

Endodontic surgery is the management or prevention of peri-radicular pathosis by a surgical approach. Peri-radicular surgery (PRS) (endodontic surgery) is a generic term for treatment that encompasses three main categories of surgical endodontic procedures:

1. Periapical curettage of persistent peri-radicular disease, including removal of the root apex (root end resection) and retrograde filling of the root canal.
2. Surgical repair of root surface irregularities such as external root resorption defects or iatrogenic perforations.
3. Root resection of posterior teeth to remove diseased roots and retention of roots suitable for further coronal restoration.

Conventional endodontic treatment is generally a successful procedure; however, in 10% to 15% of cases the symptoms can persist or spontaneously recur. Findings such as a draining fistula, pain on mastication, or the incidental noting of a radiolucency increasing in size indicate problems with the initial endodontic procedure. Many endodontic failures occur a year or more following the initial root canal treatment, often complicating a situation because a definitive restoration may have already been placed. This creates a higher "value" for the tooth because it now may be supporting a fixed partial denture.

Periapical Surgery (apicectomy or apicoectomy)

Periapical (i.e., periradicular) surgery includes a series of procedures performed to eliminate the symptoms. Periapical surgery includes the following:

1. Appropriate exposure of the root and apical region
2. Exploration of the root surface for fractures or other pathologic conditions
3. Curettage of the apical tissues
4. Resection of the root apex
5. Retrograde preparation with the ultrasonic tips or microdrills

7. Appropriate flap closure to permit healing and minimize gingival recession

Indications for periapical surgery

- Anatomic problems preventing complete debridement/obturation
- Restorative considerations that compromise treatment
- Horizontal root fracture with apical necrosis
- Irretrievable material preventing canal treatment or retreatment
- Procedural errors during treatment
- Large periapical lesions that do not resolve with root canal treatment

It is important to tell the patient preoperatively that endodontic surgery is exploratory. The precise surgical procedure is dictated by the clinical findings once the site is exposed and explored. For example, a fracture of a root may be noted, and the decision whether to resect the root or extract the tooth will need to be made intraoperatively. If the tooth is to be extracted, provisions for temporization must be made in advance if removal is an esthetic issue, or a decision must be made to close the flap and schedule the extraction in the future.

Anatomic problems

Calcifications or other blockages, severe root curvatures, or constricted canals (i.e., calcific metamorphosis) may compromise root canal treatment, that is, prevent instrumentation, obturation, or both. A non-obtured and cleaned canal may lead to failure because of continued apical leakage.

Although the outcome may be questionable, it is preferable to attempt conventional root canal treatment or retreatment before apical surgery. If this is not possible, removing or resecting the uninstrumented and unfilled portion of the root and placing a root end filling may be necessary.

Restorative considerations

Root canal retreatment may be risky because of problems that may occur from attempting access through a restoration, such as through a crown on a mandibular incisor. An opening could compromise retention of the restoration or perforate the root.

A common requirement for surgery is failed treatment on a tooth that has been restored with a post and core. Many posts are difficult to remove or may cause root fracture if an attempt at removal is made to re-treat the tooth.

Horizontal root fracture

Occasionally, after a traumatic root fracture, the apical segment undergoes pulpal necrosis. Because pulpal necrosis cannot be predictably treated from a coronal approach, the apical segment is removed surgically after root canal treatment of the coronal portion.

Irretrievable material in canal

Canals are occasionally blocked by objects such as broken instruments, restorative materials, segments of posts, or other foreign objects. If evidence of apical pathosis is found, those materials can be removed surgically, usually with a portion of the root. A broken file can be left in the root canal system if the tooth remains asymptomatic.

Procedural error

Broken instruments, ledging, gross overfills, and perforations may result in failure. Although overfilling is not in itself an indication for removal of the material, surgical correction is beneficial in these situations if the tooth becomes symptomatic. Because the obturation of the canal is often dense in these situations, surgical treatment has an excellent prognosis.

Large, unresolved lesions after root canal treatment

Occasionally, very large periradicular lesions may enlarge after adequate debridement and obturation. These lesions are generally best resolved with decompression and limited curettage to avoid damaging adjacent structures such as the mandibular nerve. The continued apical leakage is the nidus for this expanding lesion, and root resection with the placement of an apical seal can resolve the lesion.

Contraindications for periapical surgery

- Local anatomic factors, such as an inaccessible root end
- Tooth with inadequate periodontal support
- Tooth has a vertical root fracture
- Uncooperative patient
- Patients with a severely compromised medical history
- Tooth is unrestorable
- Inexperienced operator with no training

Important considerations in periapical surgery

An important consideration is, first, to identify the cause of failure, and then second, to design an appropriate corrective treatment plan. Often, orthograde retreatment is indicated and gives the best chance of success. Surgery to correct a treatment failure for which the cause cannot be identified is often unsuccessful. Surgical management of all periapical pathoses, large periapical lesions, or both is often not necessary because they will resolve after appropriate root canal treatment. This includes lesions that may be cystic; these also usually heal after root canal treatment.

Most oral structures do not interfere with a surgical approach but must be considered. Expertise in operating around a structure such as the maxillary sinus or mental nerve region is imperative before undertaking surgery in these regions. Exposure of the maxillary sinus, which occurs in most molar apical surgeries, is in itself not a complication but a known consequence of the surgery. Creating a sinus opening is neither unusual nor dangerous. However, caution is necessary not to introduce foreign objects into the opening and to remind the patient not to exert pressure by forcibly blowing the nose until the surgical wound has healed (for 2

weeks) . Correct flap design is also crucial to prevent the development of an oral-antral communication. The sulcular flap keeps the incision line far from the sinus opening, thereby allowing spontaneous healing.

Surgical procedures around the mental foramen require caution to avoid stretch injury or direct damage to the nerve. Some authors think that exposure of the mental nerve is safer than attempting to estimate its position. Careful, subperiosteal reflection of the flap with adequate release allows the surgeon to identify the nerve where it exits from the bone. Once identified, staying a safe distance above and/or anterior is crucial to preventing an injury. Important to note is that the nerve may have an anterior loop of 2 to 4 mm, so that distance should be accounted for anteriorly.

When molar apical surgery is performed, the mid-root of the molar should be identified by slow removal of bone, and then the bone removal should be carried inferiorly. Once reaching the apical region, cautious curettage of the soft tissue lesion is carried out to avoid mechanical injury of the inferior alveolar nerve as it passes under the molar roots. It is important to mention that it is not necessary to remove the entire area of periapical granulation tissue or cyst, if present, because the treatment of the apical lesion and sealing of the root canal with the retrograde filling causes the apical lesion to heal.

Teeth with very short roots have compromised bony support and are poor candidates for surgery; root end resection in such cases may compromise stability. However, shorter roots may support a relatively long crown if the surrounding cervical periodontium is healthy.

Factors Associated with Success and Failures in Periapical Surgery

- The success of periapical surgery has been reported to vary between 25% and 99%.
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- Periradicular resurgery has been demonstrated to have a significantly greater failure rate than a first surgical procedure.
- Periradicular re-surgery remains a valid alternative to dental extraction.

- In a recent study, it has been concluded that the volume of the lesion has a significant effect on the outcome of endodontic surgery; periapical lesions with a volume above 50 mm³ were significantly associated with failures.

SUCCESS

Preoperative Factors

- Dense orthograde fill
- Healthy periodontal status
- No dehiscence
- Adequate crown/root ratio
 - Radiolucent defect isolated to apical one third of the tooth
 - Tooth treated
- Maxillary incisor
- Mesio Buccal root of maxillary molars

Postoperative Factors

- Radiographic evidence of bone fill following surgery
- Resolution of pain and symptoms
- Absence of sinus tract
- Decrease in tooth mobility

FAILURE

Preoperative Factors

- Clinical or radiographic evidence of fracture
- Poor or lack of orthograde filling
- Marginal leakage of crown or post
- Poor preoperative periodontal condition
- Radiographic evidence of post perforation
- Tooth treated
- Mandibular incisor

- Lack of bone repair following surgery
- Lack of resolution of pain
- Fistula does not resolve or returns

Pre-operative imaging

Conventional radiology has been the principle technique for assessing periradicular anatomy prior to performing endodontic surgery. This facilitates the assessment of the number, length and shape of the roots, the presence of a sclerosed canal, and type of restoration present. However, these two-dimensional (2D) images of three-dimensional (3D) structures have their limitations. For example, conventional periapical radiographs do not facilitate accurate predictions in the preoperative assessment for the potential perforation of the maxillary sinus. As a consequence, the use of 3D cone-beam computed tomography (CBCT) imaging is now becoming established in preoperative assessment for PRS. The detail provided by 3D CBCT imaging in diagnosing the precise size and location of resorption defects or periradicular pathology is greatly beneficial over conventional radiography. Such enhanced preoperative information allows improved precision in performing PRS procedures, thereby preventing complications arising through trauma to adjacent anatomic structures.

Surgical procedure

Prophylactic antibiotics

Almost without exception, periapical surgery is performed in an area with mixed acute and chronic infection. Due to the nature of the surgery and potential spread of the infection into adjacent spaces, preoperative prophylactic administration of antibiotics is indicated. A risk of infection of the hematoma exists because of the amount of edema expected after the procedure. In addition, inadvertent opening of adjacent structures such as the maxillary sinus is expected to occur with molar surgeries.

The basics of antibiotic prophylaxis are that antibiotics are to be administered before surgery to have any protective benefit. A preoperative dose of penicillin V

(2.0 g) or clindamycin (600 mg) 1 hour before surgery should be considered by the surgeon. The need for postoperative dosing has not been clearly defined and may not be of benefit to the patient. Other adjuncts, such as the use of corticosteroids perioperatively, may reduce edema and speed recovery.

Surgical access

Surgical access is a compromise between the need for visibility and the risk to adjacent structures. Many surgeons use the **semilunar flap** to access the periapical region. Although it provides rapid access to the apices of the teeth, it substantially limits the surgery to only a root resection and periapical seal. Proponents of this flap claim that it prevents recession around existing crowns, which could lead to a metal margin showing postoperatively.

The semilunar flap is placed entirely in the nonkeratinized or unattached gingiva. By definition, this tissue is constantly moving during normal oral function, leading to dehiscence and increased scarring. Incisions placed in unattached tissues tend to heal slower and with more discomfort.

Once a semilunar incision is made, the surgeon has access limited to only the periapical region. If the root is noted to be fractured, extraction via this flap may lead to a severe defect. With a multirrooted tooth, a root resection of one of the fractured roots may not be possible. In addition, localized root planing or other periodontal procedures cannot be accomplished. The size of the bone defect may be greater than that anticipated based on the preoperative radiographs and the possibility of the suture line being over the defect might cause the incision to open up and heal secondarily.

Last, it is known that many cases of periapical surgery on maxillary molars and premolars will involve an opening into the sinus cavity. The incision line with this type of flap might contribute to a postoperative oral-antral fistula.

In contrast, a sulcular incision with 1 or 2 vertical releases (**full mucoperiosteal flap**) keeps the incision primarily within the attached gingiva, promoting rapid healing with less pain and scarring. Healing of the incision is facilitated by curetting the adjacent teeth and any exposed root surfaces before closure. The incision permits full observation of the root surface, leading to more accurate

apical localization and treatment of a fractured root should it be discovered on flap reflection. By keeping the incision as far away from the sinus opening as possible and over healthy bone (vs. a semilunar incision), the chance of an oral-antral communication is significantly reduced.

The disadvantages are that the flap is more difficult to replace and to suture; also, gingival recession can develop if the flap is not reapproximated well, exposing crown margins or cervical root surfaces (or both).

A common misconception is that flaps should be designed that are trapezoidal, having a broader base than edge. A trapezoidal flap design creates a longer component in the nonkeratinized tissue that heals more slowly and with more discomfort. As the vertical release tends to broaden out apically, the incision crosses more bony prominences over the roots of teeth and across the muscle frenum, further delaying the healing process. The dental papilla just adjacent to the released flap actually ends up having a compromised blood supply and the potential for recession.

In contrast, by making the vertical release more perpendicular to the sulcus, a shorter length in the nonkeratinized tissue may permit the same amount of flap release. The vertical incision should parallel the long axis of the teeth and should be made between two teeth where the tissue is the thickest and has the best blood supply. The direct vertical incision makes sense because the blood supply to the gingiva follows the long axis and is oriented longitudinally.

A recent publication has proposed the use of a “**papilla-based incision**” in which the triangle of interdental papilla is not incised and not mobilized during reflection of the flap. It reports maintenance of the papilla with little to no recession in contrast to mobilization of the papilla.

In selected cases, an **Ochsenbein and Luebke flap**, also known as a **submarginal flap**, can be used. The requirements for this flap include at least a band of attached gingival tissue 2 mm in length (not including any periodontal pocketing) along with a periapical lesion that does not extend to this region. Therefore, there are few cases whereby this flap design can be used. There is the limitation that if extraction

of the tooth or root resection becomes the intraoperative decision, there becomes a technical complication. In addition, scarring is significant and recession can occur from that outcome.

Anesthesia

For most surgical procedures, anesthetic approaches are conventional. In most mandibular regions a block is administered; then local infiltration of an anesthetic with epinephrine is given to enhance hemostasis. Frequently, the patient is sensitive to curettage of the inflammatory tissue, particularly toward the lingual aspect. Placing a cotton pellet soaked with local anesthetic solution can also reduce this discomfort.

A long-acting anesthetic agent is recommended, such as bupivacaine, for the inferior alveolar nerve block. Bupivacaine 0.5% with epinephrine 1: 200,000 has been shown to give long-lasting anesthesia and, later, provide a lingering analgesia.

Long-acting local anesthetic agents such as bupivacaine do not diffuse well through the tissue because they are so highly protein bound, so their effectiveness for an infiltration-type injection is limited.

If there is active infection in the region, profound local anesthesia may not be able to be achieved, and these patients may be candidates for intravenous sedation or general anesthesia.

Incision and reflection

A firm incision should be made through periosteum to bone. Incision and reflection of a full-thickness flap is important to minimize hemorrhage and to prevent tearing of the tissue.

Reflection is with a sharp periosteal elevator beginning in the vertical incisions and then raising the horizontal component. To reflect the periosteum, the elevator must firmly contact bone while the tissue is raised. Reflection is to an apical level adequate for access to the surgical site, although still allowing a retractor to have contact with bone. Enough width and vertical release of the flap must be included

to prevent the flap from being stretched, which can lead to tearing and slower healing.

Periapical Exposure

Frequently, the cortical bone overlying the apex has been resorbed, exposing a soft tissue lesion. If the opening is small, it is enlarged using a large surgical round bur, until approximately half the root and the lesion are visible. With a limited bony opening, radiographs are used in conjunction with root and bone topography to locate the apex. A measurement may be made with a periodontal probe on the radiograph and then transferred to the surgical site to determine the apex location.

To avoid air emphysema, handpieces that direct pressurized air, water, and abrasive particles (or combinations) into the surgical site must not be used. Electrical surgical handpieces are preferred during osseous entry and root end resection. Regardless of the handpiece used, there should be copious irrigation with a syringe or through the handpiece with sterile saline solution. Enough overlying bone should be removed to expose the area around the apex and at least half the length of the root. Good access and visibility are important; the bony window must be adequate. The clinician should not be concerned about the bone removal because once the infection resolves, the bone will reform.

The exposure of the root is done before resecting the root to avoid the potential of blending the root in with the bone and losing surgical orientation. This is especially critical in the mandible where the bone is dense. Lower incisor roots are carefully exposed because the proximity with adjacent teeth could lead to treatment of the wrong apex. The curvature of the root, particularly the maxillary lateral incisor, demands close attention to avoid surgical misadventures.

Curettage

Most of the granulomatous, inflamed tissue surrounding the apex should be removed, using suitably sized sharp curette, to gain access and visibility of the apex, to obtain a biopsy for histologic examination (when indicated), and to minimize hemorrhage.

Often there is extensive debris that has been forced out the apex of the tooth during the initial endodontic therapy. Cleaning this out this debris removes what may have been the nidus for the acute and chronic infection.

Portions of inflamed tissue or epithelium may be left, without compromising healing; total removal is not necessary. It is better to leave a small portion of this tissue than to damage the inferior alveolar nerve.

Root end resection

Root end resection is indicated because it removes the region that most likely had the poorest obturation because of the distance from the coronal portion of the tooth. The presence of accessory canals increases at the apex as well, which may have not been initially cleaned and debrided, thereby leaving a source of continued infection.

The resection is done with tapered fissure bur. Depending on the location; a bevel of varying degrees is made in a faciolingual direction. With the use of ultrasonic instruments to prepare the apex, a minimal bevel is needed, especially in maxillary anterior teeth. By minimizing the length of the bevel, fewer dentinal tubules are exposed, thereby reducing leakage into the apical region.

The amount of root removed depends on the reason for performing the resection. Sufficient root apex must be removed to provide a larger surface and to expose

additional canals. In general, approximately 2 to 3 mm of the root is resected, and more if necessary for apical access or if an instrument is lodged in the apical region; less if too much removal would further compromise stability of an already short root. There is no consensus concerning the amount of root that has to be resected. An anatomic study of the root apex conducted at the University of Pennsylvania revealed that at least 3 mm of the root end must be removed to reduce 98% of the apical ramifications and 93% of the lateral canals.

Root end preparation and restoration

A retrograde filling should be placed in cases unless technical aspects prohibit it. The filling seals the canal system, preventing further leakage. The depth of the preparation must be at least 1 mm deeper than the length of the bevel to seal the apex adequately. In the past, root end preparation was done by slow-speed, specially designed micro-handpieces. The rotary instruments are too complicated to follow the root canal system, occasionally leading to misaligned preparations. Contemporary apical preparation uses ultrasonic tips.

Ultrasonic instruments offer the advantages of control and ease of use; they also permit less apical root removal in certain situations. Another advantage of the ultrasonic tips, particularly when diamond coated, is the formation of cleaner, better-shaped preparation. Evidence suggests that success rates are significantly improved with ultrasonic preparation. While preparing the apex with the ultrasonic instruments, constant saline irrigation is needed to avoid overheating, which causes fracture of these fine instruments. Various designs and shapes of tips are available to access different apices of each tooth in the oral cavity. The ease of use and special angulations require less of a bony opening and less beveling of the apical region and permit a deeper, denser fill.

Root end filling materials

The root end-filling material is placed into the cavity preparation. These materials should seal well and should be tissue tolerant, easily inserted, minimally affected by moisture, and visible radiographically. Importantly, the root end-filling material must be stable and non-resorbable.

Many filling materials have been used throughout the years and many do work well. The most contemporary material is MTA (mineral trioxide aggregate), which has been shown histologically to deposit bone around it. Its handling characteristics are somewhat different than other dental materials because it is hydrophilic and do not reach a full firm set for 2 to 4 hours; this is not clinically significant because the region is not load-bearing, at least for quite some time following the apical surgery. MTA has been shown to produce regeneration of cementum, something not seen with other root end filling materials.

The surgeon must be careful not to irrigate MTA out after placement, so irrigation is done before placing the filling, and any excess is wiped with a just dampened cotton pellet.

On the basis of published research, MTA is the material of choice for use in endodontic surgery, but new bioactive materials, such as bioceramic, seem to be equally reliable and probably more user friendly in clinical practice.

Flap replacement and suturing

Just before closure, the surgical site is flushed with copious amounts of sterile saline to remove soft and hard tissue debris, hemorrhage, blood clots, and excess root end-filling material. The flap is returned to its original position and is held with moderate digital pressure and moistened gauze. This expresses hemorrhage from under the flap and gives initial adaptation and more accurate suturing.

A sling suture is ideal in the esthetic zone to avoid gingival recession. After suturing, the flap should again be compressed digitally with moistened gauze for several minutes to express more hemorrhage. This limits postoperative swelling and promotes more rapid healing.

Postoperative instructions

Oral and written information should be supplied in simple, straightforward language. The wording should minimize anxiety arising from normal postoperative sequelae by describing the ways in which the patient can promote healing and comfort. Instructions inform the patient of what to expect (e.g., swelling, discomfort, possible discoloration, and some oozing of blood) and the ways in which these sequelae can be prevented, managed, or both. The surgical site should not be disturbed, and pressure should be maintained (cold packs over the surgical area until bedtime might help). Oral hygiene procedures are indicated everywhere except the surgical site; careful brushing and flossing may begin after 24 hours. Proper nutrition and fluid intake are important but should not traumatize the area.

A chlorhexidine rinse, twice daily, reduces bacterial count at the surgical site. This minimizes inflammation and enhances soft tissue healing. Analgesics are recommended, although pain is frequently minimal; strong analgesics are usually

not required. No category of pain medication is preferred; selection depends on the clinician and the patient. Analgesics for moderate pain usually suffice and are most effective if administered before the surgery or at least before the anesthetic wears off.

The patient is instructed to call if excessive swelling or pain is experienced. Postoperative complications are a response to injury from the procedure; infection after this type of surgical procedure is rare. However, the patient should be evaluated in person if there are difficulties. Occasionally, sutures have torn loose, a foreign body (e.g., a cotton pellet) is under the flap, or an overreaction of the soft tissues takes place. Again, antibiotics are not indicated; palliative or corrective treatment usually suffices.

Suture removal and evaluation

Sutures ordinarily are removed in 5 to 7 days if still present, with shorter periods being preferred to enhance healing. After 3 days, swelling and discomfort should be decreasing. In addition, there should be evidence of primary wound closure; tissues that were reflected should be in apposition. Occasionally, a loose or torn suture may result in non-adapted tissue. In these cases the margins are only readapted and re-sutured if in the maxillary anterior esthetic zone.

To perform biopsy or not

A clinical controversy has ensued over the consideration as to whether all periapical lesions treated surgically should have soft tissue removed and submitted for histologic evaluation.

Organizations such as the American Association of Endodontists have stated in their standards that if soft tissue can be recovered from the apical surgery that it must be submitted for pathologic evaluation. It seems that it is easier to make this recommendation than to have the surgeon determine if there is anything unusual about the case that warrants histologic examination.

There is a convincing argument against the submission of all tissues, because similar appearing radiolucencies that are not treated surgically do not have tissue retrieved for pathologic identification. It also is accepted that the differentiation

between a periapical granuloma or periapical cyst has no direct bearing on clinical outcomes and therefore cannot be used as a rationalization for the submission of tissue.

To solve this dilemma logically, certain guidelines have been set up for not to submit tissue for histopathological examination. These guidelines are:

- 1- Clear evidence of pre-existing endodontic involvement of a tooth (pulpal necrosis was present, not just a periapical radiolucency).
- 2- Unilocular radiolucency associated with apical one-third of the tooth.
- 3- Lesion is not in association with an impacted tooth.
- 4- No history of malignancy that could represent spread of a metastasis.
- 5- Patient will return for follow-up examinations and radiographs.
- 6- No tissue recovered at the time of surgery.

Determination of success

The treatment outcome of apical surgery should be assessed clinically and radiographically.

Clinical healing is based on the absence of signs and symptoms such as pain, sinus tract, swelling, apico-marginal communication, and tenderness to palpation or percussion.

Standard radiographic healing classes include complete healing, incomplete healing (“scar tissue formation”), uncertain healing (partial resolution of postsurgical radiolucency), and unsatisfactory healing (no change or an increase in postsurgical radiolucency).

An appropriate follow-up protocol is to obtain a repeat periapical film 3 months after surgery with critical comparison with the immediate postoperative film. If significant bone fill has occurred, mobility has decreased, pain is resolved, and no fistula is present, the case can proceed to the final restoration. However, if significant bone fill has not been noted, the patient should be recalled at 3 months for a new film. In contrast, any increase in the size of the radiolucency or no improvement should caution the dentist about making a final restoration. If the situation is not clear at that time (6 months postsurgically), a temporary restoration,

loaded for at least 3 months, is often a good test of the success of the surgery and predictive as to whether the final restoration will last for some time.

Microsurgical technique

True progress in apical surgery resulted from the introduction of microsurgical techniques in the mid-1990s. Microsurgical principles in apical surgery include production of a small osteotomy for access to the root end, resection of the root end perpendicular to the long axis of the root, inspection of the resected root face for microstructures, and preparation of a root-end microcavity. These surgical steps are important to minimize surgical trauma and to create optimal conditions for the subsequent root-end filling. Technical requirements for the performance of apical microsurgery include the use of magnification/illumination and microsurgical instruments.

Several authors have described the benefits of using a surgical microscope in apical surgery which include: inspection of the surgical field at high magnification, smaller osteotomy, identification of microstructures (additional canals, isthmus) and root integrity (cracks, fractures, perforations), distinction between bone and root, identification of adjacent important structures (roots of neighboring teeth, maxillary sinus, nasal cavity, mandibular canal, mental foramen, etc.). The use of a surgical microscope also requires an erect posture, thus reducing occupational and physical stress. In addition, video recordings of surgeries can be used for research, education or case documentation.

There is some controversy in the endodontic literature that the use of magnification may improve outcomes in surgical management of endodontic failures.

Although some clinicians advocate and are excited about the use of these microscopes, as yet there have not been demonstrated substantial clinical benefits through long-term controlled studies. However, some evidence suggests that the microscope use improves surgical techniques and short-term outcomes.

Fiberoptics

A new system, known as endoscopy, is available that uses a very small, flexible fiber bundle that contains a light and an optic system. The optics are connected to a

monitor that permits visualization of precise details of the surgical site. This system also gives the clinician the option of videotaping and recording procedures.

Guided tissue regeneration (GTR)

Originally intended for periodontal surgery, guided tissue regeneration also has been applied to endodontic surgery. The membranes used in this procedure are applied where defects have extended to cervical margins or as a covering of large defects surrounded by bone. These membranes, particularly those that are resorbable, may prove useful in selected situations. Yet evidence indicating their long-term effectiveness in endodontic surgery is incomplete, and studies have not shown an increase in bone density when a membrane is used.

Regarding the use of membranes results in long-term, substantial benefits have not been demonstrated. Authors' opinion is that the elimination of the source of infection permits regeneration of the junctional epithelium and healing without the use of membranes.

Bone augmentation

Various substances have been placed in the peri-radicular surgical cavities in the attempt to enhance bony healing. Because of the location of the cavity and because most of the periphery is encased in bone or periosteum, bone regeneration is predictable. Such augmentation materials are of minimal to no benefit and need not be placed. Because the materials are being placed in a site with active infection, these adjuncts may then act as a nidus for infection.

The one exception for this is in the case of a through-and-through lesion where a bone substitute and GTR may help to avoid healing of the defect site with granulation tissue.

Good Luck

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