The resolution of a persistent endodontic infection through the synergism between Operatory Microscopy, Ultrasound and use of MTA in Periapical Microsurgery

Prof. Dr. Leandro A. P. Pereira

Prof. Dr. Leandro A. P. Pereira
Endodontics Professor of São Leopoldo Mandic Faculty
Dental Master and PhD in Pharmacology, Anesthesiology and Drug Therapy UNICAMP
Endodontics Specialist - Surgical Microscopy - Sedation Inhalation

Pulpal and periapical pathologies, in most cases, are caused by intracanal infection. Their initial treatment consists in conventional endodontic treatment. In cases of teeth without apical periodontitis, the success rate of the endodontic treatment is approximately 98%. In cases of teeth with apical periodontitis and primary infections, the success of the treatment is reduced to 86% (Torabinejad 2005). This failure may be of bacterial or non-bacterial origin (Nair 2006). Usually, endodontic failure is associated with technical limitations, which prevent adequate intracanal microbial control due to the complex internal microanatomy of the root canal system, (Wu et al., 2006).

The treatment recommended for cases of primary endodontic infections is endodontic re-treatment with a success rate of approximately 83%(Torabinejad 2009). Thus, even after the endodontic re-treatment, due to the factors of complex internal microanatomy, the failure may persist. In these clinical situations, apical microsurgery is an alternative for the clinical treatment of these infections.

Various technological advances have taken place in recent years in the area of apical microsurgery. A very important triad was established for achieving high success rates. This triad consists in the use of Operatory Microscopy in association with ultrasound and MTA. When periapical microsurgery is performed in the traditional manner, without the use of microscopy, ultrasound, and MTA – that is, in the MACROsurgical form – its success rate does not exceed 60% (Wesson 2003; Tsesis et al. 2006; Setzer et al. 2010; Rahbraran et al. 2011). However, when performed with the contemporary technique of MICROsurgery, its success rate is over 90% (Rubistein, Kim 1999; Rubistein, Kim 2002; Tsesis et al. 2006; Kim et al. 2008; Christiansen et al. 2009; Setzer et al 2010). This evolution enables microsurgical endodontic treatment to be a more viable clinical procedure with greater predictability.

DESCRIPTION OF CLINICAL CASE

Female patient, 42 years of age, ASA I, BP 115 X 70 mm/Hg, heart rate 68 bpm, oxygen saturation 96%, body temperature 36.50C, weight 68 kg, appeared at the clinic complaining of the presence of spontaneous pain and persistence of apical periodontitis on tooth 36. She reported to have had the last endodontic re-treatment 19 months previously. During the semio-technical exam, a negative response to pain can be observed in the palpation and vertical and horizontal percussion tests. The thermal and electric pulpal tests revealed normal responses on the neighboring teeth and absence of response on tooth 36.

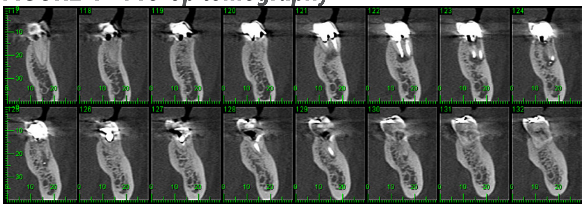
Radiographically, on tooth 36, a metal-ceramic prosthetic crown was seen within suitable functional standards; along with the presence of a cast metal intraradicular retainer, a satisfactory endodontic treatment with good modeling and good obturation; tooth 36 presented apical periodontitis (FIGURE 1, FIGURE 2, FIGURE 3). The pre-operative tomography showed breakage of the vestibular cortical bone (FIGURE 4)

FIGURE 1 - Initial X-Ray

FIGURE 2 - Initial X-Ray

FIGURE 3 - Pre-op clinical image

FIGURE 4 - Pre-op tomography

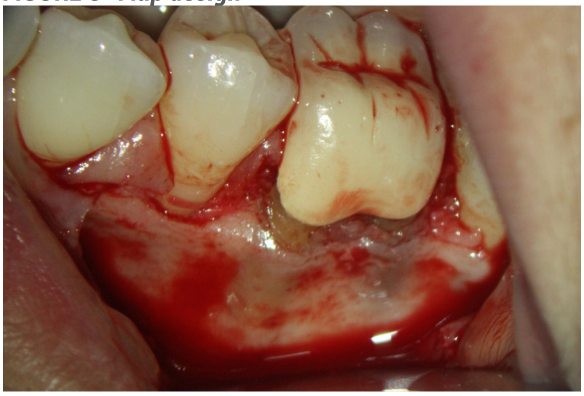


The clinical and imaging analysis led to the pulpar clinical diagnosis of prior endodontic treatment and the periapical diagnosis of acute periapical abscess. The proposed treatment was endodontic microsurgery aimed at endodontic retro re-treatment. In this therapeutic situation, the prosthetic crown and the intraradicular retainer would be kept, with no need for new prosthetic rehabilitation. After examining all the advantages, disadvantages, and risks, the endodontic microsurgical treatment was performed.

One hour before the microsurgical procedure, for the purpose of preemptive analgesia, 4mg of dexamethasone was administered orally (Andrade e cols 2013). The control of trans-operative anxiety was accomplished through conscious inhalation sedation with nitrous oxide/oxygen mixture at a rate 65/35% and minute volume of 6.5 l/min. 5.4 ml of lidocaine 2% with 1:100,000 epinephrine were used as anesthetic solutions, with 1.8 ml of the solution used in the traditional technique to block the inferior alveolar nerve, 1.8 ml to block the buccal nerve, and 1.8 ml of the same solution in an infiltrative manner on the dividing line between gums and mucus membranes.

After anesthesia, the papilae-based incision was made, followed by a relaxing vertical incision. Using a micro-syndesmotome, the syndemotomy was performed smoothly to cause minimal damage to the soft tissue structures (FIGURE 5).

FIGURE 5- Flap design



The breakage of the vestibular cortical bone was done using piezo-osteotomy with ultrasonic tips ST3 Bone Surgery Tip (Vista Dental) in full power. The osteotomy exposed the entire periapical lesion (FIGURE 6). Then, apical curettage was performed (FIGURE 7).

FIGURA 6- Piezo-osteotomy

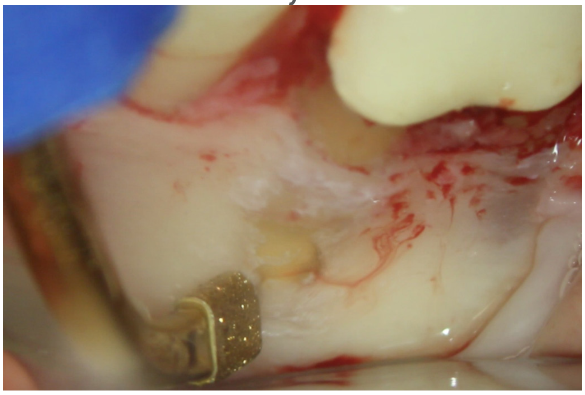


FIGURE 7- Osteotomy

The apicoectomy was also performed using a piezo-electrical ultrasonic system with W7 ultrasonic insert (CVDentus) at a power of 80% and plentiful irrigation with sterile saline solution (FIGURE 8). The apex was cut at an angle perpendicular to the long axis of the root to allow for removal of possible ramifications of canals located to both the vestibular and lingual directions. After the apicoectomy of the medial root, it was possible to observe an apical region of the mesial canal, which had not been cleaned and modeled, remaining infected (FIGURE 9). With a retro-mirror, an isthmus was seen connecting the vestibular mesial canal to the lingual mesial (FIGURE 10). This isthmus had not been modeled and disinfected by the conventional endodontic preparation due to the limitations inherent to the kinematics and design of the endodontic instruments and the irritant auxiliary chemicals. These areas of poor cleaning and modeling of the canals were identified as the possible explanations for the maintenance of the apical periodontitis.

FIGURE 8- Apical resection

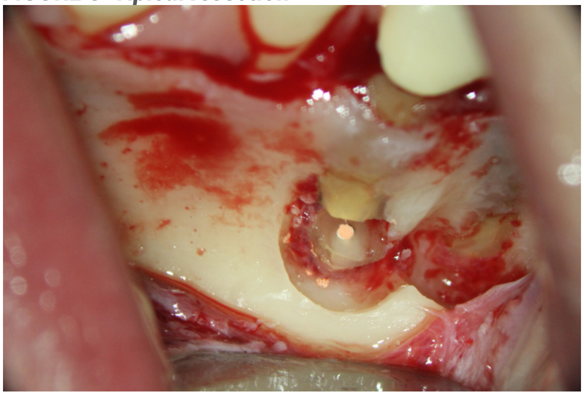


FIGURE 9 - Missed anatomy

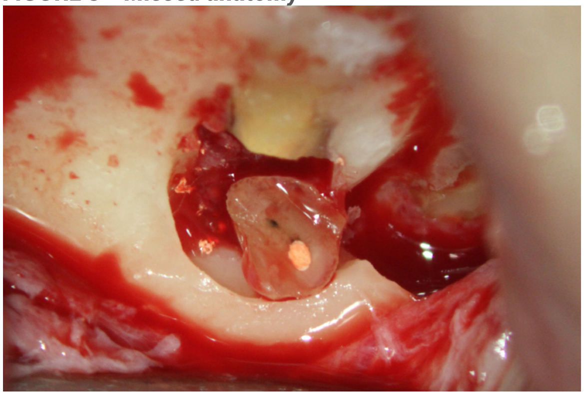
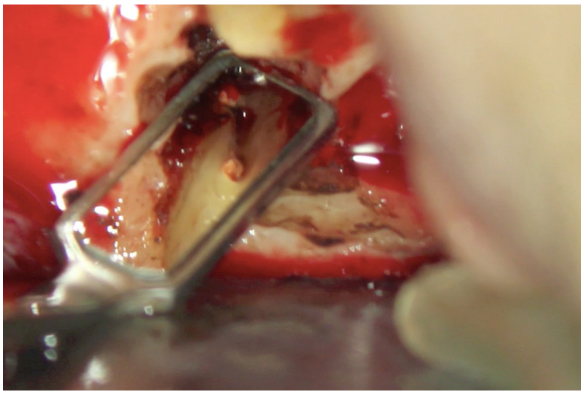


FIGURE 10 - Isthmus



With the use of JetTip JT-1 ultrasound inserts (B&L Biotech), the retro-preparation was executed, adjusting the ultrasound power to 30% and irrigation with sterile saline solution. The quality of the retro-preparation was evaluated using the surgical micro-mirror. (FIGURE 11). The isthmus of the medial root was cleaned using these ultrasound tips in movements in the vestibular-lingual direction. The retro-prepared canal was irrigated with a 2% Chlorhexadine followed by sterile saline with irrigation microcannulas (Endo Tips 0.14 Aspirator - Angelus). The use of aspiration microcannulas (Endo Tips 0.14 Aspirator - Angelus) on a vacuum pump promoted drying of the canal, leaving it fit to receive the retro-obturation material.

The canal was retro-obturated using White MTA (Angelus). The placement of the MTA in the retro-cavity was done with the MAPSystem (Roydent) and retro-condensed until total filling of the canal (FIGURE 12). After this step, with the purpose of preventing the growth of the connective tissue inside the apical bone cavity, its was filled with surgical Calcium Sulfate (NewOsteo - GMReis).

The post-operative controls were done 72 hours after (FIGURE 13, 14, 15), 6 months after (FIGURE 16), and 12 months after (FIGURE 17). On the X-ray after 12 months, it is possible to view the advanced bone repair of the apical region

FIGURE 11- Retrograde preparation

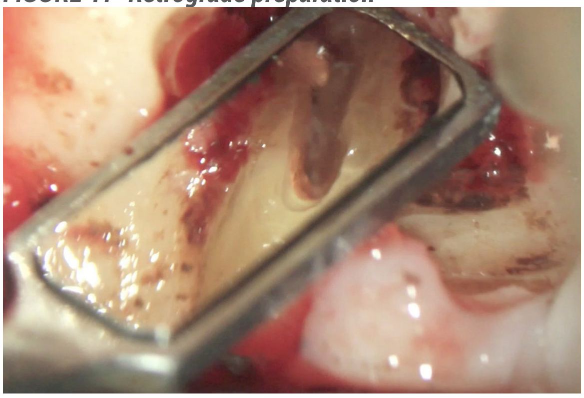


FIGURE 12- Isthmus filled with White Angelus MTA

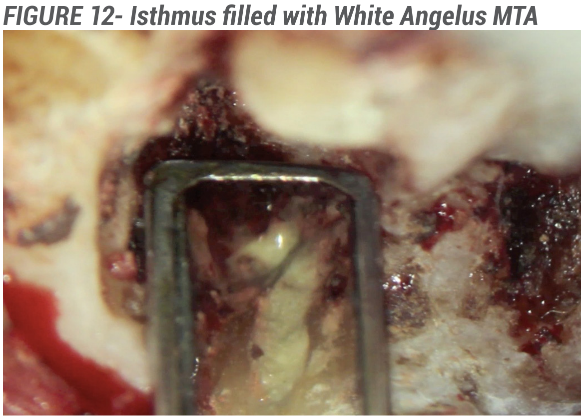


FIGURE 13 - Post operative: 72 hours

FIGURE 14- Post operative Xray

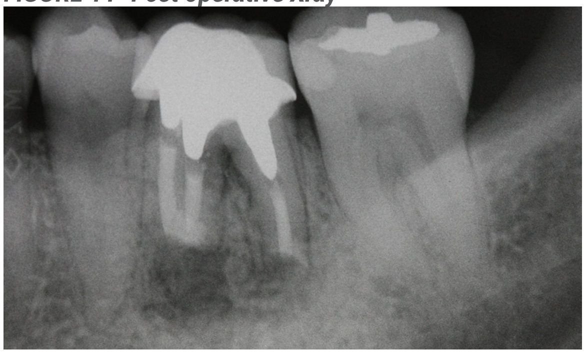


FIGURE 15- Post operative CBCT - isthmus filled

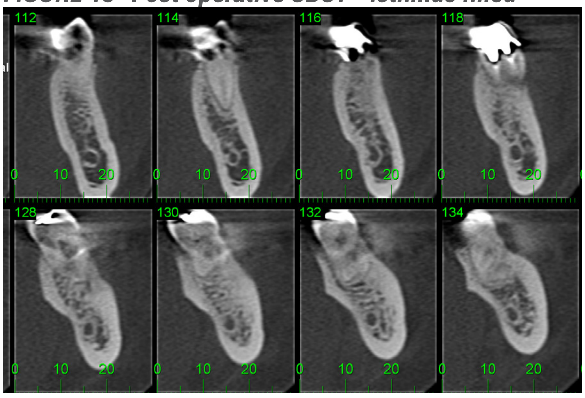


FIGURE 16- Post operative Xray - 6 months

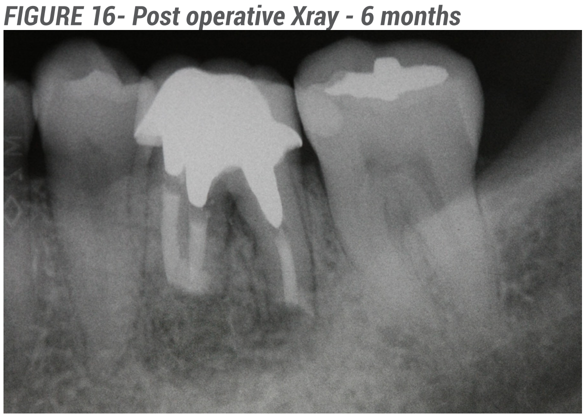
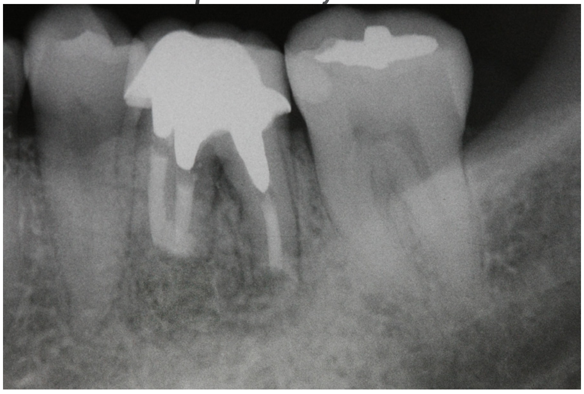


FIGURE 17- Post operative Xray - 12 months



DISCUSSION

The use of operatory microscopy in association with the ultrasound inserts as well as the Mineral Trioxide Aggregate (MTA)-based bioactive retro-obturation materials, associated with the technical and scientific evolution raised the success rates of endodontic microsurgery from 60% to levels above 90%.

The visibility provided by the microscope allows for evaluation of micro-structures and details not visible to the naked eye. Its use allows the micro-surgeon to refine his or her motor precision Bowers 2010. Trauma on the delicate periodontal and periapical tissues is minimized, leading to better aesthetic results.

The osteotomy needed for access to the apical third had traditionally been done with chisels or drills and high rotation. In the 80s, piezo-osteotomy was introduced (Labanca 2008). In this surgical method, the osteotomy is done with ultrasound, without the use of drills. This has technical and biological advantages when compared to the use of drills at high or low rotation. Ultrasound is safe due to its selectivity for tissue cutting with its action only on mineralized tissues. Ultrasound preserves soft tissues such as nerves, blood vessels, and mucus membranes. The amplitude of its micromovements varies between 60 and 210 micrometers, allowing for precise cuts on hard tissues such as bone and tooth. With the use of ultrasound, there is the formation of acoustic microcurrents in the operating field, which in turn promote a clean surgical field by improving hemostasis (Labanca 2008, Preti 2007, Horton 1981, Sortino 2008). The ultrasonic energy acts on cellular viability in the region operated on, making the first post-operative phases of the bone repair process better. The induction of a faster increase of morphogenetic bone proteins; the modulation of the inflammatory reaction, and the stimulations of the formation of osteoblasts are physiological benefits which contribute to this better and faster healing (Preti 2007).

The apicoectomy must be performed at 3 mm from the root apex, thus providing the maintenance of the length of the dental root as well as the elimination of the majority of the apical ramifications and lateral canals Kim S 1997. The rotational movement of drills or vibrational movement of ultrasound during the apicoectomy causes disarray of the remaining gutta percha. This leads to misalignment of this gutta percha with the walls of the canal. This is one of the reasons which leads to the necessity of the confection of the retro-preparation and later retro-obturation. In addition, during the retro-preparation, removal of the infected dentin, the obturation material, and the cleaning of the isthmus is done, optimizing the intracanal bacterial control, and the canal is modeled, leaving it fit to receive the sealing material.

A retro-cavity must have at least 3 mm in depth inside the root canal on its long axis Kim S 1997. If this cannot be done, the cleaning and disinfection achieved, as well as the prognosis of the treatment, will be uncertain. In the microsurgical technique, the retro-preparation is always done with ultrasonic inserts, because it is the only way to achieve preparations with 3mm or more into the root canal. This is possible thanks to the long neck of the ultrasonic inserts added to a sequence of 3 to 4 bends in its length. These bends allow full accessibility for the active tip to the root canal.

The ultrasonic inserts also allow for non-circular movements for better mechanical cleaning of flat areas of the root canals known as isthmuses. It is possible to observe the elliptical preparation with greater vestibular-lingual extension for the original anatomy of the microanatomy of the mesial root. Filling of the elliptical-shaped retro-cavity with MTA is also evident on the post-operative tomography (FIGURE XXXX)

The choice of the retro-obturation material is fundamental for achieving high levels of success Kim S 2010. The ideal material should promote the filling of the region, protect the surgical wound, be radiopaque, and also be biocompatible, impermeable, antimicrobial, osteoconductive, and have excellent behavior in a moist environment. Various materials such as Cavit®, Zinc Oxide and Eugenol, Calcium Hydroxide, Amalgam, Gutta Percha, Tricalcium Phosphate, and Hydroxiapatite were used in the attempt to seal retro-preparations (Pitt Ford et al 1999). However, none of these materials was capable of re-establishing the original architecture of the areas affected (Arens & Torabinejad 1996).

The introduction of bioactive sealant materials, such as MTA, the precursor of the group of bioceramics, brought a great advance in sealing and biocompatibility. MTA presents the best desirable characteristics of a repair material: tissue biocompatibility, stimulation of neo-formation of cement, suitable for environments with moisture, produces biomineralization, and promotes superior sealing when compared to other materialsTorabinejad et al 1995, Holland et al 1999, Main et al 2004). Due to the aforementioned qualities, MTA is now the material which best meets the requirements for material suitable for retro-obturations, and is the material with the greatest scientific proof of effectiveness and clinical safety. For this reason, it was the material of choice for the apical sealing.

In the apical repair process, bone repair is expected to occur through a neo-formation of bone tissue in the region of the apical periodontitis and the repair is also expected to be without scars or periodontal recessions.

CONCLUSION:

The synergism between operatory microscopy, ultrasound, and MTA allows for extremely precise and predictable treatments to be performed. Endodontic microsurgery, when performed within the modern concepts, is a therapeutic alternative to be considered for the aesthetic and functional maintenance of teeth with secondary or persistent apical periodontitis.

REFERENCES

Andrade ED. Terapêutica Medicamentosa em Odontologia. 3rd ed., São Paulo, Artes Médicas, 2014; 119-128.

Labanca M, Azzola F, Vinci R, Rodella LF. Piezoelectric surgery: twenty years of use. British Journal of Oral and Maxillofacial Surgery. 2008;46:265–269.

Preti G, Martinasso G, Peirone B, et al. Cytokines and growth factors involved in the osseointegration of oral titanium implants positioned using piezoelectric bone surgery versus a drill technique: a pilot study in minipigs. J Periodontol. 2007;78:716–22

Horton JE, Tarpley Jr TM, Jacoway JR. Clinical applications of ultrasonic instrumentation in the surgical removal of bone. Oral Surg Oral Med Oral Pathol. 1981;51:236–42.

Setzer FC, Shah SB, Kohli MR, Karabucak B, Kim S. Outcome of endodontic surgery: a meta-analysis of the literature--part 1: Comparison of traditional root-end surgery and endodontic microsurgery. J Endod. 2010 Nov;36(11):1757-65.

Rahbaran S, Gilthrope MS, Harrison SD, Gulabivala K. Comparison of clinical outcome of periapical surgery in endodontics and oral surgery units of a teaching dental hospital: a retrospective study. Oral Surg Oral Med Oral Pathol 2001;91:700-9.

Rubinstein R, Kim S. Short-term observation of the results of endodontic surgery with the use of a surgical operation microscope and Super-EBA as root-end filling material. J Endodon 1999;25:43-8.

Rubinstein RA, Kim S. Long-term follow-up of cases considered healed 1 year after apical microsurgery. J Endodon 2002;28:378-83.

Torabinejad M, Hong C U, McDonald F, Pitt Ford T R. Physical and chemical properties of a new root-end filling material. J Endod, 1995, 21:349-353.

Torabinejad M, Corr R, Handysides R, Shabahang S.Outcomes of nonsurgical retreatment and endodontic surgery: a systematic review. J Endod. 2009 Jul;35(7):930-7.

Sortino F, Pedullà E, Masoli V. The piezoeletric and rotatory osteotomy technique in impacted third molar surgery: comparison of postoperative recovery. Journal of Oral and Maxillofacial Surgery. 2008;66(12):2444-2448.

Bernardes R A, de Souza Junior J V, Duarte M A H, De Moraes I G, and Bramante C M .Ultrasonic Chemical Vapor Deposition–coated Tip versus High- and Low-speed Carbide Burs for Apicoectomy: Time Required for Resection and Scanning Electron Microscopy Analysis of the Root-end Surfaces. Journal of Endod Vol 35, N 2, February 2009.

Christiansen R, Kirkevang LL, Hørsted-Bindslev P, Wenzel A. Randomized clinical trial of root-end resection followed by root-end filling with mineral trioxide aggregate or smoothing of the orthograde gutta-percha root filling–1-year follow-up. Int Endod J 2009;42:105-14.

Gilheani PA, Figdor D, Tyas MJ. Apical dentin permeability and microleakage associatedwith root end ressection and retrograde filling. J Endod. 1994;20:22-26.

Bowers DJ, Glickman GN, Solomon ES, He J. Magnification's Effect on Endodontic Fine Motor Skills. J Endod. 2010 Jul;36(7):1135-8.

Holland R, de Souza V, Nery M J, Otoboni Filho J A, Bernabe P F, Dezan Junior E. Reaction of dog's teeth to root canal filling with mineral trioxide aggregate or a glass ionomer sealer. J Endod 1999, 25 (11): 728-30, Nov.

Main C, Mizayan N, Shabahang S, Torabinejad M. Repair of root perforations using mineral trioxide aggregate: a long-term study. J Endod, 2004, 30

(2): 80-83, Feb.

Nair PN. On the causes of persistent apical periodontitis: a review. Int Endod J. 2006 Apr;39(4):249-81.

Torabinejad M, Kutsenko D, Machnick TK, Ismail A, Newton CW. Levels of evidence for the outcome of nonsurgical endodontic treatment. J Endod. 2005 Sep;31(9):637-46.

Wu MK, Dummer PM, Wesselink PR. Consequences of and strategies to deal with residual post-treatment root canal infection. Int Endod J. 2006 May;39(5):343-56.

Wesson CM, Gale TM. Molar apicoectomy with amalgam root-end filling: results of a prospective study in two district general hospitals. Br Dent J 2003; 195:707-14.

Tsesis I, Rosen E, Schwartz-Arad D, Fuss Z. Retrospective evaluation of surgical endodontic treatment: traditional versus modern technique. J Endodon 2006;32:412-6.

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 Aug;36(8):1323-5.

Kim S. Principles of endodontic microsurgery. Dent. Clin. North. Am. 1997; 41:481-497.

Kim E, Song JS, Jung IY, Lee SJ, Kim S. Prospective clinical study evaluating endodontic microsurgery outcomes for cases with lesions of endodontic origin compared with cases with lesions of combined periodontal-endodontic origin. J Endodon 2008;34:546-51.

Walsh WR, Morberg P, Yu Y. Response of a calcium sulfate bone graft substitute in a confined cancellous defect. Clin Orthop Relat Res. 2003; 406:228.

Peltier L.F. The use of Plaster of Paris to fill defects in bone. Clin Orthop, 21:1-29.1961.

Kelly CM, Wilkins RM, Gitelis S, Hartjen C, Watson T, Kim PT. The use of a surgical grade calcium sulfate as bone graft substitute. Clin Orthop Rel Res, 382:42-50. 2001

Peters CL, Hines JL, Bachus KN, Craig MA, Bloebaum RD. Biological effects of calcium sulfate as a bone graft substitute in ovine metaphyseal defects. J Biomed Mater Res A, Mar 1;76(3):456-62. 2006.

Setzer FC, Shah SB, Kohli MR, Karabucak B, Kim S. Outcome of endodontic surgery: a meta-analysis of the literature--part 1: Comparison of traditional root-end surgery and endodontic microsurgery. J Endod. 2010 Nov;36(11):1757-65.