REVIEW ARTICLE

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The New Era in Surgical Endodontics: Microsurgical Endodontics

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ABSTRACT:
The advancement of Dental Operating microscope since its first use in 1980 has taken the level beyond imagination and has now led to the beginning of a new era of microsurgical endodontics. Not only it increases the working efficiency of the practioner but due to its conservative approach it gives great benefit to the patient also.

Keywords: Apicectomy, Dental operating microscope (DOM), Microsurgical Endodontics, Root end preparation.

INTRODUCTION:

In the Modern era of 21th century, people have understood the importance of healthy teeth in their lives. Everybody emphasize on restoring and preserving the tooth rather than extraction. There has been a volcanic eruption of endodontic treatment in recent years because it is the best possible way to restore the tooth.[1] To overcome the failure rate of Traditional endodontics (feel not sight), there is recent advancement in surgical endodontics which is known as Microsurgical Endodontics. Magnification helps the user not only to see more, but to see well. High levels of magnification increase the aggregate amount of visual information available to endodontists for diagnosing and treating dental pathology.[2] Routine endodontic practice, confronts the dental practitioner with an enormous number of challenges.[3] Dental operating microscope provides better visualization to enhance visibility which helps in diagnosis and identification of complicated root canal systems.[4] It improves the efficiency in microsurgical endodontics and in endodontic procedures for effective cleaning, shaping and obturation which helps in faster healing.[3]

This article emphasizes on use of DOM in microsurgical endodontics and high-lighting its advantages over the traditional procedures.

Figure 1: Microsurgical Instruments

Dental operating microscope: The Historical Perspective

Surgical endodontic intervention has emerged over the past 150 years as a significant tool in Endodontic treatment.[5] In1595, Hans and Zacharias Jansen, Dutch businessmen were the first to introduce microscope and from then the journey of microsurgical endodontics began. In the middle of the 19th century, Surgical Operating Microscope (SOM) has been used in medical practice e.g. the field of ophthalmology and otolaryngology and for the first time used in oral surgical procedures in 1962. Dr Apotheker coined the term 'microdentistry' and introduced the Dental Operating Microscope (DOM). It was propagated by Carr, Kim, Pecora and Rubinstein. In 1999, Gary Carr launched an operating microscope with Galilean optics and that was ergonomically configured for dentistry.[6] From 2000, various advancements in microscopic accessories came in practice such as beam splitter, camera, LCD screen, video camera and HD cameras which further enlightened the path of microsurgical endodontics.[7]

Classification of Endodontic Micro-surgical cases

Classification of Endodontic Microsurgical cases given by Dr Kim, based on parameters like presence or absence of periapical lesion, pocket depth etc has been summarized as[8]:(Table 1)

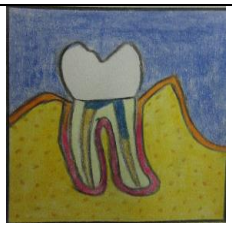
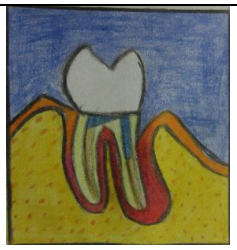
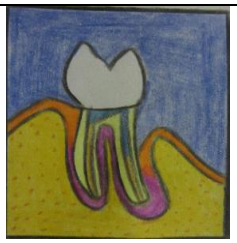
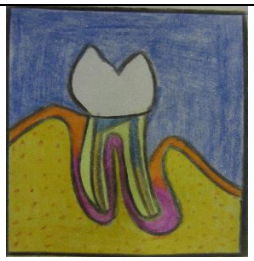
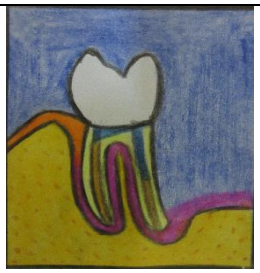
Indications of Microsurgical Endo-dontics[9] Indications for microsurgery when non-surgical endodontics has been unsuccessful are clear in many situations. For instance:

1. Adequately executed endodontics but failed with a persistent periapical radiolucent lesion.
2. Adequately executed endodontics with constant pain with or without swelling.
3. Apical transpotation, ledges and other iatrogenic problems with persistent pathology and symptoms.
4. Tooth with a large post and crown restoration completed maxillary anterior teeth.
5. Calcified canals with or without symptoms and PAR (Periapical radio-lucency).
6. Broken instrument in apical half of the root.
7. Failed traditional surgery.
8. Overfilled canal with Periapical radiolucency.
9. Complex/compound apical curvatures that are inaccessible from am orthograde approach.

Contraindications of Microsurgical Endodontics[10]

The contraindications to endodontic surgery are:

1. Systemic complications of patients like bleeding disorders, severe heart diseases (myocardial infarction) and medically immuno-compromised conditions should be managed before surgery is planned for the patient.
2. Lesions situated much closed to important anatomical structures like the inferior alveolar nerve, lingual nerve; mental foramen and maxillary sinus are at higher the risk of their damage.
3. Inadequate periodontal support and active uncontrollable periodontal disease. The successful outcome for isolated endodontic lesions is 95.2%.
4. Practitioner's/ Dentist's skill and expertise with microsurgical treatment also plays an important role.

Table 1: Classification of Endodontic Micro-surgical cases	
Class A: Represents the absence of a periapical lesion, no mobility and normal pocket depth, but unresolved symptoms after nonsurgical approaches have been exhausted.	
Class B: Represents the presence of a small periapical lesion together with clinical symptoms. The tooth has normal periodontal probing depth and no mobility.	
Class C: Teeth have a large periapical lesion progressing coronally but without periodontal pocket and mobility.	
Class D: Teeth are clinically similar to those in class C, but have deep periodontal pockets.	
Class E: Teeth have a deep periapical lesion with an endodontic periodontal communication to the apex but no obvious fracture.	
Class F: Total buccal fenestration present and shows absence of cortical plate.	

Anaesthesia and Hemostasis

Local anesthetics are widely used to provide regional analgesia for both surgical and non-surgical procedures. Local anesthetics are used to achieve three major goals in endodontic surgical procedures: (1) Anesthesia during surgery, (2) Hemostasis during surgery, (3)

Prolonged post-surgical pain control.[11] To anesthesize maxillary anterior teeth, bilateral anterior superior alveolar or infraorbital nerve block and for posterior teeth middle superior and posterior superior alveolar block are usually indicated. Whereas for mandibular anterior teeth, bilateral mental nerve blocks and for posterior teeth, inferior alveolar nerve block supplemented with a mental nerve trunk block are indicated. The control of hemorrhage to achieve dry field is a major concern during endodontic microsurgery.[11,12] Hemostasis in a surgical procedure can be considered Presurgical, Surgical and Postsurgical.[13] The use of long acting anesthesia decreases the risk of post operative pain.

Soft Tissue Management

The establishment of good surgical access, both visual and operative, is a requirement for all surgical procedures has been summarized in Table 2.

Principles and Guidelines for Flap design:[10,14]

Various flap designs have been recommended, each having its own set of advantages and limitations

Regardless of the design of the surgical flap, there are a number of cardinal principles that are paramount:

• The base of the flap should wider than free end to ensure adequate circulation into the flap.

• The sutured flap margins should rests on solid cortical bone plate.

• Avoid horizontal and severely angled vertical incisions.

• Incisions should be placed and flaps repositioned over solid bone.

• Avoid incisions across major muscle attachments.

• Incisions should be made with a fine, continuous stroke, perpendicular to the cortical bone plate.

• A sinus tract when present be included in the flap.

• Releasing incisions should be made between the bony eminences because tissue even such structures is thin and stretches and tears when sutured.

• The retracted flap should be held in position with passive pressure by means of a periosteal elevator pressed against underlying solid bone.

• Flap should generally extend one or two teeth laterally to allow for relaxed retraction and prevent stretching and tearing.

Retractors for Endodontic Micro-surgery[8]

Kim-Pecora (KP) retractors were designed specifically for endodontic microsurgery. They have wider (15 mm) and thinner (0.5 mm) serrated working ends than standard retractors. These can be concave or convex to accommodate the irregular contours of the buccal plate.

Triangular flap: It entails a full sulcular incision at least one tooth mesial and distal of the intended surgical field. The blade tip is in contact with the crest of alveolar bone throughout the incision, severing the periosteum, and carried through the sulcus and into each interdental papilla.

The Ochsenbein-Luebke flap: It was designed for maxillary anteriors because of exposure of crown margins or gingival recession following apical surgery. The specific instruments are called as pocket markers used to mapped sulcus depths and incision is made 2-3 mm apical to markers

Table 2: Flap design for Endodontic Microsurgery	
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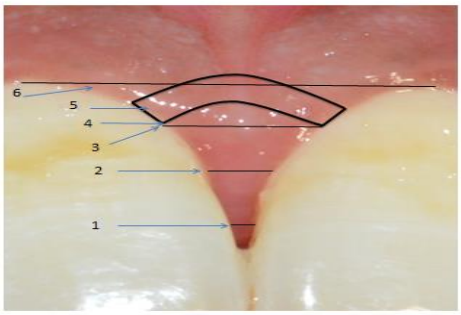
Papilla based Flap: Also called a hybrid variation of a full sulcular and split thickness incision. It and has been suggested to prevent the gingival recession seen with given above flap designs.	



1. Top of the papilla.
2. Apical third of papilla.
3. Middle third of papilla.
4. 90° incision beginning.
5. Vertical incision.

Figure 2: Papillary incisions of delLembo "Papilla Base" Flap (acc. Velvart):

in a scalloped fashion to mimic the contour of the respective gingival crests.

Papilla based Flap: Also called a hybrid variation of a full sulcular and split thickness incision. It and has been suggested to prevent the gingival recession seen with given above flap designs.

Hard tissue management

The aim of surgical endodontics is to restore the integrity of the supporting tissues of a tooth.

a) Osteotomy and Apicoectomy

Osteotomy is a surgical removal of bone. Apicoectomy is the surgical removal of the

apical portion of a tooth. Objectives of apicoectomy is to eliminate the 'apical delta' of minor root canals that cannot be effectively sealed by conventional endodontics.[15]

The microsurgical instruments uses smaller instruments, resulting in a smaller oseotomy, less healthy tissue damage, faster healing and fewer complications in contrast to conventional approach. The size criterion for an osteotomy is "just large enough to manipulate ultrasonic tips freely within the bone crypt".[8] The length of the ultrasonic tip is 3mm, so the ideal diameter of the osteotomy is about 4mm. An apicoectomy with a minimal bevel angle enables to prevent; a potential endodontic - periodontic communication; minimizes the removal of the plate results in a more stable tooth and faster healing of the osteotomy; exposes fewer dentinal tubules and prevents excessive leakage and contamination. But in some cases, a 0° bevel is not possible as in mesiolingual root of the mandibular first molar. In such cases, the surgeon should use 10° bevel.[8,16]

Traditional Root end preparation techniques

The osteotomy is quite large which encroached the coronal border of the alveolar bone, resulting in a periodontal-endodontic communication. They were also too shallow, causing them to get dislodged.

Modern Root end preparation Technique

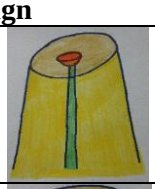
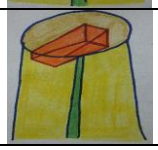
The osteotomy size depends strictly on the size of the ultrasonic tips; an additional 1 mm is added to the size so that the tip can be manipulated freely in the bone crypt. Hence, the size of osteotomy need not be larger than 4 to 5 mm diameter.[8,19]

Piezosurgery instruments can also be used for osteotomy, root end resection and root end preparation, but there are no published data available on the effect of piezosurgery on the outcomes of endodontic surgery.[17]

b) Root End Preparation

The main objective of apical surgery is to create an optimal environment for periradicular tissue healing. For this purpose, a retrograde cavity is prepared following root-end resection, and a filling material is placed into this cavity to completely seal the root canal system at the resection level.[18] Various designs have been prepared for conventional root end cavity which have been summarized in Table 3.

Table 3: Root end cavity design

Funnel shaped cavity	
Conventional Class I cavity. This design causes less leakage.	
Slot shaped cavity	

Root end filling Materials

Endodontic microsurgery has advanced to such a level of sophistication and precision that the demand for creating the ideal retrograde filling material is even greater than before.[8] A plethora of root end filling materials have been used so far in the field, most of common of these have been declared in Table 4.

Table 4: Root end filling material	
Amalgam[21]	It is the most extensively used retrofilling material from past seven decades, but one of the first reports of placing it as a root-end filling subsequent to resection is attributed to Farrar (1884)
Zinc oxide Eugenol (ZOE) and Reinforced ZOE cements[21]	The use of ZOE as a root end sealing agent in periradicular surgery has limited documentation.
Guttapercha	Orthograde gutta-percha root canal obturation that is associated with apical surgery is burnished after apicoectomy with a burnisher.
Cavit	It is a Zinc oxide based temporary filling material.
Gold foil	The first report of its use as a root end filling material is attributed to Schuster in 1913 and Lyons in 1920.
Polycarboxylate cement	It was introduced by Smith in 1968.
Zinc phosphate cement	Rhein in 1897 used zinc phosphate cement along with guttapercha to seal the root canal system.
Glass ionomer cement (GIC)[22]	It is easy to handle and does not cause any adverse histological reaction in the periapical tissue.
Composite resin[23]	Composite resins due to their cytotoxic or irritating effects on pulp tissue.
Calcium Phosphate Cement (CPC)	Developed by ADA-Paffenbarger Dental Research Centre at the United States National Institute of Standards and Technology, CPC is mixture of two calcium phosphate compounds, one acidic and the other basic.
Mineral Trioxide Aggregate (MTA) [24]	MTA was developed at Loma Linda University, USA in 1993.
Biodentine[25,26]	Biodentine was developed by Prof Gilles Richard from Septodont's Research Group in 2010 as a new class of dental material.
Endosequence root repair material (ERRM) [27]	Recently, ERRM putty and paste (Brasseler USA, Savannah, GA, USA) have been developed as ready-to-use
Bioaggregate[27]	Bioaggregate appears to be a modified or synthetic version of original MTA.
iRoot BP Plus bioceramic putty[27]	iRoot BP Plus (Innovative BioCeramix Inc., Vancouver, Canada) is a fully laboratory-synthesized, water-based bioceramic cement.
Novel root-end filling material[27]	A novel resin based root-end filling material (termed New resin cement, NRC) has been introduced. NRC is a powder and liquid system.
EndoBinder[27]	A new calcium aluminate-based endodontic cement, called EndoBinder.
Generex A[27]	Generex A (Dentsply Tulsa Dental Specialties, Tulsa, OK, USA) is a calcium-silicate-based material that has some similarities to ProRoot MTA.
Capasio[27]	Capasio (Primus Consulting, Bradenton, FL, USA) is composed primarily of bismuth oxide, dental glass, and calcium alumino-silicate with a silica and polyvinyl acetatebased gel.
Quick-Set[27]	Recently, Capasio powder has been refined and renamed as Quick-Set.
Novel root-end filling material using epoxy resin and Portland cement (EPC) [27]	EPC, a novel composite made from a mixture of epoxy resin and Portland cement, was found to be a useful material for root-end filling.

Suturing

The primary function of sutures is to help to stabilize the flap during the healing phases without imposing needless traction on the soft tissue.[28] Most commonly used suturing techniques used in microsurgical endodontics are described in Table 5.[29,30]

Table 5: Suturing technique
Interrupted sutures: Used for the vertical releasing incision. a) **The Simple Loop** is the most commonly used technique in dentistry and is routinely used for tension-free, mobile surgical flaps. b) **The Figure-8** is placed similarly to the simple loop on the buccal aspect and on the lingual aspect.
Sling sutures: The interrupted suspensory suture, commonly referred to as the sling suture.

CONCLUSION

Endodontic surgery has now evolved into endodontic microsurgery. The introduction of the microscope into precision dental practice is one of the greatest advances seen in modern dentistry. Ironically, the impetus for the evolution of contemporary surgical endodontic principles came from a better understanding of the challenges faced in the cleaning, shaping, disinfection and obturating the complex and unpredictable anatomy of the root canal system.Coupled with the introduction of magnification through the use of the Surgical Operating Microscope, refined principles of soft and hard tissue management, use of tissue regenerative root end fill materials and enhanced principles of wound closure and postoperative management have contributed to the increase in success rate. We must consistently learn and teach microsurgery to all endodontists so that they can treat nonsurgical as well as surgical endodontic cases with equal ease and skill. All these equipments cannot replace experience, knowledge and clinical skill. So we have to strike a balance between technological advancement and clinical skills so as to achieve excellence.[31]

REFERENCES

1. Ruddle CJ. Micro endodontic nonsurgical retreatment. Dent Clin North Am 1997;41(3):429-54.
2. Das UK, Das S. Dental Operating microscope in Endodontics-A review. J Dent Med Sci 2013;5(6):1-8.
3. Clauder T. The Dental Microscope: An Indispensable Tool in Endodontic Practice. The Microscope in Dentistry, USA, Philadephia.
4. Von Arx T, Walker WA. Microsurgical instruments for root-end cavity preparartion following apicoectomy: A literature review. Endod Dent Traumatol 2000; 16:47-62.
5. Gutmann JL. Surgical endodontics: past, present and future. Endod Topics 2014; 30(1):29-43.
6. Rubinstein. Magnification and illumination in apical surgery.Endodontic topics 2005;11:56-77.
7. Glenn A, Van AS. Digital documentation and the dental operating

microscope: What you see is what you get. Int J Microdent 2009; 1:30-41.
8. Kim et al. A Color atlas of Endodontic microsurgery.
9. Endodontics collegues for excellence. Fall 2010.
10. Grossman, Oliet, Del Rio. Endodontic practice. 11th edition.
11. Hargreaves KM, Khan A. Surgical preparation: anesthesia and hemostasis. Endodontic Topics 2005;11:32-55.
12. Maestreferrin L, Diago MP. Hemostatic agents used in periapical surgery: a review. J Clin Exp Dent 2011; 3(4):e310-3.
13. Inamdar S, Sureshchander B. Blood-less operating Field- An endodontists's enigma: Hemastasis in periradicular surgery- A review. Endodontology 2003; 15:42-4.
14. Ingle. Endodontics. 5th edition.
15. Matthew IR. Surgical endodontics. Oral and maxillofacial surgery 2007:67-82.
16. Kim. Modern endodontic surgery concepts and practice: A review. J Endod 2006; 32:601-23.
17. Abella F, De Ribot J, Doria G, Duran-Sindreu F, Roig M. Applications of piezoelectric surgery in endodontic surgery: a literature review. J Endod 2014; 40(3):325-32.
18. Von Arx T, Saeed M. The use of regenerative techniques in apical surgery: A literature review. Saudi Dent J 2011; 23:113–27.
19. Carr. Ultrasonic root end preparartion. Dent Clin N Am 1997; 41(3):541-4.
20. Aggarwal V, Nayak D, Sharma M, Reddy YG, Singla M, Nanda Z. Comparative evaluation of different retrograde cavity designs of amalgam for assessment of micro-leakage by dyepenetration method - An in vitro study. Endodontology: 91-9.
21. Vasudev, Goel, Tyagi. Root end filling materials- A review. Endodontology 2003; 15:12-8.
22. De Bruyne MA, De Moor RJ. The use of glass ionomer cements in conventional and surgical endodontics. IntEndod J 2004; 37(2):91-104.
23. Bodrumlu E. Biocompatibility of retrograde root filling materials: A review. Aust Endod J 2008; 34(1):30-5.
24.Camilleri J. Hydration characteristics of Calcium silicate cements with alternative radiopacifiers used as Root-end filling materials. J Endod 2010; 36(3):502-8.
25. Biodentine: A typical love story. Dental Tribune 2010; United Kingdom Ed Oct:4-10.
26. Biodentine: Active biosilicate Tech-nology. R&D Department. Septodont.
27. Saxena P, Gupta SK, Newaskar V. Biocompatibility of root-end materials: Recent update. Restor Dent Endod 2013; 38(3):119-27.
28. SandroSiervo. Suturing Techniques In Oral Surgery. Illustrations By Luisa Lorenzini; Quintessenza Edizioni.
29. Silverstein LH, Kurtzman GM, Shatz PC. Suturing for optimal soft tissue management. J Oral Implant 2009; 35(2):82-90.
30. Velvart P, Peters CI, Peters OA. Soft tissue management: suturing and wound closure. Endodontic Topics 2005; 11(1):179-95.
31. Gutmann J. Surgical endodontics: quo vadis? Endodontic Topics 2005;11(1):1-3.

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