The State of the Art in Micro-Surgical Endodontics

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Abstract

In the last 15-20 years several important developments have been introduced in surgical endodontics: the ultrasonic root end preparation, the surgical operating microscope and a new biocompatible material.

The introduction of the ultrasonic root end preparation made possible to obtain what is defined as the ideal retropreparation: a class 1 preparation at least 3 mm into the root dentin with walls parallel to and coincident with the anatomic outline of the pulpal space. In order to do this, special ultrasonic tips were developed to enable the clinician to reach every root in all clinical situations.

The introduction of the surgical operating microscope represents another important development in surgical endodontics as it has several advantages in surgical endodontics:

a) better visualization of the surgical field  
b) better evaluation of the surgical technique  
c) better accuracy during the entire procedure  
d) better predictability of long term results

As far as the new materials are concerned, recently the Mineral Trioxide Aggregate became available. This is a revolutionary material, which is extremely biocompatible, is hydrophilic, and is capable of stimulating the healing processes and osteogenesis.

Thanks to all these revolutionary progresses, the long-term success rate of surgical endodontics is higher and endodontic therapy today is more predictable and even more fun!

Keywords: Easy Surgery, Apicoectomy, Retrofill, Microscope.
By Surgical Endodontics one refers to that branch of Dentistry that is concerned with the diagnosis and treatment of lesions of endodontic origin that do not respond to conventional endodontic therapy or that cannot be treated by conventional endodontic therapy. The scope of Surgical Endodontics is to achieve the three dimensional cleaning, shaping and obturation of the apical portion of the root canal system which is not treatable via an access cavity, but only accessible via a surgical flap.

In the last 20-25 years three important developments have been introduced in surgical endodontics: the ultrasonic root end preparation, biocompatible materials and the surgical operating microscope. Today, the entire procedure is performed through the operating microscope, from anesthesia and incision up to the suture and the removal of suture.

In a recent article Setzer et al. conducted a meta-analysis and a systematic review of the literature. The authors compared the outcomes of contemporary root-end surgery techniques with micro-instruments but only loupes or no visualization aids with the outcomes of endodontic microsurgery using the same instruments and materials but with high power magnification as provided by the surgical operating microscope. The conclusion of the study was that the probability for success was significantly greater if the surgical procedure was performed using the high power magnification rendered by the dental operating microscope. This conclusion is in agreement with the most recent literature, and depending of different studies, the success rate has been described of 98%!

For this reason, it is correct to speak in terms of “Micro” (because the use of the microscope is today mandatory to perform the entire procedure) and then “Surgical Endodontics” because, as stated before, it is an Endodontic procedure performed through a surgical flap, and not just a surgical procedure performed just to remove periapical inflammatory tissue. Therefore, it is something that is pertinent to the Endodontist and must be carried out with the knowledge, the skillfulness, and the hand of the Endodontist. He or she will take care of cleaning, shaping and three-dimensionally obturating the root canal system with a surgical approach, just because (this is what happens most of the time) the root canal system was not negotiable non surgically (Fig. 1).

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Fig 1a: Pre-operative radiograph of the upper left first molar. The two canals of the mesio-buccal root were not negotiable. This is an indication for the surgical approach
Fig 1b: Post-operative radiograph. MB1, MB2 and the isthmus have been obturated with white MTA

Fig 1c: Recall radiograph after 2 years

**Diagnosis and Treatment Plan**

Once a diagnosis of endodontic failure has been made, it is necessary to understand what the cause of the failure was so that successively the possibility of correcting the failure by orthograde retreatment can be evaluated. Only in the case where this possibility does not exist or better still after failure of the non-surgical therapy carried out to resolve the problem, only then is one authorized to intervene surgically. Apical Surgery in other words is not a substitute for incomplete debridement and poor endodontics and the real indication for the surgical endodontic treatment is just mechanical.
In agreement with what Nygaard-Ostby and Schilder\textsuperscript{10} confirmed, Surgical Endodontics must be reserved for those cases in which the preparation and obturation of the root canal appear impossible right from the beginning or when the nonsurgical retreatment attempts have failed. Nevertheless, even in such cases, the authors recommend filling as much of the root canal by conventional method as possible.

Ultimately even after the indication for surgery has been established, in agreement with Weine and Gerstein,\textsuperscript{11} it is recommended to remove as much as possible of the inadequate preceding canal obturation material and replace it with well compacted gutta-percha: in this way lateral canals, forgotten additional canals can be filled, often removing the need for surgery. Nevertheless, in those cases which still have the indication for surgery it is currently possible to have a notably increased percentage of success with the treatment of surgical cases compared with what could be attained up until a few years ago, and this is thanks to recent technological progress and new materials today available for surgical endodontics. As already stated, in the last 25 years three important developments have been introduced in surgical endodontics: the surgical operating microscope,\textsuperscript{12,13} the ultrasonic root end preparation\textsuperscript{12,14} and the use of new biocompatible materials for the retrofill of the root canal system.\textsuperscript{15}

**The Surgical Operating Microscope**

The introduction of the surgical operating microscope represents a very important development in surgical endodontics.\textsuperscript{12} For many years periapical surgery has been performed without any magnification, using the dental light as the only light source to illuminate the surgical field. No surprise therefore if until recently the success rate after surgery was much lower compared to nonsurgical endodontics.\textsuperscript{16} To increase visibility, surgical telescopes or loops and surgical headlamps became available. Loops are available in a variety of configurations and magnifications, starting from 2x up to 6x, with Galileian optics or prismatic optics. When a fiberoptic headlamp is added to the loops, a coaxial light is projected into the surgical field, so that both magnification and illumination are enhanced.

On the other hand, clinicians who have benefited from the use of loops and headlamps soon understand the limitations of this system. Magnification of 6x sooner or later is not enough anymore and the headlamp is not capable to send the light deep into the canal in surgical and nonsurgical endodontics. Furthermore, at that magnification the operative field is quite small and the depth of field is also reduced, with consequent strain for the head and neck.

The surgical operating microscope has a range of magnifications from 2.5x to 25x and the illumination is always perfectly coaxial with the line of sight.

The coaxial illumination has two advantages: a) the clinician can look into the surgical field without any shadows (which means for example that it is possible to examine the cleanliness of the retro-preparation during surgical endodontics); b) since the coaxial illumination is made possible because the operating microscope uses Galileian optics, and since Galileian optics focus at infinity and send parallel beams of light to each eye, the operator’s eyes are also focusing at infinity and every procedure can be performed without any eye fatigue.
As far as the magnification is concerned, there is no need to go beyond 20-25x. Lower and medium magnifications are used for operating; higher magnifications are used only for observing fine details. Working at high magnifications means to have a very limited depth of field and limited illumination, and therefore is not practical. 

In conclusion, the use of the surgical operating microscope has several advantages in surgical endodontics:

a) better visualization of the surgical field;

b) better evaluation of the surgical technique;

c) better accuracy during the entire procedure;

d) better predictability of long term results.

For these reasons, the author is firmly convinced that surgical endodontics should not be performed without the use of the microscope, from the injection of anesthesia to the removal of sutures.

The ultrasonic root end preparation

At the end of the ‘80 Gary Carr made a big revolution in the field of the Periapical Surgery: he invented the ultrasonic preparation of the root end and since then the use of low speed hand pieces and burs are no longer accepted as the standard of care for apical surgery. Too many are the advantages of the Ultrasonic Root End Preparation compared to the use of rotary hand pieces and burs:

1) it is now possible to clean the apical root canal at 360°, including the buccal aspect of the preparation

2) the preparation is made along the main axis of the root canal

3) the retroprep is smaller and consequently is easier to seal

4) the bony crypt is smaller and less dentin is removed using a short bevel

5) it is much easier to follow the root canal anatomy and to prepare isthmuses

6) the access is comfortable even in canals difficult to be reached, like the palatal canal of a first premolar, the MB2 of upper molars and the ML of lower molars

7) there is no need to make undercuts to give retention to the cavity and this means less risk to make perforations on the palatal aspect of the retroprep

8) it is much easier to retreat a surgical failure and to remove the old amalgam retrofill, which most of the times can be removed in one single piece, while using a bur a lot of amalgam dust was made with consequent high risk of tattoo in the soft tissue.
The only “disadvantages” of the use of ultrasonic tips are:

1) the tips are fragile and for sure they don’t last so long like the burs

2) more instruments are needed, like tips, ultrasonic units, and many micro-instruments, like mirrors, pluggers, carriers etc.

3) the cost is therefore higher

4) the technique is not familiar for the operator who is invited to test the instruments first on extracted teeth.

Many recent articles agree that the use of micro-surgical techniques is superior in achieving predictably high success rates for root-end surgery (93.52 %) when compared with traditional techniques (59 %)\textsuperscript{1-9}

Several piezo electric units are available in the market, like Spartan, Satelec P-5, Amadent, EMS, and they all are very efficient. Also several different kind of ultrasonic tips are available and the operator can choose depending on the requested efficiency: the tips in stainless steel with no coating are the less effective, the tips chemically coated (zirconium or titanium nitride) (Fig. 2) are more efficient and the diamond coated are definitely the most efficient. All of them have a water port for the irrigation, since they must never work dry. The amount of irrigating solution is also very important: too much irrigation will decrease the visibility, too little will overheat the dentin and can cause the fracture of the tips. They have to be used at the minimum power, very gently, without finding any resistance while preparing the retro-cavity. During the preparation of the retro-cavity it is suggested to work with the microscope at lower magnification, in order to take into consideration the long axis of the root and consequently to orient the retrotip parallel to the root canal (Fig. 3).

![Fig 2a: Ultrasonic retrotips by Dentsply Maillefer](image-url)
Recently Dr. Khayat designed new longer ultrasonic tips diamond coated of 3, 6, and 9 mm of length (Fig. 4). They are particularly useful in case when the surgical procedure is performed in root canals partially empty and therefore the retroprep has to be particularly long. Of course these cases must still have the real indication for the surgical endodontic treatment and they cannot be treated non-surgically. The three tips of different length have to be used in sequence, always starting with the small one of 3 mm and then if there is room enough for the others, proceed with the one of 6 and then 9 mm of length (Fig. 5).
Fig 4: Ultrasonic retrotips designed by Dr. Bertrand Khayat

Fig 5a: Pre-operative radiograph of the upper central incisors. The root canals have been obturated with a surgical approach during the previous surgical procedure
Fig 5b: The tip of 9 mm of length is entering in the root canal

Fig 5c: C. Recall radiograph after 2 years. The root canals have been prepared using in sequence the long tips and obturated with thermoplastic gutta-percha and white MTA in the apical 3 mm.

Usually the surgery is made to retreat non-surgical failures and the root canal contains at least sealer or may be sealer and gutta-percha. Therefore, the tip should not meet resistance while is cleaning the root canal from the previous material. If the operator feels resistance, it means that the tip is working against the dentinal wall instead of just removing material from the root canal. The only time when the operator will fill resistance is when the canal is completely calcified, it was not negotiated before and it doesn’t contain any obturating material. In such a case, it is suggested to progress coronally very slowly, checking every few seconds that the tip is going in the right direction. It is enough to stop, dry the field and check with the micro-mirror that the calcified canal is always in the center of the retroprep.
In case of a root with two canals the operator should always remember that there is an isthmus, even though it is not visible with the microscope. The isthmus used to contain vital pulp tissue, now it contains bacteria, therefore it must be always included in the retro-preparation, must be cleaned and filled with the obturating material (Fig. 6). We know from the recent literature that the mesio-buccal root of upper first molars has two canals 93 % of the time.¹⁸ This means that the isthmus is present in the same percentage. The same is valid for upper second molars (59 %) and for the mesial roots (80 %) and distal roots (20 %) of lower molars.

Fig 6a: The root resection is made almost at 90° to the long axis of the tooth and the isthmus is prepared and sealed.

Fig 6b: MB1, MB2 and the isthmus have been obturated with white MTA

When the retro preparation is completed, it is rinsed with the irrigation of the retrotip, dried with the Stropko irrigator and inspected with the micro-mirror of adequate size, checking the cleanliness at several magnifications. Now the cavity is ready to be filled.
Root End Filling Materials

The ideal retrofilling material should have the following characteristics:

1) easy to carry and to manipulate
2) relatively fast setting time
3) dimensionally stable and non resorbable
4) capable to guarantee a perfect seal of the cavity
5) biocompatible
6) non-toxic
7) insoluble in tissue fluids
8) bacteriostatic
9) sterile or easily sterilizable before use
10) radiopaque
11) easily removable if necessary

Many retrofilling materials have used through the years: amalgam, IRM, Super EBA, Optibond, Gerestore and more recently Mineral Trioxide Aggregate (MTA).

Amalgam has been abandoned for many reasons, like leakage, corrosion, blood mercury level, and more so that it can be concluded that there is no valid reason today to continue its use. Nevertheless, many Oral Surgeons and Maxillo Facial Surgeons still use amalgam… The only advantage of amalgam was its radiopacity.

Super EBA has been used for many years, especially after the advent of the ultrasonic root end preparation. In the Author’s experience Super EBA demonstrated to be an excellent material, showing a long term success rate of more than 91.5%. On the other hand, the material has few drawbacks. First of all it is technique sensitive, and it takes about 5 minutes of manipulation before being condensed into the cavity and several minutes for setting and finishing. The material comes with two different kinds of powder, fast and slow setting time. It is not always easy to make the right choice, so that sometimes the setting time is too fast and the material start the setting during the compaction, some other times the setting takes forever… During the compaction the bleeding control must be perfect because the material cannot be contaminated by blood. If this happens, the damaged material needs to be removed and the filling had to start all over again. Another drawback that I found recently in my practice is the dimensional stability and the resorbability. In one case I had to retreat my surgical failure and I found that the SuperEBA that I had positioned several years before was completely washed out.
Composite materials like Optibond (SybronEndo) and Geresto (Den-Mat, USA) can be used today thanks to the perfect crypt control and the absolutely dry operative field. Like in restorative dentistry, the material doesn’t want to be contaminated by any moisture and being positioned under the microscope, it is important to reduce the intensity of the illumination as much as possible and use a filter to prevent a significant reduction of the setting time.

Mineral Trioxide Aggregate (MTA; ProRoot MTA, Dentsply Tulsa Dental) became recently available and today there are many articles in the literature showing that MTA can be considered the material of choice.

MTA is an endodontic cement that is extremely biocompatible, capable of stimulating healing and osteogenesis, and is hydrophilic. MTA is a powder that consists of fine trioxides (Tricalcium oxide, Silicate oxide, Bismute oxide) and other hydrophilic particles (Tricalcium silicate, Tricalcium aluminate, responsible for the chemical and physical properties of this aggregate), which set in the presence of moisture. Hydration of the powder results in formation of a colloidal gel with a pH of 12.5, that solidifies to a hard solid structure in approximately three-four hours. This cement is different from other materials currently in use because of its biocompatibility, antibacterial properties, marginal adaptation and sealing properties, and its hydrophilic nature.

In the Author’s experience, MTA has replaced all the previously mentioned materials for many reasons, first of all its biocompatibility, its hydrophilic nature, then because it has superior sealing quality, is not affected by moisture or blood contamination, it is relatively easy to manipulate and today an excellent carrier is available. MTA has several advantages:

1) easy to mix and place into the cavity with a small carrier
2) since it sets in the presence of moisture, it is not moisture sensitive and is not affected by blood contamination
3) seals better than amalgam, Super EBA or IRM
4) has a better adaptation to the surrounding dentin
5) has excellent biocompatibility
6) activates cementogenesis.

The only disadvantage that existed years ago when the material was first introduced into the market was the difficulty to handle just because there was not an adequate carrier. The first carrier that became available was the Dovgan Carrier (Quality Aspirators, Duncanville, TX, USA), but even though the needles were bendable, its use was not comfortable during surgery, especially in posterior teeth.
In the year 2000 another carrier was proposed by Edward Lee,\textsuperscript{35,36} the MTA Pellet Forming Block. After being properly mixed to a putty-like consistency (not too dry and not too wet), the MTA is just pressed into the previously selected groove of the Lee block, then a small spatula slides into the groove to take the selected length of material, this adheres to the tip of the spatula and it is ready to be easily placed into the retroprep.

Recently, another carrier has been designed and manufactured by Produits Dentaires SA (Vevey, Switzerland) in cooperation with Dr. Bernd Ilgenstein, called The MAP (Micro Apical Placement) System (Fig. 7) and this can be considered an “universal” carrier, since it has special needles that can be used both in clinical and in surgical endodontics and during surgery allows an easy positioning of MTA also in posterior teeth and in lateral canals.\textsuperscript{37}

Fig 7a: The MAP System

Fig 7b: The needle acts as a carrier and also as a plugger, condensing the material inside the cavity

Once the retro-cavity has been prepared using the ultrasonic retro-tips and the bleeding of the bony crypt is under control, the operator asks the dental assistant to mix the MTA to the correct consistency and then to handle the pre-fitted applicator syringe. The consistency of MTA must be neither too wet nor too dry.
During the placement of MTA in the retro-cavity, the dental assistant is asked to touch the metal plugger with an ultrasonic tip in order to release the entrapped air, to improve the adaptation to the cavity walls and to improve the density of the obturating material. The material is always carried in excess, condensed with a big burnisher and then is finished with a small spatula and a micro-brush to the level of the resected root end.

The MTA is hydrophilic and requires moisture to set. The necessary moisture will come from the blood which immediately after surgery will fill the bony crypt.

Micro-Surgical Technique

Anesthesia

When treating teeth of the upper arch, only the topical anesthesia will be used.

When treating teeth of the lower arch, after obtaining the block of the inferior alveolar nerve then the topical anesthetic will be injected in the entire area that will be involved in the surgical procedure (Fig. 8). The topical anesthesia is used mainly and only to provide a good vasoconstriction in order to have a good control of the bleeding and then an excellent visibility for the surgical team. For this reason, the anesthetic solution used is Lidocaine with epinephrine 1:50,000. This is a “conditio sine qua non” to perform the surgical procedure, which in other words means: “No Epinephrine, no Surgery”!

![Anesthesia diagram](image.png)

Fig 8: The anesthesia should involve the entire area of the surgical procedure, introducing the needle only few millimeters in the mucosa, in order not to involve the beta receptors.
The incision

The incision is made with the microsurgical blade CK2 (SybronEndo), which is much smaller than the BP #15 (Fig. 9). The blade will allow to make more precise and accurate incisions, which later will allow a more accurate repositioning and suturing of the flap and consequently a better and faster healing.

![Fig 9: The Bard-Parker # 15 compared to the micro-blade of the CK2](image)

The incision must always be made thinking of the later suture. Must be extended always one tooth mesial and one tooth distal to the involved tooth.\(^{38}\) Must be large enough to allow adequate vision, atraumatic elevation and retraction, passive repositioning and then an easy suture.

Various flap designs have been discussed in the literature.\(^{39-41}\)

1) Semilunar flap
2) Marginal flap
3) Para-marginal flap

Basically, the incision should provide a good access and protect the epithelial attachment. The selection of the flap design depends on several factors, like the integrity of the bone over the roots, the amount and nature of the attached gengiva and the presence or absence of a fixed dental prosthesis.

The Semilunar flap

This flap has a concave design with the concavity towards the apex of the root. It is a full thickness flap and the incision is made entirely in the alveolar mucosa. This is the incision usually preferred by the oral surgeons and the only advantages of this flap are the respect of the epithelial attachment and the absence of a periodontal involvement: the marginal tissue remains untouched and thus no recession will occur. On the other hand, there are many disadvantages, like limited access to the surgical area, poor visibility, difficult control of the bleeding, the suture is not over healthy bone, it is difficult to precisely reposition and suture the flap, the healing could be by secondary intention, and quite often there are visible scars.

Because of the many drawbacks mentioned a semilunar flap design is no longer recommended.\(^{42}\)
The Marginal flap

This flap design is most indicated when there is not enough attached gingiva and where esthetic is not a concern. For sure this is the flap design of choice when a vertical root fracture is suspected, since it provides excellent visibility of the root surface.

The disadvantage of this flap is represented by the epithelial involvement, which as consequences could have a periodontal involvement. In case of the presence of fixed prosthesis involving subgingivally placed crown margins, a postoperative sequel can result in recession, leading to esthetically compromising exposure of the crown margins.

The Para-marginal flap (Ochsenbein-Lubke)

The most popular submarginal flap is the flap design by Ochsenbein and Luebke. This flap is most indicated when there is an adequate amount of attached gingiva and there is no periodontal involvement in the surgical area, being the probing within normal limits. It is also better indicated in case of presence of dental restorations in the front area, in order not to interfere with the cervical tissue and avoid later aesthetic problems. The flap is full-thickness and has one horizontal and two vertical components (Fig. 10). The horizontal is made about 1 mm coronal the muco-alveolar junction, leaving at least 2 mm of attached gingiva at the coronal margin of the flap. The incision has rounded scallops that follow the architecture of the teeth and later will allow an easy and passive repositioning and suture. The incision must always involve one tooth mesial and one tooth distal to the one being operated on. The two vertical components at each end of the horizontal one are made as releasing incisions, in order to allow a passive and atraumatic reflection of the flap. The releasing incisions must have a 90° rounded angle with the horizontal component, and must be parallel to the long axis of the teeth, in order not to section the blood vessels who are also parallel to the long axis of the teeth. In case there is not adequate amount of attached gingiva along the entire length of the horizontal component, the flap can be modified, being a sulcular flap where there is no attached gingiva and para-marginal where there is attached gingiva. However, according to Kramper et al., the para-marginal incision is the flap of choice in surgical endodontics, when not contraindicated by the anatomical location of the lesion or by insufficient attached gingival tissue.

The ultrasonic root end preparation and the use of the retrofilling materials have already been described.
Fig 10: Schematic representation of the para-marginal flap

Suture

As already mentioned before, the suture can and should be done using the operating microscope. Suturing under the microscope has the advantage of being more accurate in repositioning the flap, allowing a perfect healing by primary intention, without any scar tissue. Ideally, the suture must keep the soft tissue in place during the time of healing and should not encourage colonization of bacteria. If repositioning has been accurate as it should be, healing occurs by primary intention in 24-48 hours and this is the reason why suture removal is indicated after 24-48 hours.\textsuperscript{45,46}

Nonabsorbable silk sutures are easy to tie and handle but are no longer recommended as they accumulate plaque, allow rapid bacterial colonization and are uncomfortable to remove because of ingrowth of tissue.\textsuperscript{45} However, some multifilament suture materials seem to inhibit bacterial transmission.\textsuperscript{47} Nylon (Supramid, S. Jackson) (like any other monofilament synthetic sutures) is colonized more slowly, allows less bacterial migration but is too rigid and often patients complain because the suture is irritating the lip or the cheek. Tevdek (CK Dental Specialties) is a newly introduced suture made of a polytetrafluoroethylene (PTFE) impregnated polyester material (PET). It is very resistant to bacterial colonization and is nonirritating. The suggested size of the suture is 6-0 (Fig. 11).

Fig 11: Needle holder, suture and scissor for suturing
Suture removal

While the periodontists are dealing with diseased tissue, and quite often reposition the flap laterally, apically, coronally so that healing comes by secondary intention, our flaps are passively elevated and passively repositioned exactly in their original place, so that healing will progress by primary intention. This is true especially if the tissue has not been traumatized during the surgical procedure and everything has been performed gently under the microscope.

According to Ruben et al.\textsuperscript{,48} the epithelial creep occurs at a rate of about 1 mm per side per 24 hours. That means that if the reapproximation performed under the microscope has been precise, the gap left by the incision is completely closed after 24 hours and the suture has completed its task. In other words there is no need to keep the suture any longer. Now it is just a foreign body that can only attract bacterial plaque, cause inflammation, delay healing and later will be responsible of a scar. On the other hand, after the procedure has been performed under the microscope with a nice scalloped incision, passive flap elevation and retraction, passive and precise repositioning, careful suture with a 6-0 filament, now the suture can be removed after 24 hours, with the result of very little or no scar at all (Fig. 12). Of course, if the patient for some reason cannot come for the removal of the suture before of two or three days, there is no problem but for sure the suture should not remain in place for one week or more…

Fig 12a: The suture Tevdek has been just positioned

Fig 12b: The suture was removed after 24 hours and the image taken after 2 years shows no scar
Conclusions

The introduction of microsurgery to surgical endodontics attempted to minimize trauma and enhance surgical results.

Micro-Surgical Endodontics is effective in saving natural teeth and the long term successfull rates have never been so high like in these days. The probability of success for Micro-Surgical Endodontics proved significantly greater than the probability of success for traditional root-end surgery. This demonstrates the evolution of periapical surgery and what can be achieved with contemporary techniques including enhanced magnification and visualization. Regarding the question whether microsurgical techniques are always needed in endodontic surgery or might not be necessary for certain tooth types, recent meta-analysis studies concluded that the use of traditional root-end surgery techniques should not any longer be considered state of the art.

The influence of high-power magnification provided by the dental operating microscope and the superiority of endodontic microsurgery over contemporary endodontic surgery with no or low magnification is today well known and universally accepted.
References


