The cortical window

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Introduction

Techniques, materials and innovations in the micro-armamentarium of endodontic microsurgery are seminal to enhanced predictable outcomes by comparison with historical microsurgical procedures.

The superior magnification and illumination of surgical operating microscopes improves the identification of root peripheries, ensures a lesser degree of root reduction and diminishes the size of osteotomies; thus retaining greater residual bone.

Smaller resection angles (perpendicular to the long axis of the root) reduce the number of tubuli exposed. Lateral canals, canal deltas, isthmus connections and micro-cracks can be identified prior to root resection, retropreparation and retro-sealing (Weller et al, 1995)

Studies of positive treatment outcomes for conventional encloclontic surgical therapy show a diverse range of success dependent upon an array of predictors (Garcia-Guerrero et al, 2017; De Chevigny C et al, 2008).

A study by Wang et al reported an overall healed rate of 74% of assessed teeth; root filling length and size of preoperative lesions proved to be important predictors of treatment outcomes (Wang et al, 2004).

Positive treatment outcomes (94%) were demonstrated by microsurgical techniques (Tsesis et al, 2013)

Retreatment of failing encloclontic procedures demonstrate statistically less positive treatment outcomes than those clone by microsurgical techniques (86%); fewer failures ensue (Setzer et al, 2012). These conditions are more readily addressed with microsurgical techniques (Floratos and Kim, 2017)

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Figure 1: A variety of piezotomes are commercially available; saw-toothed tips of 8mm to 10mm are essential. Piezotomes ensure precise and safe cutting of mineralized tissues and preserve soft tissues (blood vessels, nerves, and mucosa)

Figure 2: The porcelain-fused-to-metal (PFM) crown appeared to fit appropriately. The root filing demonstrated incomplete sealing and there was no evidence of the expected MB2 canal

Figure 3: The post-operative radiograph showed four treated canals

Figure 4: Eighteen-months post-endodontic retreatment therapy. Apical pathology appeared to be present

The computer-guided cortical window approach

A cortical window (bone lid) access to the apical region is less invasive, minimises bone loss and is less traumatic in comparison to alternative techniques.

The perimeter of the window is determined from racliographs of the area. Radiographs are essential to all aspects of encloclontics; however, flat films are two-dimensional images of three-dimensional structures and so data interpretation is subjective.

Cone beam computed technology (CBCT) enables the clinician to visualise structures in sagittal, axial and coronal planes. Three-dimensional imaging provides more substantial data for diagnosis, pre-treatment planning, post-treatment assessment and reassessment evaluations (Ahlowalia et al, 2013; Venskutonis et al, 2014).

A printed stereolithographic surgical template can guide the osteotomies during the surgery; minimising deviation from the digital surgical plan. Surgical templates printed

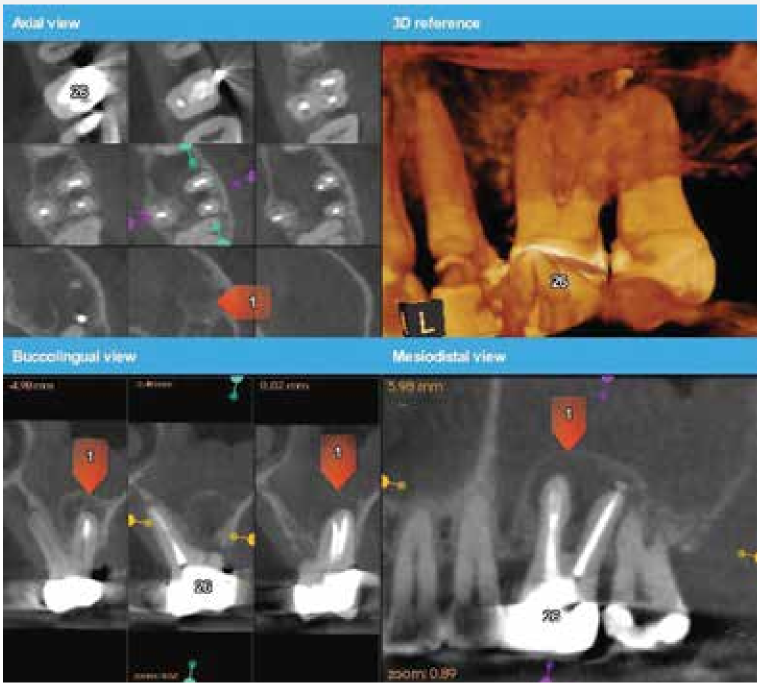

Figure 5: The cone beam computed tomography (CBCT) scan results showed rarefying osteitis and sinus cortical floor elevation along the mesiobuccal and distobuccal roots

from three-dimensional imaging optimise site preparation, the perimeter of the osteotomy, depth of cortical bone, extent of pathology and volume of bone graft required (Kuhl et al, 2015; D'haese et al, 2012; Pinsky et al, 2007; Strbac et al, 2017).

Piezotome osteotomy

Traditional osteotomies use large, round burs which remove significant cortical bone. Delayed healing, increased post-operative pain and other complications may ensue.

With microscopes, piezotomes and ultrasonic tips, a smaller osteotomy is created, thus minimising the aforementioned sequelae.

Piezo surgery enables micrometric saw cuts which preserve cortical bone loss and facilitates preservation of root length by lower resection angles and enhanced visiblity.

In deep spaces, ultrasonic vibrations break clown irrigants into small particles readily washed from the crypt.

Less vascular presence in the crypt minimises use of hemostatic agents (Viscostat) and interference with retro-seal setting time. The use of a piezo surgical devices (Figure 1) enables accurate shaping of the cortical window and diminished osseous removal, in contrast to traditional crypt creations which are freehand guided (Abella et al, 2014).

Case report

The patient presented to our surgery with a history of 'sporadic discomfort in the gum' overlying tooth LR2.

A two-dimensional intraoral racliograph revealed a prior history of root canal therapy and a porcelain-fused-to-metal (PFM) crown (both completed approximately 10 years ago) (Figure 2)

Swelling began the evening prior to the appointment; the patient reported that the throbbing necessitated analgesics for relief of the pain. No sensitivity to pressure nor reaction to temperature were noted; the patient could not localise the tooth causing the distress. Treatment options were discussed with the patient; retreatment through the PFM crown was chosen.

Anaesthesia was administered (posterior superior alveolar nerve block - 2% xylocaine with epinephrine 1: 100,00 and infltration facially and palatally 2% xylocaine with epinephrine 1 :50,000). A conservative access preparation was made; decay was identified proximal to the palatal

Figure 6: The digital rendering of the surgical stent used to guide the cortical bone window osteotomies

Figure 7: The 3D-printed model and surgical stent used to guide our cortical bone window access

Figure 8: The surgical stent was put in place against the bone to guide the piezosurgical saw osteotomies

Figure 10: The clinical view of the surgical site once the cortical window had been removed and the roots resected

Figure 11: The microsurgical view of the root apical retro-preparation and apical seal

Figure 12: The defect was grafted with allograft cortical bone chips (Straumann Allograft)

Figure 13: The cortical bone window was replaced and fixated in place with gentle pressure

Figure 14: The flap was replaced and sutured with prolene monofilament sutures

Figure 15: The immediate post-operative radiograph

Figure 16: The nine-month post-operative radiograph showed excellent bone regeneration

canal and no fractures or cracks were noted.

Cavil was present beneath the composite core and the untreated MB2 canal (Stropko, 1999) was discovered.

A reservoir was made in the gutta percha (Proultra ultrasonic tip). Endosolv E was used to soften the gutta percha (Hwang et al, 2015)

After debridement and shaping, Ca(OH)2 (Ultracal XS) was placed in the root canal space to further enhance disinfection.

Prior to obturation, drainage was noted coming from the MB2 canal; drainage was arrested and the canals root was filled with vertical condensation of warm gutta percha (VCWG) and AH-Plus sealer (Figure 3).

The patient returned in six months for reassessment. Tooth LR2 was within normal limits to percussion, bite, palpation, mobility and probing.

Eighteen months later, the patient returned for a second reassessment appointment (Figure 4). Tooth LR2 was slightly sensitive to percussion and the overlying gingival tissues were inflamed.

The patient was referred for a CBCT; the scan (Figure 5) revealed a common area of rarefying osteitis surrounding the mesial buccal and distal buccal roots which had caused elevation of the sinus floor. As the endodontic pathology had not resolved, treatment options were proposed. The patient chose to have microsurgical therapy performed.

A 3D-printed stereolithographic template was created by combining the CBCT scan data with an intraoral scan's (3Shape Trios intraoral scanner) digital data. The data was then imported into Codiagnostix software in order to plan our approach and design our cortical window dimensions for optimal access to the roots (Figure 6).

The guided microsurgical approach would facilitate an osteotomy design to minimise the potential for sinus membrane perforation. The JD-printed guide for the cortical window would guide the length and angle of the osteotomies using the piezosurgical saw (Figure 7).

Cervical recession and decay were in evidence about teeth LU and LRl in addition to exposure of the crown margin of tooth LR2.

The cervical area of tooth LR3 was severely abraded. An intra-sulcular full-thickness muco-periosteal fap was raised; a vertical releasing incision was positioned mesial to tooth LRl.

The surgical stent was placed over the maxillary teeth (Figure 8) and a piezotome-guided surgical window was developed using the margins of the stent (Figure 9).

A chisel was used to elevate the cortical plate and root resection performed with Lindemann burs (Figure 10).

The cortical window was placed in sterile saline while the endodontic microsurgery was completed. After resection using Lindemann burs, the root periphery was stained with methylene blue and examined for anomalies and the root canal space was retro-prepared with ultrasonic tips to a depth of three millimetres, creating a reservoir for the retro-sealing materials.

The retro-preparation was rinsed with ethylene-diaminetetraacetic acid (EDTA) and dried with paper points.

Bosworth Super-EBA was placed (Figure 11) and the root end burnished with a multi-fluted carbide bur. Radiographs were taken at the retro-preparation stage and the retro-sealing stage to ensure accuracy of direction and material placement. The defect thoroughly debrided and was grafted with allograft (Straumann Allograft) (Figure 12). The cortical bone window was replaced and ensured to have no mobility (Figure 13)

The flap was closed with Ethicon 5-0 Prolene monofilament sutures (Figure 14) and a post-operative radiograph was taken (Figure 15).

The patient was directed to use 800 mg of ibuprofen and 1000 mg of acetaminophen for pain and to rinse with chlorhexidine.

Sutures were removed in seven days and the patient reappointed for reassessment. The re-evaluation radiograph taken at nine months showed substantial osseous

Figure 17: The one-year post-operative cone beam computed tomography (CBCT) scan showed complete regeneration of the defect and buccal plate

regeneration (Figure 16) and a post-operative CBCT scan was taken after one year, showing complete bone regeneration and continuity of the buccal plate. (Figure 17).

Conclusions

Along with surgical operating microscopes and piezotomes, integration of optical scanners and CBCT Dicom files to JD-printed stereolithographic surgical guides is yet another iteration in the advancement of endodontic microsurgery

This novel, digitally-guided approach used in this case report, along with the intraoperative use of a JD-printed osteotomy guide, allows for greater effciency and accuracy for creation of the access window to the roots.

The technique gives the advantage of bone preservation by allowing the cortical plate to be replaced, yet still provides adequate access for the apical root preparation.

The JD-printed guide provides a control for the osteotomies without risking damage to vital structures. This digitally-guided microsurgical approach provides accuracy, access, control and bone preservation to the endodontic apical surgery procedure.

As we come upon the dawn of a new age of digital dentistry, we can see the future applications to be endless.

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