PERIODONTALLY ACCELERATED OSTEOGENIC ORTHODONTICS: A REVIEW OF THE LITERATURE

PERİODONTAL OLARAK HIZLANDIRILMIŞ OSTEOJENİK ORTODONTİ: BİR LİTERATÜR DERLEMESİ

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ÖZET

AMAÇ: Periodontologlar ve ortodontistler arasındaki sinerji, her iki disiplini de ilgilendiren kombine terapilerin klinik sonuçlarını geliştirmek için önemli fırsatlar yaratır.
YÖNTEMLER: Bu iki uzmanlık alanının işbirliği, ortodontik tedaviye bağlı olarak periodontal sağlığın daha iyi düzeye ulaşmasına ve buna karşılık doğru periodontal idame ile ortodontik terapinin başarısının artmasına yol açar. Periodontoloji ve ortodontinin beraberliği konvansiyonel tedavilerin yanı sıra, 'periodontal olarak hızlandırılmış osteojenik ortodonti™ (PAHOO)' gibi yeni gelişen tedavi alternatifleri açısından da önemli rol oynar.
BULGULAR: PAHOO™ tekniği, 'ortodontik tedavi ile kombine edilmiş alveolar kortikotomiye ilave olarak kemik ogmentasyonuna yönelik gretfleme' olarak tanımlanır. Sağlıklı dokulardaki deminerilizasyon-reminerilizasyon süreçlerinin çabuk ve geçici doğasına dayalı destekleyici ve umut veren bir teknik olarak PAHOO™, alveolar kortikotomi ile labial ve palatinal/lingual yüzeylerin kemik greftlemesini takiben ortodontik kuvvet uygulanmasından oluşur. Azalmış ortodontik tedavi süresi, artmış kemik hacmi ve post-ortodontik stabilite PAHOO™ tekniğinin en önemli avantajları olarak sıralanmaktadır. Kortikotomi-yardımlı ortodontinin tarihsel kökenleri 1800'lü yıllara kadar dayansa da, literatürde az sayıda hayvan deneyi ve klinik olgu sunumu izlenmekte ve bu tekniğin uzun dönem başarısını doğrulamak için kontrollü, prospektif ve histolojik araştırmalara ihtiyaç duyulmaktadır.
SONUÇ: Bu bağlamda derlememizin amacı PAHOO™ tekniğini tarihsel gelişim, biyolojik esaslar ve klinik düşünceler çerçevesinde gözden geçirmektir.

Anahtar Kelimeler: Hızlandırılmış ortodonti, alveolar dekortikasyon, kemik ogmentasyonu.

SUMMARY

OBJECTIVE: Synergism between periodontists and orthodontists creates crucial opportunities to enhance clinical outcomes of combined therapies regarding both disciplines.
METHODS: Collaboration of these specialties leads to promoted periodontal health as a result of orthodontic treatment or intensified orthodontic therapy due to proper periodontal maintenance, reciprocally. Co-operative approaches of periodontology and orthodontics play significant role not only in conventional therapies but also in emerging treatment alternatives such as periodontal accelerated osteogenic orthodontics™ (PAOO).
RESULTS: PAOO™ technique is defined as the orthodontic treatment combined with alveolar corticotomy plus bone augmentation grafting. As a promising adjuvant technique based on the transient nature of demineralization-remineralisation process in healthy tissues, PAOO™ consists of alveolar corticotomy and bone grafting of labial and palatal/lingual surfaces, followed by orthodontic force. Main benefits of PAOO™ are listed as reduced orthodontic treatment time, increased bone volume and post-orthodontic stability. Although the historical background of corticotomy-assisted orthodontics lies back to 1800s, modern literature offers a few animal studies and human clinical cases, where controlled prospective and histologic studies are needed to confirm the long-term success of this technique.
CONCLUSION: On this basis, our review aimed to revise the perspective of PAOO™ technique through historical background, biologic basis and clinical considerations.

Key words: Accelerated orthodontics, alveolar corticotomy, bone augmentation.

INTRODUCTION

Orthodontic treatments in adult patients have become popular in recent years in regard to increasing demands and expanding treatment modalities. In a recent study, it was stated that correction of malocclusion in adults leads to improved periodontal health and enhanced psychosocial status.[1] The Medical Expenditure Panel Survey revealed that orthodontic visits by adults were 23.1% of all orthodontic appointments. Similarly, in 2008 Keim et al.[2], demonstrated that the percentage of adult active patients was approximately 20% among all patients being orthodontically treated in USA. But, there are also some clinical facts to be considered for adult patients opting for orthodontic treatment; (1) these patients might have different requirements regarding the duration of the treatment, concerns on facial and dental aesthetics and also types of appliance to be used, (2) these patients have special features regarding periodontal hyalinization and alveolar flexibility in comparison to adolescents.[3] Achieving success in orthodontic therapy for adults is clinically challenging and lengthened in time especially due to the cease of dentoalveolar development after adolescence. The average treatment period for adults, ranging from 18.7 to 31 months, is considerably higher than adolescents.[4, 5] Additively; aplastic, narrow, less vascular periodontal membrane and alveolar bone morphology observed in adults make these patients more vulnerable to root resorptions and periodontal pathologies during or following active orthodontic treatment.[6, 4] Therefore, some treatment modifications in regard to surgical modalities have been suggested to reduce the treatment time and achieve optimal clinical results with long-term stability in adults undergoing orthodontic therapy.

HISTORICAL BACKGROUND

Surgical aid in orthodontic tooth movement (OTM) has been used since the 1800s. Bryan described the first corticotomy-facilitated tooth movement in 1893, published by Guilford in a textbook called ‘Orthodontia: Or Malposition of the Human Teeth, Its Prevention and Remedy’.[6] Most important feature of this approach was reduced treatment time to one-third of conventional treatment and promised more predictable results in adults. Fifty years later, the corticotomy procedure was described for closing diastemata in patients aged over 16 as he classified orthognatic surgeries under major (total or segmental maxillary and mandibular correction) and minor (interdental osteotomy or corticotomy) headlines.[7, 6] In 1959, Heinrick Köle[3] described the combined radicular corticotomy/supraapical osteotomy technique, which has been adopted or modified by most clinicians for the current corticotomy procedures. Köle’s approach consisted of creating bone blocks by buccal and lingual interproximal vertical corticotomy cuts limited to cortical layers, as these vertical corticotomy cuts are connected by horizontal osteotomy cuts approximately 1 mm beyond the root apices. Köle relied his technique on reducing cortical resistance and obtaining trabecular vascular supply for the teeth in order to move the bone segments with the embedded teeth in a rapid fashion. Using the technique, Köle was able to correct retrusive (*i.e.* deep overbite) or protrusive incisors (*i.e.* open bite or diastemic incisors). Enhancing alveolar expansion and limiting buccal tilting of the posterior teeth through buccal and palatal corticotomies was also advocated.[8, 3]

The first experimental study of alveolar corticotomy was performed in monkeys.[9] As a model of vertical interdental osteotomy through simultaneous reflection of labial and palatal flaps was described, histologic study revealed that full mucoperiosteal detachment and cuts in medullar bone jeopardized the vascularity of dental pulp and surrounding medullar bone. Progressive recovery of distinct avascular zones within 3 weeks postoperatively, excluding central incisors zone, was also demonstrated. Another experimental study was performed in beagle dogs to evaluate how corticotomy affected the vitality of the teeth and marginal periodontal health.[10] As no damage was found in the pulp or periodontal ligament (PDL) following corticotomy and application of orthodontic forces, it was advocated that marginal crestal bone should be preserved from interdental cuts at a minimum distance of 2 mm. The biologic concept of periodontally accelerated osteogenic orthodontics™ (PAOO), relying on decreased bone density and accelerated bone turnover, emerged as Goldie and King[11] demonstrated enhanced tooth movement and decreased root resorption in lactating rats with an osteoporosis state due to depleted calcium intake. Additively, Bogoch et al.[12] reported an increase in apposition and resorption of rabbit tibia spongiosa and Sebaoun et al.[13] demonstrated an increase in apposition and resorption of rat alveolar spongiosa, both adjacent to the corticotomy site. These findings created further credence to PAOO™ approach.

The initial approaches of surgical intervention for orthodontics utilised alveolar osteotomy (complete cut through cortical and medullar bone) solely or in combination with corticotomy (partial cut of cortical plate without penetrating medullar bone), so-called 'bone-block movement'. Traditional bone cuts in regard to vertical and horizontal osteotomies jeopardized the vitality of the teeth or the bone and also integrity of the periodontium especially in cases with an interradicular space less than 2 mm.[14] In contrast, as Köle[3] described, corticotomy offers significant advantages over osteotomy such as maintenance of periodontal stability, tooth vitality and nutritive function of the bone which avoids the risk of aseptic bone necrosis. Considering the scientific cumulation and clinical opinions, surgical procedures in relation with orthodontic therapy stepped towards corticotomy gradually. Generson and coworkers[15] demonstrated rapid tooth movement with single-stage corticotomy-only approach in two cases of dentoalveolar abnormality. Anholm et al.[16] achieved the orthodontic treatment of a case with severe malocclusion in 11 months following corticotomy. Gantes et al.[17] reported five cases with a corticotomy approach consisting circumscribing corticotomy cuts facially and lingually around maxillary anterior teeth. The technique, claimed to cause minimal changes in the periodontal attachment post-orthodontically, also included the extraction of maxillary first premolars followed by removal of buccal and palatal socket walls. Chung et al.[7] offered removal of medullary bone blocks, block by block, with the aid of orthopaedic forces. Hwang and Lee[18], demonstrating a similar approach with Chung and co-workers[7], reported two adult cases of intrusion of unantagonized molars without extruding the adjacent teeth through corticotomy where they utilised magnets to deliver the orthodontic force. Wilcko et al.[5] 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. Before PAOO™, alveolar augmentation was performed to increase alveolar bone thickness and to reduce the risk for dehiscence during rapid OTM where this new approach allowed increasing the buccolingual thickness of overlying buccal bone and cover the pre-existing fenestrations. Tooth movement was initiated two weeks postoperatively and activation of the orthodontic appliance was scheduled as once every two weeks. Remarking, Wilcko and co-workers[19, 5] justified that the reason for tooth movement was, rather than tooth-bone block repositioning, the cascade of transient localized reactions in alveolar bone leading to bone healing.

BIOLOGIC FUNDAMENTALS

Alveolar bone and PDL host a variety of cellular and molecular events in regard to signal generation and transduction in extracellular matrix, cell membrane, cytoskeleton, nuclear protein matrix and genome structures when an adaptive biochemical response emerges against an applied orthodontic force and provides a favourable micro-environment for remodelling in both mineralized and non-mineralized tissues.[20, 21] Basically, bone turnover is in related with skeletal maintenance and mineral metabolism and consists resorbing (catabolic) and forming (anabolic) phases. Orthodontic tooth movement (OTM), influenced by increased alveolar bone metabolism and decreased bone density, was demonstrated to be in correlation with bone turnover rate as high bone turnover significantly increased the rate of OTM.[21, 22] A sum of data have stated that catabolic activity mediated by osteoclasts limits the rate of OTM and PDL plays a crucial role in this process.[22] In parallel, several histologic researches have supported the pressure/tension theory, which relies on the emergence of local bone resorption (pressure) and bone apposition (tension) sides during OTM.[23] On the resorption side; disturbance of blood flow in the compressed PDL, cell death in the compressed area of the PDL (hyalinization), resorption of the hyalinised tissue by macrophages, and undermining bone resorption by osteoclasts beside the hyalinised tissue ultimately results in OTM. On the apposition side, blood flow is activated where the PDL is stretched, which promotes osteoblastic activity, osteoid deposition and mineralization. Several studies revealed that hyalinization appears in local pressure zones of the PDL during 'the initial phase' of OTM. Von Bohl et al.[24], on contrary to conventional understanding, showed that not only in the initial phase of orthodontic tooth movement could hyalinization be observed but also in the later stages small hyalinised patches were found. Their findings also confirmed the outcome of a previous study on changes of the PDL during experimental tooth movement with a similar experimental set-up by Kohno et al.[25] These findings contradict the common theory of the relationship between tooth displacement and hyalinization. Additively, save the fact that bone adaptation to orthodontic force depends on the regular gene expression of osteoblasts and osteoclasts, recent discoveries of OTM-related gene mutations which regulates osteoclast bone-matrix acidification and osteoblast-derived mineral-protein matrices promoted the biologic basis of orthodontic treatment to a combination of mechanics and molecular-genetic-cellular interventions [21]. A recent experimental study proposed a single continuous periodontal compartment in OTM rather than distinguishable pressure/tension sides and proclaimed that the bone formation on the apposition side is the limiting factor for OTM acceleration.[26] Another 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.[27]

Considering the type of surgical damage in alveolar bone, corticotomies and osteotomies induce different types of alveolar bone reactions as demonstrated by micro CT based study.[28] An experimental research revealed that corticotomy-assisted OTM produced transient bone resorption around the dental roots under tension that was replaced by bone after 60 days. On the other hand, osteotomy-assisted OTM resembled distraction osteogenesis and did not exhibit a regional bone resorption phase.[29] In a recent study comparing corticotomy-facilitated OTM versus standard technique in dogs with mini screws as anchor units, corticotomy doubled the rate of OTM and histologic analysis evidenced more active and extensive bone remodelling for corticotomy, suggesting acceleration in OTM associated with corticotomy is due to increased bone turnover and relies on a regional acceleratory phenomenon (RAP).[30]

The regional acceleratory phenomenon (RAP), recognized by Frost[31, 32], defines a complex physiologic healing process involving accelerated bone turnover and decreased regional bone density in response to surgical wounding of osseous tissue. As a local response to noxious stimuli in sites of decortication extending to the marrow, RAP is an intensified bone response and rapid remodelling process featuring increase in osteclastic-osteoblastic activity and in levels of local and systemic inflammation markers. RAP varies in duration, size and intensity in regard to the magnitude of the stimulus and type of the tissue. In human bone, RAP usually lasts about 4 months and causes bone healing to occur 10-50 faster compared to normal bone turnover and is considered as a physiological emergency mechanism due to potentiating tissue reorganization by a transient burst of localized remodelling.[33, 7, 5] A sum of experimental and clinical data demonstrated RAP in different bone types including alveolar bone and reported strong indirect evidence associated with RAP following surgical trauma which, in turn, results in rapid tooth movement due to calcium depletion and diminished bone density.[32, 34, 35, 5, 36] As surgical injury causes transient local osteopenia in alveolar bone, biomechanical resistance of the bony structure decreases and enables rapid tooth movement through trabecular bone. Utilising orthodontic power may prolong the transient osteopenia and perpetuates a therapeutic osteopenic state, considering having a limited window to limit the RAP to the teeth surrounded by corticotomy for an estimated time of 3-4 months. During this process, continuous tensional stress altered in frequency and magnitude via the roots every 1 to 2 weeks is clinically imperative to maintain the osteopenic state, accelerated tooth movement and post-treatment phenotype stability where the alveolar bone adapts to an inactive ‘steady state’ equilibrium under constant force.[33, 37] Collectively, surgically-assisted or periodontally driven orthodontic treatment is a combination of somatic cell therapy (bone regeneration) and gene therapy (alteration of gene expression). In vivo tissue engineering principles shared by the PAOO™ protocol and science of periodontal regeneration is as an entirely new dimension in dentofacial orthopaedics, claiming to elicit an optimal and steady tissue response to accomplish OTM rapidly.[33, 21, 38]

CLINICAL CONSIDERATIONS

Indications and Contraindications

Following the first reports by Wilcko[5] brothers, alveolar corticotomies in combination with mechanic forces have been used for various clinical indications, which are grouped in three main categories: (1) To accelerate corrective orthodontic treatment, as a whole, (2) to facilitate the implantation of mechanically challenging orthodontic movements, and (3) to enhance the correction of moderate to severe skeletal malocclusions. On the other hand, although referred by a few studies, there are certain clinical conditions where PAOO™ is contraindicated: (1) Patients with any sign of active periodontal disease, (2) inadequately performed or prognostic poor endodontic treatment, (3) history of prolonged corticosteroid usage, (4) current medication interfering bone metabolism such as bisphosphonates or non-steroidal anti-inflammatory drugs (NSAID).[33, 39-41, 19]

Case Selection and Treatment Planning

Case selection and treatment planning are the mutual tasks of the orthodontist and the surgeon as the orthodontist determines the OTM plan, identify the teeth to provide anchorage and arch segments to be expanded or contracted while the surgeon considers the clinical periodontal status, mucogingival structure, options for minimally invasive surgery and incorporation of aesthetic needs of the patient into the treatment plan.[33, 38]

Orthodontic bracketing and activation of arch wires should be performed no later than two weeks postoperatively to take the full advantage of the limited time of RAP occurrence. If required, as common in Class II malocclusions requiring retraction, anchorage must be established before the initiation of PAOO™ procedure. Also, in cases presenting dental arches with different degrees of OTM, PAOO™ and conventional orthodontic therapy could be performed in different arches simultaneously if it is predictable to have both arches corrected in a similar time frame. In fact, the orthodontist is challenged with a time period of 4 to 6 months following the surgical phase to accomplish OTM which makes it obligatory to engage the largest arch wire possible initially and advance arch wire sizes rapidly. During active orthodontic treatment, adjustments at least every two weeks is obligatory to sustain the osteopenic state, decrease the risk of recalcifiation in midtreatment and facilitate OTM.[38, 5] As in all types of fixed orthodontic treatment, maintenance of proper oral hygiene measures with appropriate motivation techniques is essential.[42] Another issue to consider is that, a detailed mucogingival consideration might enhance the outcome of PAOO™ and complex mucogingival surgeries are easier to be accomplished before bracketing.

Surgical Technique

The flap design should provide full access to corticotomy site, gain tissue coverage for the graft material, maintain interdental tissue dimensions and enhance the gingival aesthetics where necessary.[38] As coronal aspect of the flap is full-thickness, a split-thickness approach in apical portions might be preferred to provide closure with minimal tension. Mesial and distal extensions are suggested to avoid the need for vertical releasing incisions. Interdental tissues regarding palatal or lingual gingival collars should be preserved in minimum and a tunnelling approach should be performed in maxillary central incisors area to enhance vascular supply and aesthetic outcome.[33, 38, 13]

Decortication is performed on both labial and palatal (lingual) aspects of the alveolar bone to initiate the RAP, without creating movable segments of bone. Typically, vertical corticotomies in mid-interdental areas are connected with circular corticotomies. There is no superior technique defining a specific pattern, selective decortication depth or extent. A high-speed hand piece or a piezosurgical knife might be used in regard to general principles of bone surgery and local anatomic structure.[43, 38, 19]

Bone grafting is commonly required in corticotomy areas. Predicted direction and amount of OTM and architecture of the existing alveolar bone in regard to buccolingual dimension and the need for labial support dictates the volume of the material to be used. A typical volume of 0.25 to 0.5 mL of graft material per tooth is used as decorticated areas elicits the necessary mesenchymal stem cells and help to stabilize the graft material. Deproteinized bovine bone, decalcified free-dried bone allograft and autogenous bone have been used solely or in combination within or with platelet concentrations such as platelet rich plasma. Usage of barrier membranes is discouraged. Up-to-date, there is no data comparing different graft materials in terms of clinical success.[38, 6, 44]

Primary closure without excessive tension is essential to predictable bone augmentation.[45] Typical choice of material is nonresorbable sutures with features respecting the thickness of the soft tissue. As a principal, interproximal sutures follow approximating sutures in the midline and are followed by closure of vertical sutures if necessary. Suture removal is scheduled at one or two weeks postoperatively. Periodontal packing is not required.[38, 19]

Patient Management

Surgical session of PAOO™ may cost several hours especially for bimaxillary approach suggesting the sedation of the patient. Short-term steroids, antibiotics and analgesics are prescribed to enhance clinical healing and patient comfort. On the other hand, long-term administration of NSAIDs postoperatively is discouraged due to the reason that NSAIDs are considered to be interfering with the RAP. Postoperative application of icepacks for supressing swelling and oedema is suggested. Oedema, ecchymosis and moderate pain are the most commonly reported postsurgical complications which are not challenging for the clinician in general.[38] Although no adverse effect on pulp vitality and periodontium due to PAOO™ procedure was reported, long-term researches are still needed.[39]

Significant Clinical Applications

The corticotomy-assisted orthodontic treatment has been demonstrated to be effective in several distinct clinical situations such as crowded dentition, canine retraction after premolar extraction, facilitation of impacted tooth eruption, facilitation of slow orthodontic expansion, molar intrusion with open bite correction and enhancement of postorthodontic stability.[33, 46, 39, 47] Innovative approach of Wilcko[5], addressing the need for surgical orthopaedics of the alveolus, combined corticotomy (selective alveolar decortication) with alveolar augmentation (bone grafting) and orthodontic (mechanic) force, suggested PAOO™ to be used in cases of traditional fixed orthodontic therapy such as Class I malocclusions with moderate-to-severe crowding, Class II malocclusions requiring expansion or extractions and mild Class III malocclusions.[38] Relying on this concept, a number of reports described the relevant clinical efficiency in enhanced correction of severe bimaxillary protrusion, closure of complex skeletal open bites, facilitated molar intrusion with removable appliances, intrusion and molar up righting with mini-implants and optimization of treatment of patients with cleft lip and palate.[48-50, 40, 41, 51]

Germeç et al.[52] reported an adult case with a modified corticotomy technique proposing the elimination of vertical and subapical selective decortication on the lingual aspect, for retracting mandibular anterior teeth after the extraction of four premolars. Nowzari et al.[6], who were first to document the use of particulate autogenous bone graft with PAOO™, initiated orthodontic movement immediately after surgery and completed the treatment in 8 months for the case of a 41-year-old male with class II, division 2 crowded occlusion. They also performed re-entry one year after the corticotomy procedure and reported that the thickness of the buccal plate in both arches remained unchanged, alveolar height was maintained and no new fenestration or dehiscence was observed. Wilcko et al.[19] reported the usefulness of PAOO™ for the treatment of two adult cases with severe crowding as they demonstrated rapid OTM in both cases and stability up to 8 years of retention. Dibart et al.[43] reported a 26-year-old female with a Class I pattern with slightly retruded maxilla and mandible and a normodivergent mandible, presenting her chief complaint as '*I have an unpleasant smile*'. They utilised PAOO™ technique to shorten the treatment time and finalized the active orthodontic treatment in 17 weeks. They also suggested piezoincisions combined with a localised tunnelling approach in order to perform hard and soft tissue augmentation, enhance the periodontium and increase the scope of the OTM. Einy et al.[53] presented six cases of adult patients from both genders, with a malocclusal variety of Angle class II and class III relationships, a constricted maxilla and maxillary dental arch, a bilateral posterior cross-bite and an anterior open bite, seeking a quick orthodontic solution for aesthetic and functional disorders. They concluded that PAOO™ could serve as a reasonable and safe option in adult patients for the growing demand of shortened treatment duration of OTM in three dimensions. Kim et al.[54] demonstrated two adult cases with Class III malocclusion undergoing anterior decompensation for mandibular setback surgery. They compared the efficiency of conventional decompensation with temporary skeletal anchorage decompensation by using a device combined with guided tissue regeneration. They referred PAOO™ as a safe and effective technique for the facilitation of decompression of the mandibular anterior teeth in severely compromised dentitions. Aljhani and Zawawi[55] reported a 25-year-old female with a chief complaint of '*I want my teeth fixed quickly'*, drafted for PAOO™. They bonded initial fixed orthodontic appliances one week before corticotomy and orthodontic activation was performed every two weeks. Total treatment ended in 8 months without adverse effects. Yezdani[56] demonstrated a 29-year-old female with Class I malocclusion and increased bidentoalveolar protrusion, treated with PAOO™. He stated that periodontal alveolar augmentation with an alloplastic graft material repaired the dehiscence's, enhanced the bone volume and improved soft tissue profile remarkably, as the case was concluded at seventh month postoperatively.

CONCLUSION

As a relatively new procedure differing from prior techniques by the additional step of alveolar bone grafting, PAOO™ offers the benefits of enhanced scope of malocclusion treatment by reduction of extractions and/or orthognatic surgery, three to four times more rapid orthodontic treatment time compared to the conventional approach, higher degree of stability in clinical outcomes, less relapse, increased alveolar volume and enhanced periodontal health. Based on experimental data and case reports, comprehensive treatment of a patient's occlusal and aesthetic needs seems possible with the interdisciplinary approach regarding PAOO™. Considering the increasing demand of adult patients to decreased treatment time, this technique will lead to an increase in the number of patients accessing to orthodontic treatment.

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