

Review

Current strategy for successful periradicular surgery

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Abstract: Periradicular surgery is often used as a last resort to save an endodontically treated tooth with a persistent periapical lesion. The introduction of surgical microscopes, ultrasonics, and compatible root-end filling materials has made periradicular surgery a much more predictable treatment. The advantages of modern periradicular surgery include easier identification of root apices, smaller osteotomies, shallower resection angles, and tight sealing within the prepared root-end cavity. Modern periradicular surgery thus has a much higher success rate than traditional periradicular surgery. (J Oral Sci 55, 267-273, 2013)

Keywords: endodontic surgery; periapical lesion; periradicular surgery; root-end filling; root-end resection; root-end cavity preparation.

Introduction

In cases of endodontic failure, non-surgical endodontic retreatment or endodontic surgery is indicated. Non-surgical endodontic retreatment is generally considered the treatment of choice. Endodontic surgery should be restricted to cases in which a non-surgical approach is impossible or has failed (1,2). Recent advances in endodontic surgery have enabled practitioners to save teeth that would have been extracted previously. Inno-

ventions in techniques and instruments have contributed to the development of endodontic surgery (3-5).

One treatment option in endodontic surgery is periradicular surgery, which includes four critical steps to eliminate persistent endodontic pathogens: 1) surgical removal of the periapical lesion, 2) root-end resection, 3) root-end cavity preparation, and 4) root-end filling (6). The main objectives of periradicular surgery and conventional root canal therapy are the same—to provide conditions that facilitate healing and repair of periapical tissue. These conditions are created by removing necrotic tissue and tissue breakdown products from the apical root canal system, eliminating bacterial organisms in the root canal system, and sealing the root canal. The relevant clinical factors in deciding to perform periradicular surgery have been classified as technical, biological, and a combination of these (7). Technical factors include the presence of a crown, post, and/or broken instruments that may prevent access to the infected root canal. Previously, root canal therapy through such a restoration was not recommended, as it was considered risky and believed to be associated with poor outcomes. When removal of restorations was not practical, periradicular surgery became the last resort for salvaging the affected tooth (Fig. 1).

This review summarizes the available literature on periradicular surgery and recommends management strategies based on the latest research.

Do surgery and endodontic retreatment have the same indications?

Surgical endodontics is an important part of endodontic practice. Periradicular surgery may be performed after unsuccessful endodontic retreatment or when orthograde retreatment is contraindicated (1,2). When an improper or defective root canal filling is the cause of endodontic

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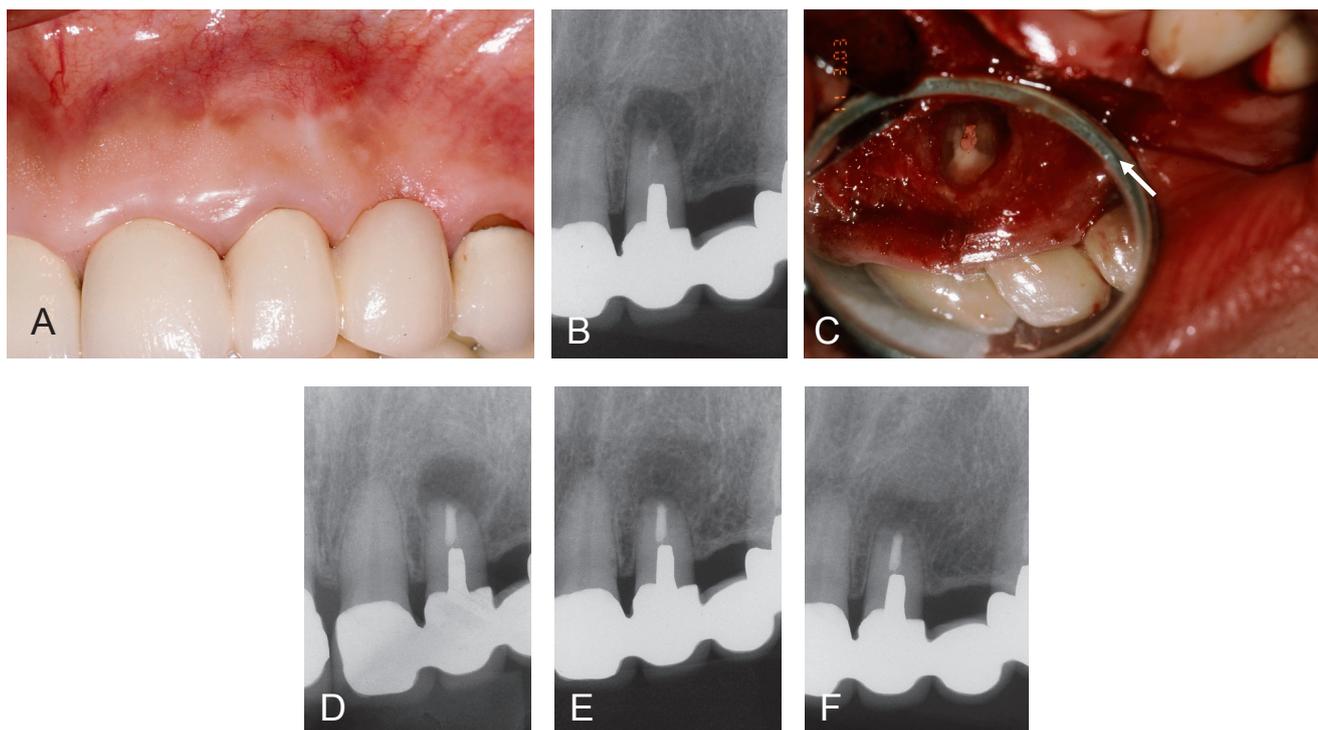


Fig. 1 Traditional periradicular surgery. (A) Clinical view of maxillary left lateral incisor. (B) Preoperative radiograph showing post, poor root canal filling, and periapical radiolucency. (C) Intraoperative view after root-end resection and root-end filling with gutta-percha. (D) Radiograph immediately after periradicular surgery. (E) Two-year follow-up radiograph showing that the periapical lesion is smaller. (F) Four-year follow-up radiograph showing excellent periapical healing. Reproduced from Tsurumachi T. *The Quintessence* (2009) 28, 1357-1359.

failure, and the root canal is coronally accessible and negotiable, surgical treatment is not considered the treatment of choice (8). The success rate for periradicular surgery is lower than that of root canal retreatment. Previous studies reported a success rate of between 50-90% for periradicular surgery, which is not higher than that for conventional root canal treatment (9-12). Furthermore, any periradicular surgery will be of little value for teeth with poorly condensed filling or untreated root canals. In such cases, the surgical procedure will simply transfer the apical foramen to a more coronal position, creating an open apex that will predispose the tooth to new or recurrent infection. Therefore, endodontic retreatment is recommended over periradicular surgery unless non-surgical retreatment is not possible or the risks of retreatment are excessive (13).

Clinical and radiographic evaluation

Routine clinical examination procedures are used to evaluate signs and symptoms such as loss of function, tenderness to percussion or palpation, subjective discomfort, mobility, sinus tract formation, signs of infection or swelling, and periodontal pocket formation.

Periapical radiographs are used clinically to diagnose apical periodontitis. Successful treatment is defined as absence of symptoms and periapical radiolucency after treatment. Posttreatment disease is diagnosed when a periapical radiolucency remains at 4 years after treatment (14). For some time, absence of a periapical radiolucency on a periapical radiograph was used to confirm a healthy periapex. However, a periapical radiograph is a two-dimensional aspect of a three-dimensional structure (15). Periapical lesions confined within cancellous bone are usually not detected (15-18). Cone-beam computed tomography (CBCT) scans were able to detect periapical lesions in many cases in which a periapical radiolucency was absent in a periapical radiograph (19-22). The absence of a radiolucency on a periapical radiograph does not guarantee a healthy periapex, and a CBCT scan may thus be better for diagnosis (23-26). When a surgical approach is chosen, it is essential to know the precise extent of the apical lesion and its relation to the root and neighboring structures. For treatment planning in periradicular surgery, CBCT provides additional beneficial information not available from two-dimensional radiographs.

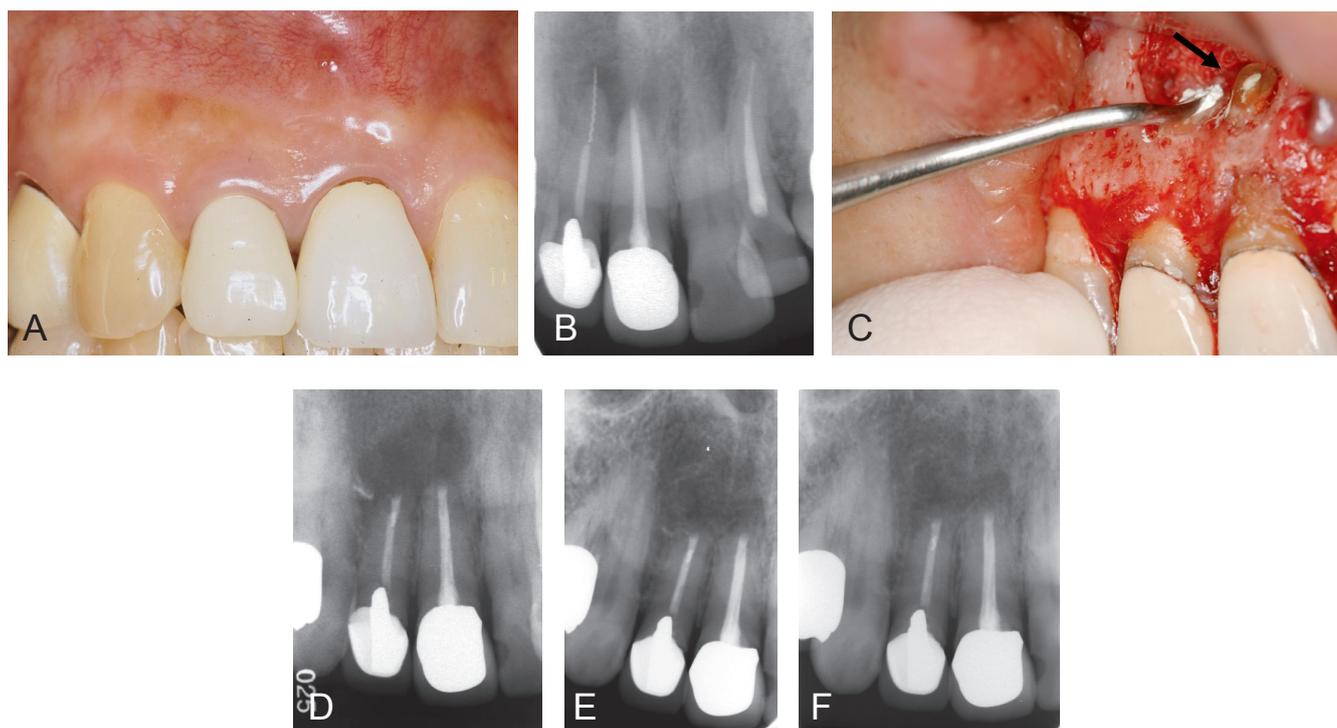


Fig. 2 Modern periradicular surgery using an M651 surgical microscope (Leica). (A) Preoperative view of maxillary right central and lateral incisors. Note swelling with the sinus tract. (B) Preoperative radiograph of lateral incisor showing a separated instrument and periapical radiolucency. The lesions in the maxillary central and lateral incisors were treated by periradicular surgery. (C) Intraoperative view after root-end resection and root-end filling with MTA. (D) Postoperative radiograph at completion of periradicular surgery. (E) One-year follow-up radiograph showing that the periapical lesion is smaller. (F) Two-year follow-up radiograph showing excellent periapical healing.

Success and failure

A thorough history, clinical examination, and good-quality periapical radiographs are essential in preoperative and postoperative assessment of teeth selected for periradicular surgery. Evaluation of the outcome of periradicular surgery is mostly based on clinical and radiographic criteria for healing of periapical tissues (27,28). The healing classification is as follows: 1) complete healing as defined by re-establishment of the lamina dura, 2) incomplete healing, 3) uncertain healing, and 4) unsatisfactory healing (4,10,29-32). The criteria for a successful outcome include absence of clinical signs or symptoms, and radiographic evidence, of complete or incomplete healing. The criteria for failure include clinical signs or symptoms, and radiographic evidence, of uncertain or unsatisfactory healing.

Modern surgical procedures

Periradicular surgery includes surgical debridement of pathologic periapical tissue, root-end resection, root-end cavity preparation, and placement of root-end filling to seal the root canal. Location, cleaning, and filling of the apical root canal are believed to be key

requirements in achieving a predictable outcome after periradicular surgery (5,33). Periradicular surgery can be performed using traditional or modern techniques. Traditional periradicular surgery included root-end resection with a 45° bevel angle and root-end cavity preparation using a carbide round bur. The introduction of surgical microscopes, ultrasonics, and compatible root-end filling materials has made modern periradicular surgery more predictable, and success rates are now high (34-36). Current microsurgical techniques permit precise performance of endodontic surgical procedures, thus eliminating the disadvantages of traditional periradicular surgery (Fig. 2). US studies show that the use of a dental microscope among endodontists has increased from 52% in 1999 (37) to 90% in 2007 (38).

Flap designs

Various flap designs are described in the literature (39-42). Flap design affects access, visibility, anatomical structures, repositioning, suturing, postoperative care of the surgical site, and postoperative sequelae. If access and visibility are limited by a flap design, the surgical procedure cannot be performed properly and is likely to

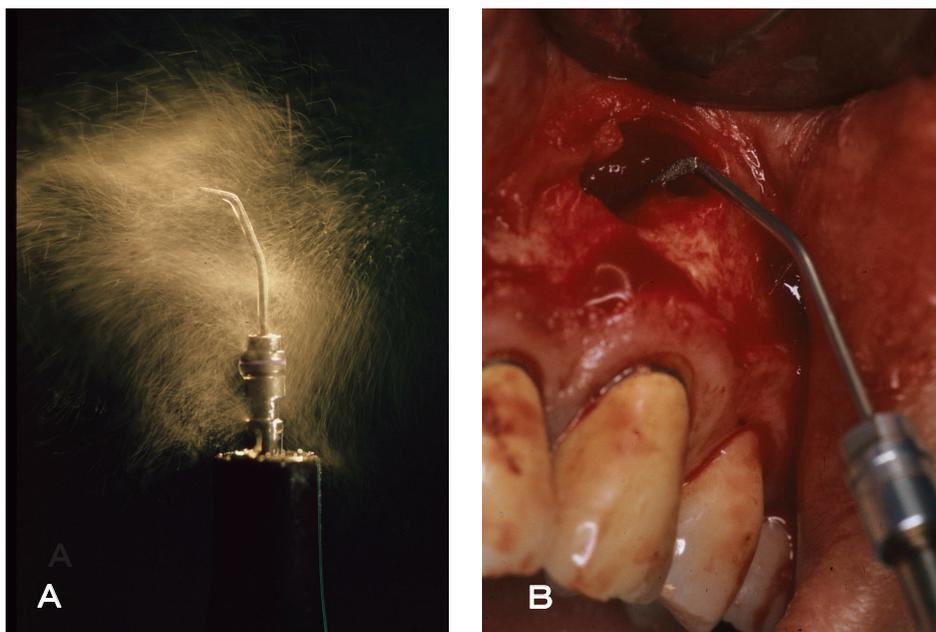


Fig. 3 (A) Vibrating ultrasonic retrotip under water flow (ST37-90; ENAC, Osada, Tokyo, Japan). (B) Photograph of ultrasonic retrotip during root-end cavity preparation.

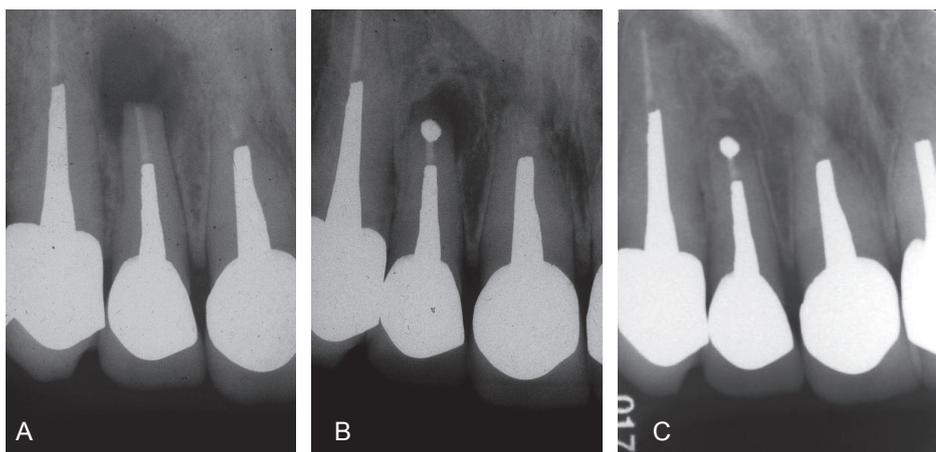


Fig. 4 (A) Preoperative radiograph showing a large periapical radiolucency after failed periradicular surgery for the maxillary lateral incisor. (B) Follow-up examination 15 years after completion of periradicular resurgery with amalgam root-end filling; recall radiograph showing incomplete periapical repair. (C) Follow-up examination 25 years after completion of periradicular resurgery; complete periapical healing is evident.

fail. Clinical designs include marginal mucoperiosteal flaps with one (triangular flap) or two (rectangular flap) releasing vertical incisions, submarginal mucoperiosteal flaps (Leubke-Ochsenbein flap) with a horizontal incision within the attached gingiva, and its modifications and semilunar flaps. The wide variety of flap designs reflects the number of variables to be considered before choosing an appropriate flap. As clinical conditions vary with the patient and specific situation, there will always be a need for individualized selection of flap design.

Root-end resection

Periradicular surgery was performed under local anesthesia. After elevation of a full-thickness mucoperiosteal flap, bone was removed from the apical area to gain access to the lesion and root end. Surgical debridement of cortical and cancellous bone was performed with a bur and sharp spoon excavator. To prevent bone dehydration, the area was intermittently rinsed with saline solution during the entire surgical procedure. This approach enhances heat control, thereby avoiding bone necrosis and eliciting new bone formation within a short period of

time (43). Root-end resection is the term used to describe removal of the root tip and placement of an apical bevel. Using a water-cooled diamond bur, an apical resection about 3 mm from the apex is performed, using a limited bevel. Kim and Kratchman suggest that at least 3 mm of the root-end must be removed to reduce 98% of apical ramifications and 93% of lateral canals (5). After debridement of pathologic tissue, hemostasis of the bony crypt was achieved.

Root-end cavity preparation

Root-end cavity preparation is an important procedure in periradicular surgery. The root-end cavity is conventionally prepared by means of a small round bur or inverted cone bur in a micro-handpiece. The use of ultrasonic tips in root-end cavity preparation is now widely accepted, because of their small dimensions and good access to the resected root end (44) (Fig. 3). Root-end bevel is minimal or unnecessary, which decreases the number of exposed dentinal tubules (45,46). Cavity preparations are smaller and cleaner, cavities are deeper and more retentive, and the root-end cavity is better aligned with the long axis of the root canal (47,48). By reducing the risk of root perforation, ultrasonic instrumentation also provides significant advantages in treating deeply fluted roots when an isthmus is present (49,50).

Root-end filling materials

There are many established root-end filling materials. In addition, several newer materials are currently used for periradicular surgery (51-55). These materials include amalgam, ethoxybenzoic acid (Super EBA), intermediate restorative material (IRM), and composite resin. The ideal root-end filling material should be biocompatible and bacteriocidal (or at least bacteriostatic). It should also be neutral to neighboring tissues and provide excellent sealing. Amalgam was the root-end filling material of choice until the 1990s. Figure 4 shows a representative result of amalgam filling accomplished using traditional techniques. However, in recent years, the safety and integrity of amalgam, in general and as a root-end filling material, have been questioned, as it has many disadvantages, including release of ions, mercury toxicity, corrosion and electrolysis, delayed expansion, marginal leakage, and its tendency to cause tissue tattoos (56,57). Super EBA and IRM generally performed quite well in leakage studies, animal studies, and retrospective human studies (51,56). A minor problem with cements based on zinc oxide and eugenol is that their radiopacity is similar to that of gutta percha. Ideally, root-end filling material should be readily distinguishable from tooth structure and

obturating materials. Mineral trioxide aggregate (MTA) was introduced to endodontics as a root-end filling material by Torabinejad et al in 1993 (35). It has excellent sealing ability and promotes osteoblast activity. In addition, many studies reported that it is biocompatible and induces osteogenesis and odontogenesis (58-62). Thus, MTA would appear to be a most promising material for use in a variety of clinical applications, including vital pulp treatments, apical filling of teeth with open apices, apexification, repair of root, furcal perforations, and root-end filling (63-69). However, prolonged setting time and difficulties in manipulation are major disadvantages of MTA (70,71).

In summary, modern periradicular surgery is successful in promoting healing in periapical lesions of endodontic origin. Thus, periradicular surgery may be performed after unsuccessful endodontic retreatment or when orthograde retreatment is contraindicated.

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