root canals, especially if the canals are curved.[80]



• **Fig. 19.18** **(A)** Preoperative radiographic image of a maxillary left central incisor showed a fractured lentulo spiral during placement of paste inside the root canal. **(B)** The lentulo spiral has been removed. **(C)** Root canal obturation after paste and the lentulo spiral removal.

Various endodontic solvents have been investigated for their efficacy in softening hard obturation pastes to facilitate their removal. Although one investigation reported sodium hypochlorite (NaOCl) to be effective in softening a resorcinol-formalin paste (Russian Red), a follow-up study comparing six different solvents, including NaOCl, found none to be more effective than water, which was used as the control (Fig. 19.19).[98,99] Mechanical instrumentation remains the most predictable means of hard paste removal. If removal of the hard paste is not successful, the option of surgery should be considered for tooth retention.

Removal of Calcifications

Root canal calcifications are often noted radiographically before treatment. Clinical management and internal visualization of these calcifications inside the access is greatly aided by magnification and illumination using the DOM. Other obstructions must be removed before exploring the calcified area. Once accessed and appropriately visualized, calcifications are managed using a combination of chelating agents, stiff hand files (e.g., C and C+ files), and ultrasonic tips or Mueller-type burs to remove the calcified tissue and locate the root canal system apical to the calcification. Use of ultrasonic instrumentation and Mueller type burs is restricted to the coronal/straight portion of the root canal. When the canal is located with the aid of microexplorers and the DOM, a small bend can be placed on stiff, small-diameter hand files, and the curved portion of the canal can be carefully negotiated using various chelating agents and lubricants. The canal may be enlarged, using the crown-down technique, with a combination of hand files and NiTi rotary file systems. If the canal cannot be negotiated as a result of extensive calcification, surgical intervention must be considered.

Management of Biofilms

Unattached microorganisms in the root canal space might aggregate, attach, and colonize the surface of root canal walls, producing bacterial biofilms. Bacterial biofilms can form not only within the root canal space but also over the root surface, resulting in nonhealing apical periodontitis despite adequate root canal therapy.[28,100,101]

Apical periodontitis around the root(s) of a tooth with a history of root canal therapy could be either persistent, recurrent, or the result of secondary infection. A tooth with apical periodontitis at the time of initial root canal therapy that does not resolve after the treatment has persistent infection. Secondary infection occurs if the practitioner cannot completely isolate the tooth during root canal therapy or when there is coronal microleakage after treatment. An example for the recurrent infection is a tooth with apical periodontitis at the time of initial endodontic therapy that recovered after treatment, exhibiting recurrent disease at a later stage.[102-104]

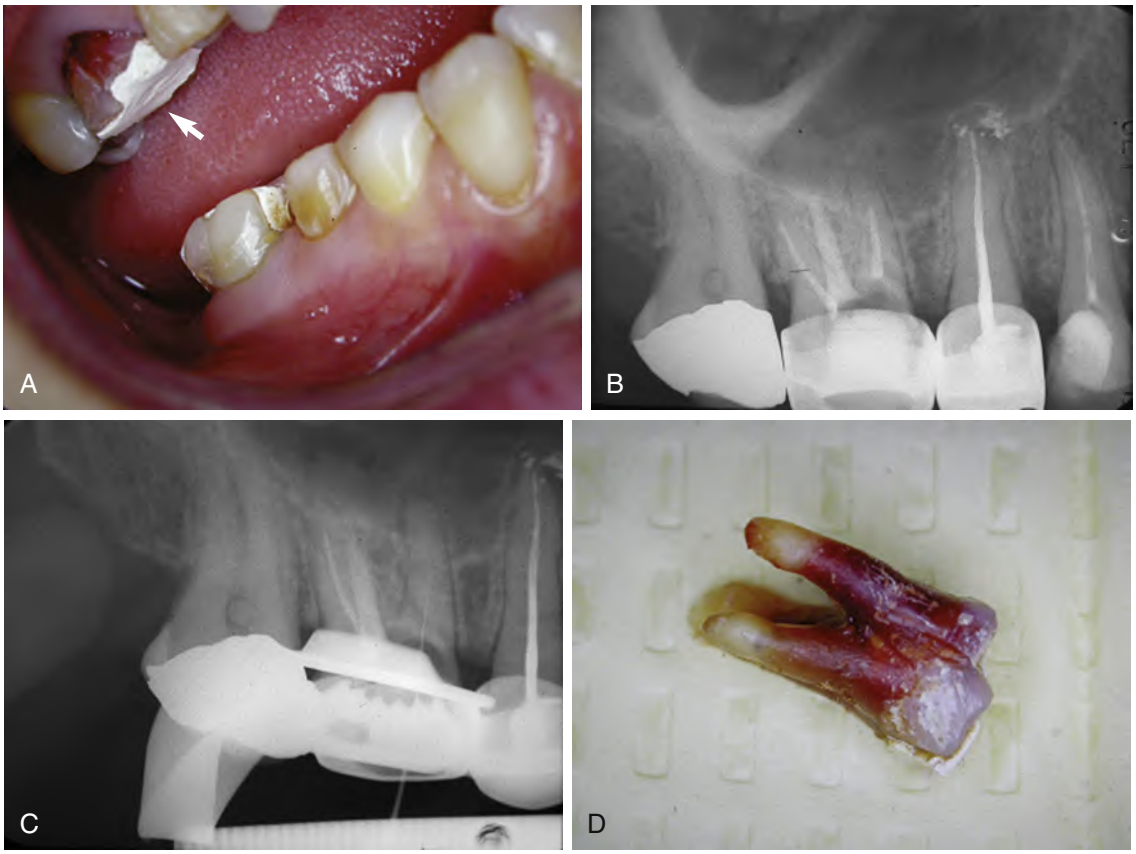
There is a higher possibility of biofilm formation over the root canal walls of teeth in need of nonsurgical endodontic retreatment as a result of the presence of persistent, recurrent, or secondary infections. Therefore the practitioner should always consider strategies to remove biofilms during root canal cleaning and shaping in retreatment cases.

Most investigations have confirmed the ability of NaOCl as an irrigant to disrupt biofilm formed by *Enterococcus faecalis* or other microorganisms, such as *Streptococcus mutans, Streptococcus oralis,* and *Actinomyces oris*.[105,106]

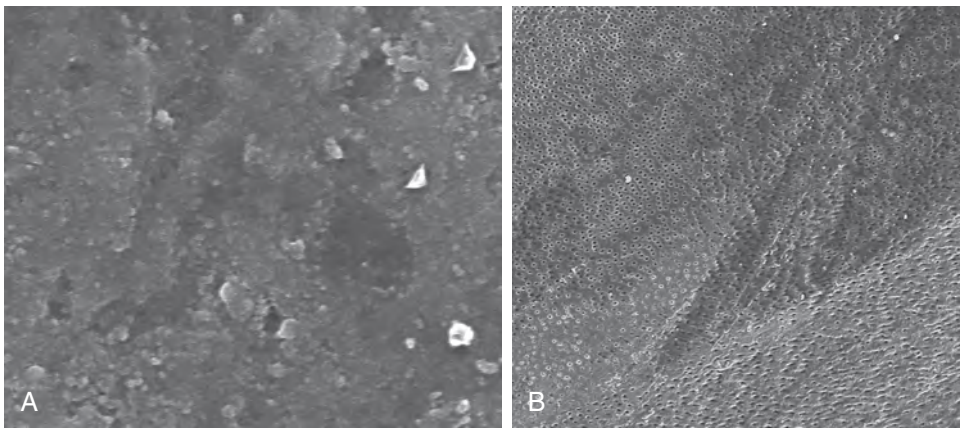
Compared with 5.25% NaOCl, 2% chlorhexidine could not effectively dissolve biofilms.[105,107] The concentration of NaOCl is an important variable for dissolving biofilms. Concentrations of 2.5% and 5.25% of NaOCl were significantly more effective on old and young *E. faecalis* biofilms compared with 1% NaOCl, which was only effective on young biofilms.[108]

If NaOCl is used as an irrigant during endodontic retreatment, the contact time of the solution is also an important variable for dissolving biofilms. When 1% or 2.5% NaOCl is used as an irrigant, the minimum contact time of 30 minutes should be considered, particularly if the practitioner is focusing on cleaning the apical third of the root canal.[107]

NaOCl is the best irrigant for dissolving organic tissues within the root canal space; however, because of its inability to remove inorganic debris, a chelating agent is also recommended. Both NaOCl and ethylenediaminetetraacetic acid (EDTA) could affect various types of biofilms via dissolving biofilm matrix



• **Fig. 19.19** **(A)** Tooth (*arrow*) exhibits red discoloration of the crown as a result of root canal obturation with a hard resorcinol paste material. **(B)** The resorcinol obturations are short of ideal length in all three canals of tooth #3. Resorcinol paste was also present in the premolars. **(C)** The resorcinol material was successfully removed from the coronal portion of the mesiobuccal canal, but the canal was calcified apical to the level of the previous obturation. A root perforation occurred during attempts to remove the material from the palatal canal. The treatment plan was altered, and the tooth was extracted and replaced as part of a bridge. **(D)** Note that the red discoloration of the roots extends to the level of the previous resorcinol obturations.



• **Fig. 19.20** **(A)** A scanning electron microscopic image shows presence of biofilm over the root canal wall. **(B)** After root canal preparation and irrigation with 5.25% NaOCl followed by ethylenediaminetetraacetic acid (EDTA), root canal wall was clean and dentinal tubules could be observed.

polysaccharides.[105] Therefore use of NaOCl as an irrigant and removal of the smear layer with EDTA or MTAD should be considered in endodontically treated teeth that require endodontic retreatment (Fig. 19.20, *A–B*).

In addition to the concentration of the irrigation solution and contact time, the needle penetration depth is another important factor that might affect biofilm removal. Needle penetration depth up to 2 mm short of the working length was more effective in removing biofilms.[109] However, irrigation should be performed with caution to prevent NaOCl accidents. To review methods used to avoid NaOCl accidents during root canal irrigation, the reader is referred to Chapter 18 of this book.

Root Canal Preparation in Retreatment

Root canal preparation technique in nonsurgical endodontic retreatment mostly focuses on removing preexisting root canal filling materials. This allows effective operation of instruments and irrigants on dentinal tubules that are covered with the fragments of these materials. Therefore root canal preparation could reduce microorganisms and debris associated with persistent, secondary, or recurrent apical periodontitis. Hand, rotary, and reciprocating instruments have been introduced for removing root canal filling materials; however, none of the instrumentation techniques can completely remove all the filling materials from the root canal space.[110-112]

There are variables that might have some effect on root canal preparation of the teeth in need of endodontic retreatment. These variables include the outline of the access cavity, cross-sectional shape of the root canal, instrumentation technique, motion during the preparation technique, working length estimation, apical preparation size, root canal anatomy, and the type of root canal filling material.

The outline of the access cavity might affect removal of filling materials from the root canal space. Contracted access cavities in oval-shaped root canals result in higher volume of residual filling materials after endodontic retreatment.[110] Therefore a standard outline of access cavity should be provided for endodontic retreatment, particularly in teeth with oval-shaped root canals.

Crown-down preparation is the instrumentation method of choice for endodontic retreatment because it minimizes apically extruded debris during root canal preparation.[113]

Oval-shaped root canals provide more challenges during endodontic retreatment because there is a higher possibility that the root canal walls will remain untouched during removal of the obturating materials.[114]

If the practitioner is going to use engine-driven instruments during retreatment, an endodontic motor with the capacity of adaptive motion (SybronEndo, Orange, CA) is recommended because of its significantly higher ability to remove more root canal filling materials compared with the reciprocating motion,[115] particularly in oval-shaped root canals.[116] Endodontic motors with adaptive motions have been designed to have both rotational and reciprocal motions based on the stresses exerted on the instrument. With no or low stress, the instrument's motion would consist of 600 degrees clockwise rotation, a complete stop, and then followed by restarting another clockwise motion. However, when the instrument engages with either the root canal wall or the filling materials, the motor will switch to reciprocating motion.

In relation to the time needed for removing root canal filling materials, hand instruments require significantly more time compared with the rotary instruments.[117] Thus from the clinical standpoint the time here is not very valuable because irrigants need a minimum contact time for root canal disinfection, and the short time spent on removing root canal filling materials and root canal preparation have not shown any advantages over the use of rotary instruments.[107,118] In addition, the possibility of iatrogenic accidents is significantly higher, particularly broken instruments, when rotary instruments are used to remove root canal filling materials.[117]

One of the most important steps in root canal instrumentation of retreatment cases is to determine the working length. Presence of obturating materials within the root canal could affect root canal impedance, therefore affecting estimation accuracy of electronic apex locators (EAL).[119] Relying on EAL without considering periapical radiography might result in overinstrumentation or underestimation of the working length; therefore both EAL and periapical radiography should be used at this step to prevent further complications.[120,121]

Feeling lower or no digital tactile sense is one of the disadvantages of rotary instruments during root canal preparation. Use of hand instruments between activation of rotary instruments would allow the clinician to use his/her digital tactile sense during root canal preparation and, in combination with the information collected from EAL and periapical radiography, it may prevent further overinstrumentation. In fact, digital tactile sense would be a supplementary aid during root canal preparation. If a clinician believes that the root canal instrument might penetrate beyond the length estimated by EAL and periapical radiography, it may be best to reconsider the working length measurement.[122]

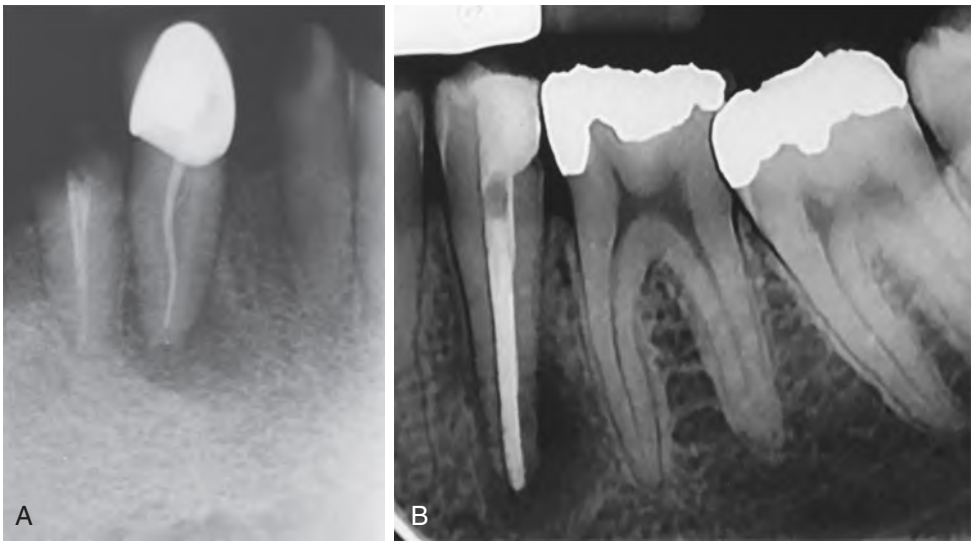
Another important factor that should be considered during preparation of root canal space is obtaining apical terminus patency to increase the success rate of retreatment procedures.[123]

Larger preparation size results in lower residual root canal filling material,[117] which significantly improves bacterial reduction in teeth that have apical periodontitis with a history of previous endodontic therapy.[124] However, it should be kept in mind that larger preparation size does not mean that the dentist should ignore the risk of root canal transportation and sacrifice dentinal structure, making the tooth prone to VRF. Therefore the practitioner should also consider several factors such as the bulk of the root, root canal configuration as well as curvature, presence of danger zones, and root surface depressions during root canal preparation in order to avoid further mishaps.

Another important point is the fact that removing root canal filling materials from teeth with complicated root canal anatomy is more difficult than from those with straight root canals.[117] In cases with complicated root canal anatomy, it is highly recommended that the patient be referred to an endodontist.

The type of root canal filling materials is also another variable that might affect root canal preparation in endodontic retreatment. Several bioactive endodontic sealers have been introduced to the market.[125] Retreatment of teeth filled with gutta-percha and these sealers might be very difficult. The type of the bioactive root canal sealer, type of the solvent, and the root canal configuration are variables that might affect successful removal of root canal filling materials during endodontic retreatment.[126] In most situations, the practitioner usually does not know the type of root canal sealer used in the obturation of a tooth designated for endodontic retreatment.

Shaping of root canal space in retreated cases depends on the root canal preparation during the initial endodontic treatment. If the root canals have not been prepared well and single-cone gutta-percha is observed in the periapical radiography, cleaning and shaping during retreatment should be performed like routine



• **Fig. 19.21** **(A)** A swimming gutta-percha cone in a mandibular right canine tooth. Root canal preparation during endodontic retreatment in this tooth should be performed similar to a routine primary root canal therapy. **(B)** Endodontic retreatment for the mandibular left second premolar should be focused on removing preexisting root canal filling materials and using irrigants for root canal disinfection.

primary root canal therapy (Fig. 19.21, *A*). However, if the previous endodontic treatment shows either well-shaped or overenlarged root canal(s), more emphasis on reshaping the root canal space might make the tooth susceptible to future fracture. In this case the practitioner is advised to focus on removing all preexisting obturating materials and using irrigants to clean the root canal space as much as possible with conservative reshaping of the root canal(s) (Fig. 19.21, *B*).

There is no general agreement on performing endodontic retreatment in a single visit or in multiple visits. The advantage of endodontic retreatment in more than one visit is the benefit of antibacterial activity of the medicaments placed within the root canal between the appointments. However, there is not sufficient evidence of significantly higher success rates when retreatment is performed in more than one visit.[127] Several investigations have posed the question whether endodontic treatment in nonvital infected cases should be performed in more than one visit to achieve a higher success rate.[128-131] Single-visit root canal therapy has some advantages, including better cost-effectiveness and less time needed for both the patient and practitioner.[131] Therefore in certain cases with no contraindications for completing the retreatment process (i.e., no wiping exudate or no symptomatic apical periodontitis), endodontic retreatment can be performed in one visit to prevent further recontamination of the root canal space that can occur between the appointments.

Irrigation in Retreatment

If all canals of the tooth are found and cleaned, a high success rate can be achieved. However, it has been shown that there are always some areas within the root canal space that remain untouched by various instrumentation techniques.[132] An important aid during endodontic retreatment is the use of chemical solutions to remove necrotic tissues, as well as bacteria and their byproducts from the root canal space.

NaOCl is the most popular irrigation solution among the members of the AAE and U.S. dentists.[133,134] All the concentrations of NaOCl provide significant reductions in microorganisms in the root canal space; however, they exhibit differences in their ability to remove biofilms.[108]

The results of a systematic review and meta-analysis on laboratory studies showed that use of intracanal activation techniques (passive ultrasonic irrigation, apical negative pressure, sonic irrigation) are superior to conventional passive form of placing a needle within the root canal and irrigating to remove debris and the smear layer.[135]

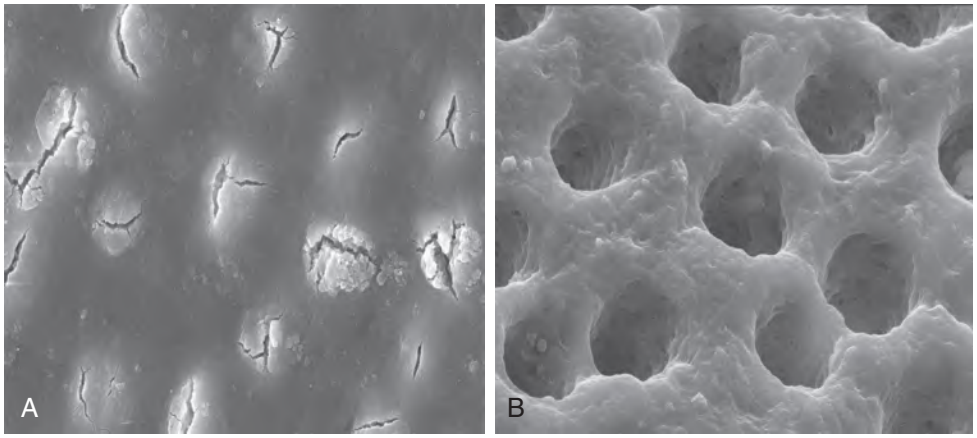
Sealing ability of root filling materials can significantly be improved by removing the smear layer before root canal obturation.[136] Smear layer removal using a combination of NaOCl and EDTA results in a marginally significant effect on the success rate of initial root canal therapy; however, in endodontic retreatment, it can significantly increase the number of healed cases.[123] Removing the smear layer may also help NaOCl better penetrate the dentinal tubules and dissolve biofilms (Fig. 19.22).

The advantages of the use of 5.25% NaOCl compared with the lower concentrations of the same solution include less postoperative pain,[137] short time needed for removing biofilms,[107] and greater efficacy against old biofilms.[108]

Obturation After Retreatment

Endodontic retreatment procedures might induce cracks during removal of preexisting root canal filling materials.[138] The method of root canal obturation during initial endodontic treatment may also affect induction of cracks and tooth vulnerability to VRF after removal of filling materials after preparation of the root canal space. The teeth initially obturated by warm vertical compaction exhibit more cracks after retreatment compared with the teeth that received cold lateral condensation as the initial obturation technique.[139]

Most often, the practitioner does not know which type of obturation technique was previously used in teeth requiring endodontic retreatment; therefore, the practitioner should always consider preparation and obturation techniques that apply lower pressure on the root canal wall. For example, use of NiTi spreaders for cold lateral compaction has been recommended as a result of lower risk of inducing cracks compared with stainless steel spreaders.[140,141] Moreover, Thermafil also exhibited promising long-term outcomes as a root canal obturation technique after endodontic retreatment.[142]



• **Fig. 19.22** **(A)** If the root canal wall is only irrigated with NaOCl, smear layer would cover dentinal tubules. **(B)** Irrigation with 17% ethylenediaminetetraacetic acid (EDTA) followed by NaOCl could successfully remove the smear layer.

Single-cone obturation technique with bioactive endodontic sealers has been introduced as an option for obturating root canals after endodontic retreatment; however, supporting investigations do not currently share high levels of evidence.[143,144]

Restorative Options

The literature shows the quality of the endodontic treatment, the presence of coronal restoration, and apical extension of root canal filling were significantly associated with healthy periapical tissues.[145] Therefore it is essential to consider a proper restoration on an endodontically treated tooth for the long-term success as the coronal restoration works as a "barrier" not only to prevent reinfection of the root canal system after endodontic treatment but also to protect the tooth from root fracture. Hence, the amount of coronal tooth structure, the presence of an adequate dentin ferrule, careful selection of luting agents for post cementation, and the type of coronal restoration are all important factors that affect endodontic treatment outcomes.[146-150] The presence of fiber posts may also contribute to the long-term success of endodontically treated teeth as fiber-reinforced, resin-based composite posts with a modulus of elasticity similar to dentin can reduce the risk of VRF.[151,152] One recent study on long-term clinical outcomes of endodontically treated teeth demonstrated that teeth restored with fiber posts yielded significantly less tooth loss than teeth restored without a post, regardless of the presence or absence of a full-coverage crown.[153] The primary reasons for VRF of endodontically treated teeth are closely related to restorative procedures and include the absence of adequate remaining tooth structure[154] and excessive occlusal forces.[155] Although endodontically treated teeth restored with crowns show a higher resistance against fracture than resin-based composites, teeth with one or two tooth surface losses and two proximal contacts restored with resin composite exhibit a more favorable distribution of occlusal forces and, hence, a survival rate comparable with full-coverage restorations.[156-158] In addition to the requirement of protecting the endodontically treated tooth with a proper cuspal coverage restoration, it is also important to place a definitive restoration as soon as possible to prevent coronal microleakage, avoid propagation of existing coronal infractions if present, conserve remaining tooth structure, and prevent the need for additional retreatment or surgical procedures. Long-term provisional restorations can lead to recontamination of the filling material, which may lead to tooth extraction and its consequences.[13]

Follow-Up Care and Posttreatment Complications

Follow-up visits are important for monitoring symptoms and ensuring that healing occurs. An initial follow-up visit usually takes place at 6 months post-retreatment, and then yearly. The first follow-up visit may be sooner than 6 months if there are extenuating circumstances requiring it. In addition to a radiographic examination, follow-up visits should include a clinical evaluation of mobility, periodontal probing, and palpation and percussion testing.

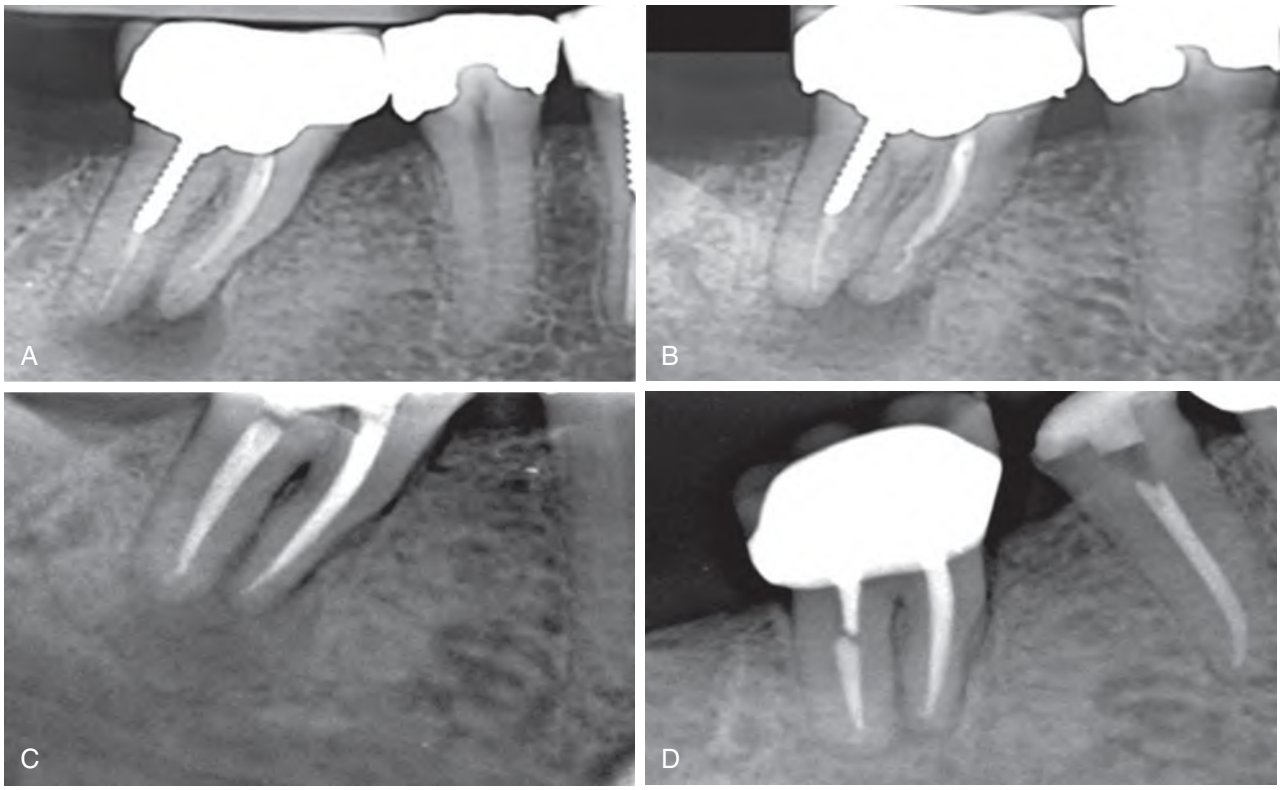
Some studies have indicated posttreatment flare-ups occur more frequently in nonsurgical root canal retreatment cases, compared with initial root canal therapy.[159-161]An explanation for this increase in flare-ups may be that retreatment procedures may result in a greater extrusion of bacteria and other irritants into the apical tissues.[9] The crown-down technique, paired with frequent use of irrigants injected with side-venting needles, promotes debris removal in a coronal direction and helps minimize this complication.

Prognosis

Nonsurgical endodontic retreatment has favorable outcomes when the cause of previous failure has been diagnosed and corrected by using contemporary technologies[162] (Fig. 19.23). In addition to successful outcomes, the teeth receiving endodontic retreatment have exhibited high survival rates.[2]

In general, nonsurgical endodontic retreatment has a lower success rate compared with primary root canal therapy. However, retreatment can have a high successful outcome that is comparable with primary root canal therapy if the apical foramen can be negotiated and the cause of failure overcome. Negotiating the entire root canal length should help eradicate microorganisms, debris, and previous filling materials from the root canal space.[123,163]

For more information on predictors of the outcome of endodontic treatments, the reader is referred to Chapter 22 of this book.



• **Fig. 19.23** **(A** and **B)** Mandibular right second molar with inadequate root canal therapy and periapical lesion. **(C)** Endodontic retreatment was performed. **(D)** Periapical lesion healed 2 years later.

Study Questions

6. What is the most predictable way to remove hard pastes?
   a. Use of solvents
   b. Use of mechanical instrumentation
   c. There is no predictable way to remove hard pastes
7. Which of the following are among the disadvantages of preparing the access cavity without removing the previous coronal restoration during endodontic retreatment?
   a. Difficulty in tooth isolation and irrigation
   b. Limitation for negotiating apical foramen
   c. Restricts the clinician from observing possible cracks
   d. Increases the possibility of electronic apex locator errors
8. The most important aspect to removing silver points successfully is:
   a. Use of solvents
   b. Use of illumination and magnification
   c. Use of ultrasonic energy
9. When would retreatment have a comparable successful outcome to primary root canal treatment?
   a. No foul odor after removing coronal restoration
   b. Using rotary instruments for root canal preparation
   c. The apical foramen of all root canals could be negotiated
   d. The tooth had no coronal discoloration before the treatment
10. A 36-year-old male with a history of previous root canal treatment for tooth number 20 presents with pain when chewing. Periapical radiograph shows a radiolucent lesion around the mesial root of the tooth. His record shows that the tooth was vital at the time of root canal treatment. Which is the type of infection most expected for that tooth?
    a. Persistent
    b. Secondary
    c. Recurrent
    d. Extraradicular

ANSWERS

Answer Box 19

1 d. All of the above
2 d. All of the above
3 a. Before treatment
4 d. All of the above
5 c. None–restorable crown
6 b. Use of mechanical instrumentation
8 b. Use of illumination and magnification
7 c. Restricts the clinician from observing possible cracks
9 c. The apical foramen of all root canals could be negotiated
10 b. Secondary

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Video 19.0: Endodontic Retreatment Introduction

Video 19.1: Post Removal. A cast post removal procedure is described in the video. First the shoulder of the metal post on the root is removed with a small diameter carbide bur. Then 180-degree semicircular space on the palatal wall is created with the same carbide bur. The depth of this space extends to one third of the post length. Ultrasonics is applied to the metal post from both the buccal and palatal sides at the maximum power setting with water spray. The post gets loosened as ultrasonic activation continues. The metal post is finally loosened and taken out of the canal with the forceps.

Video 19.2: Calcified Canal. Calcified canal is stained with caries detector dye to differentiate calcified tissues from normal dentin. A small diameter ultrasonic tip is applied to the stained spot and activated to break through the calcified tissues. A negotiation file is placed into the canal to confirm the removal of calcified canal.

Video 19.3: Gutta Percha Removal. Small diameter ultrasonic tip is used to create a small space between the canal wall and the gutta percha fillings for the insertion of an XP-Endo Shaper. Then the XP-Endo Shaper is inserted into the space rotating at 1,000-3,000 rpm in an up/down motion. When the majority of the root fillings are removed, the canal is irrigated with chloroform, and then the XP-Endo Shaper/Finisher is rotated in the presence of chloroform. Make sure all the gutta percha root fillings are removed under the DOM.

Video 19.4: Silver Point Removal. Periphery of the silver point in the orifice is removed with a small diameter ultrasonic tip. Then the head of the silver point is exposed. The loop is placed over the head of the silver point and tightened around it. The loop holding the silver point is gently pulled in a coronal direction with a swaying motion. The silver point is pulled out of the canal