Case Series

Endoscopically Assisted Tunnel Approach for Minimally Invasive Corticotomies: A Preliminary Report

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Background: The dental community has expressed low acceptance of traditional corticotomy techniques for corticotomy-facilitated orthodontics. These procedures are time consuming, entail substantial postoperative morbidity and periodontal risks, and are often perceived as highly invasive.

Methods: A total of 114 interdental sites were treated in nine consecutive patients. Under local anesthesia, a tunnel approach requiring one to three vertical incisions per arch (depending on the targeted teeth) was used. Piezosurgical corticotomies and elective bone augmentation procedures were performed under endoscopic assistance. Postoperative cone-beam computerized tomography evaluation was used to confirm adequate corticotomy depth.

Results: Procedures were completed in a mean time of 26 minutes. Follow-up evaluations revealed no loss of tooth vitality, no changes in periodontal probing depth, good preservation of the papillae, and no gingival recession. No evidence of crestal bone height reduction or apical root resorption was detected.

Conclusions: The tunnel approach minimizes soft-tissue debridement and permits effective cortical cuts. The combination of piezosurgery technique with endoscopic assistance provides a quick, reliable means to design and perform these corticotomies while maximizing root integrity preservation. Moreover, the sites needing bone augmentation are selected under direct vision. Compared to traditional corticotomies, this procedure has manifest advantages in surgical time, technical complexity, patient morbidity, and periodontium preservation. *J Periodontol 2012;83:574-580.*

KEY WORDS

Endoscopy; malocclusion; periodontium; orthodontics, corrective; osteotomy.

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At present, the number of patients seeking orthodontic treatment during adulthood to correct esthetic and occlusal aberrations is increasing significantly. Short treatment time is a constantly recurring request. However, conventional orthodontic therapy is associated with long treatment times and potential risk of periodontal deterioration and root-end resorption, especially in patients with a thin periodontal biotype. In addition, significant jaw discrepancy and the anatomic limits set by the cortical plates of the alveoli may hinder orthodontic movement.[1,2] Hence, clinicians have searched for alternative methods to accelerate tooth movement with the aid of segmental osteotomies and corticotomies.[1-9] However, traditional techniques have often been considered rather invasive, leading to low acceptance by patients and the dental community.[10]

Although some authors[2,3,5,6,9] believe that the rapid tooth movement observed with corticotomy-facilitated orthodontics is attributable to the movement of the small outlined blocks of bone, others[7,8,11-13] consider it is more likely the consequence of a sequential demineralization–remineralization process. Based on computed tomography studies, Wilcko et al.[7,8] suggested an

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increase in cortical bone porosity and a dramatic increase of trabecular bone surface turnover consistent with the initial phase of the regional acceleratory phenomenon (RAP). Described by orthopedist Harold Frost,[14,15] the RAP comprises a complex cascade of physiologic healing events involving accelerated bone turnover and regional osteopenia. Surgical wounding of cortical bone is followed by a transitory burst of localized hard- and soft-tissue remodeling that gives way to tissue reorganization and healing.[16] In other words, according to the RAP theory, corticotomy-facilitated orthodontics would be more appropriately portrayed as "bone matrix transportation" rather than "bony block movement."[8]

As described in the scientific literature, traditional corticotomy techniques imply full-thickness flap elevation, corticotomy cuts, and elective bone grafting.[2,7,8,17] These procedures are: 1) often time consuming (3 to 4 hours according to some reports[8]), 2) require oral and/or intravenous sedation,[2,7,8] and 3) lay down undeniable postoperative morbidity and periodontal risks for the patient. Alternative minimally invasive procedures are being developed with the aim of reducing surgical time and patient discomfort and increasing periodontal safety and patient acceptability of the procedure.[10,18] Sharing this objective, the purpose of this article is to present a simple yet effective technique to perform corticotomies through a minimally invasive approach with endoscopic assistance. The proposed procedure has manifest advantages in surgical time, technical complexity, patient morbidity, and periodontium preservation.

CASE DESCRIPTION AND RESULTS

From March to July 2010, a minimally invasive tunnel technique for corticotomies was performed in nine consecutive patients (four males and five females; median age: 37 years; range: 22 to 46 years) at the Institute of Maxillofacial Surgery and Implantology of the Teknon Medical Center (Barcelona, Spain). Specific written informed consent was obtained in all cases, and approval from the Teknon Medical Center Review Board was obtained to perform the technique and report its results. A total of 114 interdental sites were treated. Indications for the procedure included: 1) deep bite; 2) posterior cross-bite; 3) open bite; and 4) anterior crowding.

Surgery was performed under local anesthesia in six cases. In the remaining three patients, the procedure was done together with another orthognathic surgery procedure in the context of a "surgery first" approach,[19] and thus general anesthesia was used.

A conjunct treatment plan was developed by the orthodontists (Drs. Jaume Janer, Ana Molina, Nuria Clusellas, Elena Portugal, and Natalia Mateo, private practice in orthodontics, Barcelona, Spain; and Dr. Blanca Loscertales, private practice in orthodontics, Seville, Spain), periodontist (Dr. Vanessa Ruiz, Department of Periodontics, Institute of Maxillofacial Surgery, Teknon Medical Center, Barcelona, Spain), and oral surgeon (FH-A). The following variables were determined: 1) teeth to be moved, 2) teeth to be used as anchorage, 3) periodontal status, 4) root morphology and position, and 5) width of the cortical plates. For the last two items, cone-beam computerized tomography (CBCT)[‡] was performed.

In all cases, local anesthesia (2% lidocaine with 1:100,000 epinephrine) was infiltrated to reduce bleeding and facilitate subperiosteal dissection of the flaps. A full-thickness (5 to 10 mm) vertical incision was performed labially at the upper or lower midline (in cases in which the anterior teeth were to be treated) and/or behind the upper canine (when targeting the posterior maxilla). A sharp periosteal elevator allowed wide subperiosteal dissection over the roots of the involved teeth. Care was taken not to damage the potential anterior loop of the inferior alveolar nerve that could extend mesially from the mental foramen. Subsequently, a piezoelectric microsaw[§] was introduced into the tunnel created underneath the flap. Interproximal corticotomies were performed between the dental roots following the long axis of the alveolus and stopping just short of the alveolar crest (Fig. 1). Endoscopic assistance through a 1.9-mm fiber optic endoscope[‖] aided corticotomy design and control and allowed for in situ corroboration of a successful cut through the cortical bone (when the saw reached the spongiosa, bleeding was observed with the endoscope) (Fig. 2). The microsaw encountered little resistance when cutting bone; resistance to the saw meant the presence of underlying roots and hence a change in the direction of the cuts. The cuts were extended through the entire thickness of the cortical layer and interrupted when penetrating the medullary bone. In one patient, interproximal corticotomies were extended to the lingual cortical bone to achieve a "box osteotomy." No luxation maneuvers were performed after any of the osteotomies. Figure 3 shows the complete sequence for a case in which the posterior maxilla was targeted.

An established augmentation procedure was performed in four patients in whom the preoperative CBCT had revealed thin cortical plates and/or the endoscope had detected bone dehiscences (Fig. 2, arrow). In these cases, demineralized bovine bone particles[¶] were applied over the corticotomies via the same approach. Finally, the incisions were sutured with interrupted 5-0 polyglactin.[#]

‡ IS i-CAT v. 17-19, Imaging Sciences International, Hatfield, PA.
§ Implant Center 2, Satelec-Acteon Group, Tuttlingen, Germany.
‖ TrueView, Olympus, Munich, Germany.
¶ Bio-Oss, Geistlich Pharma, Wolhusen, Switzerland.
# VICRYL, Ethicon, Somerville, NJ.

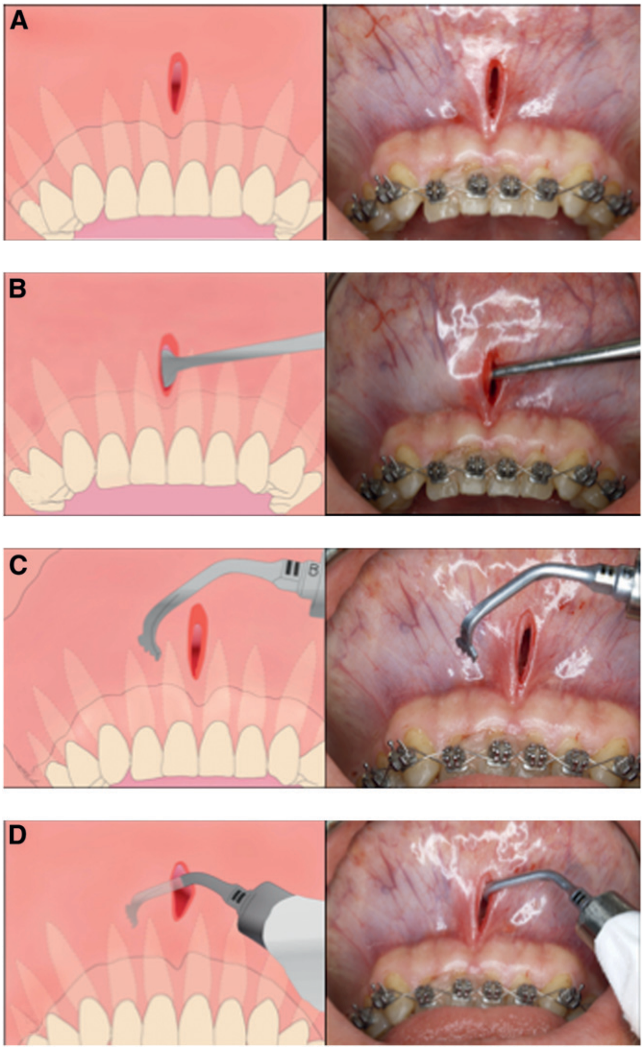

Figure 1.
A) *Labial full-thickness vertical incision at the upper midline. The anterior teeth are to be treated.* ***B)*** *Subperiosteal "tunneling" dissection.* ***C)*** *Introduction of a piezoelectric microsaw with angled inserts through the tunnel approach.* ***D)*** *Performance of interproximal corticotomies between the roots of the targeted teeth. Crown direction serves as an external reference; endoscopic control permits in situ vision.*

Mean surgical time was 26 minutes (range: 14 to 32 minutes). Postoperative CBCT evaluation to confirm adequate corticotomy depth revealed a complete vestibular corticotomy in 102 interdental sites. In eight sites, a vestibular cortical cut was present but failed to reach the spongiosa. In the remaining four sites (corresponding to one patient), the corticotomy was extended to the lingual cortical bone following the orthodontist's instructions (Fig. 4).

Patients were discharged within 2 hours of the procedure. For patients in whom the corticotomies were performed together with another orthognathic surgery procedure under general anesthesia, hospital discharge was postponed 24 hours. Prophylactic antibiotic medication was prescribed for 1 week; routine non-steroidal anti-inflammatory drugs were restricted to the first 5 postoperative days so as to avoid interference with the RAP. In all cases, orthodontic treatment was resumed the day after surgery. Pulp vitality and probing depth (PD) were evaluated in all the teeth involved in the procedure at least once per month.

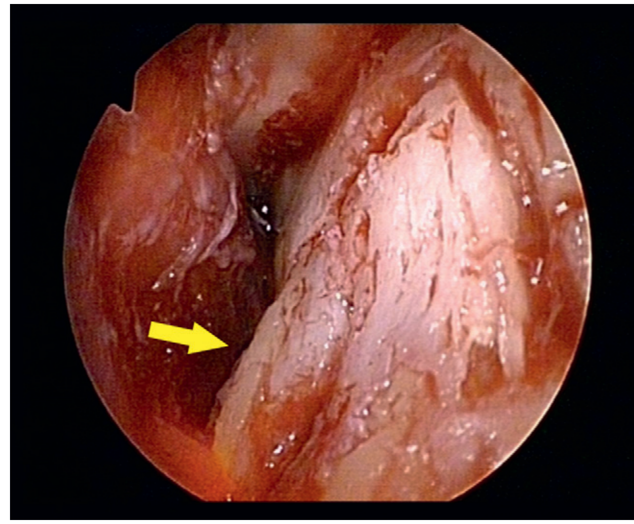

Figure 2.
Endoscopic view of the corticotomy. Bleeding confirms the cut has reached the spongiosa. The arrow shows a dehiscence of the buccal plate of the canine.

Postoperative follow-up detected dentinary hypersensibility in three teeth of one patient, but it resumed without complications after 5 weeks. No loss of tooth vitality and no adverse periodontal effects were clinically noticeable. Indeed, periodontal checkups revealed no changes in periodontal PD, good preservation of the interdental papillae, and no gingival recession (Fig. 5). Similarly, no significant reduction in crestal bone height and no evidence of apical root resorption were detected by radiographic methods during 12 months of follow-up evaluations.

DISCUSSION

The key advantages of corticotomy-facilitated orthodontics compared to traditional orthodontics include enhanced scope of malocclusion treatment with decreased need for extractions, significantly reduced active orthodontic treatment time (three-fold average), and the possibility to restore alveolar volume and periodontium integrity in a one-stage procedure.[2,8,10] These progresses have led to an increase in the number of adult patients who choose to undergo orthodontic treatment.

Traditional orthodontic movement can be explained by a series of cell-mediated histologic and biomolecular phenomena in the periodontal ligament

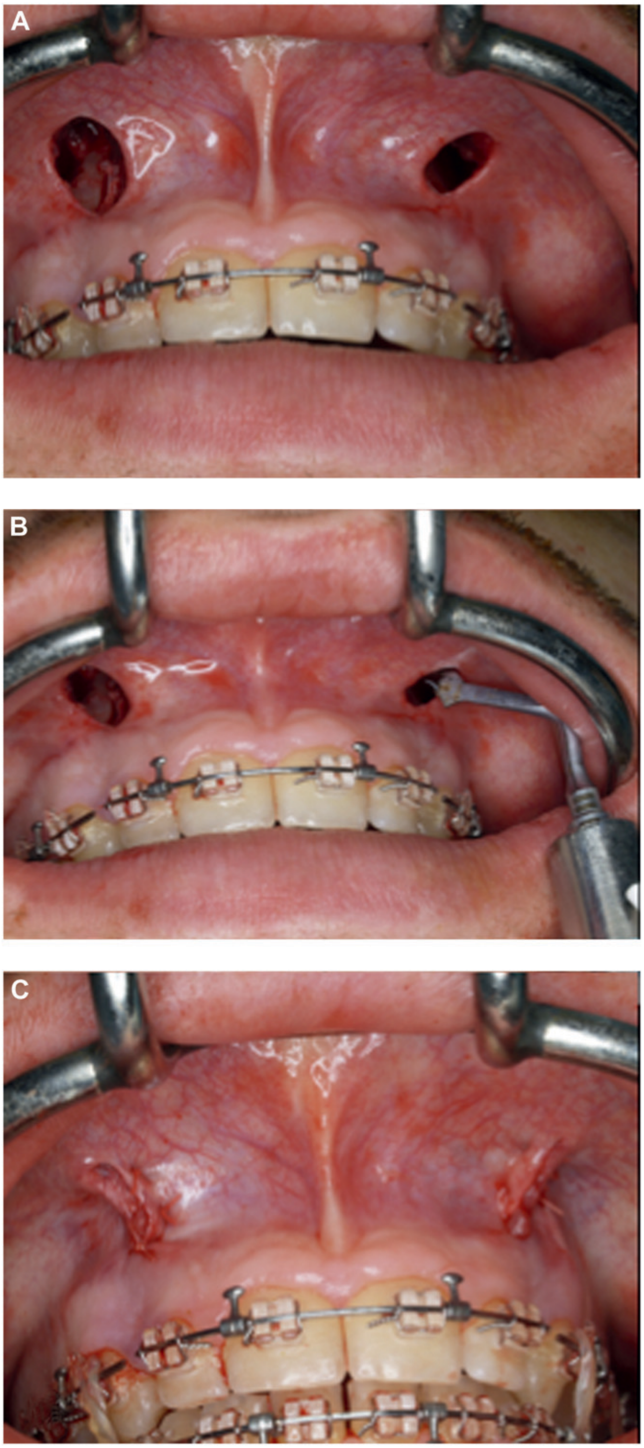

Figure 3.
A) *Tunnel approach through two incisions behind the canine to reach the posterior teeth.* ***B)*** *Corticotomy performance with piezosurgery.* ***C)*** *Wound closure.*

as a result of periodontal compression.[2] Conversely, consistent with the initial phase of the RAP, corticotomy-facilitated orthodontics seems to entail a process of localized osteopenia in which the thin layer of bone that overlies the root prominence to be

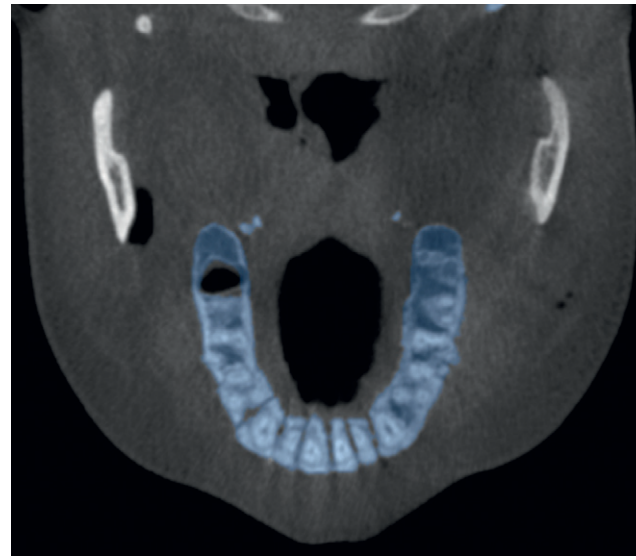

Figure 4.
Postoperative CBCT evaluation in a case in which the anterior maxillary teeth were targeted. In this patient, the corticotomy has been extended to the lingual cortical bone.

moved demineralizes and later remineralizes at the completion of the orthodontic therapy.[7,8] According to this theory, selective bone injury results in an overwhelming activating stimulus for both the catabolic and anabolic responses in the periodontium.[13] This sequential demineralization–remineralization phenomenon justifies the facilitated tooth movement after corticotomy surgery.[7,8] Technical variables, such as amount of decortication, depth of cut, and use of onlay grafts, may alter the RAP response.[11] Extending this concept to other types of bone cuts, such as the osteotomies performed in the context of orthognathic surgery, it is possible that the greater pace and efficiency of orthodontic movements observed with a "surgery first" approach[19] is also attributable to increased bone turnover in the alveolar bone adjacent to the osteotomies.[20,21]

Various types of orthodontic-facilitating corticotomies have been proposed. The accelerated osteogenic orthodontics technique (AOO) described by Wilcko et al.[7,8,17] implies: 1) a sulcular-releasing incision; 2) full-thickness flap elevation labially and lingually; 3) "bone activation" by means of circumferential corticotomy cuts with burs; and 4) bone grafting. The procedure is performed under intravenous or oral sedation and takes 3 to 4 hours for a full case in which the upper and lower arches are treated. Although quite effective, this technique and subsequent modifications entail long surgical times and significant trauma derived from the elevation of large flaps and the extensive nature of the corticotomies. Moreover, the performance of bone cuts with burs imply

Figure 5.
Example of one completed case (1-year follow-up). ***A)*** *The patient underwent bimaxillary orthognathic surgery, esthetic rhinoplasty, and corticotomy-facilitated orthodontics in the anterior segments of the maxilla and mandible. Total orthodontic time lasted 9 months.* ***B)*** *A stable occlusion with an adequate periodontal status and satisfactory facial esthetics are clinically evident postoperatively.*

potential damage to the teeth attributable to close root proximity and impaired bony regeneration as a result of excessive heat.[10]

The introduction of ultrasonic microsaws permits a safe corticotomy around the root with maximum precision and surgical control.[2] Hard- and soft-tissue healing is rapid and entails minimal morbidity, eliminating the risk of osteonecrosis.[22] Vercellotti and Podesta[2] have applied this technology for their monocortical tooth dislocation and ligament distraction technique (MTDLD). However, this procedure still requires extensive approaches (one full-thickness flap, buccal or palatal, on the side corresponding to the direction of movement), generally under intravenous sedation as well. In addition to ensuing patient discomfort, the MTDLD method is linked to long hours of surgery,[10] although Vercellotti and Podesta did not report specific surgical times. Conversely, our minimally invasive procedure through the tunnel approach typically lasts an average of only 26 minutes. Hence, local anesthesia is enough to provide adequate analgesia and patient comfort for this procedure.

Another treatment modality is "speedy orthodontics," developed by Chung et al.[1,23] This procedure is specifically aimed at correcting anterior protrusion with or without open bite. It uses a corticotomy through a full-thickness flap and an orthopedic force with intraosseous temporary anchorage. The force applied after the corticotomy is greater than the typical orthodontic force because the aim is to move the circumscribed block of bone rather than the teeth through the bone.[1,6] In contrast with our method and AOO and MTDLD techniques, speedy orthodontics requires the removal of a section of cortical bone followed by orthopedic traction against the isolated block of bone and teeth. We only performed a "box osteotomy" through four interdental corticotomies in one patient (Fig. 4). According to Chung et al.,[23] this technique produces bony block movement as a result of surface corticotomy, strong orthopedic forces, bone bending, and RAP. In these authors' protocol,[1,23] the maxillary palatal and buccal corticotomies are performed at different surgical times, 2 to 3 weeks apart. Hence, although this procedure may be performed under local anesthesia, it entails two surgical appointments with their respective postoperative periods of discomfort and a prolonged treatment time.

Recently, alternative procedures have been proposed to reduce chairside time and postoperative discomfort, increase patient acceptance of the procedure, and achieve a stronger periodontium. These objectives were also the motivation for our minimally invasive method. Dibart et al.[10,18] have popularized the concept of "piezocision," a procedure that entails small incisions, minimal piezoelectric osseous cuts to the buccal cortex only, and bone or soft-tissue grafting. As in our protocol, piezocision is performed under local anesthesia through a tunnel approach. However, piezocision involves 10 vertical interproximal incisions, whereas our procedure uses only one to three buccal vertical incisions per arch (at the upper or lower midline and/or behind the upper canine, depending on the targeted teeth). In this manner, one single mesial incision allows access to the six anterior teeth, and one single distal incision allows access to the premolars and molars of one quadrant. This reduced access is possible due to the angled inserts of the piezoelectric saw and the precise endoscopic control over the corticotomy design and depth. Indeed, the endoscope provides illumination and magnification as well as improved control of root position. The procedure is endoscopically assisted and not endoscopically performed, because the endoscope is used to check on the action of the microsaw once it has been removed from the tunnel.

Regardless of the corticotomy-facilitated orthodontics technique performed, potential repercussions on the periodontium are a crucial issue. It is absolutely imperative that an accurate periodontal diagnosis is established before treatment initiation and that periodontal checkups are regularly performed after surgery and throughout orthodontic movements. If periodontal disease is diagnosed at baseline evaluation, it must be properly treated and stabilized before the instauration of any orthodontic treatment.[1] Research has shown that orthodontic movement of plaque-infected teeth can interfere with the configuration of the connective tissue attachment and give way to infrabony pocket formation.[24] Our method intends to be as respectful with the periodontium as possible and thereby avoids sulcular incisions and full-flap elevation. Moreover, the use of the piezosurgery microsaw together with endoscopic assistance provides a quick, reliable means to selectively cut the bone and facilitate the preservation of root integrity. Corticotomy design and performance are based on direct crown vision (and the corresponding imaginary longitudinal axis of the tooth), together with the tactile sensation of the interdental concavity between the root prominences. When limitations such as root proximity, root convexity, or abnormal root angulations are present in the posterior segment, the use of angled inserts of the piezoelectric saw together with the direct vision provided by the endoscope is an efficient way to maximize root safety. In our opinion, full-flap elevation does not add to the safety or precision of the procedure because tooth roots are still concealed by the cortical bone, although it does entail increased morbidity for the periodontium. In our series, patients showed: 1) good maintenance of interdental papillae, 2) no changes in periodontal PD, 3) no significant reduction in crestal bone height, and 4) no evidence of root damage at 12 months follow-up. Most patients are still under ongoing orthodontic treatments; a final report will be presented at the appropriate time.

CONCLUSIONS

The authors present a simple yet effective technique to achieve rapid orthodontic tooth movement. A tunnel approach through one to three buccal vertical incisions per arch is used to minimize soft-tissue debridement and periodontal risks. Endoscopic assistance is useful to design and perform the corticotomies and to select the sites needing bone augmentation. The preservation of root integrity is further maximized with the use of piezosurgical instruments. Compared to traditional corticotomies, the procedure has manifest advantages in surgical time, technical complexity, patient morbidity, and periodontium preservation.

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The authors report no conflicts of interest related to this case series.

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