Review Article

Microsurgical Endodontics: Modernization in an Endodontic Era

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Abstract

The classic view that endodontic surgery is a last reserve is based on past experience with collateral unsuitable surgical instruments, inadequate vision, frequent postoperative complications, and failures that often resulted in extraction of the tooth. Thereby, the surgical approach to endodontic therapy, or surgical endodontics, was taught with minimum enthusiasm at dental schools and was practiced by very few in private practices. Stated simply, endodontic surgery was not considered to be important within the endodontist domain. In this review, we attempted to provide the most current concepts, instruments, techniques, and materials. The ultimate goal is to assertively teach the future generation of graduate students and to introduce themselves to the new era of microsurgical endodontics and also train our colleagues to incorporate these techniques and concepts for lucrative healing and much better prognosis. Endodontic microsurgery has emerged as predictable treatment option which can be performed with accuracy with advanced microsurgical instrument and magnification, giving an option to the tooth that earlier used to be considered for extraction. The concurrent development of better techniques has resulted in greater understanding of the apical anatomy, greater treatment success, and a more favorable patient response. These developments marked the beginning of the endodontic microsurgery era that began in the 1990s. There is a considerable difference in surgery outcome between those using the dental operating microscope and those do not. Use of advanced techniques and technologies like a microscope, specially designed microinstruments, newer advanced and biocompatible root end filling materials help faster wound healing with lesser post-operative complication.

Keywords: Dental operating microscope, Magnification, Illumination microsurgery.

Introduction

Although non-surgical endodontic treatment is a highly, generally agreed and predictable option in most cases, surgery might be necessary for teeth with persistent periradicular pathosis which has not responded to nonsurgical approaches. Endodontic surgery including root end resection has been practiced since the 1800s. In 1906, Schamberbg described use of radiographs to assist diagnosis and use of surgical burs to perform a rapid osteotomy and root end "ablation."[1] Endodontic surgery is perceived difficult because the surgeon must often acknowledge the location of anatomical structures such as large blood vessels, the mental foramen, the maxillary sinus, and the exit and entry point of nerves in the area. Due to the invasive nature and questionable outcome of traditional surgery and chances of damage to these structures, traditional surgeries do not have a positive image in dental profession.[2]

Preservation of natural teeth is one of the ultimate goals of modern dentistry. Peri-radicular surgery includes three critical steps:

1. Surgical debridement of pathological periradicular tissue
2. Root-end resection (apicoectomy)
3. Retrograde root canal obturation (root end fillings).

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The ideal root end filling material should be bactericidal or bacteriostatic at least, biocompatible, should provide excellent sealing, should be neutral to neighboring tissues, plus it should promote regeneration of the original tissues.[2]

Objectives of root-end resection and root-end obturation are shown in Table 1.[3]

Principles of Endodontic Microsurgery

The triad of endodontic microsurgery encompasses magnification, illumination, and instruments. In the absence of any of these elements, microsurgery could not be possible. Magnification and illumination are provided by surgical operating microscope and have fundamentally transformed the way of endodontic microsurgery performance.[4] Some differences between

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Table 1: Objectives of root-end resection (apicoectomy)

Objectives of root-end resection (apicoectomy)	Objectives of root-end obturation
Surgical removal of apical delta (root canal ramifications)	Removing irritants during root-end cavity preparation
Enhancement of access to apex	Preventing penetration of microorganisms and their by-products from the root canal into the periapical region
Facilitate debridement of periapical tissue	
Creation of a working surface for retrograde preparation and observation of resected root end for the presence of vertical fractures	Optimizing conditions for periapical tissue healing including regeneration of attachment apparatus

traditional and microsurgical approaches given in Table 2. With bright, focused light on a 4× to 31× magnified surgical site, the surgeons can appreciate every detail of apical anatomy and can execute treatment precisely and it resulted in smaller osteotomies which are beneficial for healing.[5]

Third factor of the triad i.e. instrumentation: working in a magnified surgical site demands a different set of instruments. Ultrasonic tips, curettes, pluggers, condensers, and mirrors were reduced in size to comfortably fit into an osteotomy no larger than 5 mm to gain access to the canals.[6]

The operating microscope; why is it essential for microsurgery?

Microsurgery is defined as a surgical procedure on exceptionally small and complex structures with an operating microscope. The dental operating microscope enables surgeon to assess pathological changes more accurately and to remove pathological lesion with great precision, thus decreasing tissue damage during surgery.[7]

The operating microscope provides crucial assets for endodontic microsurgery in the following ways:

1. Removal of diseased tissue is exact and complete
2. Dissimilarity between the bone and root tip can easily be made at high magnification, especially with methylene blue staining
3. The surgical field can be examined at high magnification so that minute but crucial anatomical details, for example, extra apex or lateral canals can be identified and managed. In addition, the integrity of the root can be examined with great precision for fractures, perforations, or other signs of damage.
4. At higher magnification, the osteotomy can be made small (3–4 mm) and this results in faster healing and less post-operative discomfort.
5. Physical and occupational stress is decreased since using microscope requires an erect posture. In addition, the clinical environment is less stressful when clinician can clearly appreciate the operating field.
6. Surgical techniques can be inspected, for example, whether the granulomatous tissue was completely removed from bone crypt.
7. Communication with referring dentists is improved significantly.
8. The video recordings or digital recordings of procedures can be used effectively for education of students and patients.
9. The number of radiographs may be reduced or may be eliminated because the surgeon can appreciate the apex or apices directly and exactly.

Table 2: Differences between traditional and microsurgical approaches[17]

Differentiating factors	Traditional	Microsurgery
Identification of the apex	Difficult	Precise
Osteotomy size	Approx. 8–10 mm	3–4 mm
Inspection of resected root surface	None	Always
Bevel angle	Large (45°)	Small (<10°)
Isthmus identification and treatment	Impossible	Always
Root-end preparation	Bur	Precise (always within canal)
Root-end preparation Instrument	Imprecise	ultrasonic tips
Rootend filling material	Approximate (seldom inside canal)	Precise
Sutures	4×0 Silk	5×0, 6×0 monofilament
Suture removal	7 days post-operative	2–3 days post-operative
Healing success (over 1 year)	40–90%	85–96.8%

Inspecting the resected root surface with the highest magnification of the microscope is not enough. To completely see all the critical anatomical details of root surface, it has to be stained with methylene blue, comparison between microsurgical and traditional technique is shown in Table 3.[8]

The microscope does not enhance admittance to the surgical field. If access is limited for traditional surgery, it will also be limited when the microscope is placed between surgeon and surgical site.

However, the dental operating microscope creates a much better view of surgical site by enhanced magnification and highly focused illumination. Due to the fact that vision is greatly enhanced, cases can be treated with a high degree of confidence and accuracy.[9]

Microsurgical instruments are classified into following groups:

1. Examination and inspection
2. Incision, elevation, and curettage
3. Retraction
4. Osteotomy and root resection
5. Root-end preparation
6. Retro-fill instruments
7. Irrigation
8. Suturing.

Table 3: Comparison of bevel angles created by microsurgical and traditional techniques[17]

Microsurgical technique	Traditional technique
No bevel or<10°	Acute bevel (45–60°)
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

Discussion

Examination and inspection

Micromirrors

It's a double ended instrument. One end is 90° bent with 2 mm tip and other end is 130° for identifying areas of leakage and also to distinguish a fracture line or craze line. Hence, for sounding the cortical plate and locating the apex, micro-explorers are ideal.[10]

Incision, elevation and curetting instruments

15 C blade and handle

Small enough to manage interproximal papilla, large enough to create a vertical releasing incision and that also in one stroke. Also, periosteal elevators small enough to access into the field and elevate the smaller and sufficient amount of soft tissue.[11]

Prichard PRP3

For separating and retracting soft tissue away from bone. Smaller tissue forceps to hold the soft tissue in surgical site.

MAR curette

These are available as MAR-C1, MAR-C2, MAR-C3, and MAR-C4.

Straight MAR curettes

These are available as MAR-SC1, MAR-SC2, MAR-SC3, and MAR-SC4.

Elevators

A thin, sharp, triangular beak on one end and a sharp rounded beak that varies in size on the other end. These edges and points to allow the precise and complete soft tissues elevation with least trauma. For example, Molts curette no 2 / 4, Mini curette and Mini molt curette, Buser periosteal elevator, Endodontic curette, Columbia no. 13 / 14 curette.[12-17]

Dental cart

The cart is a compact, all in one unit with the essential built in. It has high- and low-speed handpiece parts, a tank for sterilized water, an ultrasonic unit, a Stropko irrigator/drier. This is valuable piece of equipment for modern microsurgery practice.[17,22]

Ultrasonic unit and tips

Most widely used three ultrasonic tips are first designed by Dr. Garry Carr and those tips are known as Carr tips or CTs. These are 1 / 4 mm in diameter and about 1 / 10 the size of a conventional micro-head handpiece. CT1 and CT5 have same design but CT5 is sharply pointed. Mainly for maxillary and mandibular anterior teeth. CT2 and CT3 have double angle to work in posterior teeth.[17,22]

Next generation microsurgical tips: Kim Surgical (KiS) ultrasonic tips

They are coated with zirconium nitride and have an irrigation port near tip rather than shaft (like CTs) with 3 mm of curetting tip. These advanced tips cut faster and smoother and cause few microfractures. These are JE Tips, Pro Ultrasonic Tips, and Diamond Coated tips. There are actually a wide range of carrier instruments for retro-fill material placement called as "Retro-fill Carriers," such as MAP system, Teflon sleeve& plugger, Micro-plugger & condenser, Microsurgical condenser/ burnisher, Irrigation Instruments.[15,17,22]

Selection of suture material

Ideal suture material should be pliable for ease of handling, knot tying, it should discourage bacterial growth, it should have smooth surface which discourages bacterial growth and wicking of oral fluids, a reasonable cost. Most commonly used size is 5-0. Resorbable suture material is not routinely used, it is used only when sutures are in the accessible areas. Gut suture materials are packed in isopropyl alcohol. By immersion in sterile water for 3–5 min before use improves handling properties of material.[1,21]

Surgical hemostats: Bone wax, epinephrine cotton, and ferric sulfate. Resorbable agents: Calcium sulfate, gelfoam, absorbable collagen, and microfibrillar collagen, surgical and biological agents: Thrombin.

Osteotomy: Smaller is better

A recent study on healing, proven by radiographic changes, evidenced that there is a direct relationship between size of osteotomy and speed of healing; the smaller the osteotomy, the faster the healing. For example, lesion <5 mm will heal in 6.4 months, lesion 6–0 mm will heal in 7.25 months, lesion of >10 mm will heal in 11 months approximately. Hence, the osteotomy should be as small as possible, however as large as required to achieve clinical objective. With the help of microsurgical techniques, size of osteotomy significantly smaller, up to 3–4 mm in diameter, or just larger than an ultrasonic tip of 3 mm in length and still allows the tip to vibrate freely within the bony cavity.[7]

Variations between bone and root tip under microscope

Main aim if using microscope is to clearly differentiate root tip from surrounding bone. The root has a darker, yellowish color and is hard, whereas bone is white, soft and when scrapped with probe bone bleeds. This is a step for limiting the size of osteotomy. If the root tip cannot be seen, careful drilling and microscopic examination along with methylene blue stain which stains PDL, allows root tip identification as well as small osteotomy.[7,15,17]

The Bevel Angle

Total elimination or minimization of bevel angle is one of the crucial benefits of microsurgery. In modern microsurgeries,

steep bevel angle of 45°–60° is given, simply for access and visibility [Table 4].[1,7,15,17,18]

Root end resection

Anatomical study of root apex proves that at least 3 mm of root-end must be removed to minimize 98% of lateral canals. It seemed that these % are same at 4 mm from apex, so we recommend root-end amputation of 3 mm, so that it leaves on average 7–9 mm of root providing sufficient strength and stability. However, root-end amputation <3 mm most likely does not remove all of the apical ramifications, lateral canals, hence, enhancing a risk of reinfection and eventual failure.[1,7,15,19,20]

The most important step in microsurgery

After root tip resection perpendicular to long axis of root, proper identification, examination and evaluation of anatomical details, and its management are of great importance and critical for success of treatment. This step of microsurgical procedure is impossible to do with unaided vision or even with loupes. The light and magnification to completely see anatomical details of root surface can only be done using high magnification of a dental operating microscope. That is, important drawback of traditional root resection technique without magnification and micro-instruments is the inability to manage and to adequately evaluate the anatomical details of root surface.[1,12,14,16,21]

On the other hand, use of bright illumination and range of magnification of dental operating microscope [Table 4] from 4× to 25×, also with the help of methylene blue resected surface can be examined in great detail. With the use of micromirrors which are placed at 45° to surface, the view of root surface shows every little anatomical detail of root canal system, which is critical for a successful surgery. These anatomical views are complex, all types of shapes, forms can be found in root canal system.[12,14,15,22]

Endodontic surgery has now evolved into endodontic microsurgery. Our ultimate goal must be the preservation of our natural teeth. After all, our natural teeth are always better than any man-made replacement, when all is said and done. We must endeavor, learn and teach microsurgery to all endodontists so that they can perform non-surgical as well as surgical endodontic cases with equal ease and skill. With a highest percentage of successful treatment outcomes of conventional endodontics with high success of microsurgical endodontics, almost all teeth with endodontic lesions can be successfully treated with much better prognosis.

Table 4: Magnifications for different surgery stages

Magnification	Procedures
Low (X_4–X_8)	Orientation, inspection of the surgical site, osteotomy, alignment of surgical tips, root-end preparation, and suturing
Midrange (X_8–X_{14})	Most surgical procedures including hemostasis. Removal of granulation tissue, detection of root tips, apicoectomy, root-end preparation, and root-end filling
High (X_{14}–X_{26})	Inspection of resected root surface and root-end filling, observation of fine anatomical details, and documentation

Conclusion

In conclusion, it can be believed that microsurgical techniques and approaches produce predictable outcomes in the resolution of periapical lesions of endodontic origin, using stateof-theart equipment, materials, and instruments that match biological concepts with clinical practice.

References

1. Carr GB. Surgical endodontics. In: Louis HB, Kenneth MH, editors. Pathways of the Pulp. 12th edition. St. Louis, Missouri: Elsevier; 2020. p. 531.
2. Adamo HL,Buruiana R, Schertzer L,Boylan RJ. A comparison of MTA, Super-EBA, composite and amalgam as root-end filling materials using a bacterial microleakage model. Int Endod J 1999;32:197-203.
3. Von Arx T, Walker WA. Microsurgical instruments for root-end cavity preparation following apicoectomy: A literature review. Endod Dent Traumatol 2000;16:47-62.
4. Kim S, Pecora G, Rubinstein R. Color Atlas of Microsurgery in Endodontics. Philadelphia: WB Saunders; 2001.
5. Velvart P. Papilla base incision: A new approach to recession-free healing of the interdental papilla after endodontic surgery. Int Endod J 2002;35:453-60.
6. Richard R. Magnification and illumination in apical surgery. Endod Top 2005;11:56-77.
7. Kim S, Kratchman S. Modern endodontic surgery concepts and practice: A review. J Endod 2006;32:601-23.
8. Plotino G, Pameijer CH, Grande NM, Somma F. Ultrasonics in endodontics: A review of the literature. J Endod 2007;33:81-95.
9. Glickman GN, Hartwell GR. Surgical procedures in endodontics. In: Ingle JI, Bakland LK, Baumgartner JC, editors. Ingle's Endodontics. 6th ed. Netherlands: BC Decker Publishers; 2008. p. 1233-94.
10. Creasy JE, Mines P, Sweet M. Surgical trends among endodontists: The results of a web-based survey. J Endod 2009;35:30-4.
11. Baek SH, Lee WC, Setzer FC, Kim S. Periapical bone regeneration after endodontic microsurgery with three different root-end filling materials: Amalgam, superEBA, and mineral trioxide aggregate. J Endod 2010;36:1323-5.
12. Carr GB, Murgel CA. The use of the operating microscope in endodontics. Dent Clin North Am 2010;54:191-214.
13. Setzer FC, Kohli MR, Shah SB, Karabucak B, Kim S. Outcome of endodontic surgery: A meta-analysis of the literature-part 2: Comparison of endodontic microsurgical techniques with and without the use of higher magnification. J Endod 2012;38:1-10.
14. Eliyas S, Vere J, Ali Z, Harris I. Micro-surgical endodontics. Br Dent J 2014;216:169-77.
15. Emre I, Burçin AO, Bilge T. Advances and new approaches in endodontic surgery-a review. J Adv Med Dent Scie Res 2015;4:4.
16. Ananad S, Soujanya E, Ananda R, Swathi A. Endodontic microsurgery: An overview. Dent Med Res 2015;3:31-7.
17. Seedat HC, Van der Vyver PJ, De Wet FA. Micro-endodontic surgery part 1: Surgical rationale and modern techniques. SADJ 2018;73:146-53.
18. Jadun S, Monaghan L, Darcey J. Endodontic microsurgery. Part two: Armamentarium and technique. Br Dent J 2019;227:101-11.
19. Taschieri S, Morandi B, Giovarruscio M, Francetti L, Russillo A, Corbella S. Microsurgical endodontic treatment of the upper molar teeth and their relationship with the maxillary sinus: A retrospective multicentric clinical study. BMC Oral Health 2021;21:252.
20. Prathap MS, Pradeep R. Endodontic microsurgical instruments-a review. J Evolution Med Dent Sci 2021;10:1532-8.
21. Kim JE, Shim JS, Shin Y. A new minimally invasive guided endodontic microsurgery by cone beam computed tomography and 3-dimensional printing technology. Restor Dent Endod 2019;44:29.