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TOPICAL REVIEW

# The use of optical magnifying devices in periradicular microsurgery

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**Abstract:** Microsurgery is a more precise modification of present procedures with less operative trauma and improved healing. The basic risk with traditional periradicular surgery arises from potential damage to major vessels or nerve bundles. These potential problems can be fixed using optical magnifying tools such as dental operating microscopes and endoscopes. Instruments have been also designed to take the full advantage of increased visibility. The higher magnification and illumination is favorable in all phases of periradicular surgery. The article focuses mainly on the advantages of optical magnifying devices by root-end resection *(Tab. 1, Ref. 22)*. Full Text in PDF *www.elis.sk.*

Key words: microsurgery, dental operating microscope, endoscope, periradicular surgery.

Surgical root canal therapy, including root-end resection has been commonly employed since the mid 1800‘s (1). In 1906, Schamberg (2) described the use of radiographs to assist diagnosis as well as the use of surgical burs to perform a rapid osteotomy and root-end “ablation” In the past several years, newly implemented operating techniques and materials have optimized the root-end resection (3, 4). New instruments have been designed to take the full advantage of increased visibility obtained with dental operating microscopes, endoscopes and orascopes. With bright illumination and magnification under the operating microscope, and with addition of many microinstruments, the endodontic surgery has become microsurgery (5). Microsugery is defined as a surgical procedure on exceptionally small and complex structures. Microsurgery starts with a magnification of at least eight. That can be achieved with a dental operating microscope (DOM) or endoscope. DOM enables a 50-cm working distance from the object, thus providing the operator with wider handling space (6). The value of improved visualization of surgical site would be limited without microsurgical instruments such as ultrasonic tips and micromirrors for inspecting the root end. Microsurgery is a more precise modification of present procedures with less operative trauma and improved healing (7). The basic risk associated with traditional endodontic surgery arises from potential damage to major vessels or nerve bundles (n. mentalis). Excessive osteotomies and steep beveling of root surface result in unnecessary damage to cortical bone and unfavorable crown/root ratios of existing teeth. These potential problems can be fixed with the use of dental operating microscopes, refined microinstruments and ultrasonic retro-tips. The microsurgical approaches allow the clinicians to perform endodontic surgery with smaller osteotomies, shallow bevels (preserving root structure and revealing additional canals and isthmuses between canals), preparation of isthmuses, examination of resected root surfaces, retropreparation in line with root canal, and precise placement of new filling materials (5). These principles narrow the gap between biological concepts and the ability to achieve consistently successful clinical results (8) (Tab. 1).

In microsurgery, the traditional high-speed handpieces with a round bur used for root-end preparation are substituted with ultrasonic retro-tips specially designed for root-end cavity preparation. The advanced view leads to higher probability that the preparation is really following the original track of the root canal.

Higher magnification and illumination are also very favorable for examining the resected root surface while methylen blue dye

**Tab.1. Comparison between traditional and microsurgical operating technique.**

| | Traditional Technique | Microsurgical Technique |
|---|---|---|
| Osteotomy | Excessive | Less than 5 mm |
| Loss of cortical bone | Bigger | Smaller |
| Bevel | Steep, 30°– 45° | Shallow, less than 10° |
| Revealed dentin tubules | Many | Few |
| Identification of apices | Difficult | Simple |
| Examination of resected root surface | Difficult, none | Always |
| Root and preparation instruments | Bur | Ultrasonic tips |
| Sutures | 40 x 0, silk | 6 x 0, 7 x 0, monofilament |
| Removal of sutures | 7th post-operation days | 2nd–3rd post-operation days |

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is used for both, staining the periodontal ligament to ensure complete resection of the root, and looking for cracks, isthmuses and extra canals (8). Over the past decade, the development of new techniques and materials has changed the typical surgical tray dramatically. Microsurgical instruments such as ultrasonic retro-tips for root-end preparation and micromirrors for inspecting the root end are the proof of this (9).

The most frequently used optical magnifying tools in periradicular surgery enabling microsurgery operating techniques include DOM and endoscope.

The operating microscope was used for the first time by Nylen in 1921 in an otorhinolaryngologic operation (10). The employment of operating microscopes became prosperous in many other medical disciplines (e.g. neurosurgery, ophthalmology), and in the past 10–15 years they were used with success in endodontics and periradicular surgery (11). The main advantages gained from using DOM include: 1) variable magnification; the instrument comprises a binocular fiber optic system with five types of magnifications, starting at 8 times up to 30 times, even a 40-time magnification is possible today; 2) enhanced illumination of the surgical field; the visibility of surgical field is one of the principal requirements of periapical surgery; DOM provides direct illumination without shades; 3) higher precision and permanent magnification during the whole procedure; 4) documentation and learning; high-resolution digital still and video cameras can be attached to the microscope; monitors enabling audio/visual teaching to staff members, dentists and other interested groups can be also attached; 5) surgeon's position; using the dental loupes and fibre-optic head lamps are helpful but their weight puts strain on the head and neck When using DOM, the spine is straight in physiological position.

Since its introduction by Hopkins in 1960's, various diagnostic and surgical endoscopic techniques have been refined including arthroscopy, laparoscopy and endoscopy in otolaryngology, gynecology, urology and many other disciplines (12). In 1975, Ohnishi was the first to use the endoscope in dentistry, namely for arthroscopy of the temporomandibular joint (13). In periradicular surgery, endoscope enables direct diagnosis without the need of micromirrors (14). Compared with operating microscope, the magnification is many times superior and thus further betters the conditions for optimizing the diagnosis and therapy. The factor of magnification is not given here by the optical system but by the distance between endoscope and object. In this case, the opportunity for exact diagnosis of microstructures on the resected surface is comparable with that of scanning electron microscope (15). The application of endoscopy according to the method used in periradicular surgery especially in root-end resection is as follows. 1) After osteotomy and location of root end, it allows observing the morphology of apex and presence of extraneous material. 2) After root end resection, it aids in visualization of morphology of the cut root surface, number and configuration of root canals and presence of isthmus tissue. 3) Following root-end preparation, it aids in assessing the direction, dimension and depth of cavity and also the cleanliness of cavity walls. 4) Assessment of root-end filling, marginal adaptation of filling as well as the presence of deficiencies can be inspected. The endoscope can aid the operator significantly in microsurgical procedures providing visualization of areas that would have been impossible to see in direct line of vision. The fact that the operator can see behind the tooth root and thus can determine whether pathosis is involved, improves the prognosis of surgical procedure (16). The 30 and 70-degree endoscope has been used as an adjunct to endodontic surgery involving maxillary and mandibular molars. This instrument, with angulations of 30 and 70 degrees has been found to allow visualization in formerly inaccessible areas (17). Surgery involving the upper second molar with roots that are many times positioned behind the disto-buccal root of the maxillary first molar can be readily visualized. Standard surgical access permits the root tips of this tooth to be identified and prepared for the acceptance of reverse filling materials (16).

## Discussion

Microsurgery in general is a discipline of multiple surgical procedures performed with optical magnification and illumination. The use of DOM improves access to the surgical field in periapical surgery. Thanks to its lens system, the microscope can identify the dental and periodontal anatomy, as well as the limits of the periapical lesion, and allows the performance of minimal osteotomy. DOM as compared with endoscope can be used in all phases of periradicular operating procedure starting with the incision and ending with the suture of the wound. Again, endoscope is used for inspection of relevant working steps. Due to its non-fixed field of vision, the endoscope allows viewing of a treatment field at various angles and distances without losing depth of field and focus. In using the microscope, when increasing the magnitude, any movement of either the microscope or the patient will cause the surgical field to drift out of focus. This is one drawback of the microscope when used as an aid in enhancing the visualization of surgical field (18). The operator can examine the morphological aspects of the roots from almost any angle in a very short time. This involves a longer procedure when using a microscope, while the examination in some parts, especially in the posterior jaw, is difficult or even impossible. It is also possible to see behind the roots and ascertain the presence of periradicular lesions and, if necessary, remove them. This is much more complicated when the operator has to use a microscope and the retro-mirror. The use of high quality magnification devices in dentistry is becoming more and more common, with the aim of improving treatment quality (19). Periradicular surgery can be performed without the benefit of enhanced magnification and illumination; however those who use microscopes, endoscopes and orascopes report a dramatically improved visualization and control of surgical site (7, 20–22).

## Conclusion

The introduction of magnification devices and microsurgical instruments has brought advantages in root-end management. Many authors showed how these devices provide the visual access necessary to perform microsurgery with a greater degree of confidence and accuracy. DOM can be used in combination with endoscope to enhance visibility during periradicular surgery. Their

main cons include high cost and need for training which initially prolongs the surgical time. But after that, higher efficiency can be achieved both in time and quality.

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