20

Apical Microsurgery

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CHAPTER OUTLINE

LEARNING OBJECTIVES

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

1. Discuss the role of endodontic surgery in treatment planning for a patient.
2. Recognize situations in which surgery is the treatment of choice.
3. Define the terms incision for drainage, apical curettage, root-end resection, root-end preparation, root-end filling, grafting, and suturing.
4. Briefly describe the step-by-step procedures involved in periapical surgery, including those for incision and reflection, access to the apex, apical curettage, root-end resection, root-end preparation and filling, flap replacement, and suturing.
5. State the different flap designs.
6. Diagram the various flap designs and describe the indications, advantages, and disadvantages of each.
7. List the more common root-end filling materials.
8. Review the different materials for grafting.
9. Review the basic principles of suturing.
10. Write out instructions to be given to the patient concerning postoperative care after endodontic surgery.
11. Review the outcome of apical microsurgery.

A Brief History

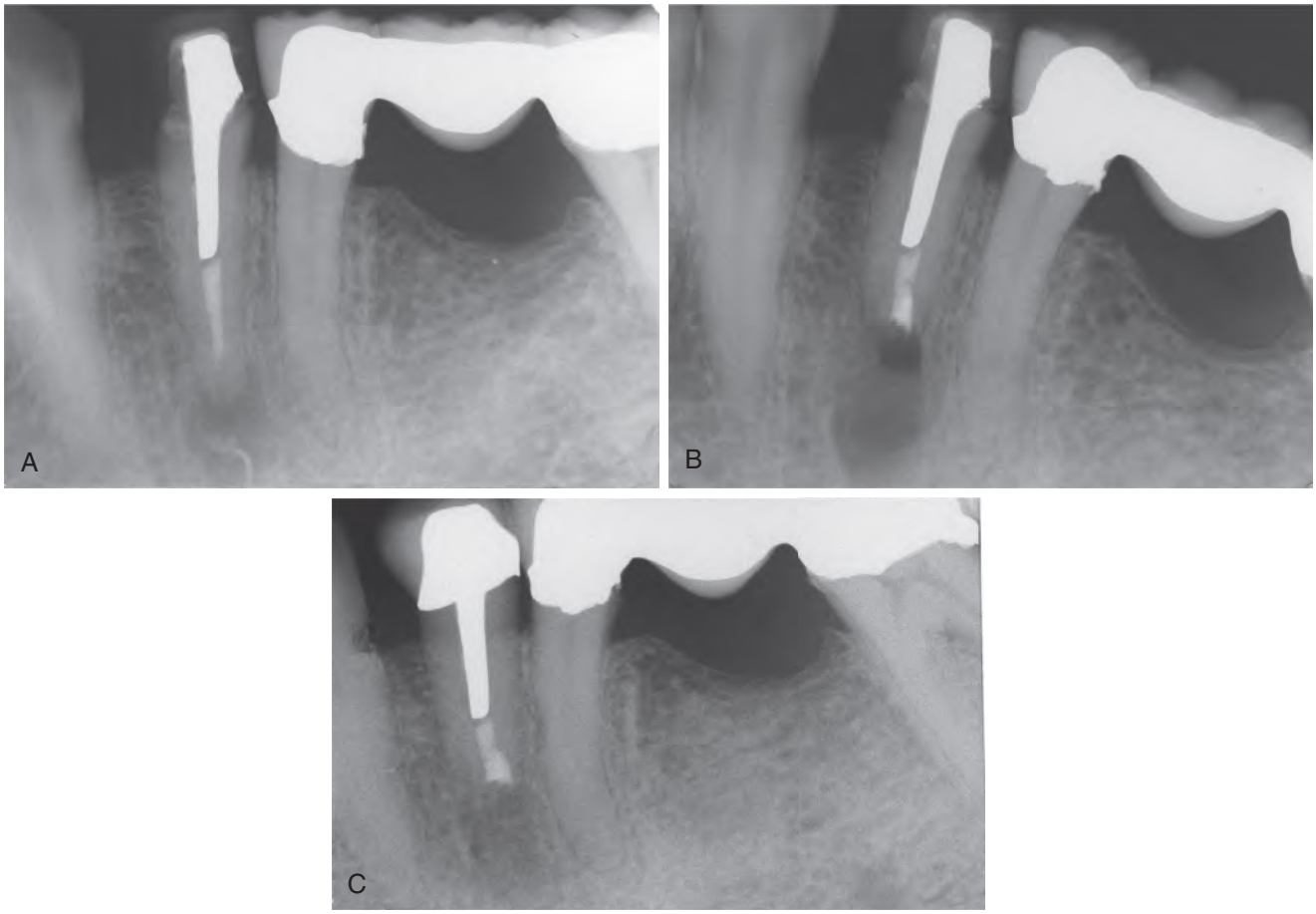
Systematic reviews with meta-analysis, studies with large sample sizes, and practice-based research networks studies all indicate extremely high medium-term and long-term survival rates for nonsurgical endodontically treated teeth without intervention.[1-9] If a nonsurgical endodontically treated tooth fails and cannot be retreated nonsurgically, and it is determined that the reason for failure is not periodontal, traumatic, or restorative in nature, apical surgery (AS) is often the treatment of choice.

Although the origins of AS can be traced to pre-Colombian times,[10,11] contemporary endodontic surgery began its journey in the early 1960s along with the recognition of endodontics as a specialty in the United States in 1964.[12,13]

The main purpose of AS is to save a natural tooth. This is accomplished by removing a portion of a root with anatomic complexities laden with tissue debris and microorganisms and/or sealing the canal when a complete seal cannot be accomplished through nonsurgical procedures.[5] Significant advances in the use of magnification and illumination, specifically the introduction of the surgical operating microscope (SOM) in the late 1980s and the supportive armamentarium and materials that followed, have benefited treatment protocols in AS such that teeth that might otherwise have been extracted now have a predictable chance for retention. AS is now considered a microsurgical procedure in the truest sense.[14] The purpose of this chapter is to discuss indications and contraindications for apical microsurgery, procedures involved in apical microsurgery, including those for incision and reflection, access to the apex, apical curettage, root-end resection, root-end preparation and filling, flap replacement, and suturing as well as instructions to be given to the patient concerning postoperative care after endodontic surgery (Video 20.1).

Indications for Apical Surgery

The main indications for AS are failing root canal treatments, procedural accidents, irretrievable materials in the root canal or periapical tissues, anatomic complexity of the root canal system that prevents complete cleaning, shaping, and obturation of the root canal system through the coronal



• **Fig. 20.1** **(A)** An inadequate root canal treatment, a large post, and patient's discomfort led to a decision to perform a periapical surgery on the mandibular first premolar. **(B)** Postoperative radiograph after endodontic surgery. Mineral trioxide aggregate (MTA) was used as a root-end filling material. **(C)** Periapical radiograph taken four and half years later shows complete healing and a functional tooth.

access, symptomatic cases, adjunctive surgeries, and exploratory surgery.

Failing Root Canal Treatments

When previous nonsurgical root canal treatment cannot be improved or performed because regaining access to the canal or removing posts would risk a perforation or root fracture and/or create a restorative problem, surgical endodontics is indicated (Fig. 20.1).

Procedural Accidents

Most procedural accidents can be corrected nonsurgically (see Chapter 18). However, when nonsurgical correction of these accidents is not feasible or practical, AS is indicated to save these teeth. Procedural accidents that may require AS include ledge formation, root perforation, separated instruments, and underfilled or overfilled canals (Fig. 20.2).

Irretrievable Filling Materials

When obturation materials cannot be removed nonsurgically or are beyond the root canal space and cause problems, AS is indicated to save the tooth (Fig. 20.3).

Anatomic Complexity of the Root Canal System

Complex anatomy, severe curvature, and canal calcifications that cannot be treated nonsurgically are indications for surgical endodontics (Fig. 20.4).

Symptomatic Cases

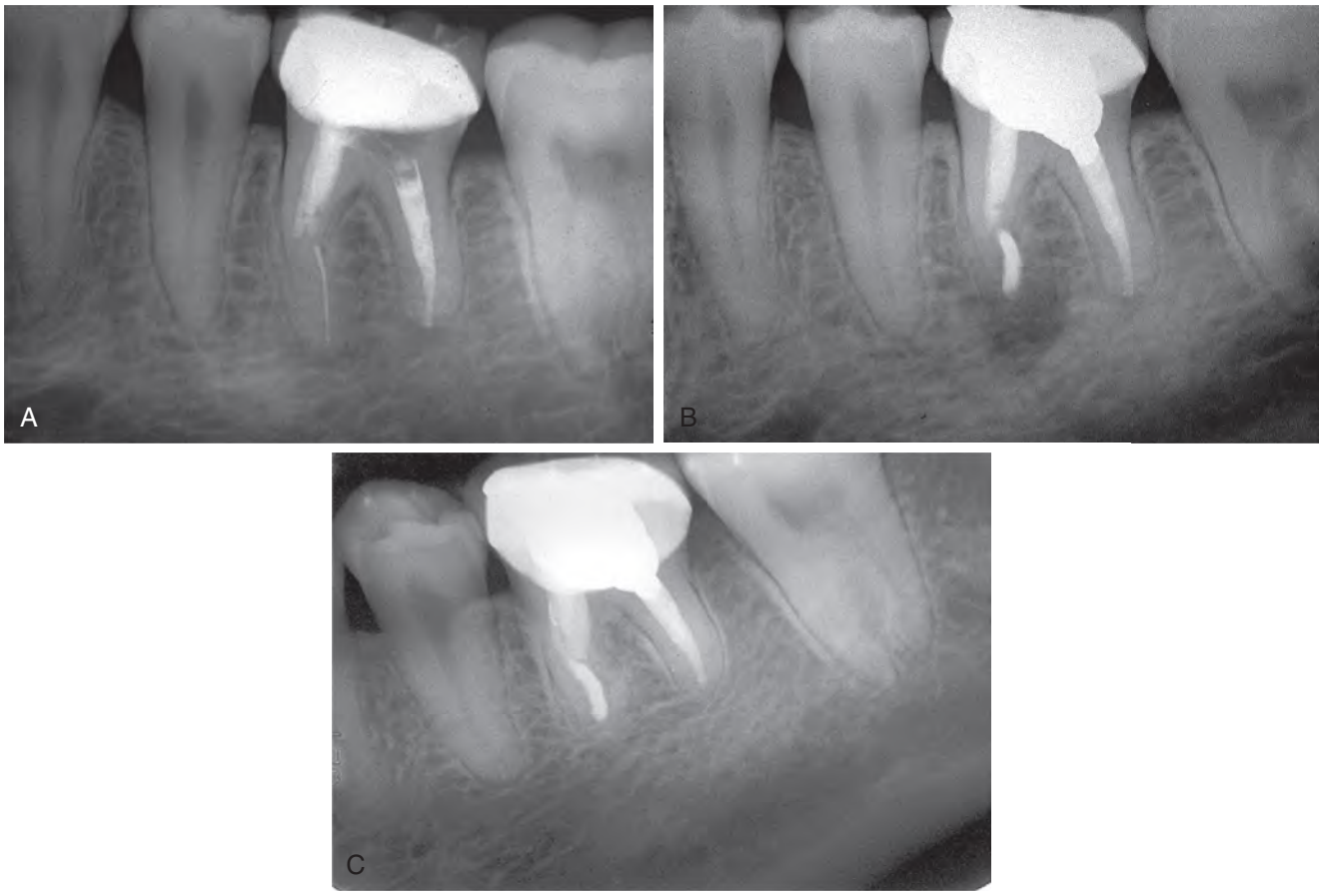
When nonsurgical retreatment does not provide relief of pain and discomfort and nonsurgical retreatment is not possible, AS should be considered to reduce pain and discomfort for the patient (Fig. 20.5).

Adjunctive Surgeries

Adjunctive surgical procedures include root resection, hemisection, crown lengthening, tooth replantation, and transplantation (see Chapter 21).

Exploratory Surgery

There are some radiolucencies that are not caused by root canal infection and may mimic periapical lesions of endodontic origin. Suspicious and nonhealing lesions require exploratory surgery and the taking of a biopsy for histologic examination (see Chapter 5).



• **Fig. 20.2** **(A)** Nickel-titanium file is separated inside the mesiobuccal canal of the mandibular first molar. **(B)** Because of the patient's discomfort, a periapical surgery was performed. Mineral trioxide aggregate (MTA) was used as a root-end filling material. **(C)** Periapical radiograph taken 32 months later shows complete healing.

Contraindications for Apical Surgery

Contraindications for AS include (1) medical or systemic complications; (2) indiscriminate use of periapical surgery; (3) anatomic factors; and (4) an unidentified cause of treatment failure.

Case Selection and Contemporary Treatment Planning

One of the most important caveats in performing apical microsurgery is in knowing when to perform apical microsurgery. Case selection will heavily affect treatment outcomes, which then influences future treatment choices and long-term success rates. The most important diagnostic tool to this end has been the introduction of cone beam computed tomography (CBCT; see Chapter 3). In addition, an appropriate armamentarium and strategic approaches can be prepared well in advance of the actual surgery.

CBCT examination can help us plan treatment by locating the exact position of the apical periodontitis.

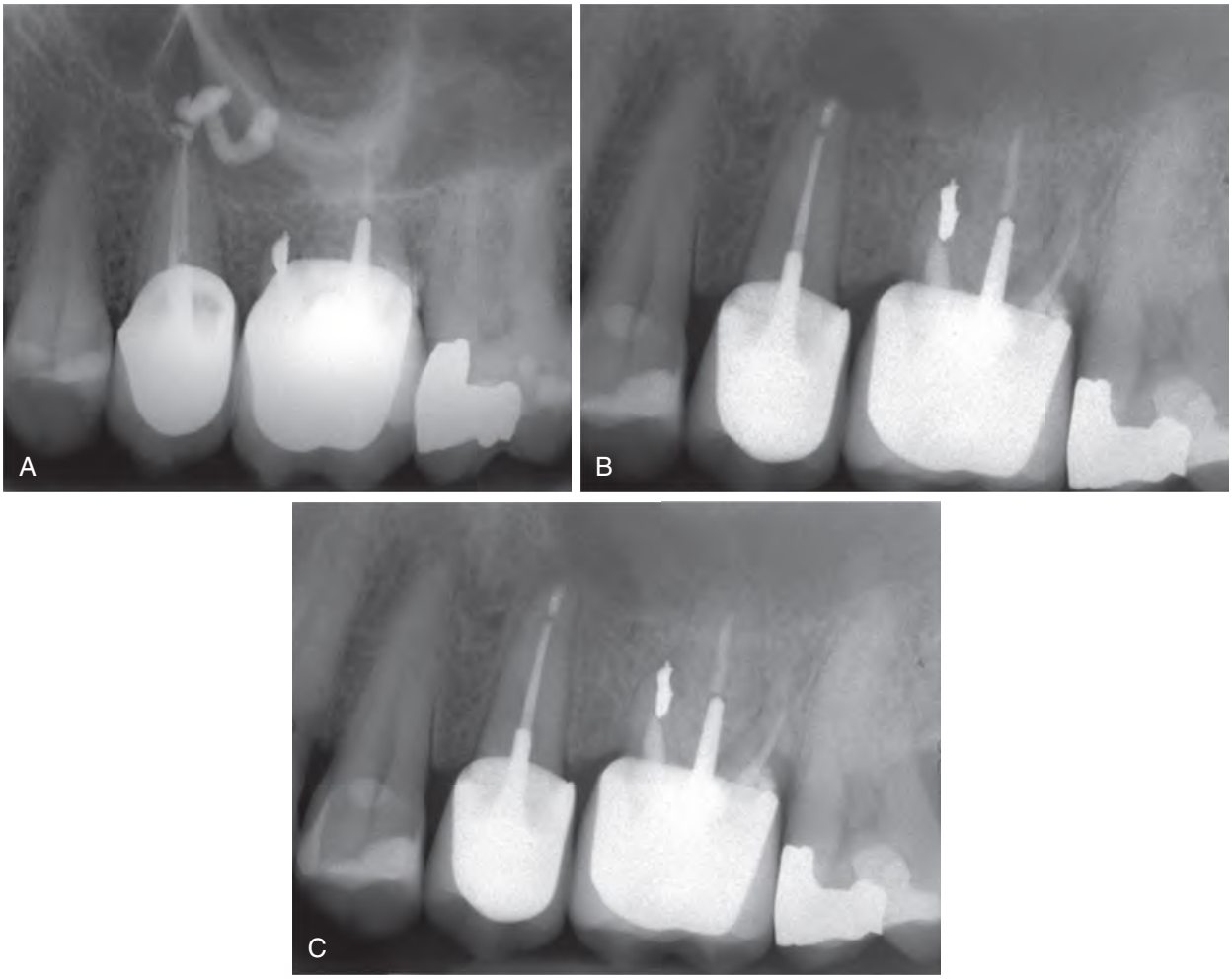
Apical Microsurgery

Although general practitioners may not perform microsurgical procedures, it is incumbent upon them to understand the armamentarium, materials, and methods so that the best treatment possible can be provided for their patients. In order to understand the objectives of apical microsurgery and the application of armamentaria, materials, and methods, it is helpful to divide the subject into multiple stages or sections (Video 20.2).

Flap Design

The first step in AS is designing a flap that allows adequate exposure of the site of the surgery. The following general guidelines and principles should be used during flap design.

1. The flap should be designed for maximal access to the site of surgery.
2. An adequate blood supply to the reflected tissue is maintained with a wide flap base.
3. Incisions over bony defects or over the periradicular lesion should be avoided; these might cause postsurgical soft tissue fenestrations or nonunion of the incision.
4. The actual bony defect is larger than the size observed radiographically.
5. A minimal flap, which should include at least one tooth on either side of the intended tooth, should be used.
6. Acute angles in the flap must be avoided. Sharp corners are difficult to reposition and suture and may become ischemic and slough, resulting in delayed healing and possibly scar formation.
7. Incisions and reflections include periosteum as part of the flap. Any remaining pieces or tags of cellular nonreflected periosteum will hemorrhage, compromising visibility.
8. The interdental papilla must not be split (incised through) and should be either fully included or excluded from the flap.



• **Fig. 20.3** **(A)** Preoperative radiograph shows presence of extruded filling materials into the periapical tissues of the maxillary left bicuspid tooth. **(B)** Because of the patient's discomfort, a periapical surgery was performed. Mineral trioxide aggregate (MTA) was used as a root-end filling material. **(C)** Postoperative radiograph taken 18 months later shows healing of the periapical tissues.

9. Vertical incisions must be extended to allow the retractor to rest on bone and not crush portions of the flap.

Although there are numerous flap designs, two meet most AS needs: the full mucoperiosteal flap (triangular or rectangular) and the submarginal flap (triangular or rectangular).

Submarginal Curved Flap

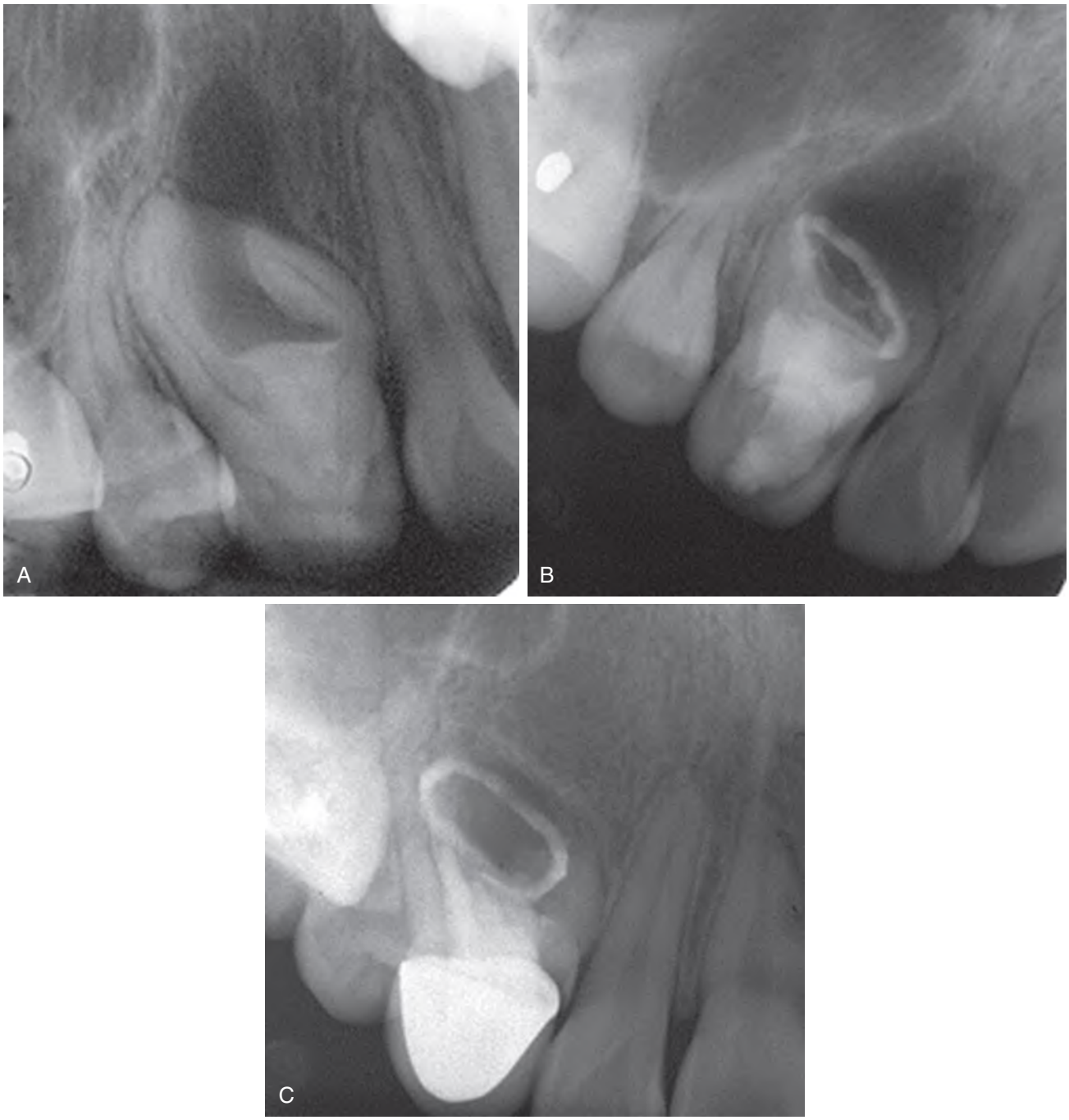
The submarginal curved flap is a slightly curved, half-moon-shaped horizontal incision made in the attached gingiva with the convexity nearest the free gingival margin. It is simple and easily reflected and provides access to the apex without impinging on the tissue surrounding the crowns. Its disadvantages include restricted access with limited visibility, tearing of the incision corners if the operator tries to improve access by stretching the tissue, and leaving the incision directly over the lesion if the surgical defect is larger than anticipated. The incision margins of this flap frequently heal with scarring. The submarginal curved flap is limited by the presence of the frenum, muscle attachments, or canine and other bony eminences. Because of its many disadvantages, this design is generally not indicated or used.

Full Mucoperiosteal Flap

The full mucoperiosteal (intrasulcular) flap consists of an incision at the gingival crest with full elevation of the interdental papillae, free gingival margin, attached gingiva, and alveolar mucosa. It may have either one (triangular) or two (rectangular) vertical releasing incisions. It allows maximal access and visibility, precludes incision over a bony defect, and has less of a tendency for hemorrhage. This design permits periodontal curettage, root planing, and bony reshaping, and it heals with minimal scar formation. Its disadvantages include the difficulty of replacing, suturing, and making alterations (height and shape) to the free gingival margin, in addition to possible gingival recession after surgery and exposure of the crown margins.

Submarginal Triangular and Rectangular Flaps

Triangular and rectangular flaps are known as *modified submarginal curved flaps*. A scalloped horizontal incision (Ochsenbein-Luebke) is made in the attached gingiva with one or two accompanying vertical incisions. This flap is used most successfully in maxillary anterior teeth with crowns. An alternative submarginal flap design is the papilla-based incision, in which the interdental papillae are left intact. Prerequisites are 4 mm of attached gingiva, minimal probing depths, and good periodontal health. Disadvantages are possible scarring and hemorrhage from the cut margins to the surgical site. This design also provides less visibility than the full mucoperiosteal flap (Video 20.3).

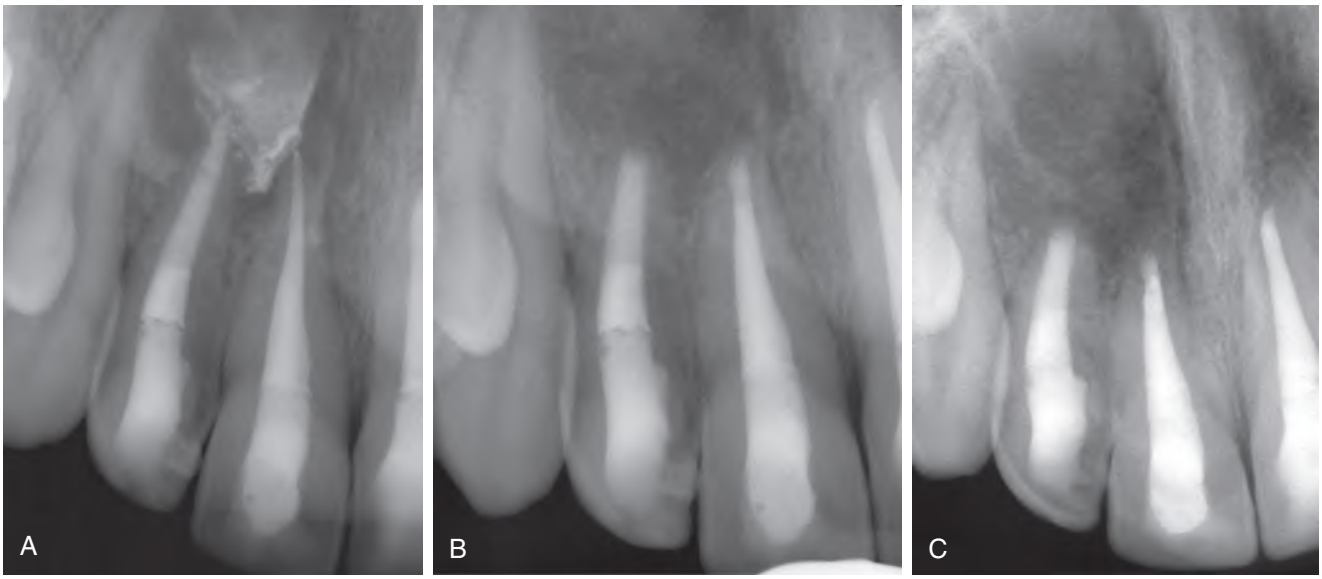


• **Fig. 20.4** **(A)** Preoperative radiograph shows presence of a dens in dente in the maxillary right cuspid tooth. **(B)** Because of inability of the operator to perform nonsurgical root canal treatment, a periapical surgery was performed. **(C)** Postoperative radiograph taken 20 months later shows complete resolution of the lesion in this tooth.

After anesthesia is obtained, and before incising the surgical flap, the oral cavity should be rinsed with a disinfectant solution such as chlorhexidine. A 0.12% chlorhexidine rinse has been shown to significantly reduce the bacterial count in the oral cavity in advance of operative procedures.[15] For a complete discussion of anesthesia see Chapter 8.

Microscalpels (Fig. 20.6) (Kerr Endodontics, Orange, CA) are used in the design of the free gingival margin flap to delicately and atraumatically incise the interdental papillae when full-thickness flaps are required. Feather Microsurgical Blades (Fig. 20.7, *A*) (J. Morita USA, Inc. Irvine, CA) are made of high quality stainless using high precision grinding technology, which produces ultra-sharp cutting edges that work with a variety of handles. These blades allow for a very fine incision and minimize the risk of tissue injury (Fig. 20.7, *B–D*).

Historically flaps have been reflected with a Molt 2-4 curette or variation of the Molt 2-4. The recently introduced periosteal elevator (Fig. 20.8) (G. Hartzell & Son, Concord, CA) has two working ends of 2 mm and 3.5 mm and 2 mm and 7 mm and accomplishes the goals of atraumatic flap reflection.



• **Fig. 20.5** **(A)** Preoperative radiograph of the right maxillary region in a young patient shows extrusion of filling materials into the periapical tissues. **(B)** Because of the presence of continued swelling and discomfort, a periapical surgery was performed on both incisors. **(C)** Postoperative radiograph taken 12 months later shows complete resolution of the lesion.

• **Fig. 20.6** A variety of microscalpels sized 1 to 5 used for precise incision.

Osteotomy

Because we can see better with the SOM, bone removal can be more conservative. Handpieces such as the Impact Air 45 (Kerr Endodontics, Orange, CA) introduced by oral surgeons to facilitate sectioning mandibular third molars are also suggested for AS to gain better access to the apices of maxillary and mandibular molars. When using the handpiece, the water spray is aimed directly into the surgical field, but the air stream is ejected out through the back of the handpiece, thus eliminating much of the splatter that occurs with conventional high-speed handpieces. Because there is no pressurized air or water, the chances of producing pyemia and emphysema are significantly reduced.

Burs such as a Lindemann H161 or H162 bone cutter (Brasseler USA, Savannah, GA) are extremely efficient and are recommended for hard tissue removal. They are 9 mm in length and have only four flutes, which result in less clogging. With the use of an SOM and an Impact Air 45, high-speed surgical burs can be placed even in areas of anatomic jeopardy with a high degree of confidence and accuracy (Fig. 20.9). The size of the osteotomy should be as small as practical so that wound healing will not be impaired, yet large enough to allow for complete débridement of the bony crypt and access for root-end procedures that will follow.

Curettage and Biopsy

It goes without saying that if tissue warrants removal, it warrants examination and diagnosis by an oral pathologist. At no time should a surgeon remove tissue and accept the responsibility of its diagnosis based on clinical impression, color, or consistency. In addition, any foreign material present in the bony crypt should be removed as it could cause persistent irritation and may prevent complete healing of the tissues.[16] For further discussion of radiolucent periapical pathosis see Chapter 5.

Apical Resection and Resected Apex Evaluation

There is general agreement that the main cause of failure in conventional endodontic treatment is the clinician's inability to adequately shape, disinfect, and obturate the entire root canal system. [17] The majority of this untreated anatomy is located in the apical 3 mm and for this reason a 3 mm resection is recommended.[18-20] With the introduction of ultrasonics for creating root-end preparations, a second reason for a 3 mm resection has emerged. Several authors have studied the incidence of craze line, cracks, and fractures in the root and cemental surfaces after ultrasonic root-end preparations.[21-25] Although all of these studies showed a statistically significant increase, none have shown any clinical significance as a result of their findings.

Historically, a long bevel was created in order to provide access for a microhead handpiece. With the introduction of periapical ultrasonics, little to no bevel is needed. This results in fewer cut dentinal tubules and less chance of leakage. Recent advancements in electric motor design and straight handpieces afford the clinician opportunities for direct visualization of the root-end while performing root resection and the creation of axial bevels that approximate zero degrees (Figs. 20.10 and 20.11).

After the root-end resection has been completed, the beveled surface of the root can be examined under midrange magnification. Using a small CX-1 microexplorer (Kerr Endodontics, Orange, CA), small microfractures, isthmuses, and portals of exit (POEs) can readily be seen (Figs. 20.12 and 20.13).

Study Questions

1. If a nonsurgical symptomatic endodontically treated tooth fails, and the quality of the root canal treatment is unacceptable, what is the appropriate first line of treatment?
   a. Surgical retreatment
   b. Nonsurgical retreatment
   c. Exploratory surgery
   d. Watch
2. Significant advances in endodontic microsurgery include all of the following except:
   a. Magnification
   b. Ultrasonics
   c. Impact air handpiece
   d. Bioceramic root-end filling materials
3. All of the following are contraindications for apical surgery except:
   a. Medical or systemic complications
   b. Indiscriminate use of periapical surgery
   c. Anatomic factors
   d. Do not have the skills
4. The surgical flap should be designed to be exactly the size of the periapical lesion.
   a. True
   b. False
5. To avoid gingival recession and papillae shrinkage in the esthetic zone, submarginal flap is the flap of choice.
   a. True
   b. False

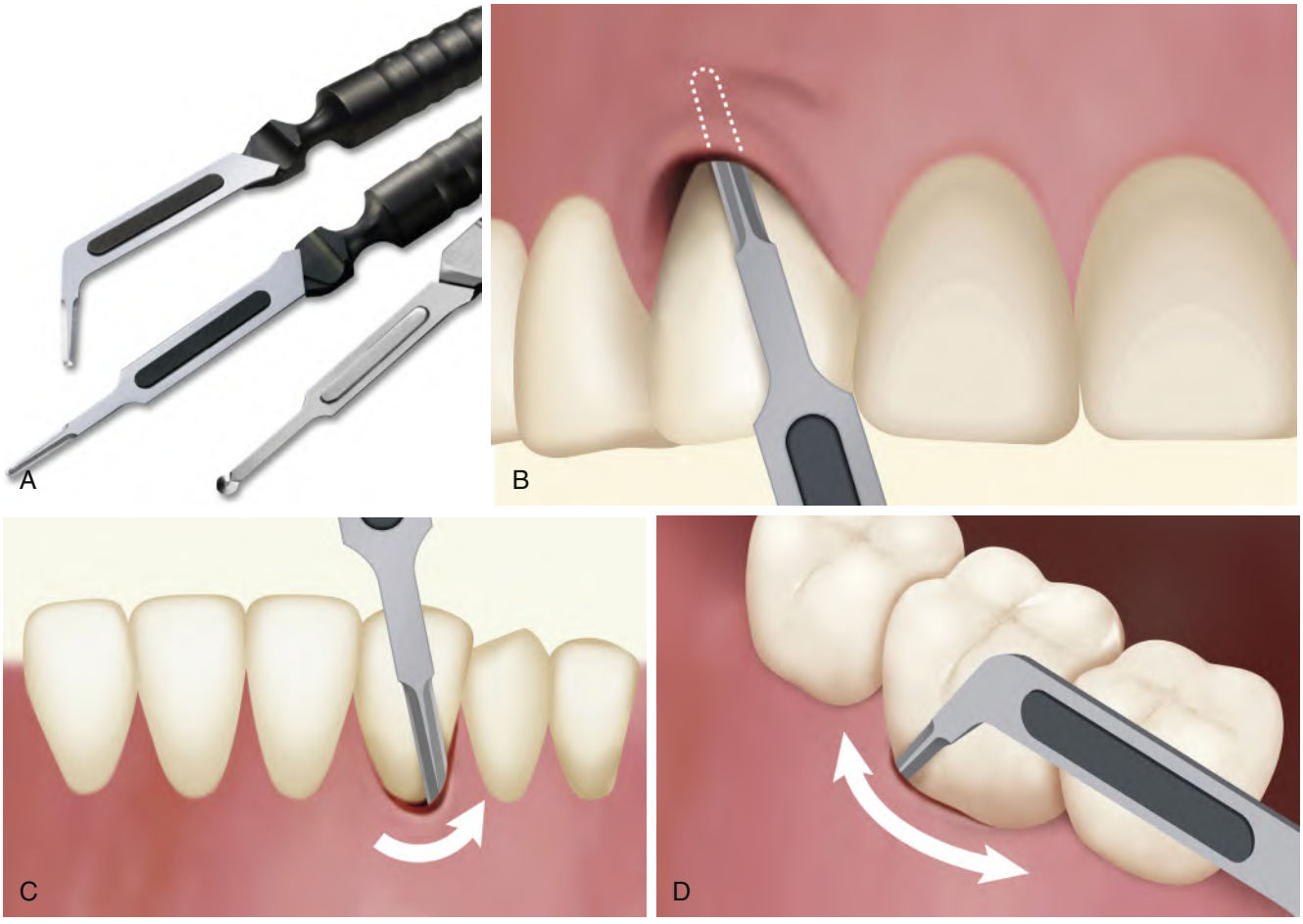
Apical Preparation

Since the introduction of periapical ultrasonic technology in the early 1990s by Carr, apical preparations have been made with ultrasonic tips.[26] A variety of tips and tip configurations have been introduced to accommodate virtually any access situation (Fig. 20.14). Most ultrasonic tips are .25 mm in diameter and approximately 3 mm in length.

Diamond coated tips are suggested as the last ultrasonic tip to be used in root-end preparation to avoid intradentin and canal cracks.[27] Furthermore, clinical use of diamond tips has shown that they are more efficient at removing gutta-percha compared with stainless steel tips (Figs. 20.15 and 20.16).

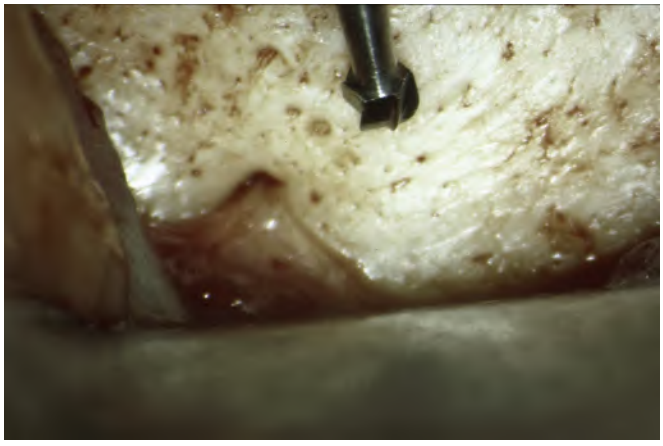
Piezosurgery

Piezosurgery is a bone-cutting modality with rapidly increasing indications in different surgical fields, including endodontic surgery. The main advantages of piezosurgery include protection of soft tissues, optimal visualization of the surgical field, decreased blood loss, reduced vibration and noise, increased comfort for the patient, and protection of tooth structures. Some disadvantages of piezosurgery include the initial financial burden associated with the purchase of the device, the long duration of the surgical procedure, and the fact that the instruction manuals of many piezoelectric units discourage use of these devices in patients with implanted cardiac pacemakers.[27] The technology was developed in



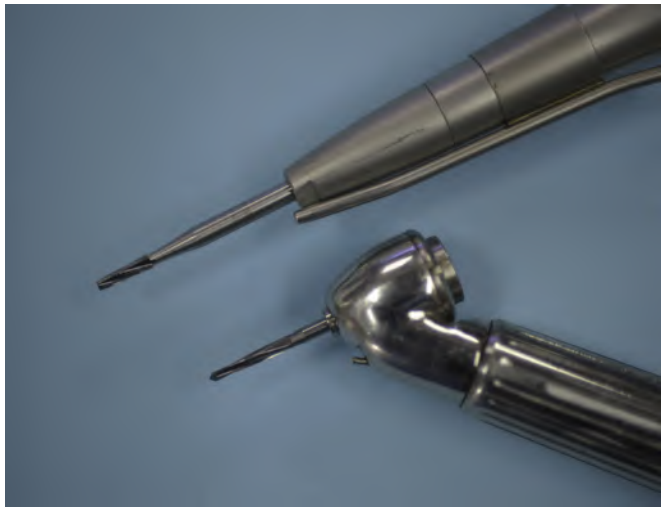
• **Fig. 20.7** **(A)** Feather microsurgical blades. (Courtesy of J. Morita.) **(B–D)** Application of Feather microsurgery blades. (Courtesy of J. Morita.)

• **Fig. 20.8** PR-1 and PR-2 periosteal elevators.

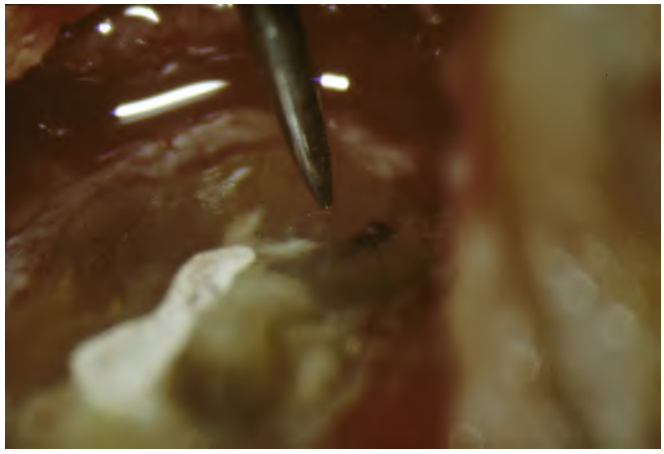


• **Fig. 20.9** Impact Air 45 and surgical length bur in close proximity to the mental nerve 8x.

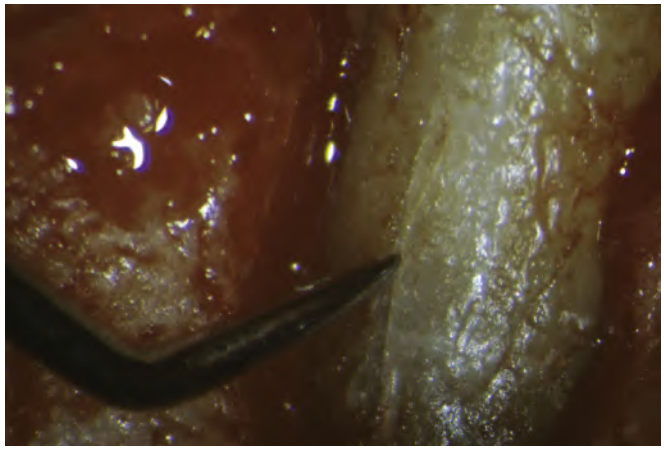
• **Fig. 20.10** Aseptico 7000 motor and NSK 2:1 nose-cone handpiece.



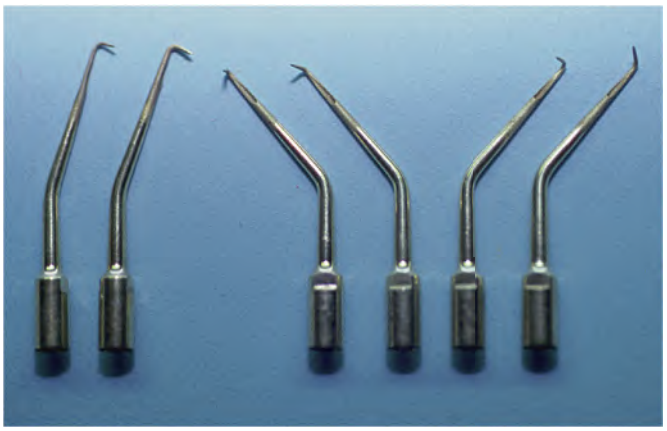
• **Fig. 20.11** A comparison of Impact Air 45 and NSK 2:1 nose-cone handpiece and surgical length burs.



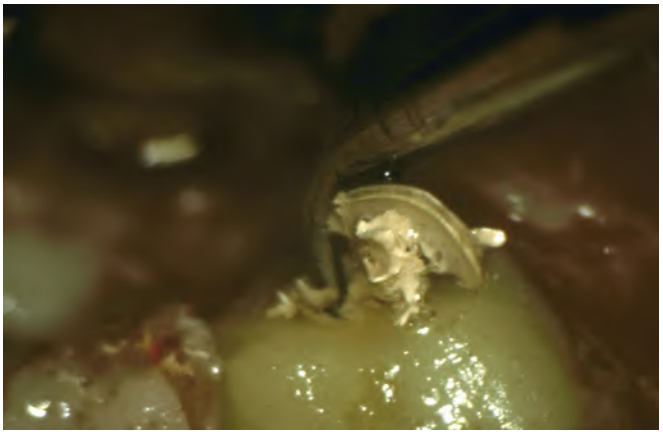
• **Fig. 20.12** CX-1 explorer locating an untreated portal of exit (POE) on the beveled surface of a previously retrofilled root at ×20.



• **Fig. 20.13** CX-1 explorer locating a crack on the facial surface of a root at ×20.



• **Fig. 20.14** Various ultrasonic tips with different shapes and angles.



• **Fig. 20.15** Thermoplasticized gutta-percha spinning around a stainless steel tip at ×16.

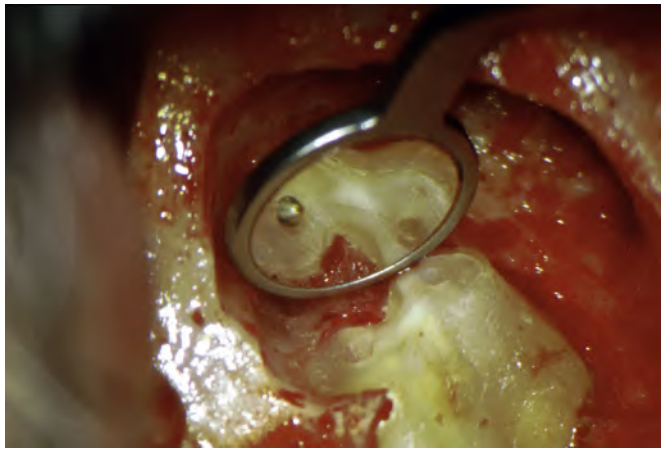
• **Fig. 20.16** Thermoplasticized gutta-percha "walking" out of the preparation at ×16.

1998 by the Italian oral surgeon Tomaso Vercellotti to overcome the limitations of conventional bone surgery[28] (Fig. 20.17).

Apical Preparation Evaluation

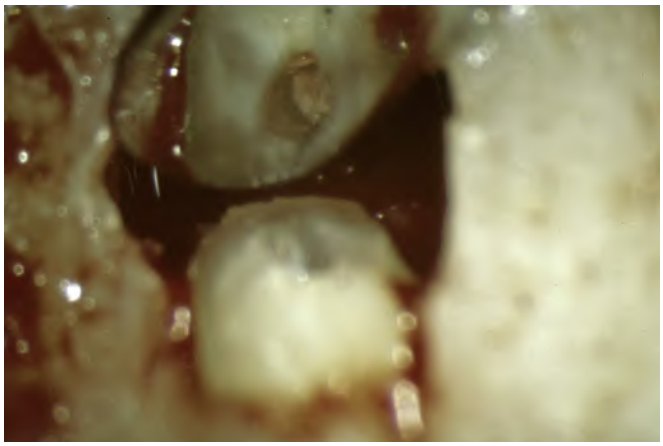
Another development in apical microsurgery has been the introduction of the surgical micromirror. Micromirrors come in a variety of shapes and sizes and have diameters ranging from 1 mm to

• **Fig. 20.17** Piezosurgery Touch (Mecron, Via Loreta, GE, Italy). The control panel allows the clinician to choose surgical procedure (power) and irrigation types.

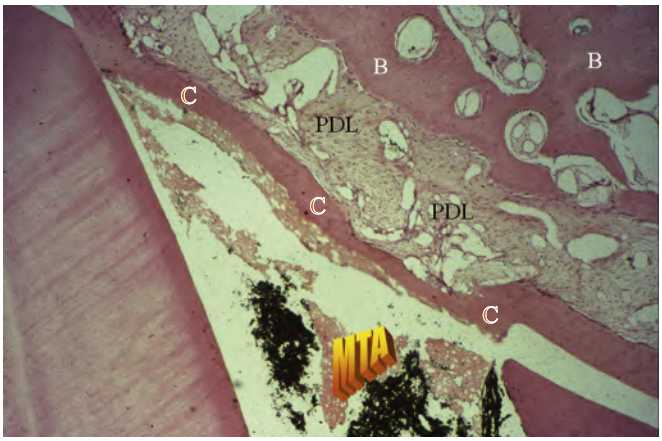


• **Fig. 20.18** Rhodium micromirror view of the beveled surface of the root at ×13.

5 mm. Recently introduced micromirrors utilize a rhodium coating. Rhodium is extremely hard and durable and is unsurpassed in reflectivity, clarity, and brightness. They are front surface, scratch resistant, and autoclavable (JEDMED, St. Louis, MO) (Fig. 20.18). Before using micromirrors, it was impossible to assess the thoroughness of apical preparation. Failure to completely remove old root canal filling material and debris from the facial wall of the apical preparation (Fig. 20.19) may lead to facial wall leakage and eventual failure if not cleaned before placement of an apical seal. Clearly, it is necessary to circumferentially remove all debris from the apical preparation to satisfy the criteria set forth by Gilheany et al. and Ricucci and Siqueira.[29,30]



• **Fig. 20.19** Micromirror view of gutta-percha and debris on the facial wall of the apical preparation at ×16.



• **Fig. 20.20** Complete regeneration of periapical tissues after using MTA as a root-end filling material in mokkeys. *B*, Bone; *PDL*, periodontal ligament; *C*, cementum; *MTA*, mineral trioxide aggregate.

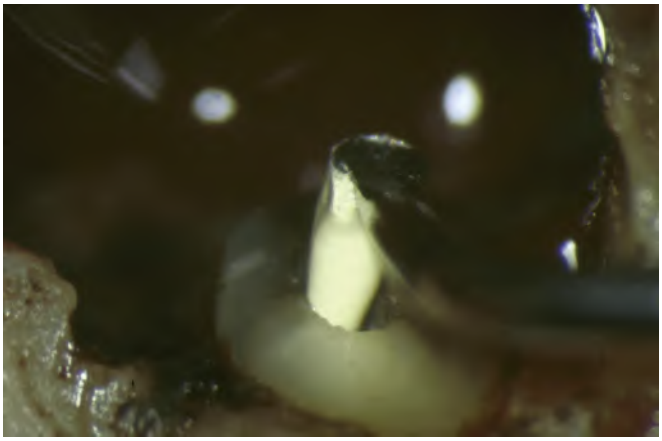
Hemostasis

Before selecting and placing retrofilling materials, it is essential to have established good hemostasis. Hemostasis begins by obtaining and reviewing the patient's health questionnaire. Consultation with the patient's physician may be necessary. Anesthesia must be profound with an adequate vasoconstrictor. There are many hemostatic materials available. Such a list could include ferric sulfate, aluminum chloride, collagen, hemostatic gauze, racemic epinephrine, or electro-cautery. When selecting hemostatic agents, one should consider their effect on hard and soft tissue and whether their use could compromise healing. For a complete discussion of local anesthesia see Chapter 8.

Selecting Retrofilling Materials

Historically, amalgam was first suggested for retrofillings by Farrar and reported in Dental Cosmos in 1884.[31] In 1978 Oynick and Oynick showed collagen fibers from the periodontal ligament against SuperEBA (Southern Anesthesia and Surgical, West Columbia, SC) retrofills and possibly into the SuperEBA matrix as well and suggested that SuperEBA may promote healing.[32] Bioceramics such as ProRoot mineral trioxide aggregate (MTA) (Dentsply Tulsa Dental, Tulsa, OK), BioAggregate (Innovative Bioceramix, Vancouver, Canada), EndoSequence Root Repair Material (Brasseler USA, Savannah, GA), Grey MTA Plus (Avalon Biomed, Bradenton, FL), and Biodentine (Septodont USA, Louisville, CO) were soon to follow. The class of bioceramics includes alumina and zirconia, bioactive glass, glass ceramics, coatings and composites, calcium silicates, hydroxyapatite, resorbable calcium phosphates, and radiotherapy glasses. The general class is used for joint and tissue replacement and for coating metal implants to improve biocompatibility. They are chemically and physically stable in a biologic environment and they chemically bond to dentin. ProRoot MTA, BioAggregate, EndoSequence Root Repair Material, and Grey MTA Plus all fit this definition.

The question as to whether SuperEBA had different outcomes than ProRoot MTA was studied by Song et al. and reported as a prospective randomized controlled study.[33] They reported that there was no significant difference in the clinical outcomes of endodontic microsurgery when SuperEBA and ProRoot MTA were used as root-end filling materials. However, ProRoot MTA produces complete periapical regeneration histologically whereas SuperEBA is incapable of doing the same thing (Fig. 20.20).



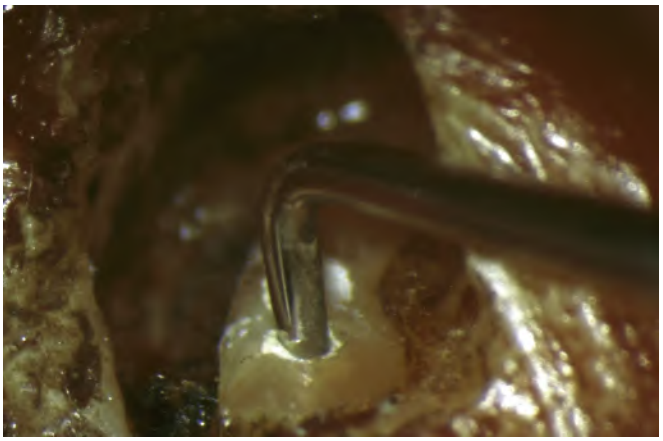
• **Fig. 20.21** Placing SuperEBA into the apical preparation with a #12 spoon excavator at ×16.

Mixing, Placing, Condensing, Carving, and Finishing Retrofilling Materials

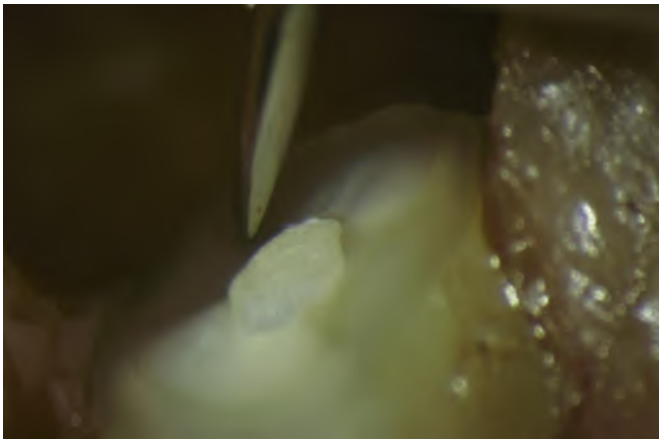
Cement consistency retrofilling materials, such as SuperEBA and desiccated intermediate restorative material (IRM), are mixed to a putty consistency and carried to the apical preparation in small truncated cones 1 mm to 2 mm in size on a #12 spoon excavator (Fig. 20.21). Between each aliquot of material, a small plugger (JEDMED Instrument Company, St. Louis, MO) that will fit inside the apical preparation is used to condense the material (Fig. 20.22).

Final examination of the retrofilling is performed after the surface has been dried with a Stropko Irrigator because it is more accurate to check the margins of the preparation when the beveled surface of the root is dry (Fig. 20.23). Materials such as ProRoot MTA are best delivered to the apical preparation with a carrier-based system (Fig. 20.24).

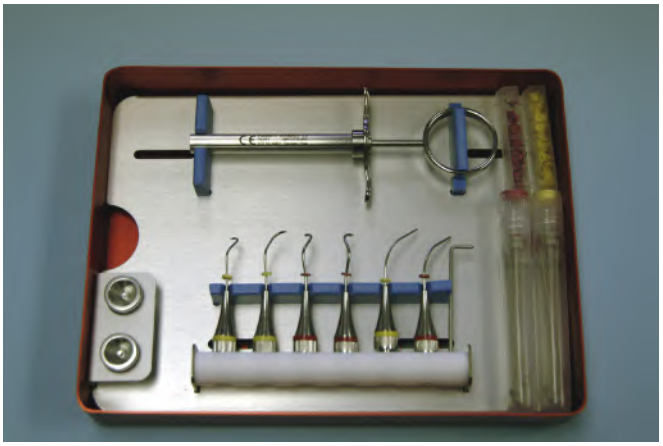
When placing ProRoot MTA, select a carrier that will fit into the apical preparation (Fig. 20.25). This will avoid spilling material into the bony crypt. As ProRoot MTA is cohesive to itself but only slightly adhesive to the walls of the preparation, care must be exerted to avoid pulling the material out of the preparation (Fig. 20.26). ProRoot MTA retrofilling is finished by wiping the beveled surface of the root with a moist cotton pellet (Fig. 20.27).



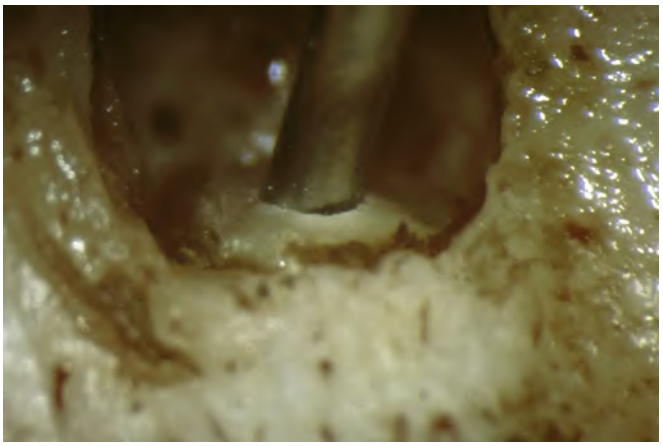
• **Fig. 20.22** Plugging SuperEBA into the apical preparation with a small plugger at ×16.



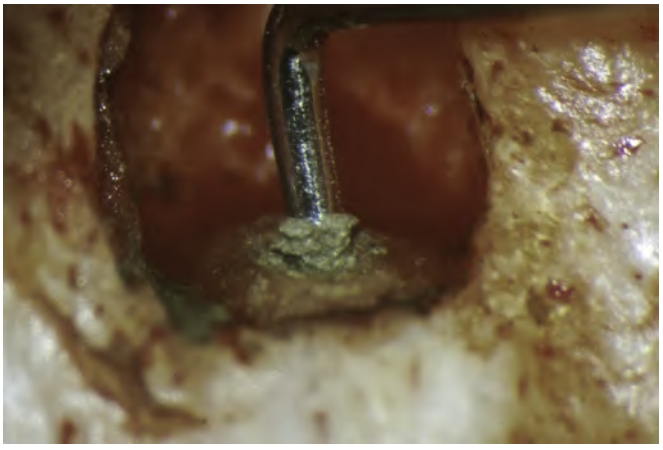
• **Fig. 20.23** Checking for marginal integrity with a CX-1 explorer at ×20.



• **Fig. 20.24** Micro Apical Placement System.



• **Fig. 20.25** MAP carrier placed inside the apical preparation at ×16.



• **Fig. 20.26** ProRoot mineral trioxide aggregate (MTA) being pulled out of the apical preparation at ×16.

• **Fig. 20.27** Checking the marginal integrity mineral trioxide aggregate (MTA) after its application at ×20.

Placing Bone Grafts and Membranes

A frequently asked question is whether a bone graft should be placed in the bony crypt or a membrane placed over the surgical site as a matter of routine. According to the review paper by Lin et al., biologically a clot is a better space filler than all bone grafting materials as it contains the host's own biologic product to provide an excellent scaffold for wound healing. The best application of membrane barriers in periapical surgery appears to be in combined endodontic-periodontal lesions or large periapical lesions communicating with the alveolar crest. They also concluded that there is no conclusive evidence to demonstrate that the application of membrane barriers in large or through-and-through bony lesions has a better long-term outcome than a control group in periapical surgery. If formation of periradicular scaring is anticipated, a membrane can be placed for cosmetic reasons.

Dahlin et al. showed complete osseous healing of experimentally induced bone defects in rat jaws occurred after 6 weeks when polytetrafluorethylene (PTFE) membranes were placed on both sides of the defect.[34] Pecora and Andreana repeated the Dahlin study with calcium sulfate as a barrier and found the same results.[35] For further discussion of grafting procedures see the section on grafting in Chapter 21.

Flap Closure

The final stage of apical microsurgery is flap closure. Care must be taken to reapproximate the flap in order to promote healing by primary intention. Suturing is a critical part of flap closure. There are several suturing materials available. Parirokh et al. showed significantly more bacterial contamination and physical debris with silk sutures compared with polyvinylidene fluoride (PVDF), a monofilament suture, at 3, 5, and 7 days post placement.[36] However, PVDF is difficult to handle and needs to be pulled several times to erase the stiff memory. In addition, patients often complain that the tag ends of the suture are stiff and irritating to the oral mucosa.

Maxima PTFE (Henry Schein, NY, USA) is a PTFE coated monofilament suture that has handling properties similar to silk but produces less inflammation and contamination.

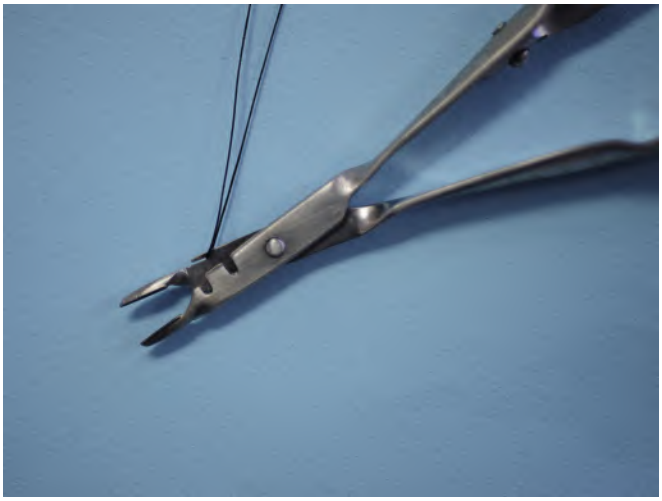
Although selection of suture material is important, it is also necessary to consider needle design. Reverse cutting needles have their cutting surfaces on the convex surface of the needle, making them ideal for suturing gingiva and oral mucosa. Maxima PTFE sutures are available with a laser cut premium needle that provides a smoother transition between the needle and the suture material, further reducing drag and tissue trauma.

Although the Adson tissue forceps can hold the flap firmly while suturing, newer instruments such as the Corn tissue forceps (Laschal Surgical Inc., Purchase, NY) are designed for precision needle placement (Fig. 20.28). The forceps grasp the tissue and the needle enters the tissue through an opening in the ends of the forceps.

There are a variety of needle holders available for the clinician. The recently introduced Baraquer needle holder (Laschal Surgical Inc., Purchase, NY) (Fig. 20.29) has an additional advantage in that it contains a small scissors that can also cut the suture.

Once the sutures are placed, the flap should be compressed with a saline soaked gauze and firm finger pressure for a minimum of 3 minutes. This will lessen the chance for the formation of a hematoma under the flap.

• **Fig. 20.28** Corn tissure forceps.



• **Fig. 20.29** Baraquer needle holder/scissors with suture material engaged in the scissor.

Postoperative Instructions

Both oral and written postoperative instructions should be given to the patient. Instructions should be written in simple, straightforward language. They should minimize patient anxiety arising from normal postoperative symptoms by describing how to promote healing and comfort.

A typical list of postoperative instructions is as follows:

1. Some swelling and discoloration are common. Use an ice pack with moderate pressure on the outside of your face (20 minutes on and 5 minutes off) until you go to bed tonight. Application of ice and pressure reduces bleeding and swelling and provides an analgesic effect.
2. Some oozing of blood is normal. If bleeding increases, place a moistened gauze pad or facial tissues over the area and apply finger pressure for 15 minutes. If bleeding continues, call the dentist's office.
3. Do not lift your lip or cheek to look at the area. The stitches are tied, and you may tear them out.
4. Starting tomorrow, dissolve 1 teaspoon of salt in a glass of warm water and gently rinse your mouth three or four times daily. Rinsing with a 0.12% chlorhexidine mouthwash may promote healing. Mouthwashes containing alcohol should be

• **Fig. 20.30** Scissors/Forcepts Combo suture removal instrument.

avoided for the first several days after surgery. Careful brushing is important, but vigorous brushing may damage the area of surgery. Tonight you should brush and floss all areas except the surgery site. Tomorrow night you can carefully brush the surgery site.

5. Proper diet and fluid intake are essential after surgery. Eat a soft diet and chew on the opposite side of your mouth. Drink lots of fluids and eat soft foods such as cottage cheese, yogurt, eggs, and ice cream.
6. Pain is usually minimal after AS, and strong analgesics are normally not required. Some discomfort is normal. If pain medication was prescribed, follow the instructions. If no medication was prescribed, take your preferred nonprescription pain remedy if needed. If this is not sufficient, call the dentist's office.
7. If you are a smoker, do not smoke for the first 3 days after the procedure.
8. If you experience excessive swelling or pain or if you run a fever, call the dentist's office immediately.
9. Keep your appointment to have the stitches removed. (Sutures are removed 3 to 7 days after surgery.)
10. Call the dentist's office if you have any concerns or questions.

Suture Removal

The key to suture removal is in the healing of the epithelium. Harrison and Jurosky reported that a thin epithelial seal was established in the horizontal incisional wound at 24 hours and a multilayered epithelial seal was established in the vertical incisional wound between 24 and 48 hours.[37] Most clinicians would agree that sutures could be left in place for up to 7 days without causing significant soft tissue irritation.

Recently introduced for suture removal is the Scissors/Forceps Combo instrument (Fig. 20.30) (Laschal Surgical Inc., Purchase, NY). Safety ended suture scissors (Laschal Surgical Inc., Purchase, NY) have been designed to remove sutures that are buried in edematous or hypertrophic tissue.

Prognosis

Based on the results of several meta-analyses endodontic microsurgery enjoys high success rates ranging from 91.4% to 94.4%[38-53] (see Chapter 22).

Study Questions

6. Apical preparation evaluation was not possible before the introduction of:
   a. Stainless steel periapical ultrasonic tips
   b. Micromirrors
   c. Piezosurgery
   d. Diamond coated periapical ultrasonic tips
7. The most important factor in controlling bleeding is:
   a. The patient's health questionnaire
   b. Ferric sulfate
   c. Hemostatic gauze
   d. Electro-cautery
8. All of the following are bioceramic retrofilling materials except:
   a. ProRoot MTA
   b. EndoSequence Root Repair Material
   c. Amalgam
   d. Grey MTA Plus
9. According to Lin et al. the best material for a bone graft is:
   a. Calcium sulfate
   b. Allograft
   c. The patient's own blood clot
   d. Bioactive glass
10. The key to suture removal is:
   a. Postoperative instructions
   b. The healing of the epithelium
   c. Needle size
   c. The choice of the suture material

ANSWERS

Answers Box 20

1 b. Nonsurgical retreatment
2 c. Impact air handpiece
3 d. Do not have the skills
4 b. False
5 a. True
6 b. Micromirrors
7 a. The patient's health questionnaire
8 c. Amalgam
9 c. The patient's own blood clot
10 b. The healing of the epithelium

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Video 20.0: Endodontic Surgery Introduction
Video 20.1: Periapical Surgery
Video 20.2: Ochsenbein-Luebke Flap
Video 20.3: Root Amputation
Video 20.4: Hemisection
Video 20.5: Bicuspidization