ISSN No:-2456-2165

Endodontic Microsurgery

Shifali G

ISSN No:-2456-2165

ABSTRACT

Endodontic microsurgery is a part of dentistry that deals with the diagnosis and treatment of endodontic lesions that does not react to the traditional endodontic treatments.. Although the success rate for primary and secondary root canal therapy is 68%-85% and 70%- 86% respectively, In cases with damaged root performing RCT is impracticle. Therefore, an endodontist opts for an endodontic microsurgery as RCT.

Endodontic surgery has evolved into Endodontic Microsurgery. Microsurgical technique is a minimally invasive procedure resulting in faster healing and a better patient response. Endodontic microsurgery has a higher success rate than the traditional root canal therapy.

This procedure includes incision and reflection of the buccal mucosa followed by locating the apices of the root of the infected tooth by removing the buccal bone. Followed by removal of the infected periradicular tissue and root end resection. Finally, the root end cavity is obturated with Mineral Trioxide Aggregate (MTA) and the surgical site is sutured. This article will review the classes of microsurgical cases, indications, contraindications, microsurguical instruments used and the step by step procedure of Endodontic Microsurgery.

ISSN No:-2456-2165

CONTENTS

ISSN No:-2456-2165

CHAPTER 1

INTRODUCTION

In case of a tooth with severe decay or a cracked tooth with an inflamed or infected pulp, a dentist will always begin with a non surgical method of treatment called as Root Canal Treatment (RCT). If the root of the tooth in question is intact, a dentist will always go for a Root Canal Treatment but, if the root of the tooth is damaged and infection continues to reoccur the patient will be referred to an Endodontist. An Endodontist will opt for a surgical method of treatment.

A. What is Endodontic Microsurgery?

Endodontic Microsurgery is defined as the treatment performed on the root apices of an infected tooth, which was unresolved with conventional root canal therapy.

This dental procedure is carried out to treat apical periodontitis which cannot be treated via conservative orthograde endodontic treatment or non surgical retreatment.

The most common procedure in endodontic surgery is apicoectomy, which implies removal of the buccal bone in order to accurately locate the root apices of an infected tooth followed by surgical debridement of pathological peri-radicular tissue and removal of root-end resection and additional apical openings that could be the cause of the failure of endodontic therapy. Finally, the root-end cavity is obturated with Mineral Trioxide Aggregate (MTA) and the surgical site is sutured.

B. CLASSIFICATION OF ENDODONTIC MIROSURGERY CASES

1. **Class A** represents the absence of a periapical lesion, no mobility and normal pocket depth, but unresolved symptoms after non-surgical approaches have been exhausted. Clinical symptoms are the only reason for the surgery(13).
2. **Class B** represents the presence of a small periapical lesion together with clinical symptoms. The tooth has normal periodontal probing depth and no mobility. The teeth in this class are ideal candidates for microsurgery(13).
3. **Class C** teeth have a large periapical lesion progressing coronally but without periodontal pocket and mobility(13).
4. **Class D** are clinically similar to those in class C, but have deep periodontal pockets(13).
5. **Class E** teeth have a deep periapical lesion with an endodontic-periodontal communication to the apex but no obvious fracture(13).
6. **Class F** represents a tooth with an apical lesion and complete denudement of the buccal plate but no mobility(13).

Classes A, B and C present no significant treatment problems but, classes D, E and F present serious difficulties.

ISSN No:-2456-2165

Fig. 1: Surgical Classificaton

C. INDICATIONS

- In case of a persistent peri-radicular disease in an endodontically treated tooth and in cases where retreatment of the tooth is unsuccessful.
- When root filling materials have protruded beyond the root apex
- When it is necessary to directly visualise a possible vertical fracture.
- When a combination of both surgical and non surgical approach is required.
- In case of Peri-radicular disease which are associated with anatomical deviations such as S and C shaped canals, tortuous root, dilaceration, and calcifications preventing the non surgical retreatment of the tooth.
- In cases where biopsy of the peri-radicular tissue is required.
- In case of procedural errors such as instrument fractures, ledges, blockages, etc. which can not be corrected non surgically.

D. CONTRAINDICATIONS

- In case of a tooth that cannot be restored.
- If the patient is not willing to undergo the procedure.
- Presence of inadequate root length.
- Poor periodontal support, active severe periodontal disease and failed coronal restorations
- Anatomical factors such as maxillary sinus, close proximity to a neurovascular bundle, root configurations, lower second molars with thick cortical plates, and lingual inclination of roots.
- When traumatic occlusion cannot be corrected(10).
- Patient factors such as psychological issues or severe systemic diseases, uncontrolled diabetes, leukaemia, patients who have undergone cardiac therapy recently etc.
- Experience, skill, knowledge and level of training of the operator as well as the availability of appropriate equipment.
- When acute infections are non-responsive to the treatment(10).

ISSN No:-2456-2165

CHAPTER 2

PRINCIPLES OF ENDODONTIC MICROSURGERY

The triad of endodontic microsurgery encompasses magnification, illumination, and instruments(8). Microsurgery would not be possible without these elements (8).

Magnification and Illumination provided by the surgical operation microscope have radically changed the way endodontic surgery is performed(8).

With bright, focused light on a × 4 to × 31 magnified surgical site, the surgeon can see every detail of the apical structures and can execute treatment more precisely(8).

Instrumentation is the third element of triad. Working in a magnified surgical site requires a different set of surgical instruments(8). The standard endodontic surgical instruments are too large for the microsurgical approach(8). Ultrasonic tips, condensers, pluggers, curettes, and mirrors were reduced in size to comfortably fit into an osteotomy no larger than 5 mm to gain access to the canals(8).

ISSN No:-2456-2165

CHAPTER 3

STAGES OF ENDODONTIC MICROSURGERY

A. PRE-OPERATIVE CONSIDERATIONS

Clinical assessment prior to an endodontic surgical procedure must include

- *Medical History:* It is important to record the general medical condition of the patient. History of cardiac diseases, asthama, diabetes etc.
- *Dental History:* History of fillings, trauma, pain, swelling, RCT etc.
  - Intraoral: Caries, periodontal status, pockets, mobility etc
  - Extraoral: Inspection, palpation, auscultation of any swelling and/or sinus discharge.
- *Radiographical evaluation:* A precise radiograph displaying all roots, local anatomical structures, foreign bodies, the whole degree of any related lesion.
  - Non-Steroidal Anti-Inflammatory Drugs (NSAIDS) are given to the patient pre-operatively to help with post-operative pain relief. Intake of paracetamol along with NSAIDs provide enhanced pain control. To prevent excessive utilization of any analgesics, the investigators suggest shifting back and forth between paracetamol and ibuprofen every 4 to 6 hours(10).
  - Anxiolytics or psycholeptics results in calming effects.
  - Patients must be informed about the challenges, inconvenience and possible dangers before surgery while taking the consent(10).
  - Rinsing preoperatively with chlorhexidine gluconate (0.12%) is endorsed to decrease the microbial load in the surgical field, as it reduces 85% of bacterial flora in remaining last 4 hrs(10).

B. OPERATOR- PATIENT POSITIONING

The patient is positioned in a supine to slightly Trendelenberg position so that the surgical osteotomy site is most superior in the operating field. The patients head is stabalized(8).

The surgeon takes position at the head of the patient (11-12 O'clock). The operators chair is adjusted in a way that a 90° angle isformed between the thigh and the lower part of the foot.

The microscope is adjusted with the line of sight axis perpendicular to the soft tissue field of the intended flap, and the binocular eyepieces adjusted to a comfortable height relative to the operator(8).

C. MICROSURGICAL ARMAMENTARIUM

Microsurgical instruments have been developed for endodontic microsurgery.

- Micro-scalpels (N6900 Nordland blade, Micro Mini, Full Radius, G Hartzell& Sons, USA) are used to create incisions. Small, sharp, microsurgical periosteal elevators are then used under the DOM for atraumatic flap elevation.

Fig. 2: Comparision of conventional 15C blade (top) with a microsurgical blade (bottom)

ISSN No:-2456-2165

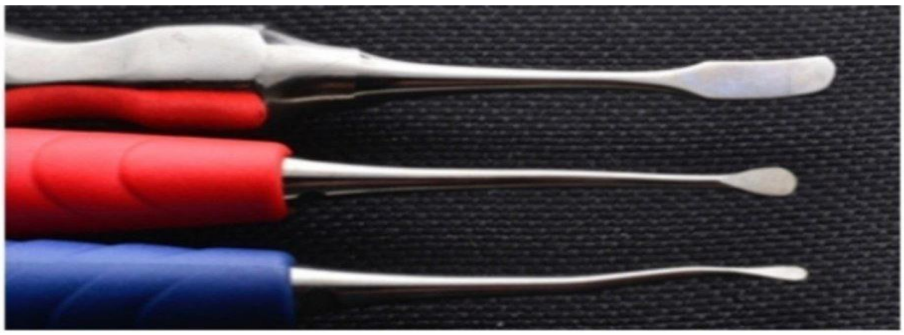


Fig. 3: Comparision of conventional periosteal elevator (top) with 2 microsurgical periosteal elevators

- Ultrasonic tips to prepare the root-end cavities
- Micro-mirros are used to examine the apical preparations

Fig. 4: Size Comparison of a conventional front surface mirror (left) with a micro-surgical 9 mm rectangular mirror (middle) and a 5 mm micro-surgical round mirror that can be used to examine the bevelled root apex

- Micro-surgical suturing techniques involve microsurgical gauged tapered needles, smaller sized sutures (5-0 and 6-0), microsurgical tissue forceps, microsurgical needle holder and microsurgical scissors

ISSN No:-2456-2165

Fig. 5: Size Comparison of a conventional surgical scissors (top) compared with a micro-surgical scissors (bottom)

Fig. 6: Size Comparison of a conventional needle holder (top) versus micro-surgical needle holder

Fig. 7: Size Comparison of a conventional surgical scissors (top) compared with a micro-surgical scissors (bottom)

Fig. 8: The Micro Apical Placement System (MAP)

Fig. 9: The Dovgan MTA Carrier

- Micro-Apical Placement System (MAP) or the jan MTA Carrier allows accurate placement of root-end fillings, such as MTA into the root-end cavity preparation.
- Endodontic Microscope- This device helps the dentist to assess the pathologicalchanges precisely and remove pathological lesions with far greater precision,thus minimizing tissue damage during the surgery.

In the past decades, the use of operating microscope for surgical endodontics has been one of the most significant developments in endodontics. The medical disciplines (e.g. neurosurgery, ENT and ophthalmology) incorporated the use of microscope for surgery 2 to 3 decade earlier than endodontists.

Benefits of an operating microscope in endodontic microsurgery is as follows:

- An endodontic microscope helps to inspect the surgical field at high magnification so that small but important anatomical details such as the extra apex or lateral canals, can be identified and managed.
- Helps to examine the integrity of the root with great precision
- Increased precision in removal of pathological lesion is precise.
- With methylene blue staining, at high magnification the distinction between the bone and the root tip can be made easily.
- At higher magnification, the size of the osteotomy can be reduced which aids in faster healing and reduces post-operative discomfort.
- Surgical techniques can be evaluated, e.g. whether the granulomatous tissue was completely removed from the bone crypt.
- With an operating microscope the surgeon can visualise and inspect the apices of the tooth directly and precisely, thus eliminating the need for radiographs.
- The entire procedure can be recorded for educational purposes and communication with the referring dentists.

Fig. 10: Dental Operating Microscope

ISSN No:-2456-2165

Magnification	Procedures
Low (×4 to ×8)	Orientation, inspection of the surgical site, osteotomy, alignment of surgical tips, root-end preparation, and suturing
Midrange (×8 to ×14)	Most surgical procedures including hemostasis. Removal of granulation tissue, detection of root tips, apicoectomy, root-end preparation, root-end filling
High (×14 to ×26)	Inspection of resected root surface and root-end filling, observation of fine anatomical details, documentation

Table 1: Magnification for different Surgery stages

➢ *DISTINCTION BETWEEN BONE AND ROOT TIP UNDER MICROSCOPE*

Once the access cavity has been prepared, the osteotomy should be examined carefully to ascertain if the root tip can be seen. The root is darker, yellowish in colour and is hard, whereas the bone is white, soft, and bleeds easily upon probing(13).

A. ANAESTHESIA AND HEMOSTASIS

The Goals of local anaesthetic during endodontic surgery are to achieve haemostasis, pain control, and post-surgical pain control.

Premedication with an NSAIDs such as ibuprofen 400 mg can be given 1hr prior to the procedure to patients who do not have any contraindications.

A pre-surgical rinse of chlorhexidine is recommended for 1 min prior to commencing surgery.

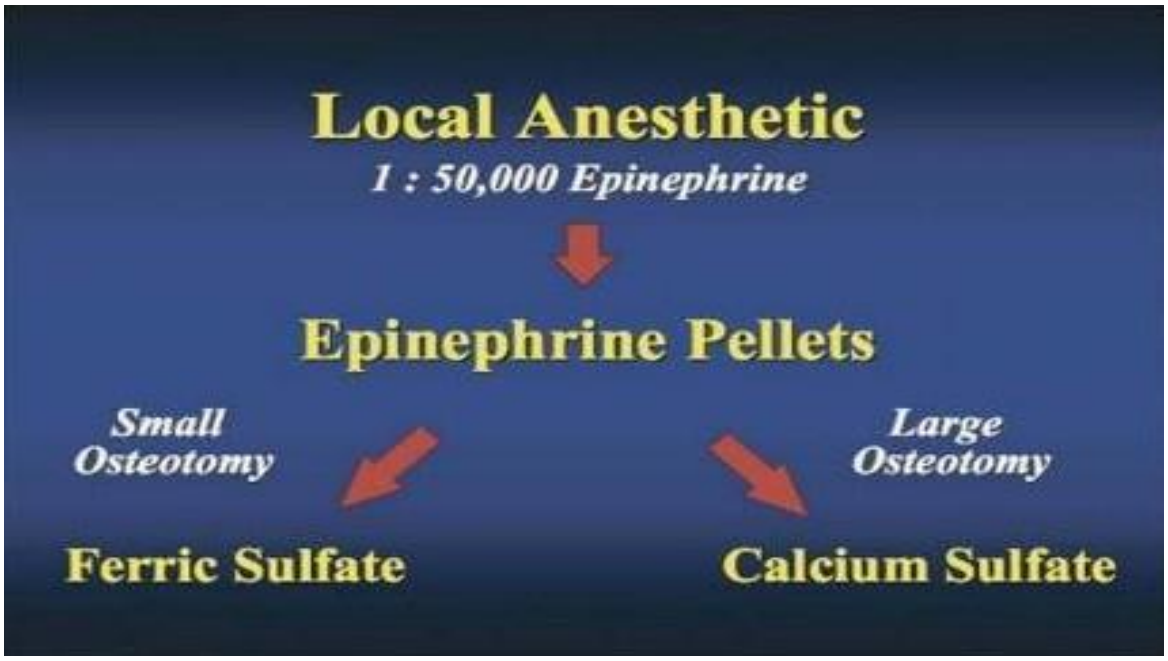
An anaesthetic with a high concentration of vasoconstrictor, for example 1:50,000 epinephrine, is preferred to obtain adequate anaesthesia and prolonged haemostasis.

Anaesthetic is injected slowly and steadily to allow diffusion and avoid accumulation in the submucosa. Kim and Kratchman (2006) recommend the application of epinephrine pellets into the bony crypt, followed by pressure to the pellets with sterile cotton pellets for two to four minutes to achieve prolonged haemostasis. In case of bleeding from bone, a cotton pellet soaked in ferric sulphate can be dabbed onto the area to further control haemostasis. In a large osteotomy site, calcium sulphate paste packed into the bony crypt is effective in achieving haemostasis, and can be left in place as it is resorbable.

ISSN No:-2456-2165

Hemostatic agents by mechanism of action	
Mechanical agents	Bone wax
Chemical agents	Vasoconstrictors (epinephrine)
	Ferric sulfate
Biological agents	Thrombin
Resorbable agents	Calcium sulfate
	Gelfoam
	Absorbable collagen
	Microfibrillar collagen
	Surgicel

Table 2: Hemostatic agents by mechanism of action



B. SOFT TISSUE MANAGEMENT

During an endodontic surgery, incision, elevation and reflection of a full thickness flap consisting of mucosal tissues, gingiva and periosteum in order to expose the cortical bone (1). It is Important that tissue incision, reflection and retraction allows for healing by primary intention. Soft tissue manipulation should avoid tearing, severing, trauma and desiccation(2).

Flap Design: The two flap designs currently recommended for apical microsurgery are the full sulcular flap in the posterior quadrants and submarginal in the anterior region.

The full sulcular flap is also known as the full thickness marginal flap. It includes a primary incision within the gingival sulcus following the contour of the teeth. It is triangular when only one vertical relieving incision is used, and rectangular when there are two such incisions.

The submarginal flap is rectangular with two vertical incisions and a scalloped horizontal incision within attached gingiva that follows the contour of the gingival margin. A minimum thickness of 2 mm of attached gingiva is a pre-requisite to performing the submarginal flap.

Fig. 11: Semilunar Flap Design

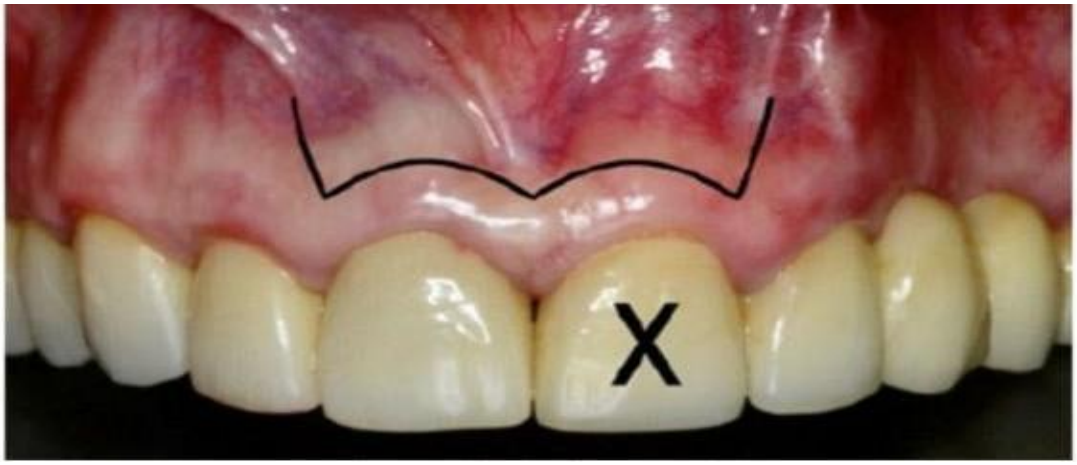


Fig. 12: Submarginal Flap Design

- *Reflection:* Soft tissue should be reflected slowly and carefully using an appropriate elevator (Molt no. 4 or Howarth's periosteal elevator), starting at the area of the vertical relieving incision. The elevator should be placed under the periosteum and should be in contact with underlying bone the entire time. A piece of gauze can be placed between the flap and the bone to protect the soft tissues while reflecting. The flap is carefully reflected using the sharp convex end of the elevator (2).

This is followed by placement of a retractor.

Extra care must be taken in regions of bony prominences, irregularities, concavities and areas of fenestrations where risk of tearing is high(2)

Fig. 13: Placement of a Retractor

ISSN No:-2456-2165

Fig. 14: Full Sulcular Flap Design

C. HARD TISSUE MANAGEMENT- OSTEOTOMY

Osteotomy involves the removal of cortical and cancellous bone to gain access to the apical portion of the tooth root. Due to enhanced magnification and illumination offered by the microscope, the diameter of the osteotomy can be reduced to 3 to 4mm which is just enough to allow an ultrasonic tip to vibrate freely within the bone cavity(1).

A constant stream of water or saline is required on the cutting surface of the bur to avoid overheating of the bone in order to prevent irreversible damage of bone. A round, steel bur with widely spaced flutes is recommended for bone removal to minimise bone chips.

A sharp bone curette is used for surgical curettage of peri-radicular soft tissue lesions, which can then be saved as a biopsy to be sent for histopathological examination(1).

D. ROOT-END RESECTION

Anatomical study of the root apex shows that a minimum of 3mm of root-end must be removed to reduce 98% of apical ramification and 93% of lateral canals.

The shape of the root outline can be oval, ovoid, reniform and various other irregular forms. The oval or ovoid shapes are frequently found in single roots while the more complex shapes, eg. Reniform shaped root outline is seen in roots of fused premolar or molar teeth(13). The entire root-end is resected during a surgery. In failed surgical cases, It is observed that most frequently only the buccal aspect of the root was resected leaving the lingual apex in situ. This results in a continuous infection from the lingual apex (13). This is more commonly seen in premolars and molars with fused roots. It can be avoided by staining the resected root surface with methylene blue (details in following section).

Some clinical guidelines during root resection are the following:

- Following resection of the root end, as there is often remaining granulation tissue behind the root tip, complete removal of all granulation tissue is facilitated,(12).
- Removal of anatomic variations such as apical deltas, accessory canals, apical ramifications, severe curves(12).
- Iatrogenic mishaps like perforations, strip perforations, ledges, blockages, separated instruments should be removed.
- Enhanced removal of the granulation tissue(12)
- Evaluation of the apical seal(12).
- Creation of an apical seal(12).

ISSN No:-2456-2165

- Access to the canal system when the coronal access is blocked or when coronal access with non-surgical re-treatment is determined to be impractical, time consuming, and too invasive(12).
- Reduction of fenestrated root apices(12).
- Evaluation for complete or incomplete vertical root fractures(12).

- BEVEL ANGLE: Traditionally a bevel angle of 45º- 60º was advocated so that the apex of the root could be visualised and accessed for root-end preparation(1). The modern technique advocates that the root-end be resected perpendicular to the root, resulting in a 0º- 10º bevel angle(1).

➢ *ADVANTAGES OF NOT CREATING A BEVEL:*
- Preservation of Greater length of root end.
- Less dentinal tubules are cut, thus reducing the microlekage of bacteria, microbes and their by-products from the root canal system.

➢ *DISADVANTAGES OF CREATING A BEVEL:*
- Results in a larger osteotomy.
- Lingually positioned apices are missed.
- Elongation of root canal.
- Weakened root as its diameter is reduced.

Microsurgical Technique	Traditional Technique
● No bevel or less than 10 degrees	● Acute Bevel (45–60 degrees)
● Expose few dentinal tubules	● Exposure many tubules
● Small osteotomy	● Large osteotomy
● Minimal loss of buccal plate	● Greater loss of buccal plate
● No danger of perio communication	● Great danger of perio communication
● Easy identification of apices	● Frequent missing of lingual apex
● No lingual perforation	● Easy lingual perforation

Table 3: Difference between microsurgical technique and traditional technique

E. ROOT-END PREPARATION

The ideal root-end preparation is a class I cavity, must be at least 3 mm into root dentin, with walls parallel to and within the anatomic outline of the root canal space (13).

Root-end preparation aims at removal of filling material, irritants, necrotic tissue, and remnants from the canals as well as the isthmus and creates a cavity that can be properly filled(13).

During ultrasonication if resistance is met, a typical high-pitch sound is produced, indicating that the tip is cutting against dentin(13). In such cases, the operator should stop the procedure, go to a low-range magnification of the microscope, realign the tip with the long axis of the root, and start again to avoid transportation or a perforation of the lingual or dentinal wall of the root.

ISSN No:-2456-2165

Root-end preparation begins with aligning a selected ultrasonic tip along the rootprominence on the buccal plate under low magnification(4-8) to ensure that the preparation follows the long axis of the root(13). The ultrasonic tip is aligned and preparation is carried out under midrange magnification(10-12).

Ultrasonic tips are used in a light, sweeping motion: short forward/backward and upward/downward strokes result in effective cutting action(13). Continuous pressure on the surface of the dentin is avoided. Interrupted strokes are more effective.
Once the apical preparation is complete, guttapercha should be compacted using a microcondenser and the preparation should be dried and inspected with a micromirror(13). There should be a dry and clean class I cavity coaxial to the root, with no debris or tissue remnants and no filling material left on the axial walls(13).

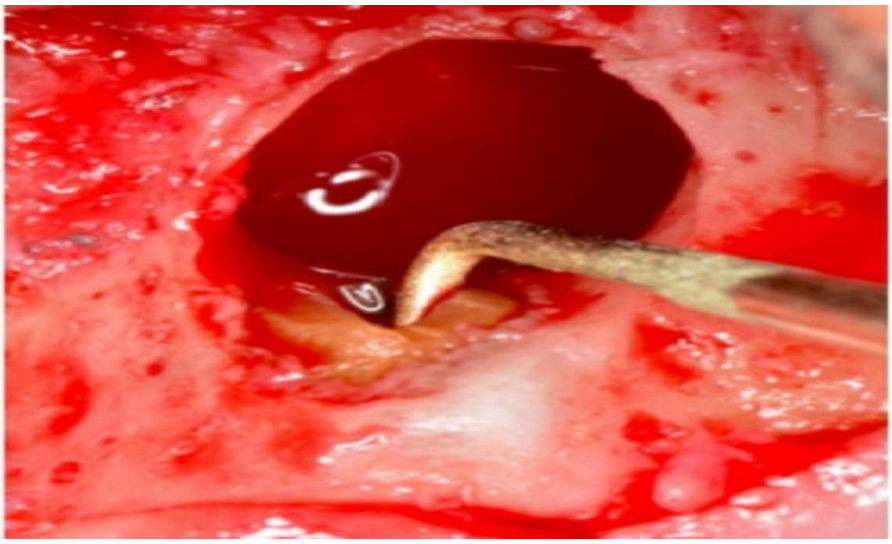


Fig. 15: Root end Preparation using Pro Ultra No 2 Surgical ultrasonic tip driven by an ultrasonic scaler

F. ROOT-END FILLING

Root-end filling is the last step of the surgical procedure.

The ideal root-end filling material should be

- Should be biocompatible
- Should be Bactericidal or at least bacteriostatic
- Should not be harmful to surrounding tissues.
- Should provide hermetic physical seal to prevent egress of microorganisms or their by-products from the root canal system into the periradicular tissues.
- Should promote regeneration of original tissue

Various materials like GIC, IRM, EBA, MTA, Retroplast, Geriostore, reinforced ZOE, composite resin, compomer, Diaket, cavit, Gutta-percha bioceramic cements are used as root-end fillings.

ISSN No:-2456-2165

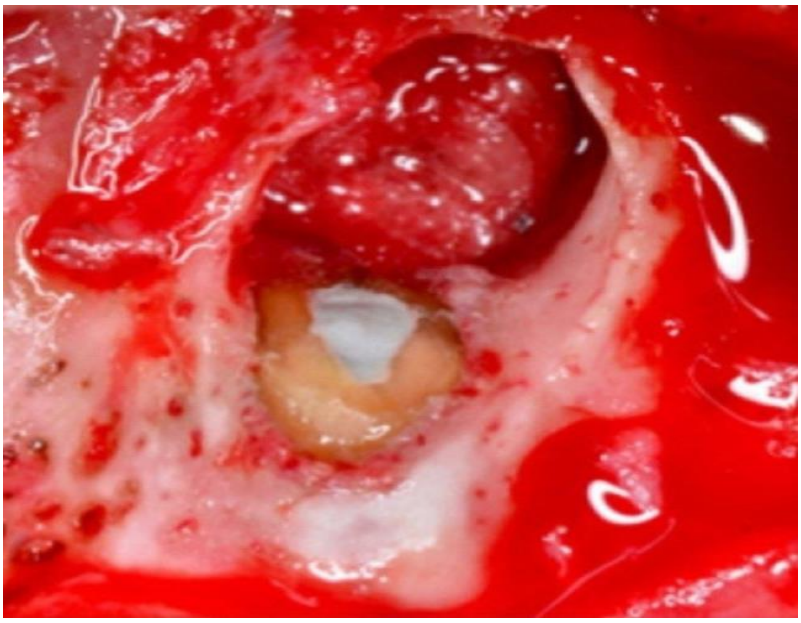


Fig. 16: Root end filling

G. SUTURING

A radiograph should be taken before concluding the suture site, to determine the status of the root end filling.

After cleansing the site of all debris and repositioning of flap, the flap is sutured. The flap should be sutured without tension to prevent necrosis at the site of incision with successive scarring or recession. Non-resorbable monofilament sutures are advised as they are less supportive of bacterial growth. Mild compression of the flap for a minute post closure confirms fibrin adhesion and might avert haematoma development.

As epithelial bridging and collagen cross-linking happens within the first 21-28 hours, removal of sutures at 3 days post operatively is suggested.

H. POST-OPERATIVE INSTRUCTIONS

Certain instructions are given to a patient who has undergone an endodontic microsurgery such as

- Avoid strenuous activity for 72 hours after surgery.
- Apply ice packs to your face – apply for a min, off for a few seconds. Apply for a period of 15 minutes , rest for 15 mins.
- Take medications as prescribed.
- Avoid smoking for a week as it can interfere with healing.
- Avoid drinking alchol.
- Avoid using a straw for 24 hours.
- Do not spit.
- Avoid eating hard food within 24 hours of the surgery.
- Do not brush your teeth for the first 24 hours after surgery.

ISSN No:-2456-2165

CHAPTER 4

DIFFERENCE BETWEEN TRADITIONAL AND MICROSURGICAL APPROACH

	Traditional Method	Microsurgical Method
Osteotomy size	Approx. 8-10 mm	3-4mm
Bevel angle degree	45º-65º	0º-10º
Inspection of resected root surface	None	Always
Isthmus identification and treatment	Impossible	Always
Root-end preparation	Seldom inside canal	Always within canal
Root-end preparation instruments	Bur	Ultrasonic tips
Root end filling materials	Amalgam	MTA
Sutures	4×0 silk	5×0, 6×0
Suture removal	7 days post op	2-3 days post op
Healing success	40-90%	85-96.8%

Table 4: DIFFERENCE BETWEEN TRADITIONAL AND MICROSURGICAL APPROACH

ISSN No:-2456-2165

CHAPTER 5

CONCLUSION

Although endodontic nonsurgical treatments have a high success rate of over 90%, in case of tooth with damaged root apex, perforated root, recurrent infections in treated tooth, root canal treatment is not effective. In such cases, the patient will experience pain and/or swelling in the treated tooth due to non healing endodontic lesions. When left untreated it can cause deterioration of the bone and tissues surrounding the root of the treated tooth. In order to avoid further complications endodontists advice undergoing endodontic microsurgery.

Endodontic surgery has evolved into Endodontic Microsurgery. Improved visibility and illumination using operating microscope, advances in ultrasonic instrument technology, and the development of biocompatible root-end filling materials have led to attain higher rate of success resulting in faster and more uniform healing. The ultimate goal of any endodontic procedure is preservation of our natural teeth.

REFERENCES

[1.] Micro-endodontic surgery - Part 1: Surgical rationale and modern techniques http://www.scielo.org.za/scielo.php?pid=S0011-85162018000300007&script=sci_arttext&tlng=en
[2.] Endodontic Microsurgery https://pocketdentistry.com/endodontic-microsurgery/
[3.] Advances in Endodontic Microsurgery Might Save Your Teeth https://www.google.co.in/amp/s/www.profendo.com/blog/advances-endodontic-microsurgery-might-save-teeth/amp/?espv=1
[4.] Endodontic Microsurgery https://www.endodonticspecialists.net/Endodontics/Procedures/EndodonticMicrosurgery.aspx
[5.] What is Endodontic Microsurgery http://drbudig.com/what-is-endodontic-microsurgery/
[6.] A new minimally invasive guided endodontic microsurgery by cone beam computed tomography and 3-dimensional printing technology https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6713074/
[7.] Endodontic Microsurgery: The Significance of Soft Tissue Management in Overall Success - American Association of Endodontists https://www.aae.org/specialty/communique/management-of-soft-tissue-in-microsurgical-endodontics/
[8.] Endodontic Microsurgery: An Overview https://www.dmrjournal.org/article.asp?issn=2348-1471;year=2015;volume=3;issue=2;spage=31;epage=37;aulast=Ananad
[9.] Root Canal Microsurgery http://m.mobilewebsiteserver.com/site/modernendocare?url=https%3A%2F%2Fmodernendocare.com%2Fendodontics%2Froot-canal-microsurgery%2F&utm_referrer=https%3A%2F%2Fwww.google.co.in%2F#2689
[10.] CONCEPTS AND PRACTICE OF MODERN ENDODONTIC SURGERY http://www.tmujdent.co.in/pdf/vol7issue4/issue%204%20final-6-11.pdf
[11.] Endodontic microsurgery: outcomes and prognostic factors https://link.springer.com/article/10.1007/s40496-019-00240-7
[12.] ENDODONTIC MICROSURGERY: PROCEDURAL STEPS https://bedentalexpert.com/wp-content/uploads/2021/09/Modern-Endodontic-Microsurgery-Concepts-A-Clinical-Update.pdf
[13.] Modern Endodontic Surgery Concepts and Practice: A Review https://www.aae.org/specialty/wp-content/uploads/sites/2/2017/07/fall2010_kim_modernendodonticsurgery.pdf