Use of operating microscopy, ultrasound and MTA in periapical microsurgery

Treatment of a persistent endodontic infection

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In most cases, pulpal and periapical pathologies are caused by intra-canal infections and their initial treatment is by conventional endodontic treatment. In cases of teeth without apical periodontitis, the success rate is approximately 98 per cent. If apical periodontitis and primary infections (which may be of bacterial or non-bacterial origin) occur, this rate is reduced to 86 per cent. Endodontic failure is usually associated with technical limitations that prevent adequate intra-canal microbial control in the complex internal microanatomy of the root canal system.3

The treatment recommended for cases of primary endodontic infections is endodontic retreatment, which has a success rate of approximately 83 per cent.4 Thus, even after the endodontic retreatment, owing to the factors of complex internal microanatomy, the failure rate may persist. In these clinical situations, apical microsurgery has been proven to be an alternative for the clinical treatment of these infections. Various technological advances in the area of apical microsurgery have occurred in recent years. A very important triad has been established for achieving high success rates, consisting of the use of operating microscopy, ultrasound and mineral trioxide aggregate (MTA). When periapical microsurgery is performed traditionally, without the use of microscopy, ultrasound and MTA—that is, in the macro-surgical form—it its success rate does not exceed
60 per cent.5–8 However, when performed with the contemporary technique of microsurgery, its success rate is over 90 per cent.6, 9–13 This evolution has made microsurgical endodontic treatment a more viable clinical procedure with greater predictability.

Clinical case

A 42-year-old female patient presented at our clinic with spontaneous pain resulting from apical periodontitis around tooth #36. The last endodontic retreatment had been performed 19 months before. During the semi-technical examination, a negative response to pain was observed in the palpation, and vertical and horizontal percussion tests. Thermal and electric pulpal tests of tooth #36 obtained no response. Responses of the neighbouring teeth were normal. On the radiograph, we detected a metal–ceramic prosthetic crown functioning within acceptable standards, as well as a cast metal intra-radicular retainer. Overall, this was a satisfactory endodontic treatment with good shaping and good obturation.

However, tooth #36 showed apical periodontitis (Figs. 1–3) and the preoperative CBCT scan showed fracture of the vestibular cortical bone (Fig. 4). The proposed treatment was endodontic microsurgery aimed at endodontic retrograde retreatment. In this therapeutic situation, the prosthetic crown and the intra-radicular retainer would be kept; there was no need for new prosthetic rehabilitation. After the evaluation of all the advantages, disadvantages and risks, the endodontic microsurgical treatment was performed.

One hour before the microsurgical procedure, 4 mg of dexamethasone was administered orally for the purpose of pre-emptive analgesia.14 The control of pre-operative anxiety was accomplished through conscious inhalation sedation with a nitrous oxide and oxygen mixture at a ratio of 65 per cent to 35 per cent and a minute volume of 6.5 l/min. As anaesthetic solution, 5.4 ml of 2 per cent lidocaine with 1 : 100,000 epinephrine was used, with 1.8 ml each of the solution administered through the traditional technique to block the inferior alveolar nerve and the buccal nerve. Another 1.8 ml of the same solution was infiltrated between the gingivae and mucosa.

After anaesthesia was established, the papilla-based incision was made, followed by a vertical relaxing incision. Using a micro-syndesmotome, the syn-
Desmotomy was performed smoothly to prevent damage to the soft-tissue structures (Fig. 5).

The fracture of the vestibular cortical bone was treated using piezo-osteotomy with an ultrasonic tip (ST3 Bone Surgery Tip, Vista Dental) at full power. The osteotomy exposed the entire periapical lesion (Fig. 6). Subsequently, apical curettage was performed (Fig. 7).

The apicectomy was also performed using a piezo-electric ultrasonic system with a W7 ultrasonic tip (CVDentus) at a power of 80 per cent and under copious irrigation with a sterile saline solution (Fig. 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 apicectomy of the medial root, it was possible to observe an infected apical region of the mesial canal, which had not been cleaned and shaped (Fig. 9). With a retro-mirror, an isthmus was found connecting the vestibular mesial canal to the lingual mesial (Fig. 10). This isthmus had not been shaped and disinfected by the conventional endodontic preparation owing to the limitations inherent in the kinematics and design of the endodontic instruments and the auxiliary irrigant chemicals. These poorly cleaned and shaped areas of the canals were identified as the possible cause of the apical periodontitis.

Using JETip JT-1 ultrasonic tips (B&L Biotech), the retrograde preparation was performed, adjusting the ultrasonic power to 30 per cent and under irrigation with a sterile saline solution. The quality of the retrograde preparation was evaluated with a surgical micro-mirror (Fig. 11). The isthmus of the medial root was cleaned using these ultrasonic tips with movements in the vestibular-lingual direction. The retro-prepared canal was irrigated with 2 per cent chlorhexidine, followed by sterile saline with irrigation micro-cannulas (Angelus). The canal was dried using aspiration micro-cannulas on a vacuum pump, leaving it ready to receive the retrograde obturation material.

The canal was retro-obturated with white MTA (Angelus). The placement of the MTA in the retrograde cavity was done with the MAP System (Roydent) and retro-condensed until the canal was completely filled (Fig. 12). In order to prevent the growth of the connective tissue inside the apical bone cavity, it was filled with surgical calcium sulphate (GMReis).

The postoperative control radiographs were taken after 72 hours (Figs. 13–15), six months (Fig. 16) and 12 months (Fig. 17). On the last radiograph, it was possible to see the advanced repair of the bone in the apical region.

**Discussion**

The use of operating microscopy in combination with ultrasonic tips and MTA-based bioactive retrograde obturation materials has increased the success rates of endodontic microsurgery from 60 per cent to levels above 90 per cent. The enhanced visibility provided by the microscope allows for evaluation of microstructures and details that are not visible to the naked eye. It allows the microsurgeon to refine his or her motor precision. Trauma to the delicate periodontal and periapical tissue can be minimised, leading to better aesthetic results.

The osteotomy needed for access to the apical third had traditionally been performed with chisels or drills and high rotation. In the 1980s, piezo-osteotomy was finally introduced. In this surgical method, the osteotomy is done with ultrasound, which has technical and biological advantages over the use of drills at high or low rotation. Ultrasound is safe, as it only works on mineralised tissue. It preserves soft tissue, such as nerves, blood vessels and mucosa. The amplitude of its micro-movements varies between 60 and 210 μm, allowing for precise cuts into hard tissue, such as bone and tooth.
With the use of ultrasound, acoustic micro-currents in the operating field are formed that clear the surgical area by improving haemostasis.\textsuperscript{16–19}\ The ultrasonic energy acts on cellular viability in the region operated on, accelerating the first postoperative phases of the bone repair process. The faster increase of bone morphogenetic protein, modulation of the inflammatory reaction and the stimulation of the formation of osteoblasts are physiological benefits that contribute to this improved and faster healing process.\textsuperscript{17}

The apicectomy must be performed at 3 mm from the root apex, thus maintaining the length of the dental root, as well as eliminating the majority of the apical ramifications and lateral canals.\textsuperscript{20}\ The rotational movement of drills or vibrational movement of ultrasound during the apicectomy dislodges the remaining gutta-percha and this often leads to misalignment of gutta-percha with the walls of the canal. This is one of the reasons for the combination of the retrograde preparation and later retrograde obturation. In addition, during the retrograde preparation, removal of the infected dentine and the obturation material and cleaning of the isthmus is done, optimising the intra-canal bacterial control and shaping of the canal and leaving it prepared for the sealing material.

A retrograde cavity must be at least 3 mm in depth inside the root canal along its long axis.\textsuperscript{20}\ If this cannot be achieved, the outcome of the proposed cleaning and disinfection, as well as the prognosis of the treatment, will be uncertain. In the microsurgical technique, the retrograde preparation is always done with ultrasonic tips because it is the only way to achieve preparations of 3 mm or more into the root canal. This is possible owing to the long neck of the ultrasonic tips in addition to a sequence of three to four bends along its length. These bends allow the active tip to gain full accessibility to the root canal. The ultrasonic tips 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 of the original anatomy of the microanatomy of the medial root. The filling of the elliptical retrograde cavity with MTA was also evident on the post-operative CBCT scan.

Selecting the appropriate retrograde obturation material is fundamental for achieving a high level of success. The ideal material should promote the filling of the region, protect the surgical wound and be radiopaque, biocompatible, impermeable, antimicrobial and osteoconductive. It should also have excellent properties in a moist environment. Various materials, including Cavit (3M ESPE), zinc oxide, eugenol, calcium hydroxide, amalgam, gutta-percha, tricalcium phosphate and hydroxyapatite, have been used in the attempt to seal retrograde preparations.\textsuperscript{21}\ However, none of these materials have been found to be capable of re-establishing the original architecture of the areas affected.

The introduction of bioactive sealant materials such as MTA, the precursor of the group of bioceramics, made a great leap in terms of sealing and biocompatibility. It offers the most desirable characteristics of a repair material, such as tissue biocompatibility, stimulation of neo-formation of cement and biomineralisation. It also promotes superior sealing compared with other materials.\textsuperscript{21–23}\ Owing to the qualities described, MTA is now the material that best meets the requirements for material suitable for retrograde obturation. It is also the material with the best scientific track record in terms of effectiveness and clinical safety. For this reason, it was the material of choice for the apical sealing in this case.

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

**Conclusion**

The combination of operating microscopy, ultrasound and MTA allows for extremely precise and predictable treatment. Endodontic microsurgery, when performed in accordance with these modern concepts, can be considered to be a therapeutic alternative for the aesthetic and functional maintenance of teeth with secondary or persistent apical periodontitis.

**Editorial note:** A list of references is available from the publisher.