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Review Article

Periodontally Accelerated Osteogenic Orthodontics: A Paradigm Shift in Orthodontic Treatment

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Abstract

A patient's function, attractiveness, and psychological well-being can all be negatively impacted by malaligned teeth, which makes orthodontic treatment necessary. Due to the extended treatment time, the majority of patients are hesitant to undergo fixed orthodontic therapy. Periodontally Accelerated Osteogenic Orthodontics (PAOO) is one of the new treatment options that have replaced the old treatment paradigm in the current era of interdisciplinary dentistry. The PAOO approach combines alveolar augmentation with a selective decortication-facilitated orthodontic treatment. The Regional Acceleratory Phenomenon (RAP), a pattern of bone healing, is the theoretical foundation for this process, which speeds up orthodontic tooth movement. As a result of PAOO, Alveolar bone width increases, treatment duration is shortened, posttreatment stability is improved, and alveolar bone dehiscence is reduced. The history, biology, clinical surgical techniques, indications, contraindications, and potential risks of the PAOO surgery are all covered in this article.

Keywords: *Periodontally Accelerated Osteogenic Orthodontics (PAOO); corticotomy; Regional Acceleratory Phenomenon (RAP)*

Introduction

The orthodontic specialist is always searching for techniques to speed up tooth movement because more and more adult patients are visiting the orthodontic clinic [1]. For more than a century, different types of surgical procedures have been documented to alter the alveolar housing and tooth mobility. However, the field of conventional orthodontic tooth movement procedures has been broadened by the spirit of interdisciplinary collaboration in orthodontics. Particulate bone grafting, orthodontic pressures, and selective alveolar corticotomy are all combined in the clinical process known as periodontal accelerated osteogenic orthodontics (PAOO). 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 [2]. Over the time the supra-apical connecting osteotomy cuts used by Köle were replaced with corticotomy cuts.

There are several psychological, biological and clinical differences between the orthodontic treatment of adults and adolescents. Adults are more concerned about the duration of the treatment, aesthetics of face and teeth and type of appliance to be applied. Growth is an almost insignificant factor in adults compared to children, and there is increasing chance that hyalinization will occur during treatment [3]. Furthermore, compared to children, adults have significantly slower cell mobilization and collagen fiber conversion. Lastly, because adult patients' teeth are contained in non-flexible alveolar bone, they are more likely to get periodontal problems [4]. Adult orthodontic

treatment is unique and difficult because of these factors, which also call for unique ideas and techniques like the use of invisible appliances, shorter treatment durations, the application of lighter forces, and more accurate tooth movements. Many restrictions in adult orthodontic treatment were addressed with the advent of corticotomy-assisted orthodontic treatment (CAOT). Periodontists are playing a bigger and bigger part in the PAOO. The periodontist must be knowledgeable about the biology of the surgery in order to satisfy the patient's needs, assisting the orthodontist in achieving more rapid and consistent outcomes.

Periodontally accelerated osteogenic orthodontics (PAOO) technique is a combination of a selective decortications facilitated orthodontic technique and alveolar augmentation [4].

This approach is said to offer a number of benefits. Reduced treatment duration, improved expansion, differential tooth movement, improved traction of impacted teeth, and, lastly, higher post-orthodontic stability are some of these. By using this method, teeth can be moved two to three times farther in one-third to one-fourth the time needed for typical orthodontic therapy, and one is no longer dependent on the alveolar volume that already exists. The aim of this review article is to elaborate historical background, technique, indications, contraindications, complications and side-effects of this therapy.

History

The first corticotomy-facilitated tooth movement was described by Bryan in 1893 in the textbook "Orthodontia: Or Malposition of the Human Teeth, Its Prevention and Remedy". 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]. It was thought that the cortical plates of bone were the primary obstacle to tooth movement, and orthodontics might be finished considerably faster as compare to it is usually anticipated by breaking the continuity of the cortical plates. Rapid tooth movement was noted by Wilcko., *et al*. (2001) [4] in their surface computed tomographic (CT) scan assessment of patients who had undergone selective decortication. It was caused by a temporary localized demineralization remineralization process in the bony alveolar housing rather than bony block migration. Düker in 1975 [6] examined the effects of fast tooth movement with corticotomy on the viability of the teeth and the marginal periodontium in beagle dogs using Kole's fundamental approach. The health of the periodontium was preserved by avoiding the marginal crest bone during corticotomy cuts. It was concluded that neither the pulp nor the periodontium was damaged following orthodontic tooth movement after corticotomy surgery. Several reports indicated that this technique is safe, effective, extremely predictable, associated with less root resorption and reduced treatment time, and can reduce the need for orthognathic surgery in certain situations [4]. RAP was first described by Frost in 1983 [7], although this phenomenon has been familiar to many histomor-phometrists since 1966. Frost [7] noted that the original injury somehow accelerated the normal regional healing processes. This acceleration is the regional acceleratory phenomenon. RAP usually occurs after a fracture, arthrodesis, osteotomy, or bone-grafting procedure, and may involve recruitment and activation of precursor cells necessary for wound healing concentrated at the site of injury. Reduced regional bone density and increased bone turnover are the two primary characteristics of RAP in bone healing, and they are thought to promote orthodontic tooth movement.

Technique

The surgical technique for PAOO consists of 5 steps viz. raising of flap, decortication, particulate grafting, closure and orthodontic force application.

Flap design

The flap in PAOO should also allow enough access to the alveolar bone, which is where corticotomies are to be carried out. Maintaining the gingival shape is also necessary for a healthy aesthetic appearance. The fundamental flap design combines a split-thickness dissection in the apical sections with a full-thickness flap in the most coronal aspect of the flap [8]. In order to avoid the need for vertical releasing incisions, the flap should be stretched beyond the corticotomy sites distally and mesially. The labial and palatal portions of the maxillary

central incisors should retain the papilla between them for aesthetic reasons. "Tunneling" from the distal aspect allows access to the labial alveolar bone in this region.

Decoronation

The process of removing the cortical section of the alveolar bone is known as decortication. It should not, however, produce moveable bone segments; rather, it should be sufficient to start the RAP reaction. Following flap elevation, low-speed round burs are used under local anesthetic to decorticate the bone next to the misaligned teeth. By performing decortication at clinical areas without going through the cancellous bone, the PAOO method reduces the possibility of harming underlying tissues including the mandibular canal and maxillary sinus. A piezoelectric knife can also be used to perform the corticotomies [9].

Particulate grafting

Following decortication, deproteinized bovine bone, autogenous bone, decalcified freeze-dried bone allograft, or a combination of these materials are most frequently utilized for grafting [8]. The majority of sites that have had corticotomies are used for grafting. The anticipated direction and magnitude of tooth movement, the alveolar bone's thickness prior to treatment, and the requirement for labial support by the alveolar bone all influence the amount of graft material used. Usually, 0.25 to 0.5 milliliters of graft material are utilized for each tooth.

Closure techniques

Non-resorbable interrupted sutures should be used to seal the flap without applying too much tension. There is no need for packing. Typically, the sutures are left in place for a period of one to two weeks [8].

Timing of orthodontic treatment

The week before to the surgical portion of PAOO, the orthodontic brackets are usually placed and the arch wires are activated. However, the absence of fixed orthodontic appliances may make suturing and flap manipulation simpler if sophisticated mucogingival treatments are added to PAOO surgery. An immediate, strong orthodontic force can be given to the teeth following flap relocation; in all circumstances, the start of orthodontic force should not be postponed for longer than two weeks following surgery. A larger delay will not fully use the short time frame during which the RAP is taking place. There is a temporal restriction on the orthodontist's ability to achieve faster tooth movement [8].

Indications [10]

1. Crossbites and tooth size-arch length discrepancies.
2. PAOO can be used as an alternative to orthognathic surgery in some cases.
3. Moderate to severe malocclusions like severe bimaxillary protrusion, Class I malocclusions with moderate to severe crowding, Class II malocclusions requiring expansion or extraction and cleft lip palate cases.
4. Uprighting of tipped molars and intrusion of supraerupted molars.
5. To facilitate eruption of impacted tooth at a faster rate.

Contraindications [10]

1. Active periodontal disease.
2. As an alternative for surgically assisted palatal expansion in the treatment of severe posterior crossbite.
3. Should not be attempted in cases where the bimaxillary protrusion is accompanied with a gummy smile, which might benefit more from segmental osteotomy.

4. Severe skeletal class III - prognathic mandible.
5. Uncontrolled over-all systemic disease with past or current history of prolonged medication (Bisphosphonates, NSAIDs and Steroids) intake.

Complications and side effects

There have been multiple reports of negative effects on the periodontium following corticotomy, despite PAOO being a less invasive procedure than osteotomy-assisted orthodontics or surgically assisted rapid expansion. These effects range from no problems to slight interdental bone loss and loss of attached gingiva to periodontal defects observed in some cases with short interdental distance [11,12]. Subcutaneous hematomas of the face and the neck have been reported after intensive corticotomies [13]. In addition, some post-operative swelling and pain is expected for several days. There was no documented impact on the viability of the tooth pulps in the corticotomy area [13]. The literature has not assessed pulpal vitality following fast movement over an extended period of time. The reduced treatment duration of PAOO may reduce the risk of root resorption. Ren., *et al*. [14] reported rapid tooth movement after corticotomy in beagles without any associated root resorption or irreversible pulp injury. Long-term effect of PAOO on root resorption requires further study.

Discussion

The development of an effort to design an alveolar bone's "optimal response" to an applied "optimal force" over the past 20 years has advanced both the directly into the realm of surgical dentofacial orthopaedics from the orthodontic and periodontal specializations. Corticotomy assisted orthodontics (PAOO), as opposed to standard orthodontics, has been crucial in getting the intended outcome faster.

Repairing preexisting alveolar dehiscences and reducing the risk of future dehiscence formation can be achieved by increasing the posttreatment alveolar volume and covering important root surfaces. In order to speed up tooth movement in adult patients, the effectiveness, efficiency, and efficacy of corticotomy-facilitated orthodontics were assessed by Mathews and Kokich [15]. They concluded that the effectiveness of this procedure was questioned because of the following reasons:

1. RAP had a limited duration;
2. PAOO required additional surgery and was associated with significant expense; and
3. There was insufficient evidence-that is, no randomized controlled trials supporting a reduction in orthodontic treatment time had been published to date. A recent histological study showed that selective alveolar decortication induced increased turnover of alveolar spongiosa.

A recent histological study showed that selective alveolar decortication induced increased turnover of alveolar spongiosa [16]. Because less time spent in fixed appliances reduces patient "burnout" and significantly shortens the time available for relatively benign commensal bacterial biofilms to undergo qualitative changes and transform into a destructive cytotoxic potential, which is frequently observed when fixed appliances have been on the teeth for more than two to three years, the ability to move the teeth more quickly, which results in shorter treatment times, is undoubtedly beneficial to the patient's periodontal health. The significance of the increase of the rate of tooth movement, however, pales in comparison to the fact that the teeth can be moved two to three times further than would be possible with traditional orthodontics alone, and that the cases can be completed with an increased alveolar bone volume [17]. Repairing preexisting alveolar dehiscences over root prominences and reducing the chance of fresh dehiscence formation-which may contribute to gingival recession-are two benefits of increasing the posttreatment alveolar volume and covering important root surfaces.

Conclusion

The PAOO approach can be an appealing treatment option and a "win-win" scenario for the patient, periodontist, and orthodontist as more teenagers and adults seek orthodontic treatment. From an aesthetic standpoint, the PAOO procedure is genuinely *in vivo* tissue engineering since it treats face features in addition to teeth alignment. We can now more frequently address the aesthetics of the entire lower face by combining orthodontic therapy with in-office periodontal surgery. After mastering the many updated diagnostic and treatment parameters needed for the PAOO approach, the orthodontist can provide their patients with a potent new treatment alternative. 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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