# Periodontally Accelerated Osteogenic Orthodontics (PAOO): Perio-Ortho Interrelationship

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## Abstract

Surgical intervention to involve the alveolar housing and influence the tooth movement has been described in various forms since 19th century. Periodontally Accelerated Osteogenic Orthodontics (PAOO) is an interdisciplinary clinical procedure that combines selective alveolar corticotomy, particulate bone grafting, and the application of orthodontic forces. This procedure facilitates faster orthodontic tooth movement and is theoretically based on the bone healing pattern known as the Regional Acceleratory Phenomenon (RAP). PAOO results in an increase in alveolar bone width, shorter treatment time, increased post treatment stability and decreased alveolar bone dehiscence. This article describes a case where PAOO technique was utilized for accelerated orthodontic closure of extraction space between maxillary right canine and second premolar in a young female with Class I malocclusion with bimaxillary protrusion.

**Key Words:** Periodontally Accelerated Osteogenic Orthodontics (PAOO), Regional Acceleratory Phenomenon (RAP), Wilckodontics, Corticotomy

## Introduction

Malaligned dentition can impair quality of life by affecting function, appearance and psychological well-being of patient thereby necessitating to seek orthodontic care. However, most of the patients are reluctant to undergo fixed orthodontic therapy due to longer duration of treatment. The modern era of interdisciplinary dentistry has taken the traditional treatment modality to emerging treatment alternatives such as Periodontally Accelerated Osteogenic Orthodontics (PAOO). PAOO technique is a combination of a selective decortications facilitated orthodontic technique with alveolar augmentation.[1,2] With this technique, one tooth can be moved 2-3 times further in one third or one fourth of the time required for traditional orthodontic therapy.[3]

Bryan (1893) described the first corticotomy-facilitated tooth movement in a textbook called 'Orthodontia: Or Malposition of the Human Teeth, Its Prevention and Remedy.'[4] In 1959, Heinrick Köle described the combined radicular corticotomy/supraapical osteotomy technique, which has been adopted or modified by most clinicians for current corticotomy procedures[5]. Over the time the supra-apical connecting osteotomy cuts used by Köle were replaced with corticotomy cuts.

Gantes et al. reported minimal changes in the periodontal attachment in corticotomy facilitated orthodontics in five adult patients with about 50% reduction in mean treatment time compared to traditional orthodontics[6]. Wilcko et al. modified the corticotomy-assisted approach, patented as accelerated osteogenic orthodontics (AOO) or PAOO, proposing additional alveolar augmentation with a combination of demineralized freeze-dried bone allograft and xenograft or a bioabsorbable alloplastic graft[1].

The role of periodontists in the PAOO is becoming increasingly important. It is imperative for the periodontist to know the biology of the procedure to fulfil the need of the patient and thus helping the orthodontist in attaining the quicker and stable results. The indications and contraindications for PAOO are:

**Table 1: Indications and Contraindications for PAOO[7,8]**

| Indications | Contraindications |
|---|---|
| Crossbites and tooth size-arch length discrepancies | Active periodontal disease |
| PAOO can be used as an alternative to orthognathic surgery in some cases | As an alternative for surgically assisted palatal expansion in the treatment of severe posterior crossbite |
| Moderate to severe malocclusions like severe bimaxillary protrusion, Class I malocclusions with moderate to severe crowding, Class II | Should not be attempted in cases where the bimaxillary protrusion is accompanied with a gummy smile, which might benefit more from segmental osteotomy |

| | |
|---|---|
| malocclusions requiring expansion or extraction and cleft lip palate cases | |
| Uprighting of tipped molars and intrusion of supraerupted molars | Severe skeletal class III – prognathic mandible |
| To facilitate eruption of impacted tooth at a faster rate | Uncontrolled over-all systemic disease with past or current history of prolonged medication (Bisphosphonates, NSAIDs & Steroids) intake |

Here we describe a case where PAOO was done for rapid space closure.

## Case Report

An 18 year old female patient undergoing fixed orthodontic mechanotherapy for correction of Class I malocclusion with bimaxillary protrusion was referred to a private clinic for accelerated orthodontic closure of extraction space between maxillary right canine and 2nd premolar (Fig. 1and Fig. 2). Both maxillary and mandibular arches were already bonded and levelling & alignment phase was complete. Thorough general assessment of the patient was made by case history recording, clinical examination, and routine laboratory blood investigations and was deemed fit for periodontal surgery. The patient received Phase-I therapy and the surgery was planned after one week.

After extra oral mouth preparation (Betadine 10%) and intraoral mouth preparation (10 mL of 0.2% Chlorhexidine for 1 minute), the area was adequately infiltrated (Lignocaine 2% with 1: 80,000 Adrenaline) buccaly and palatally. A modified incision technique was employed where two parallel incisions were given on the interdental gingiva, which was extended crevically on the adjacent teeth along the buccal and palatal aspects (Fig. 3). A full thickness mucoperiosteal flap was reflected and the rectangular wedge of fibrous tissue causing soft tissue impaction was removed (Fig. 4).

Vertical corticotomy cuts extending up to the root apex were made on the alveolar bone between the roots of maxillary canine and 2nd premolar on both buccal and palatal aspects (Fig. 5) using straight fissure bur in contra angle handpiece under copious saline irrigation. The cuts were approximately 1.5 - 2 mm deep and extended to spongiosa. Cortical perforations were also made at selective areas using round bur. Sybograf-Plus™ (synthetic nanocrystalline hydroxyapetite + β-tricalcium phosphate allograft) bone graft was placed (Fig. 6). The flap was repositioned and closed by simple interrupted suture (Fig. 7).

The patient was prescribed with 3 days medication consisting of antibiotic (Amoxicillin 500 mg - TDS), analgesic (Tramadol 50 mg - TDS) and probiotics. Tooth brushing was discontinued for the first 2 weeks at the surgical site and 10 mL of 0.2% chlorhexidine mouth rinse twice daily was instructed till 4 weeks after surgery. The area healed uneventfully and the suture was removed after 7 days. Patient was subjected to active orthodontic treatment just after suture removal and complete space closure was achieved at 5th month (Fig. 8 and Fig. 9).

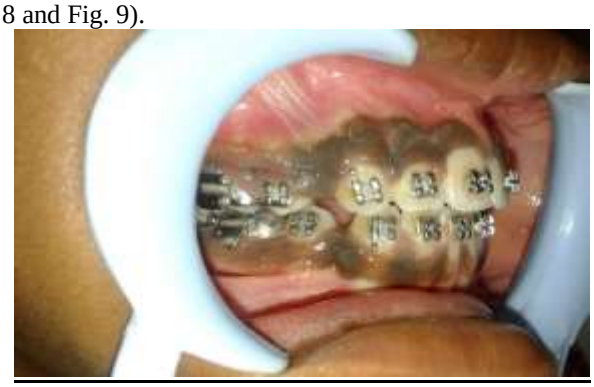

**Fig. 1: Pre-Op Right Buccal View**

**Fig. 2: Pre-Op Occlusal View**

**Fig. 3: Incision Given**

**Fig. 4: Mucoperiosteal Flaps Reflected**

**Fig. 5: Corticotomy Done**

**Fig. 6: cotrical Perforations done & Bone Graft Placed**

**Fig. 7: Interrupted Suture Placed**

**Fig. 8: Post-Op Right Buccal View**

**Fig. 9: Post-Op Occlusal View**

## Discussion

Corticotomy facilitated orthodontics has been employed in various forms over the past to speed up orthodontic treatments. It was believed that the main resistance to tooth movement was the cortical plates of bone and by disrupting its continuity, orthodontics could be completed in much less time than normally expected. The original technique described by Köle[(5)] included a combined interradicular corticotomy and supraapical osteotomy. Although the results of the procedure were stable, pulp mortifications were not rare[(9)].

Wilcko et al. (2001) in their surface computed tomographic (CT) scan evaluation of selectively decorticated patients reported that rapid tooth movement was not as a result of bony block movement, but rather due to transient localized demineralization-remineralization phenomenon in the bony alveolar housing[(1)]. Wilcko et al. (2003) have also demonstrated that it is not the design of the selective alveolar decortication that is responsible for the rapid tooth movement but rather the degree of tissue metabolic perturbation per se[(2)].

This process was consistent with the wound healing pattern of the Regional Acceleratory Phenomenon (RAP), developed by Frost[(10,11)] and described in the periodontal literature by Yaffe et al[(12)]. RAP is a local hard and soft tissue response to a surgical wound where tissue forms faster than the normal regional regeneration

process. The surgery results in a substantial increase in alveolar demineralization resulting in transient osteopenia which enables rapid tooth movement because teeth are supported by and moved through trabecular bone[13]. When orthodontic tooth movement is comple, an environment is created that favours alveolar re-mineralization.

A recent histological study showed that selective alveolar decortication induced increased turnover of alveolar spongiosa[14]. The RAP begins within a few days of injury, typically peaks at 1–2 months, usually lasts 4 months in bone and may take 6 to more than 24 months to subside[13]. As long as tooth movement continues, the RAP is prolonged. By enhancing the various healing stages, this phenomenon makes healing occur 2–10 times faster than normal physiologic healing[15].

Thus, decortication should just be enough to initiate the RAP response and not to create bone segments. Alveolar bone can be activated conventionally by using surgical burs as described in this case, or by using piezosurgical units[16]. Park et al.[17] introduced the alternative approach consisiting of incisions directly through the gingiva and bone using a combination of blades and a surgical mallet. Dibart et al.[18] introduced a new, minimally invasive procedure, combining microincisions (peizocision) with selective tunnelling that allowed for hard- or soft-tissue grafting. Recently, researchers have demonstrated Er-Cr: YSGG (Erbium, Chromium doped Yttrium Scandium Gallium Garnet) LASER for flapless corticomy in animal model with reduced treatment time and minimal damage to the periodontium[19].

The bone activation is followed by particulate bone grafting facially and lingually over the areas that have undergone corticotomies. The materials most commonly used for grafting are deproteinized bovine bone, autogenous bone, decalcified freeze-dried bone allograft, or a combination thereof[20]. Xenografts and synthetic material may be "osteoconductive," but it may not be adequate just to establish a scaffold for bone growth. Bone Morphogenetic Proteins (BMP's) in allografts may further increase the osteogenic potential[21]. While the best evidence suggests an important role for growth factors, one cannot rule out the possibility that volumetric distension of the periosteum itself is an important factor in achieving clinical results, as it too is a functional matrix of bone[22].

The volume of the graft material used is dictated by the direction and amount of tooth movement predicted, the pretreatment thickness of the alveolar bone and the need for labial support by the alveolar bone. A typical volume used is 0.25 to 0.5 ml of graft material per tooth[20]. Wilcko et al.[1,2,13] recommended the use of mixture of demineralized freeze-dried bone and bovine bone with clindamycin. Care should be taken not to place an excessive amount of bone graft which might interfere with flap placement. If there is any recession in the teeth, it can be treated at the same time with connective tissue graft or acellular dermal matrix allograft[23].

Duker[24] reported that the time required aligning the teeth after corticotomy could be 1½-3 months or less. Chung et al.[25] reported complete retraction of anterior teeth combined with corticotomy in a case with severe bimaxillary protrusion took less than 3½ months. Geramc et al.[26] observed the total dramatical reduction in the orthodontic treatment time (16 months) when compared with the average treatment time for extraction therapy (31 months)[27].

Medications that reduce the turnover rate of the bone and increase calcium uptake can potentially be problematic for such procedures. The bisphosphonates, and even some calcium nutritional supplements, would fall into this category[13]. Additionally, osteopenia that facilitates the tooth movement is a sterile inflammatory process and certain medications especially the nonsteroidal anti-inflammatory drugs (NSAIDs) could counteract this[13]. Therefore postsurgical pain management by opoid analgesics is recommended. A recent experimental research suggested that maintaining transgenic overexpression of receptor activator of the nuclear factor-kB ligand (RANKL) would accelerate OTM and selective gene therapy with RANKL could be an alternative to corticotomy surgery[28].

The advantages and disadvantages of PAOO have been tabulated below:

**Table 2: Advantages & Disadvantages of PAOO**

| **Advantages [1,2,4,13]** | **Disadvantages [1,2,13,23]** |
|---|---|
| Reduced treatment time: one-third the time of conventional orthodontics | Extra-surgical cost |
| Less root resorption due to decreased resistance of cortical bone | Mildly invasive surgical procedure, and like all surgeries, it has its risks. Post-surgical crestal bone loss and recession may occur |
| Less need for extra-oral appliances and headgear | Some pain and swelling is expected, and there is possibility of infection |
| History of relapse reported to be very low upto 10 year post de-bonding | Not applicable to all cases, proper case selection is necessary to attain a good result |

| | |
|---|---|
| More bone support due to addition of bone graft and prevention the formation of new fenestrations and dehiscences and correction of the existing ones | Patients who take NSAIDs or Bisphosphonates on a regular basis or have other chronic health problems will not be treated with this technique. |

The efficacy, effectiveness, and efficiency of corticotomy facilitated orthodontics for accelerating tooth movement in adult patients was evaluated by Mathews and Kokich[29] and they concluded that efficiency of this procedure was questionable due to:

a. Limited duration of RAP
b. Additional surgical procedure and significant expense associated to PAOO
c. Lack of evidence that is no randomized controlled trials to substantiate reduction in orthodontic treatment time has been reported until date.

## Conclusion

Over the last two decades, the refinements of an attempt to engineer an "optimal response" of alveolar bone to applied "optimal force" has propelled both the periodontal and the orthodontic specialties directly into the field of surgical dentofacial orthopaedics. In comparison to traditional orthodontics, corticotomy facilitated orthodontics (PAOO) has been instrumental in achieving the desired result in a shorter time period. The ability to increase the post treatment alveolar volume and cover vital root surfaces can result in the repair of preexisting alveolar dehiscences and lessen the likelihood of new dehiscence formation.

The periodontist should consider an appropriate technique according to the alveolar topography to avoid complications and to assist accelerated orthodontic tooth movement. With the increasing number of adolescents and adults undertaking orthodontic treatment, the PAOO technique can be an attractive treatment option and be a "win-win" situation for the orthodontist, the periodontist and the patient. However, further research, randomised clinical trials and histological studies are needed for an in-depth evaluation of the technique and long-term stability of the treatment outcome.

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