Endodontic Microsurgery

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Abstract

The field of endodontics has seen vast improvements in technology and techniques over the past several years. Perhaps the one area of endodontics that has improved the most is the way in which surgery is performed. With the use of state-of-the-art instruments, new and improved materials, and a surgical operating microscope, the gap has narrowed between biological concepts and the ability to achieve consistently successful clinical results. The practice of these techniques is now referred to as endodontic microsurgery.

Learning Objectives

After reading this article, the reader should be able to:

- explain the concepts of endodontic microsurgery.
- describe the advantages of performing endodontic microsurgery over the traditional methods of surgery.
- discuss the clinical applications, indications, and techniques of endodontic microsurgery.

Traditionally, endodontic surgery was considered a procedure of last resort, filled with negative connotations because of lack of experience and understanding of the merits of the procedure. Clinicians were willing to sacrifice a well-fitting prosthesis to avoid a surgical approach. The lack of understanding of endodontic microsurgery combined with the aggressive approach of dental implant companies, has resulted in many teeth being extracted and replaced by implants, when a surgical approach could easily, with >90% success, save the tooth[1] (Figure 1).

A recent publication showed that when patients are surveyed after endodontic microsurgery, they report that the procedure was better than expected, and often they report equal, if not less, pain postoperatively as in conventional root canal therapy.[2] The patient population should continue to be educated about the ease of endodontic microsurgery to make educated decisions along with their clinicians, alleviating preconceived negative feelings.

An inherent preconceived risk with traditional endodontic surgery was potential damage to major vessels or nerve bundles (eg, mental nerve). Because of excessive osteotomies and steep beveling of root surfaces, unnecessary damage to cortical bone and unfavorable crown/root ratios of existing teeth were the results. These potential problems have been overcome with the use of surgical operating microscopes and refined microsurgical instruments and ultrasonic tips. The root apices can now be more easily located, smaller osteotomies are made (preserving important cortical bone), and shallower apicoectomies are done (preserving root structure and revealing addi-

Figure 1—Central incisor that was slated for extraction/implant and was saved by endodontic surgery.

Figure 2—Mandibular molar with cystic lesion shows complete resolution after endodontic surgery.

tional canals and isthmuses between canals). These apices can then be properly filled with root-end materials that are both biocompatible and have osteogenic potential (eg, mineral trioxide aggregate [MTA[a]]).[3]

Regardless of one's opinion of whether radiographic periapical lesions are granulomas, cysts, or differentiating between true cysts (completely enclosed lumen) and pocket cysts (open to the apex of the affected root),[4,5] it is agreed that a certain percentage of these lesions will not heal from conventional root canal treatment and retreatment. In reviewing papers with varying opinions, Nair found that from a purely pathological viewpoint, approximately 10% of all periapical lesions will require surgery in addition to conventional endodontic therapy (Figure 2).[6] Also, there are many more cases with procedural

[a] Dentsply Tulsa Dental, Tulsa, OK 74135; www.tulsadental.dentsply.com

Figure 3—Correct positioning of patient to perform surgery on mandibular posterior tooth.

Figure 4—Patient moves into slight class III occlusion to aid in apical surgery.

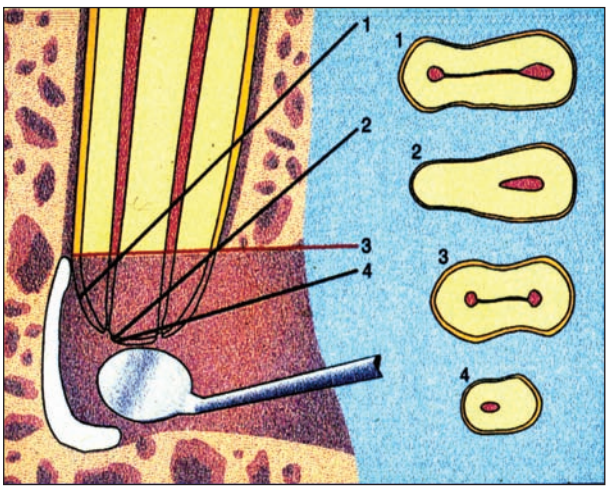


Figure 5—Proper bevel angle (#3) showing both canals with isthmus exposed without excessive cutting of root tip.

errors (eg, apical transportation, ledging, and separated instruments) and anatomical considerations (eg, apical ramifications and isthmuses) that will require a surgical intervention to solve the problem. When a tooth has an acceptable root canal treatment, it is restored with a well-fitting post and crown and an endodontic retreatment could destroy the prosthesis, surgical intervention could actually be considered a more conservative approach.

In addition to the benefits mentioned before of using a microscope to perform endodontic surgery, the higher magnification and illumination allow the operator to more easily distinguish between cutting bone (whiter appearance) and cutting the root tip (more yellow), aid in complete removal of granulomatous material, and allow for documentation of cases by recording or taking digital photographs directly through the microscope. This vastly improves the communication between the endodontist and the referring dentist. In addition to the benefit of magnification and illumination, when examining the resected apex of a tooth, methylene blue dye is used to both stain the periodontal ligament, which ensures the complete resection of the root, and to look for cracks, isthmuses, and extra canals.

After case selection and scheduling, the flap then must be designed for proper access to the site. The 2 types of incisions used are sulcular and submarginal, dictated by the area in the mouth and the status of the periodontal tissue.[7,8] For endodontic surgery, a vertical releasing incision is necessary to gain access to the apex. The sulcular full-thickness incision is generally used when

Figure 6—Missed palatal canal when an acute bevel placed on root. Failure occurred from bacterial leakage through the palatal canal.

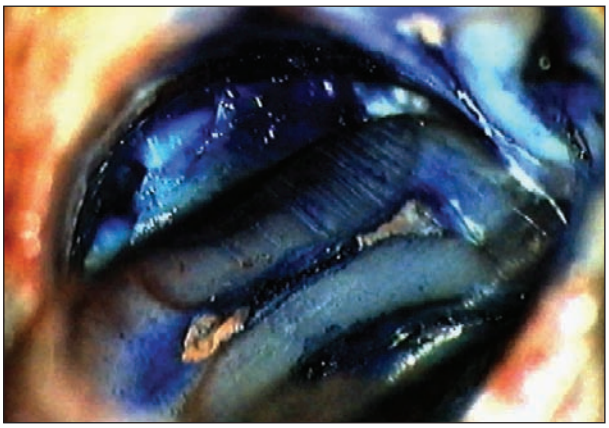


Figure 7—Isthmus between canals stained with methylene blue dye.

esthetics around crown margins are not a concern because of the shrinkage that will occur after closure. Submarginal mucogingival incisions are indicated in the anterior region where there may be several crowns and any soft-tissue shrinkage would greatly compromise the esthetics. Retraction of the soft tissue is accomplished with long-handled titanium retractors that must rest on bone, not impeding circulation to the flap, and not lacerating the soft tissue. When steady retraction is difficult, especially in the mandibular posterior region, a groove is cut in the bone apical to the surgical site, allowing for a firm yet comfortable resting site.

Patient and operator positioning is critical for surgical procedures. Generally, the operator sits between 10 o'clock and 2 o'clock, depending on the quadrant being surgically treated, and the patient is supine, allowing the operator to sit upright and maintain a good posture while looking through the microscope. The operator's elbows should be at approximately 90º, resting firmly on the arms of a chair. A trick is to have the patient's headrest gently touching the operator's knee so that by slightly elevating the knee, which slightly elevates the patient's head, one can fine-focus under the microscope. This keeps both of the operator's hands free to work.

The positioning of the patient's body and head is also critical for alleviating some of the stresses of surgery. When working in the anterior region, the patient's head should be tilted up or down to allow for straight-line access through the microscope. When working in the posterior region, the patient is instructed to lie on his or her side as if sleeping, allowing the operator to look directly into the field (Figure 3). A trick when working on mandibular molars is to have the patient closing in a slightly class III occlusion, bringing the buccal surface out to allow for better vision (Figure 4). Perhaps the most difficult root to visualize surgically is the mesiolingual root of mandibular molars, and with this technique, one can often establish direct vision of this root.

Osteotomies are easily performed with the end-cutting and side-cutting Lindemann bur[b]. Sterile water or saline must be used to avoid localized necrosis of the bone. Other systems exist for cutting bone such as piezoelectrical units, but they do not cut as efficiently as a highspeed handpiece. Piezoelectrical units can be helpful to harvest bone for a surgical site or for fine bone contouring during a periodontal surgery. The recommended high-speed handpiece used for endodontic surgery is called the Impact Air 45[c]. The head of the handpiece is at a 45º angle to allow for better visualization of the root, and air escapes from the back of the head of the handpiece instead of onto the bur, which avoids air emphysema. The osteotomy should remain at approximately 4 mm in diameter, unless the amount of granulation tissue dictates otherwise, allowing for the 3-mm ultrasonic tip to fit into the crypt and to vibrate freely within the apical a few millimeters.[3]

A shallow-angle bevel of the resected root is recommended to ensure uncovering the entire canal and to preserve as much of the buccal plate of bone as possible. Sometimes a slight bevel is necessary to establish direct vision of the apex, but this bevel should not exceed 10º. Three millimeters of root end should be resected, which removes 98% of the apical ramifications and 93% of the lateral canals (Figure 5).[9]

After root-end resection, one must inspect the cut surface under the highest magnification and with methylene blue dye. At that time, the operator is looking for any cracks, canal aberrations, extra canals, and isthmuses, as well as confirming that the entire root has been resected with no lingual lips of tooth structure (Figure 6).

An isthmus is a communication between root canals containing pulpal tissue (Figure 7).[10] Because the isthmus is part of a canal system, it needs to be cleaned and filled. There are complete and incomplete isthmuses. At the 3-mm level from the apex, 90% of mesiobuccal roots of maxillary molars have an isthmus, over 80% of mesial roots of mandibular molars, and 30% of maxillary and mandibular premolars have an isthmus. This is why in addition to a root end resection, a root-end filling (retrograde) should be placed (Figure 8).

[b] Hu-Friedy, Chicago, IL 60618; www.hu-friedy.com

[c] Palisades Dental LLC, Englewood, NJ 07631; www.palisadesdental-llc.com/

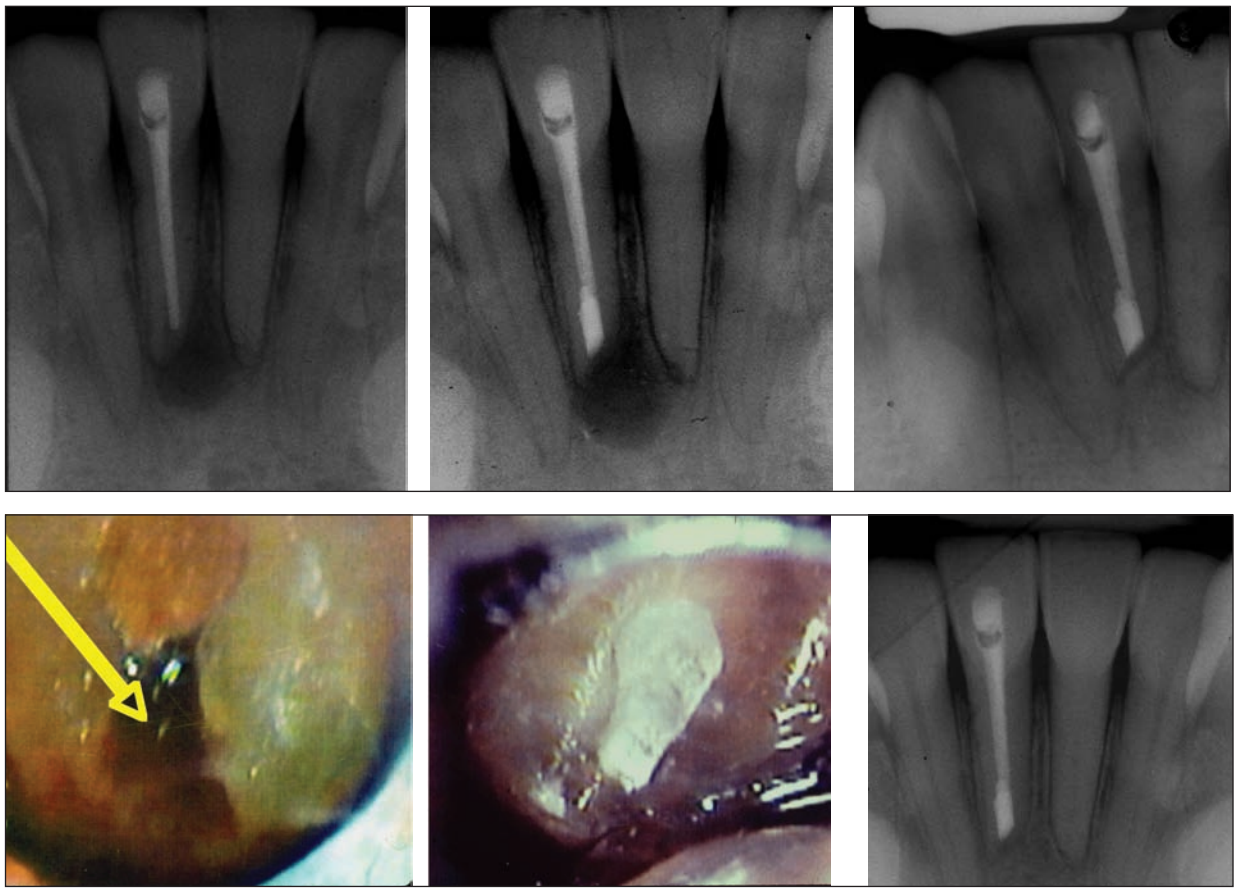


Figure 8—Leakage seen around gutta-percha at the end of root; Super EBA root-end filling and complete healing of bone.

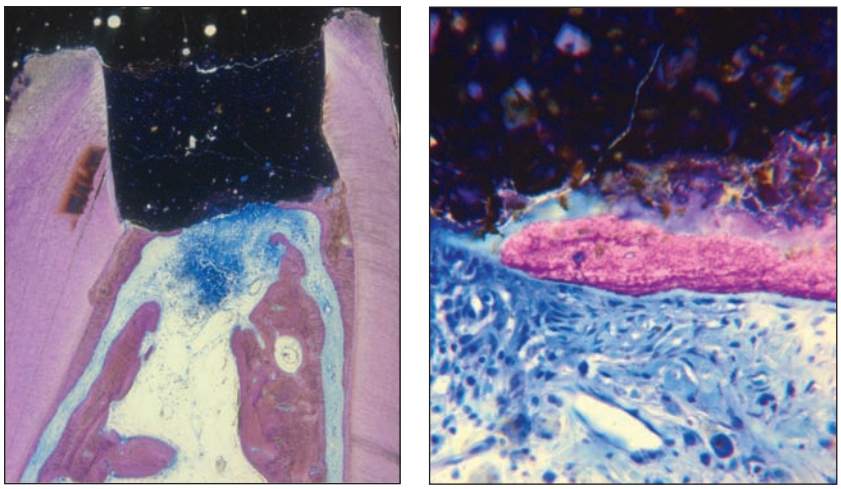


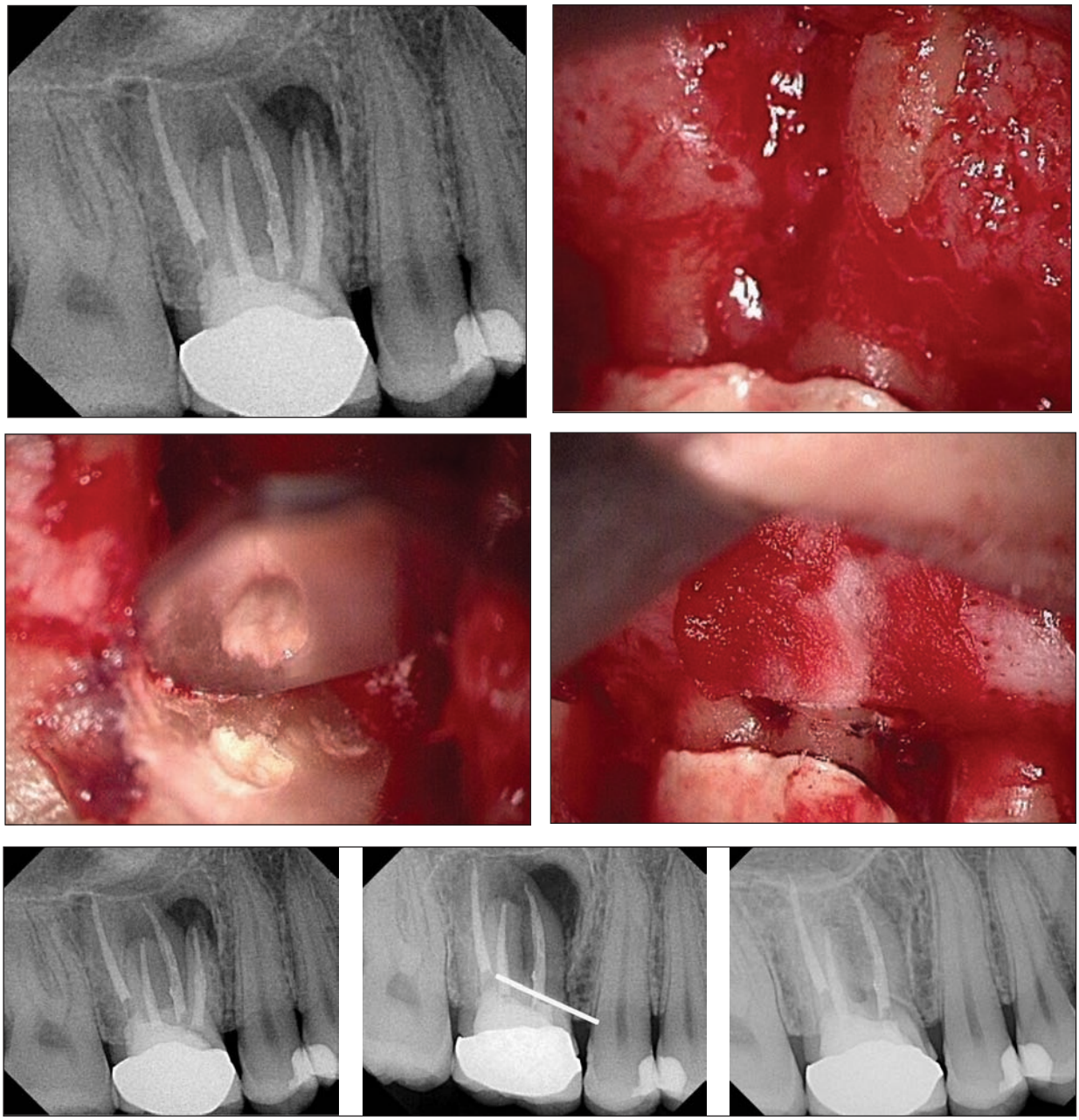
Figure 9—Histological slide showing cementum formation directly onto MTA in a furcation.

After the root-end resection and inspection of the apex under high magnification, the next step is to go to low magnification, choose the proper ultrasonic tip, line up the ultrasonic tip with the long axis of the root, and begin the root-end preparation. The KiS ultrasonic tips[d] provide all the necessary angles and are diamond coated for cutting efficiency. The proper depth of a root-end preparation equals the 3-mm length of the KiS ultrasonic tips.[11] Other available ultrasonic tips include MiniEndo[e] and ENAC[f].

An ultrasonically prepared root end now needs to be filled with a biocompatible material that will create a bacteria-tight seal. Perhaps the ideal filling material still does not exist, but the materials have evolved with time. Amalgam was the first retrograde filling material used, replaced for the most part by zinc oxide-containing materials such as IRM[g] and Super EBA[g], and now the most ideal material available is MTA.[12,13] MTA is not only biocompatible but has been shown to have the capability of inducing bone, dentin, and cementum formation (Figure 9).[14] Consistent use of MTA resulted in regeneration of periapical tissue including periodontal ligament and cementum.[15] MTA has greater healing induction potential and is more biocompatible than any root-end filling material available.

[d] Obtura Spartan, Fenton, MO 63026; www.obtura.com

[e] Sybron Endo, Orange, CA 92867; www.sybronendo.com
[f] Osada, Los Angeles, CA 90048; www.osadausa.com
[g] Harry J Bosworth, Skokie, IL 60076; www.bosworth.com



Figures 10 and 11—Root resection of a maxillary molar with collacote collagen membrane placement and subsequent complete healing of bone.

The outcome of endodontic surgery depends on the preexisting condition of the tooth and its surrounding periodontium.[16] Surgical classifications are as follows: (1) little to no periapical lesion; (2) periapical lesions involving the apical third of the root to half way up the root; (3) a combination of an endodontic lesion with periodontal communication; and (4) complete fenestration of the root surface. Although bone grafting procedures are typically incorporated during periodontal surgery or implant placement, it also is important for the endodontist to have those materials available when needed. There are many times when the presurgical probing and radiographs are not accurate depictions of the actual site after reflection of the flap; therefore, the endodontist must be prepared and knowledgeable as to which clinical situations may warrant bone grafting and membrane placement (Figures 10 and 11).

Conclusion

Endodontic surgery has evolved into endodontic microsurgery. By using state-of-the-art equipment, instruments, and materials that match biological concepts with clinical practice, the author believes that microsurgical approaches produce predictable outcomes in the healing of lesions of endodontic origin. With continued education of the patient population and referring dentists, endodontic microsurgery should be a predictable and viable alternative for saving teeth.

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Quiz 3

1. **Nair found that from a purely pathological viewpoint, approximately what percent of all periapical lesions will require surgery?**
   a. 1%
   b. 10%
   c. 30%
   d. 47%

2. **Methylene blue dye is used to stain the periodontal ligament:**
   a. to look for 3-wall defects.
   b. to look for single-wall defects.
   c. which ensures the complete resection of the root.
   d. as a by product of looking for canals.

3. **For endodontic surgery, which incision is necessary to gain access to the apex?**
   a. vertical releasing
   b. full thickness
   c. practical thickness
   d. horizontal intrasulcular

4. **Perhaps the most difficult root to visualize surgically is the:**
   a. anterior maxillary incisor.
   b. mesiolingual root of mandibular molars.
   c. maxillary MB-2 root.
   d. palatal root of maxillary molars.

5. **What is the recommended angle of the high-speed handpiece head?**
   a. 0º
   b. 10º
   c. 45º
   d. 90º

6. **The osteotomy should remain at approximately _____ in diameter, unless the granulation tissue dictates otherwise.**
   a. 2 mm
   b. 3 mm
   c. 4 mm
   d. 5 mm

7. **Three millimeters of root end should be resected, which removes what percent of the apical ramifications?**
   a. 2%
   b. 7%
   c. 93%
   d. 98%

8. **An isthmus is a communication between root canals containing:**
   a. pulpal tissue.
   b. bacteria.
   c. calcium channels.
   d. stem cell procedures.

9. **What percent of maxillary and mandibular premolars have an isthmus?**
   a. 5%
   b. 30%
   c. 50%
   d. 75%

10. **Perhaps the ideal filling material:**
    a. is MTA.
    b. is IRM.
    c. is Super EBA.
    d. does not exist.

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