

# Periodontal Accelerated Osteogenic Orthodontics: A Description of the Surgical Technique

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Periodontal accelerated osteogenic orthodontics (PAOO) is a clinical procedure that combines selective alveolar corticotomy, particulate bone grafting, and the application of orthodontic forces.<sup>1</sup> This procedure is theoretically based on the bone healing pattern known as the regional acceleratory phenomenon (RAP).<sup>2</sup> PAOO results in an increase in alveolar bone width,<sup>3</sup> shorter treatment time,<sup>4</sup> increased post-treatment stability,<sup>5</sup> and decreased amount of apical root resorption.<sup>6</sup> The purpose of this article is to describe the clinical surgical procedures that comprise the PAOO procedure.

## Historical Perspective

A *corticotomy* is defined as a surgical procedure whereby only the cortical bone is cut, perforated, or mechanically altered. The medullary bone is not changed. This is in contrast to an *osteotomy*, which is defined as a surgical cut through both the cortical and medullary bone. This term is frequently used when describing the creation of bone segments.

Surgical intervention to affect the alveolar housing and tooth movement has been described in various forms for over a hundred years. Heinrich Köle's pub-

lication in 1959 was the first to describe modern-day corticotomy-facilitated orthodontics.<sup>7</sup> From Köle's work arose the term *bony block* to describe the suspected mode of movement after corticotomy surgery.

Köle<sup>7</sup> believed the surgical preparation of the alveolus would permit rapid tooth movement, suggesting that it was the continuity and thickness of the denser layer of cortical bone that offered the most resistance to tooth movement. He erroneously assumed that the surgically outlined blocks of bone retained their structural integrity during healing. By use of relatively gross movements accomplished with very heavy orthodontic forces using removable appliances fitted with adjustable screws, Köle reported that the major active tooth movements were accomplished in 6 to 12 weeks.

Most of the movements described by Köle<sup>7</sup> were space closing. He used vertical wedge-shaped crestal osteotomies, thus leaving only a thin layer of bone over the proximal root surfaces of the adjacent teeth. Köle reported that after 6 to 8 months of retention, the corticotomy-facilitated orthodontic cases remained remarkably stable. One confusing semantic aspect of Köle's publication was that a corticotomy cut was often referred to as an osteotomy of the cortical layer of bone.

Subsequent publications by Generson et al<sup>8</sup> in 1978, Anholm et al<sup>9</sup> in 1986, Gantes et al<sup>10</sup> in 1990, and Suya<sup>11</sup> in 1991 built upon the supra-apical horizontal osteotomy used by Köle.<sup>7</sup> In these publications the osteotomy cut was replaced with labial and lingual corticotomy cuts. Köle's interpretation of the rapid tooth movement being attributable to "bony block" movement did prevail until the 2001 publication of Wilcko et al.<sup>1</sup> Case reports were presented in which computed tomography scan evaluation of patients who had undergone corticotomy showed that the rapid tooth movement was not the result of bony block movement but rather a transient localized demineralization/remineralization process in the bony alveolar housing consistent with the wound healing pattern of the RAP.<sup>12</sup> The authors proposed that after the demineralization of the alveolar housing

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over the root surfaces, a soft tissue matrix of the bone, which could be carried with the root and later remineralize, occurred after the completion of the orthodontic treatment. In an effort to enhance bony volumes after the application of orthodontic forces, they also suggested the use of particulate bone grafting in combination with the decortication procedures. The Wilckos combined the refined corticotomy-facilitated orthodontic technique with alveolar augmentation and named the orthodontic and periodontal aspects of this procedure the accelerated osteogenic orthodontics (AOO) technique and, more recently, the PAOO surgical technique, respectively.

## Case Selection

PAOO can be used in most cases in which traditional fixed orthodontic therapy is used. PAOO has been shown to be efficacious in the treatment of Class I malocclusions with moderate to severe crowding, Class II malocclusions requiring expansion or extractions, and mild Class III malocclusions. The orthodontic therapist determines the plan for the movement, identifying the teeth that will provide anchorage and those portions of the arch that will be expanded or contracted. From this plan, a prescription for areas requiring corticotomies is developed. Careful coordination between the surgeon and orthodontist is required for successful outcomes. It is suggested that both the surgeon and orthodontist be trained together in the use of this technique to ensure a common basis of knowledge.

The surgical specialist must also evaluate the esthetic needs of the patient and incorporate these requirements into the surgical treatment plan. For example, if a patient presents with gingival recession in an area requiring corticotomy, a subepithelial connective tissue graft can be placed in conjunction with the PAOO surgery.

In some cases anchorage must be established before the PAOO procedure is initiated. This is most commonly seen in Class II malocclusions requiring retraction. Both dental arches may present with different degrees of desired movement. For example, mild anterior crowding may present in the mandibular anterior region and yet significant expansion is required in the maxillary arch. In this scenario PAOO may be performed in the maxillary arch while traditional orthodontic therapy is used to treat the mandibular arch. Having both arches corrected in a similar time frame is ideal.

The placement of orthodontic brackets and activation of the arch wires are typically done the week before the surgical aspect of PAOO is performed. However, bracketing can occur up to 1 to 2 weeks

after surgery. If complex mucogingival procedures are combined with the PAOO surgery, the lack of fixed orthodontic appliances may enable easier flap manipulation and suturing. In all cases initiation of orthodontic force should not be delayed more than 2 weeks after surgery. A longer delay will fail to take full advantage of the limited time period that the RAP is occurring.

The orthodontist has a limited amount of time to accomplish accelerated tooth movement. This period is usually 4 to 6 months, after which finishing movements occur with a normal speed. Given this limited "window" of rapid movement, the orthodontist will need to advance arch wire sizes rapidly, initially engaging the largest arch wire possible.

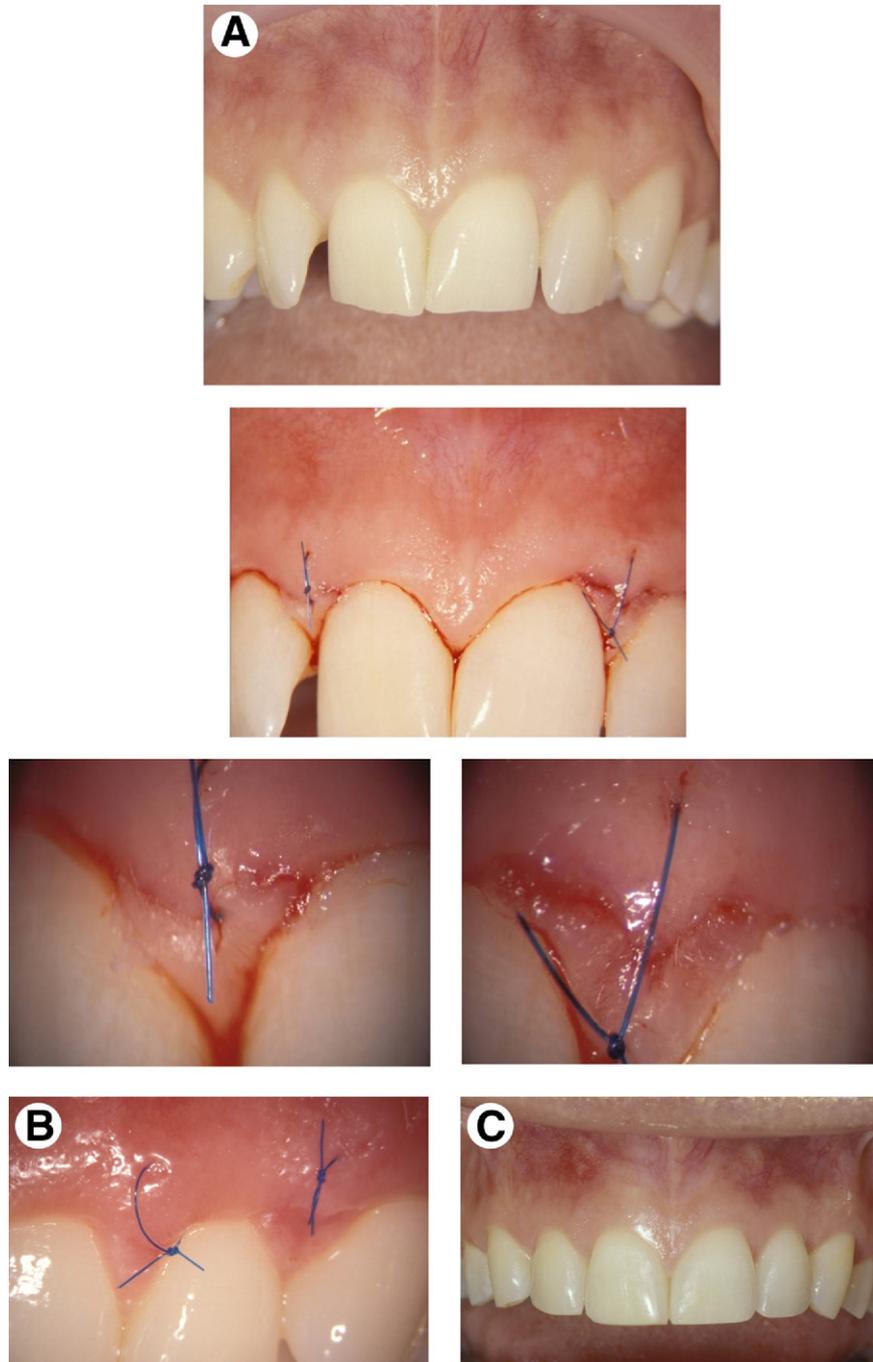
## Surgical Technique

### FLAP DESIGN

The objectives of the flap design are to 1) provide access to the alveolar bone wherein corticotomies are to be performed, 2) provide for coverage of the particulate graft, 3) maintain the height and volume of the interdental tissues, and 4) enhance the esthetic appearance of the gingival form where necessary.

The basic flap design is a combination of a full-thickness flap in the most coronal aspect of the flap with a split-thickness dissection performed in the apical portions. The purpose of the split-thickness dissection is to provide mobility of the flap so that it may be sutured with minimal tension. After the split-thickness dissection is performed, the periosteal layer is carefully elevated from the alveolar bone, providing access to the alveolar bone surface and facilitating identification of critical neurovascular structures. Mesial and distal extension of the flap beyond the corticotomy areas is suggested to reduce the need for vertical releasing incisions. The initial incision is carried out on both surfaces of the alveolus.

Preservation of the interdental gingival tissues is critical for a successful esthetic outcome. Numerous different papillae preservation techniques are frequently used. If possible, the papillae between the maxillary central incisors should not be elevated. Access to the labial alveolar bone in this area is achieved by "tunneling" from the distal aspect (Fig 1). In almost all cases the papilla is not reflected from the palatal aspect between the central incisors. Retention of a palatal or lingual gingival collar of tissue, not reflected from the underlying alveolar bone, is frequently used to provide a collateral blood supply to the papillary tissue (Fig 2).



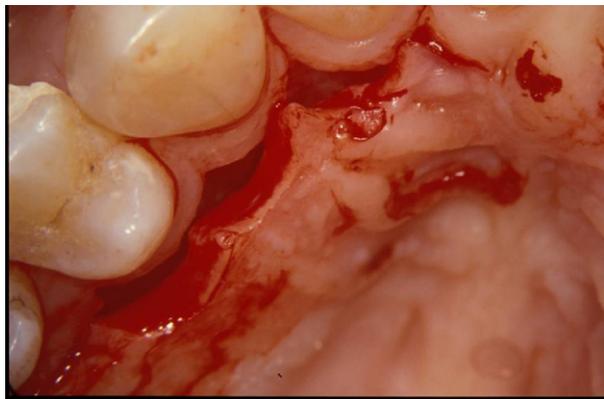
**FIGURE 1.** A, In esthetically sensitive areas such as the papillae between the central incisors, the initial incision is not carried through the papillae. Access to the interproximal bone is achieved by tunneling under the flap. B, Healing at 7 days after use of microsurgical closure techniques. C, Completed tooth movement at 6 months. (Orthodontic therapy was performed by Dr Nancy Ward, Baltimore, MD.)

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#### DECORTICATION

The purpose of the decortication is to initiate the RAP response and not to create movable bone segments. By use of a No. 1 or No. 2 round bur in either a high-speed handpiece or dental implant drill, decortications are made in the alveolar bone. The corticoto-

mies may also be achieved with a piezoelectric knife. At this time, there are no objective data to suggest that any specific pattern, depth, and extent of the corticotomy are superior. The corticotomies are placed on both the labial and lingual (palatal) aspects of the alveolar bone.



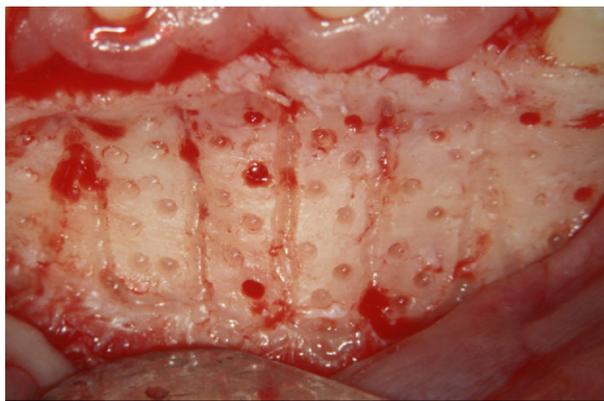
**FIGURE 2.** Typical palatal incision leaving collar of gingival tissue, decreasing likelihood of sloughing of interproximal tissue.

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Typically, a vertical groove is placed in the interdental space, midway between the root prominences in the alveolar bone. This groove extends from a point 2 to 3 mm below the crest of the bone to a point 2 mm beyond the apices of the roots. These vertical corticotomies are then connected with a circular-shaped corticotomy. Care is taken not to extend the cuts near any neurovascular structures. If the alveolar bone is of sufficient thickness, solitary perforations may be placed in the alveolar bone over the radicular surface. However, if this bone is estimated to be less than 1 to 2 mm in thickness, these perforations are omitted to ensure no damage to the radicular surface (Fig 3).

#### PARTICULATE GRAFTING

Grafting is done in most areas that have undergone corticotomies. The volume of the graft material used is dictated by the direction and amount of tooth movement predicted, the pretreatment thickness of



**FIGURE 3.** Common decortication scheme.

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**FIGURE 4.** Particulate bone graft layered over decorticated alveolar bone. Demineralized freeze-dried bone allograft was bound with activated platelet-rich plasma resulting in a gelatinous consistency. This combination facilitates easier graft handling and physical stability.

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the alveolar bone, and the need for labial support by the alveolar bone. No objective data exist comparing one grafting material with another in terms of superiority. The most commonly used materials are deproteinized bovine bone, autogenous bone, decalcified freeze-dried bone allograft, or a combination thereof. The use of a barrier membrane is not suggested (Figs 4, 5).

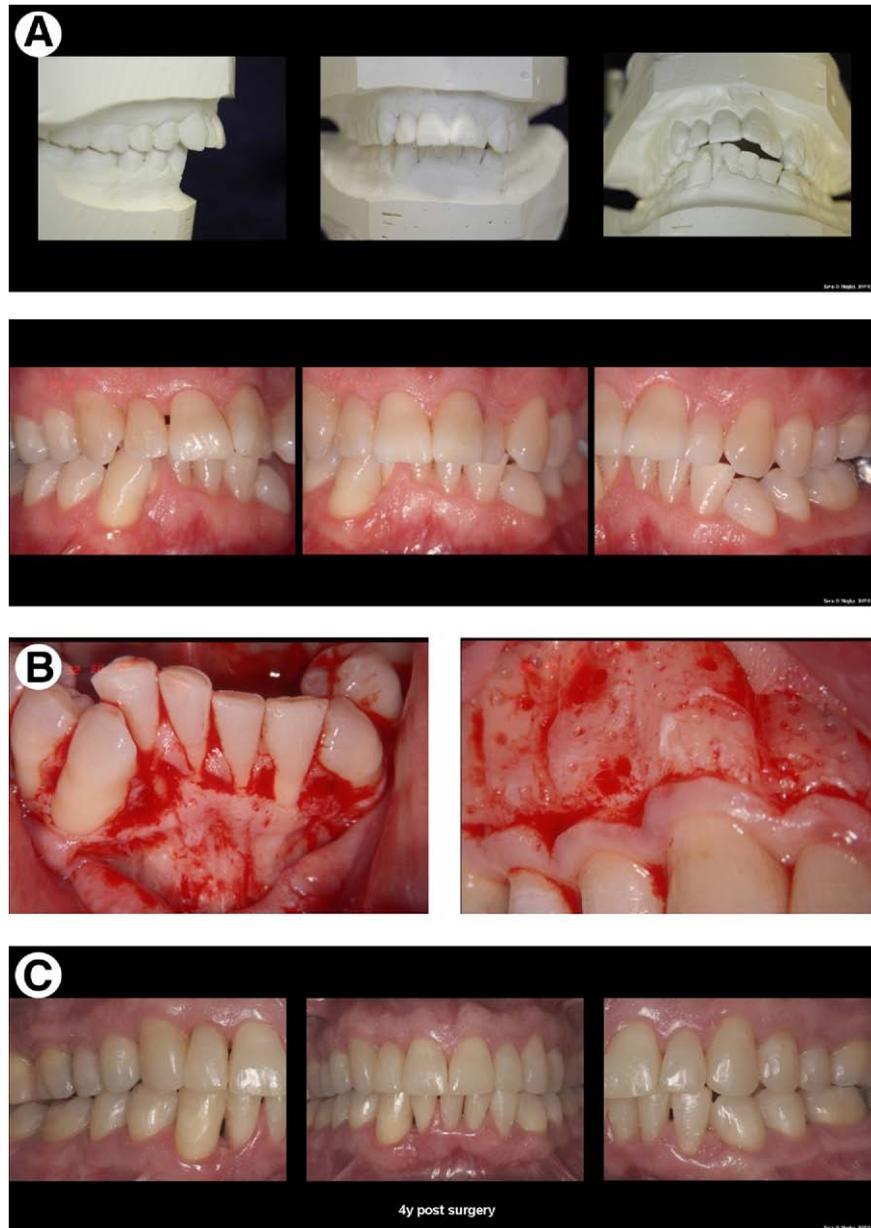
The grafting material is placed with an effort not to place an excess amount. A typical volume used is 0.25 to 0.5 mL of graft material per tooth. The decorticated bone acts to retain the graft material. However, slumping of the graft can occur. The use of platelet-rich plasma or calcium sulfate has been reported to increase the stability of the graft material.

#### CLOSURE TECHNIQUES

Primary closure of the gingival flaps without excessive tension and graft containment are the therapeutic endpoints of suturing. These are typically achieved with nonresorbable interrupted sutures. The specific suture used is determined by the thickness of the tissue. The sutures that approximate the tissues at the midline are placed first to ensure the proper alignment of the papillae. The remaining interproximal sutures are placed next, followed by the closure of any vertical incisions. No packing is required. The sutures are usually left in place for 1 to 2 weeks.

#### PATIENT MANAGEMENT

The PAOO surgical procedure can take several hours to complete when treating both dental arches. Because of the length of this procedure, sedation of the patient is suggested. The use of short-term steroids, given either intravenously or orally, also en-



**FIGURE 5.** A, Pretreatment of patient with severe Class II malocclusion. B, PAOO corticotomies performed. C, Four-year retention. (Orthodontic therapy was performed by Dr Nancy Ward, Baltimore, MD.)

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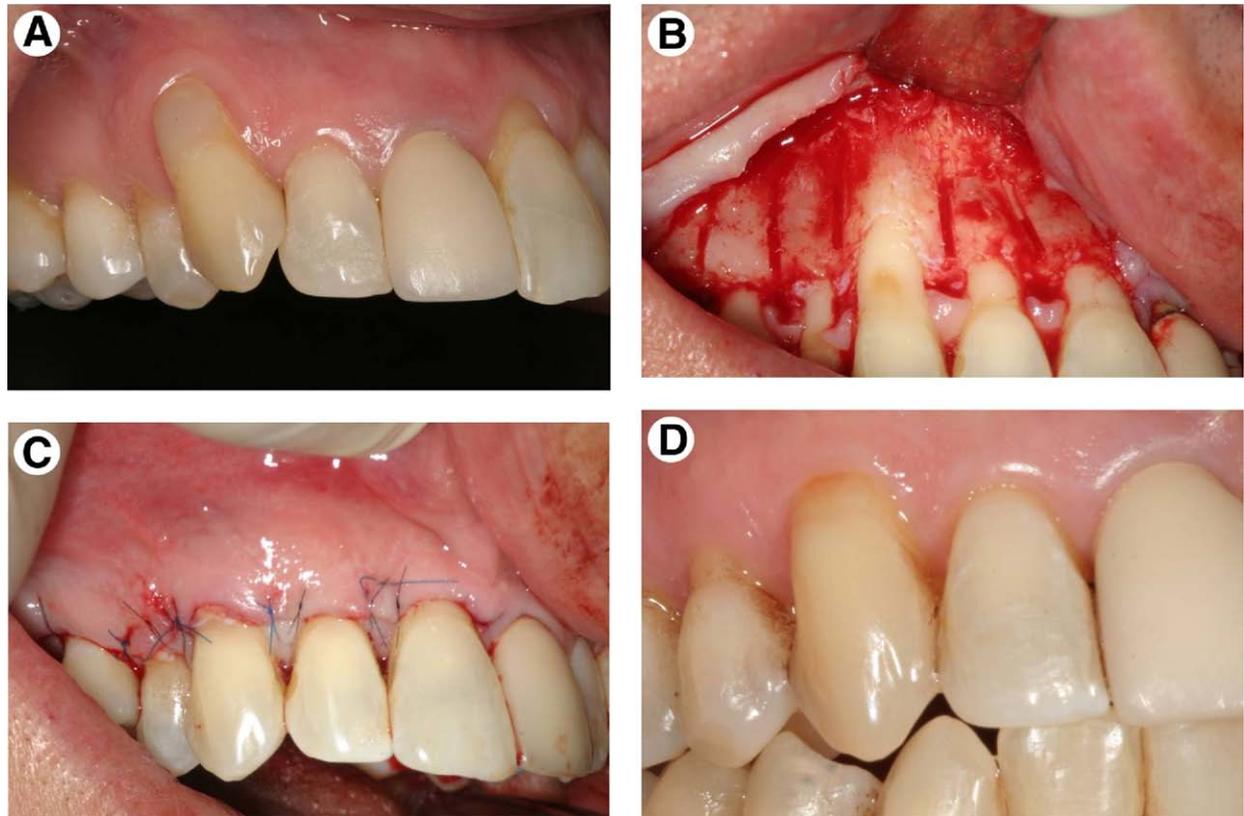
hances patient comfort and clinical healing. Antibiotics and pain medications are administered at the clinician's preference. However, long-term postoperative administration of nonsteroidal anti-inflammatory agents is discouraged, because they may theoretically interfere with the regional acceleratory process. The application of icepacks to the affected areas also is suggested to decrease the severity of any possible postoperative swelling or edema.

The most commonly reported postsurgical complications are edema and ecchymosis, both of which are self-limiting. The patient will return for postsurgical

evaluation and gentle prophylaxis every week for the first month and then monthly thereafter.

#### TECHNIQUE MODIFICATIONS

PAOO can be successfully combined with gingival augmentation procedures.<sup>13</sup> This is particularly important to the adult patient who presents with significant gingival recession. In these situations a subepithelial connective tissue graft is placed over the denuded root surface in addition to particulate graft placement. The graft is harvested by removing a 1- to



**FIGURE 6.** A, Pretreatment view of patient undergoing PAOO procedure presenting with severe gingival recession on tooth 6. B, Composite restoration removed and corticotomies performed. C, Subepithelial connective tissue graft placed under coronally advanced flap. D, Two-year postsurgical result. (Orthodontic therapy was performed by Dr Marty Lang, Lutherville, MD.)

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2-mm thickness of gingival connective tissue from the elevated palatal flap (Fig 6).

## Discussion

PAOO can play an important role in the comprehensive treatment of a patient's occlusal and esthetic needs. This technique has been shown to increase alveolar bone thickness, decrease treatment time, and enhance post-treatment orthodontic stability. PAOO is an extension of previously described techniques that surgically alter the alveolar bone to decrease treatment time. It differs from prior techniques by the additional step of alveolar bone grafting. It is this additional step that is believed to be responsible for the increased post-treatment alveolar bone width. Likewise, the additional alveolar bone width may be responsible for enhanced long-term orthodontic stability.

A distinct disadvantage of this procedure is the additional cost and morbidity associated with surgery. Conversely, the true increase in treatment cost may be offset by the decreased treatment time or, in some cases, the need for orthognathic surgical procedures.

No objective data exist that describe the severity of postoperative pain with PAOO. However, case reports claim there is surprisingly little postoperative pain. Patients report more discomfort with arch wire activation than with the surgical procedure. For the patient who presents with the need for gingival augmentation, this disadvantage of introducing a surgical procedure, as well as the associated costs, may not be relevant because surgical correction of the gingival deficiency would be required regardless of the need for the PAOO procedure.

On the basis of case reports, surgical complications appear to be minimal with PAOO. Unfortunately, controlled multicenter data are not available at this time and objective assessment is not possible. The incidence of root resorption by use of PAOO is decreased when compared with conventional treatment. The frequency of other possible complications, such as ankylosis and devitalization, is unknown, but such complications have not been reported.

Because PAOO is a relatively new clinical procedure, long-term data (>5 years) regarding occlusal stability are not available. However, 2-year data suggest that PAOO can effectively, and with increased

efficiency, facilitate the orthodontic treatment of patients. A key component to this increased efficiency and these significantly decreased treatment times is the successful coordination of the orthodontic and surgical specialists. Without this coordination of the treatment plan and therapy, chances for a successful treatment outcome are decreased.

PAOO does result in significantly decreased treatment time. We assume that a decrease in the length of treatment would probably increase the likelihood that patients, especially adults, would elect to pursue orthodontic therapy when they would otherwise decline treatment. By decreasing treatment times, PAOO effectively increases a patient's access to orthodontic therapy by decreasing an obstacle to treatment. Conversely, the introduction of a surgical phase to the orthodontic therapy may prevent a patient from considering PAOO as a treatment option. Only after careful consultation and communication with an orthodontic therapist, periodontal therapist, and oral and maxillofacial surgeon will the patient be able to understand the advantages and disadvantages of treatment.

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