Case report

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Apicoectomy of maxillary anterior teeth through a piezoelectric bony-window osteotomy: two case reports introducing a new technique to preserve cortical bone

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Two case reports describing a new technique of creating a repositionable piezoelectric bony window osteotomy during apicoectomy in order to preserve bone and act as an autologous graft for the surgical site are described. Endodontic microsurgery of anterior teeth with an intact cortical plate and large periapical lesion generally involves removal of a significant amount of healthy bone in order to enucleate the diseased tissue and manage root ends. In the reported cases, apicoectomy was performed on the lateral incisors of two patients. A piezoelectric device was used to create and elevate a bony window at the surgical site, instead of drilling and destroying bone while making an osteotomy with conventional burs. Routine microsurgical procedures - lesion enucleation, root-end resection, and filling - were carried out through this window preparation. The bony window was repositioned to the original site and the soft tissue sutured. The cases were re-evaluated clinically and radiographically after a period of 12 - 24 months. At follow-up, radiographic healing was observed. No additional grafting material was needed despite the extent of the lesions. The indication for this procedure is when teeth present with an intact or near-intact buccal cortical plate and a large apical lesion to preserve the bone and use it as an autologous graft. (*Restor Dent Endod* 2016;41(4):310-315)

Key words: Apicoectomy; Autologous graft; Bony window; Piezoelectric

Introduction

The probability of success of modern Endodontic Microsurgery is remarkably high.[1-3] It is the recommended therapy for endodontically treated teeth with unresolved periapical lesions when the prognosis of secondary non-surgical root canal treatment is questionable.[4,5] In comparison to the traditional apical surgical technique wherein the osteotomy is inherently large, modern surgical technique advocates a smaller access through the cortical bone in order to visualize, enucleate, and manage the resected root end. This is in part due to the advent of the microscope and microsurgical instruments.[4] Due to the disease process and intraoperative removal, the cumulative loss of cortical bone may hinder or retard healing at the surgical site.[6,7] In a large apical lesion, such as in the presence of a true cyst, in order to adequately enucleate the diseased tissue, the iatrogenic loss of the buccal cortical plate becomes substantial. Healing in such cases can be uncertain or delayed.[8,9] In 1972, Rud *et al*. performed a radiographic, clinical, and histologic evaluation of the healing kinetics after apicoectomies in human subjects.[10] There were several publications related to this study in that year.[11,12] In

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the histological review of the samples, they demonstrated that lesions presenting with the loss of buccal and palatal cortical plates postoperatively, will heal with fibrous tissue formation instead of complete regeneration of the periapical tissues.[12]

As the extent of loss of the cortical plate increases, the operator should contemplate the use of regenerative techniques with alloplastic or xenograft materials.[6,13] The best grafting material is autologous in nature.[14] Hence, there is a need to introduce a methodology that will preserve the integrity of the healthy cortical plate in its entirety, to serve as the best available regenerative material.

The purpose of these two case reports is to describe a novel technique of piezoelectric bony window osteotomy along with a modern microsurgical technique in the maxillary anterior region to maintain the cortical plate, which in turn may induce accelerated and predictable healing of the surgical site.

Case Reports

Case 1

A 48 year old male patient was referred to a private endodontic practice for evaluation and treatment of a maxillary left lateral incisor. He complained of pain on biting and palpation in the area. Medical history was non-contributory. In his dental history, he reported that the tooth had been treated non-surgically 12 months earlier. Clinical examination revealed moderate percussion sensitivity. Periodontal probing and mobility were within normal limits when compared to contralateral and adjacent teeth. The radiographic examination revealed periapical radiolucency 7 - 8 mm in diameter along the distal surface of the root, indicative of either an accessory canal or a possible apical fracture (Figure 1a). The radiograph also showed a titanium screw that was used for fixation of the membrane during a previous implant placement procedure performed two years before presentation. The tooth had porcelain fused to a metal crown with good margins and esthetics. On the basis of the history and clinical and radiographic examination, a diagnosis of a previous root canal treatment with symptomatic apical periodontitis was established. The patient was offered all treatment options; he opted for microsurgical retreatment. Written consent was obtained.

The micro-surgical technique, as suggested by Kim and Kratchman,[4] was performed in addition to creation of a bony window osteotomy. After rinsing with 0.12% chlorhexidine solution (Peridex, Zila Pharmaceuticals Inc., Phoenix, AZ, USA) for 60 seconds, the patient was administered 2 carpules of 4% articaine with 1:100,000 epinephrine (3M ESPE, Seefeld, Germany) buccal and palatal infiltration. After ensuring profound anesthesia, a full thickness sulcular flap was elevated, with one release incision distal to the left canine. The exposed site was considered a candidate for the bony window osteotomy as the cortical plate was found to be intact. The osteotomy was performed using a piezoelectric device (Piezotome 2, Acteon Satelec, Acteon Germany GmbH, Mettmann, Germany). The BS5 Tip (Acteon Satelec, Acteon Germany GmbH) was used to make an outline on the exposed cortical plate based on the measurement made on the digital radiograph and the topography of the exposed bone. Two vertical and two horizontal grooves were joined to create a bony window of approximately 6 mm by 12 mm, at the recommended setting mode of 3 with 60 mL/minute irrigation of sterile saline (Figure 1e). The average width of the cut was approximately 1 mm. The carved bony window was lifted off with a curved osteotome (Figure 1f). The bone block was stored in Hanks Balanced Salt Solution (Life Technologies, Grand Island, NY, USA) in order to keep it hydrated. The granulation tissue at the surgically exposed site was removed by curettage with bone and curved periodontal curettes until healthy bone margins were encountered and the root tip was clearly visible. A biopsy sample was sent for histologic evaluation. The denuded root was stained with methylene blue and inspected under high magnification (x16) with a surgical operating microscope (Carl Zeiss OPMI Pico, Carl Zeiss, Oberkochen, Germany) for a vertical root fracture or perforation. Upon curettage, the root presented with a fracture line extending from the root tip to about 4 mm along the length on the distal surface. The fractured portion of the root was eliminated during apical resection with a high-speed carbide Lindemann surgical bur (Hu-Friedy, Chicago, IL, USA) at a zero degree bevel. The resected root surface was then stained again for inspection under high magnification (x16). The root-end preparation was achieved using ultrasonic surgical JetTips (B&L Biotech USA Inc., Fairfax, VA, USA), and the root-end cavity was filled with white mineral trioxide aggregate (MTA, ProRoot MTA, Dentsply Tulsa Dental, Tulsa, OK, USA) (Figure 1g). The bony window was repositioned (Figure 1h). Care was taken not to depress it into the osteotomy site but instead place it in alignment with the remaining bone in its original alignment. As the insert used with the piezoelectric to create the bone window was very thin, the bone flap was re-approximated firmly. 6-0 propylene nylon sutures (Supramid, S. Jackson Inc., Alexandria, VA, USA) were used for suturing the soft tissue. A postoperative radiograph was taken (Figure 1b). The patient was prescribed an oral analgesic (ibuprofen 600 mg) and instructed to rinse twice daily with a 0.2% chlorhexidine mouth rinse for 1 week. The sutures were removed 7 days after surgery.

The patient presented for follow-up at 9 (Figure 1c) and 18 (Figure 1d) months with radiographic signs of complete

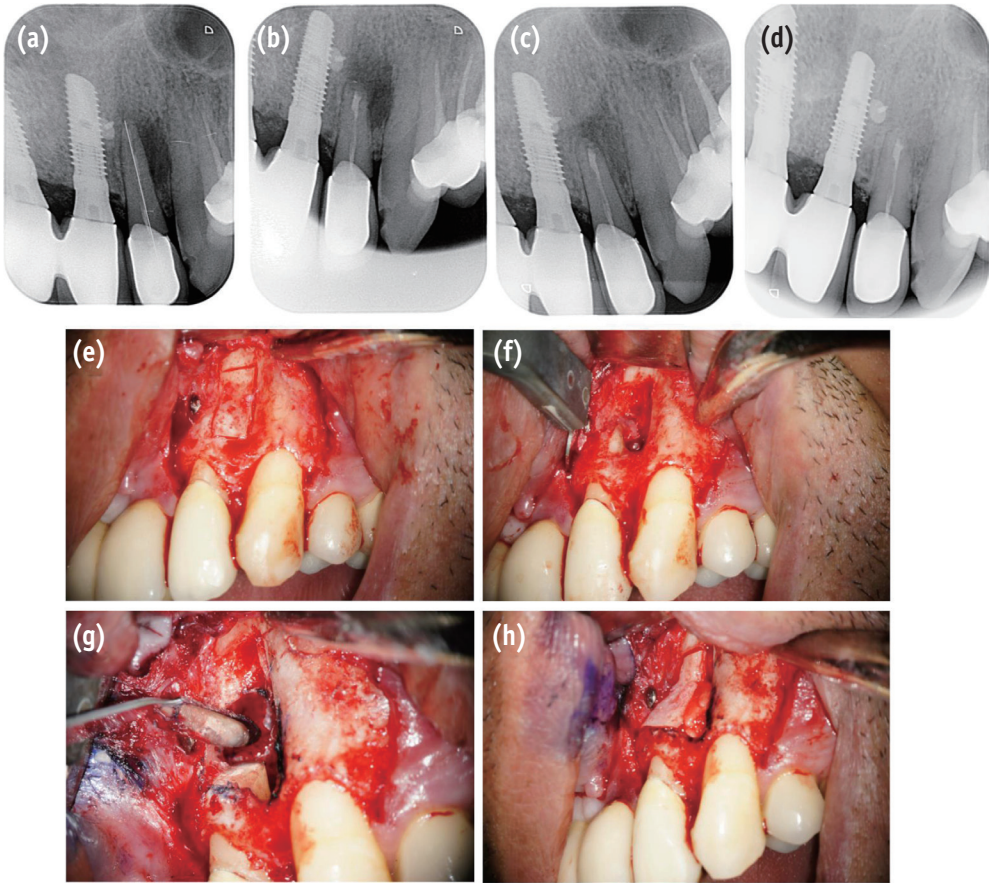

Figure 1. Treatment radiographs and clinical pictures of Case 1. (a) Pre-operative radiograph with measurement tool; (b) Post-operative radiographs; (c) 9 month follow-up radiograph; (d) 18 month follow-up radiograph; (e) Piezoelectrically created bony window (magnification, x8); (f) Bony window osteotomy exposing the lesion site; (g) Root-end filling with white MTA and a clean osteotomy site; (h) Bony window repositioned.

healing and no clinical signs or symptoms.

Case 2

A 16 year old male patient with a history of dental trauma 4 years prior was referred for treatment of the maxillary right lateral incisor. Mild percussion and pain on palpation was observed during clinical examination. The radiographic examination revealed a previously treated root canal with an 8 - 9 mm periapical radiolucency, extending apically and along the distal surface of the incisor with signs of a disto-lateral resorptive defect at the mid-root (Figure 2a). On the basis of a history, clinical examination, and radiograph, a diagnosis of a previous root canal treatment with symptomatic apical periodontitis was established. The previous operator had restored the access with radiolucent flowable composite, the coronal portion of which was removed and light cure composite (Filtek Supreme XT, 3M ESPE, St Paul, MN, USA) was placed. In discussion with the patient, apicoectomy was selected as the treatment of choice. Upon flap elevation, as the cortical plate was found to be intact, the surgical procedure as described above was implemented (Figure 3a). The bone window measured about 9 mm horizontally and 18 mm vertically. The lesion in this case was found to have a cyst-like appearance, which was confirmed by histopathological evaluation of the biopsy sample sent to the laboratory. Other than the apical root-end preparation, the lateral perforation was also exposed after curettage. Both areas were carefully prepared with JetTips ultrasonic tips (B&L Biotech USA Inc.) and sealed with white MTA (ProRoot MTA, Dentsply Tulsa Dental) (Figures 2b, 3b, and 3c). Upon completion of the microsurgery, the bone flap was replaced and held in position with some CollaCote collagen material (Zimmer Dental, Carlsbad, CA, USA), as there was a break seen along the approximated bone margins (Figure 3d). The flap was

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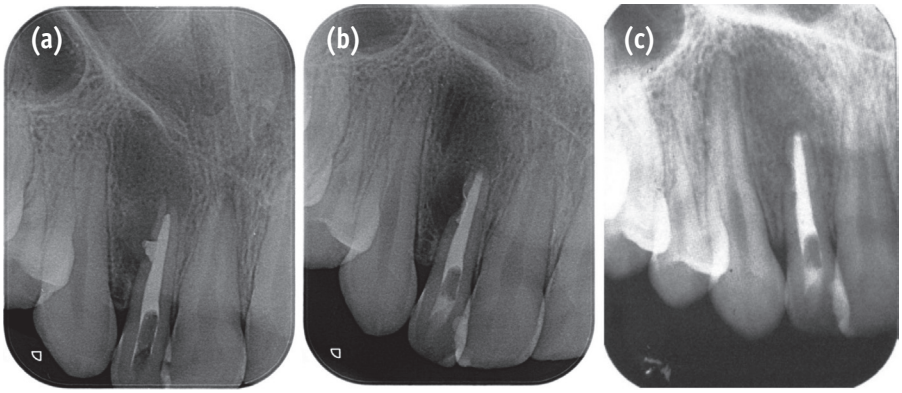

Figure 2. Treatment radiographs of Case 2. (a) Pre-operative radiograph; (b) Post-operative radiographs; (c) 12 month follow-up radiograph.

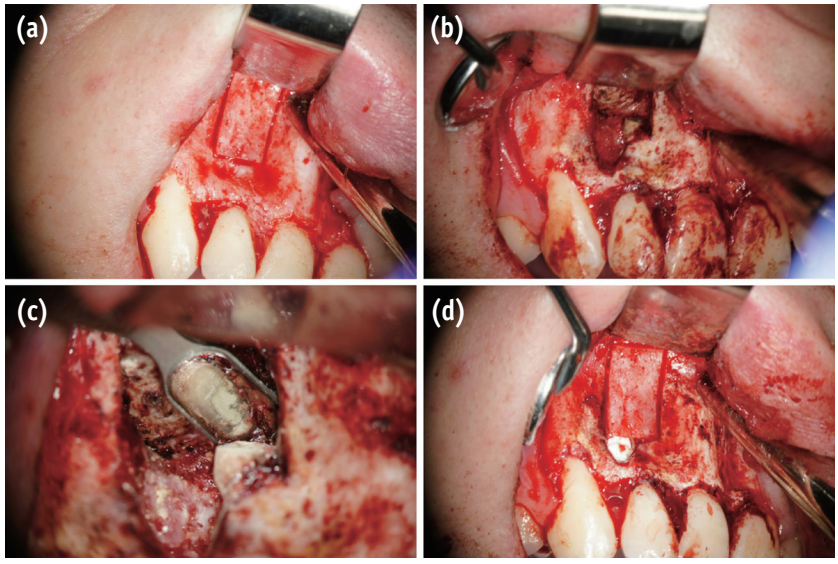

Figure 3. Intra-operative clinical pictures of Case 2. (a) Piezoelectrically created bony window (magnification, x8); (b) Bony window osteotomy exposing the lesion site after curettage and root resection; (c) Root-end filling with white MTA; (d) Bone flap repositioned along with some CollaCote collagen material.

sutured with 6-0 propylene nylon sutures (Supramid, S. Jackson Inc.) and the surgical procedure was completed. The patient presented for follow-up at 12 months with radiographic signs of complete healing and no clinical signs or symptoms (Figure 2c).

Discussion

The piezoelectric surgical technique is a relatively new procedural advancement in oral maxillofacial surgery. The technique uses a specially engineered surgical insert that has three times greater power than that of a normal ultrasonic instrument. It allows the surgeon to drill through bone with precision and ease. Piezosurgery has the unique characteristic that it spares soft tissue, preventing accidental injury to structures like the sinus membrane or inferior alveolar nerve.[15,16]

Vercellotti *et al*. introduced the piezoelectric bony window osteotomy as a simplified technique for sinus elevation.[16] Due to the cessation of the surgical action of the piezoelectric scalpel when it comes in contact with non-mineralized tissue, there is a reduced risk of perforation of the Schneiderian membrane. Piezoelectric handpieces also reduce intraoperative bleeding due to the cavitation effect of the coolant being used, making the surgical site easier to operate in due to better visibility.[16,17]

However, the main purpose of using the piezotome instead of surgical burs for elevating a bony window in the presented cases was that the size and shape of the elevated window corresponded to the donor site precisely, making re-approximation easier. Conventional burs will result in a window that is ultimately much smaller in size than the donor surgical site due to their dimensions and the cutting action. The inserts made for the piezoelectric devices are narrower than both the carbide bur and micro-saws used in oral surgery. Combining two settings produces the working frequency of the vibrating tips: one modulates a horizontal amplitude of 60 - 200 mm and the other, a vertical amplitude of 20 - 60 mm.[18] The cutting action is far more exact and controlled than a micro-saw or a surgical bur. In Case 2, CollaCote collagen (Zimmer Dental) was used to plug a small defect between the margins of the bone window and the surrounding bone, which had been present preoperatively. The filler material can be used as guided tissue regeneration (GTR) material to fill a deficiency and to hold the segment in place, preventing it from dislodging or depressing into the cavity.

A similar bone lid technique was described by Degerliyut *et al*. in 2009 to extract an impacted third mandibular molar close to the inferior alveolar canal.[19] Other than to avoid injury to the nerve, the aim was to create a bone window enabling access to the impacted site in the body of the mandible without sacrificing healthy bone. During endodontic surgery, enucleating granulation tissue in bony lesions makes reduction of cortical bone inevitable, especially in a large apical lesion. This extensive intraoperative removal of the buccal bone plate may result in delayed healing and dehiscence of the resected roots.[20] In two recent studies, one on dogs and another on human subjects, cone-beam computed tomography (CBCT) evaluation of healing at 6 months and one year, respectively, showed that the slowest component to regenerate was the cortical plate. A greater bone regeneration score was observed at the resected root surface and the surrounding medullary bone, however, the cortical bone was not reestablished to its preoperative continuity and thickness.[21,22] Jansson *et al*. reported uncertain healing in teeth with larger defects, when compared to small lesions that healed completely.[23] They measured an average defect diameter of 5.9 mm in successful cases, but a diameter of 7.5 mm in uncertain cases. von Arx *et al*. showed similar healing patterns. When osteotomy sites were small (7.04 mm), complete healing was more frequently observed than in unhealed cases with larger osteotomy sites (> 8.60 mm).[20] Hence, preserving a healthy buccal plate may enhance the prognosis.

The repositioned bony window can act similar to a harvested autologous bone graft from a donor site, without the ensuing morbidity. Surgical treatment of large apical lesions may require bone grafting and GTR to enhance healing.[13,14] Various grafting techniques have been advocated: intraosseous graft and membrane or membrane alone.[24] Of all the graft materials available, autologous bone grafting is expected to become the 'gold standard', as it is both osteoinductive and osteoconductive.[25] Therefore, replacing a large intact bone piece in the original site seems advantageous over xenogeneic or allogeneic grafting materials.

In the cases described here, piezosurgery was used only to lift a bony window. An extensive recent review of the literature presents the use of piezoelectric devices in endodontic surgery in various stages of the procedure.[15] To the best of our knowledge, bony window osteotomy for endodontic surgery has never been reported before. The apicoectomy was carried out with a Lindemann bone bur and ultrasonic devices instead of a piezoelectric one in these cases, primarily to save time. The bone flap was soaked in Hanks balanced salt solution in order to keep it hydrated and reduce the possibility of necrosis, while the rest of the surgical procedure was executed proficiently as prescribed in the microsurgical literature.[4]

CBCT imaging has added tremendously to the diagnostic, treatment planning, and treatment execution capabilities of dental procedures.[26] CBCT volumetric analysis of the case preoperatively can help the operator study the anatomical conditions before the treatment is implemented. Lack of access to a preoperative CBCT scan was a limitation of this investigation. In these case reports, the decision to use a bone flap technique was made after elevation of the soft tissue when an intact or near-intact cortical plate was encountered. Preoperative CBCT data can provide this information prior to surgery and also assist the surgeon in designing the extent of the bone flap with more accuracy and less likelihood of accidental tissue damage. The technique offers a unique opportunity to preserve a healthy block of bone.

Conclusions

The technique described above is an excellent approach to preserving bone and using it as an autologous graft for the surgical site. The indication for a bony window osteotomy is the presence of an intact or near-intact buccal cortical plate and a large bony cavity/lesion. A piezoelectric device is required to create and elevate a bony window osteotomy. Additional large scale studies are required to conclude whether the bony window technique offers advantages over guided tissue regeneration with other grafting materials.

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Conflict of Interest: No potential conflict of interest relevant to this article was reported.

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