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Endodontic Microsurgery - A Narrative Review

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Abstract: ***Endodontic treatment aims to cure or prevent apical periodontitis caused by root canal infections. Microsurgical endodontics has significantly increased the success rate of endodontic surgery to around 90% through better visualization, precise preparation and filling, and conservation of bone and root length. The dental operating microscope provides bright, focused light and magnification for better visualization of the surgical site, and instruments have been reduced in size to fit comfortably into the osteotomy, allowing access to the canals. The use of dental operating microscopes in endodontic surgery has highlighted previous shortcomings and ushered in a new era of microsurgical techniques, resulting in less postoperative pain, edema, and faster wound healing. Continual scientific investigation is necessary for the evaluation and modification of techniques and materials used in endodontic surgery, emphasizing long - term outcomes***

Keywords: Endodontic treatment, Endodontic microsurgery, dental operating microscope

1. Introduction

Endodontic treatment aims to cure or prevent apical periodontitis caused by root canal infections. However, 33 to 60% of root - filled teeth may require nonsurgical retreatment, while endodontic surgery is reserved for persistent lesions, complex canal anatomy, extraradicular infections, or inadequate healing after nonsurgical retreatment.[1, 2]Traditional endodontic surgery has a success rate of 43% to 75% and is considered invasive and unpredictable due to its inability to remove all necrotic tissue and fill all complex apical ramifications.[3] Microsurgical endodontics, which combines the use of a microscope and microinstruments, has significantly increased the success rate of endodontic surgery to approximately 90%. Factors that influence the success of endodontic microsurgery include preoperative, intraoperative, and postoperative factors.[4]Advantages of microsurgery include precise root - end preparation and filling, conservation of bone and root length, and easy identification of anatomical details.

2. Principles

Endodontic microsurgery involves magnification, illumination, and instruments, all essential for precise treatment. The surgical operation microscope provides bright, focused light and magnification, allowing for better visualization of the surgical site. The size of osteotomies can be minimized with a zero - degree bevel, reducing apical ramifications and lateral canals.5Instruments, such as ultrasonic tips, condensers, pluggers, curettes, and mirrors, have been reduced in size to fit comfortably into the osteotomy, allowing access to the canals. The ultrasonic hand piece has proven to be advantageous in treating deeply fluted roots with an isthmus while reducing the risk of perforations compared to the conventional micro hand piece.

3. Indications

Although nonsurgical retreatment generally is believed to be the preferred first approach in the management of persistent apical periodontitis,[6] periradicular surgery is indicated when nonsurgical retreatment is impractical or unlikely to improve on the previous result

1) **Necessity for drainage**
   a) Elimination of toxic material
   b) Alleviation of pain
2) **Postoperative failure of conventional therapy**
   a) Obvious inadequate filling
   b) Apparently adequate filling
   c) Persistent postoperative discomfort
3) **Predictable failure with conventional therapy**
   a) Flaring apex
   b) Severely curved root end
   c) Internal, external, or apical resorption
   d) Fractures in the apical third
   e) Persistent infection
   f) Persistent suppuration or exudation
   g) Forecast of acute abscess
   h) Apical cyst
4) **Impracticality of conventional therapy**
   a) Porcelain jacket crown
   b) Fixed partial denture attachment
   c) Dowel - retention crown
   d) Excessive calcification
   e) Associated periodontal lesion
5) **Procedural accidents**
   a) Instrument fragmentation
   b) Perforation
   c) Over instrumentation
   d) Gross overfilling

Contraindications
Endodontic surgical therapy should not be used as a catchall solution for every endodontic case, or to cover up lack of

skill in nonsurgical techniques. It is not recommended for patients who are highly emotional or apprehensive, or who have debilitating or terminal diseases. Surgical inaccessibility, short root length, poor bony support, and missing cortical bone are all anatomic contraindications to endodontic surgery. Periapical surgery is not necessarily indicated for the presence of a periapical lesion, a large lesion, or because a lesion may become cystic.[7]

Osteotomy in Endodontic Microsurgery

An osteotomy involves removing the cortical plate to expose the root end, which should be approached carefully to ensure it is made exactly at the apices. Radiographs are taken to determine the length, curvature, position, and number of roots, as well as the proximity to adjacent teeth, the mental foramen, the mandibular nerve, and sinus space. Once the exact location of the apex is identified, the cortical bone is removed slowly and carefully using the H 161 Lindemann bone cutter and Impact Air 45 handpiece under low magnification with a water spray to minimize frictional heat. Microsurgical techniques allow for smaller osteotomies, just 3 - 4mm in diameter, using Columbia #13 and #14 curettes and Molten or Jacquette 34/35 curettes to remove granulation tissue under medium magnification (×10 to × 16). The microscope is used to distinguish the root tip from the surrounding bone, with the root having a darker, yellowish color and being hard, whereas the bone is white, soft, and bleeds when scraped with a probe. The use of the microscope allows for more conservative osteotomy, which results in faster healing and greater patient comfort. With the availability of microsurgical instruments, the size criteria for an osteotomy are just large enough to manipulate ultrasonic tips freely within the boney crypt. Since the length of an ultrasonictip is 3mm, the ideal diameter of an osteotomy is about 4mm, leaving just enough space to manipulate the ultrasonic tip and microinstruments within its confines.[8]

Ultrasonic TIPS for Cavity Prepration in Microsurgery

The conventional root - end cavity preparation technique using rotary burs in a micro – hand piece poses challenges for the surgeon, including difficult access to the root - end, high risk of perforation, insufficient depth and retention of filling material, exposure of dentinal tubules, and inability to remove necrotic isthmus tissue. The (Ultrasonic Root End Preparation) USREP procedure, carried out under a microscope at low to middle magnifications, involves using an ultrasonic tip with coolant to prepare the root - end.[9] The ideal root - end preparation can be defined as a Class I cavity at least 3 mm into root dentine, with walls parallel to and coincident with an anatomic outline of the root canal space.[10] In single canal roots, the tip is placed in the centre of the canal space and allowed to passively seek its way down the canal. In roots with multiple canals, they are prepared separately to establish the correct angulation, then the isthmus connecting them is prepared. Overall healing has been shown to be 92.5%, and a study comparing different ultrasonic diamond tips found no difference in their ability to provide regular apical cavity preparations[11]

Root End Materials Used

The properties that root - end filling materials should possess include biocompatibility, impervious sealing ability, and ease of use. Some materials that have been used for root - end fillings include gold foil, amalgam, gutta - percha, zinc oxide eugenol, composite, and polycarboxylate cement.[12] Gold foil was difficult to use due to cost and placement and finishing issues. Amalgam was commonly used but has potential disadvantages such as moisture sensitivity and leakage, corrosion, staining of tissues, and the need for an undercut in the retrograde cavity preparation. Gutta - percha has received little attention as a root - end filling due to its porous nature resulting in microleakage, but it has been reported to have a high success rate. Zinc oxide eugenol has been modified to improve its mechanical properties, and Super ethoxybenzoic acid and intermediate restorative material have been used as root - end filling materials with good sealing ability. Composite resin is hydrophobic and requires a dry field for predictable sealing. Polycarboxylate cement has the advantage of chemically bonding to tooth substance. Each material has its advantages and disadvantages, and the choice of material depends on the specific case and the preference of the clinician. Tricalcium silicate replaced the original formularisation of the Portland cement eliminating aluminium and trace elements. These new materials were developed and are based on radiopacifier and tricalcium silicate chemistry, which are recognised by their bioactivity and biocompatibility. **BioAggregate, Biodentine, Calcium enriched mixture cement (CEM), EndoSequence Root Repair Material Putty and Paste (ERRM), and iRoot BP Plus**Root Repair Material (BP - RRM) are examples of the new calcium silicate cements[13 - 18]

4. Recent Advances

Endodontic Microsurgery Using Guided Template

Using a guide template for endodontic microsurgery provides many advantages over freehand surgery, such as increased accuracy in locating the root apex, reduced surgical time and bone preparation volume, better post - operative healing, and fewer iatrogenic soft tissue damages. The guide template also reduces the risk of damaging vital structures during surgery.[19], [20]However, limitations include reduced accuracy when there is scattering artifact of CBCT caused by metal prosthesis and surgical access and vision being disturbed by lips and cheeks. The guide template was designed for implant placement, so its length of metal sleeve or drills may be inappropriate for root - end resection. The accuracy of the impression process also affects the accuracy of the guide template. High - precision impression material such as rubber impression materials may improve the accuracy of the guide template. Further clinical studies are needed to improve the accuracy and reduce surgical time, and a modeless guide template using an intraoral scanner is worth considering for easy application

Trephine Endodontic Microsurgery

TEMS is a technique that uses 3D - printed surgical guides and trephine burs to achieve precise control of osteotomy and rootend resection depth, diameter and angulation before the first incision. Studies suggest that TEMS offers increased accuracy and efficiency, although further research is needed to explore the nature of root surfaces after TEMS resection. TEMS allows for surgical treatment at sites that were previously difficult, and if the stent is properly seated, deviation from ideal under clinical conditions is minimized. In vivo comparisons of EMS and TEMS are needed, and

further research is indicated to investigate guide port length.[21]

Dynamic Navigation System

Dynamic navigation systems have been developed to improve the accuracy of dental implant placement and minimize iatrogenic damage to nearby structures. Navident is a portable system that offers real - time 3D control, reducing patient discomfort and improving healing. In vitro studies showed that Navident allows more accurate implant placement compared to the conventional freehand method, and it provides advantages to novice professionals. Dynamic navigation systems could also be used in endodontic procedures, including calcified canals, minimally invasive access cavity, and surgical endodontics. The system offers many advantages over static guides, such as the possibility to modify the plan during the procedure, precise angulation of the bur, and better posture for the clinician.[22 – 27]

5. Conclusion

The use of surgical operating microscopes in endodontic surgery has highlighted previous shortcomings and ushered in a new era of microsurgical techniques, along with new biologically acceptable materials. This minimally invasive approach results in less postoperative pain, edema, and faster wound healing, with a higher success rate than traditional methods. Continual scientific investigation is necessary to evaluate and modify concepts, techniques, and materials used in endodontic surgery, with an emphasis on long - term outcomes

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