Content available at: https://www.ipinnovative.com/open-access-journals

IP International Journal of Periodontology and Implantology

Journal homepage: https://www.ijpi.in/

Review Article

Periodontally accelerated osteogenic orthodontics: A narrative review

Amal El-Aouame[1], Kenza Khamlich[1,*], El Quars Farid[1]

[1] *Faculty of Dental Medicine, Casablanca Hassan II University, Casablanca, Morocco*

ARTICLE INFO

Article history:
Received 04-04-2023
Accepted 12-06-2023
Available online 29-06-2023

Keywords:
PAOO
Orthodontic movement
Accelerating orthodontic movement

ABSTRACT

The orthodontic patient has evolved in recent years, leaving an important place for adult patients. These patients most often require special management, they are demanding aesthetic orthodontic treatments, but also shorter. The acceleration of orthodontic movement has long been sought for its multiple potential contributions, including the reduction of treatment time, a reduction of side effects linked to the maintenance of orthodontic equipment in the oral cavity (such as bacterial plaque retention, root resorption, and the open spaces of the gingival embrasure), an improved tooth movement envelope, differential tooth movement, and improved stability after treatment. Numerous surgical techniques have been developed to speed up orthodontic movements. The aim of this study was to review the current literature regarding the periodontally accelerated osteogenic orthodontics technique.

1. Introduction

In 1989, the orthopaedist Frost noticed a phenomenon of Activation-Differentiation-Reorganization after a surgical attack of long bones near the surgical site. This cascade of scar events is named by Frost regional activation phenomenon (PAR) or Regional Accelerated Phenomenon (RAP).[1] RAP is characterized by: an increased cell turnover, a decrease in bone density, a link between surgical trauma, intensity healing and proximity to the surgical site, a transient and reversible nature of the phenomenon.[1] Several animal studies also confirm the presence of PAR after corticotomies. Sebaoun, et al. find, three weeks post corticotomies, a tripling of osteoblastic and osteoclastic activities, associated with a decrease in bone density near the surgical site. At 11 weeks, a return to normalcy is observed. The authors describe this phenomenon as a "localized space-time opportunity window".[2]

The PAOO technique was introduced by the Wilcko brothers (a periodontist and orthodontist), and has become a relevant therapeutic approach in the field of surgical orthodontics for induction of faster dental movement.[3] PAOO is the combination of 2 procedures, alveolar shelling and periodontal augmentation, and has been proposed to facilitate rapid dental orthodontic movement. It differs from previous techniques by the additional stage of alveolar bone grafting. It has been suggested that this technique may be responsible for an increase in the amount of postoperative alveolar bone, which prevents relapse.[4] Compared to traditional orthodontic treatment, this approach has the advantage of being faster, amplifying dental displacement and providing greater alveolar volume for increased post-operative stability with reduced side effects.[5]

Thus PAOO technique involves induced and controlled surgical damage that accelerates the bone metabolic mechanism to help the orthodontic displacement, resulting in a treatment 2 to 3 times faster than the conventional orthodontic technique.[6] The aim of this study was to review the current literature covering the periodontally accelerated

* *Corresponding author.*
E-mail address: kenza.khamlich94@gmail.com (K. Khamlich).

https://doi.org/10.18231/j.ijpi.2023.013

osteogenic orthodontics technique.

2. Orthodontic Bone Remodeling

The physiological process of activation-resorption (catabolic) or activation-formation (anabolic) on bone surfaces, which produces three-dimensional changes in shape, size, or circumstance, is known as bone modeling.[7] On the other hand, bone remodeling or renewal is a local physiological process that starts with bone resorption and ends with the replacement of the old bone with a new bone, using a renewal sequence that uses osteoclasts, osteoblasts, and osteocytes.[8] Bone remodeling affects the rate of orthodontic motion even though, under physiological conditions, it only renews the internal bone content without altering the size or shape of the bone.[9] Orthodontic displacement is influenced by two processes: bone remodeling and bone modeling. Bone resorption at the periodontal bone-ligament (PDL) interface is the limiting factor in dental motion velocity. Bone modeling during orthodontic motion is an inflammatory process.[10] The initial step in the orthodontic dental movement appears to be the activation of osteoblasts by mechanical orthodontic forces, inflammatory stimuli, or hypoxia. Specific mediators of osteoclastic formation and early bone resorption are triggered by activated osteoblasts.[11] The cellular actions of osteoclasts, osteoblasts, and osteocytes regulate both physiological processes. In the process of bone modeling, osteoclasts carry out bone resorption while osteoblasts carry out bone formation. Basic multicellular units, which are organized osteoclasts and osteoblasts, carry out the resorption-formation sequence of the bone remodeling process.[11] The rates of bone modeling and remodeling are regulated by biochemical and mechanical factors. According to earlier research, orthodontic treatment promotes alveolar bone modeling and bone remodeling that is similar to the regional accelerator phenomenon (RAP), which is characterized by an increase in the quantity and activity of osteoclasts and osteoblasts.[11] Most animal studies have shown that the main biological mechanism underlying the acceleration of orthodontic motion is the phenomenon of regional acceleration (RAP). RAP was defined as a physiological event and reorganization activity that happened close to the site of the lesion and caused a localized decrease in bone density in healthy tissue.[12]

3. The Periodontally Accelerated Osteogenic Orthodontics (Paoo) Technique

It involves combining periodontal and orthodontic care, which includes surgical alveolar decortication, bone grafting, and orthodontic treatment. The achieved results lead to a reduction in the length of orthodontic treatment while also improving periodontal health over the long term.[13]

For the first time, L. C. Bryan (1892) treated malocclusion cases using a corticotomy; subsequently, Heinrich Kole reintroduced this method to treat malocclusion. Wilcko et al. recently recommended orthodontic therapy, grafting, and selective alveolar dehiscing. They created the term "PAOO." According to the authors, PAOO surgery can treat orthodontic cases in 6 to 8 months, which is significantly less time than traditional orthodontic treatment.[14] The purpose of this intervention is to ensure adequate periodontal support in the prevention and aggravation of the risks of dehiscence and fenestration. In addition, this bone graft would provide an expanded alveolar base guaranteeing a wider envelope of orthodontic movements. Finally, greater stability of treatment would be achieved. The Wilcko brothers question the mechanical theory of “bone blocks” and highlight a new biological theory.[15] This technique offers better stability after treatment and less recidive. The prognosis of malocclusion can be improved to consider new therapeutic options and thus avoid orthognathic surgery and extractions in some cases. It provides rapid removal of impacted teeth such as canines that have the highest prevalence of inclusion. It was also noted that the patient profile can be improved.[14] However, it may be contraindicated in the case of fine mandibular cortical, patients at risk of active periodontal disease or gingival recession. Some malocclusions constitute a limit to this technique: A posterior cross joint associated with a brachymaxilla, cases of biprotrusion with a gummy smile.[14]

4. The Surgical Technique

In order to fully expose the surgical field and release tissue tension, PAOO surgery is performed under local anesthesia. A full-thickness mucoperiosteal flap is lifted at the interdental papillae on the oral aspect (from the first premolar to the first controlateral premolar), and two vertical release incisions are placed one tooth beyond the bone activation region.[16] After that, a split-thickness flap is slowly raised between 3 and 4 mm apical. In the coronal and apical regions, two segments of periosteal flaps are produced as a result. A corticotomy is done after the flap is reflected. More specifically, horizontal grooves (2 to 3 mm beyond the root ends) are connected to vertical alveolar shelling (2 to 3 mm below the crest of the alveolar bone) in the interradicular space. A collagen membrane is then used to increase the stability of the grafted material after deproteinized bovine bone material has been lightly pressed into the prepared area. The grafted material and collagen membrane must then be completely covered by the flap tissue, which must then be coronally advanced and positioned at the cement-enamel junction.[16] Individual absorbent interrupted sutures that connect the lingual tissue, the labial flap, and the membrane are then used to finish the procedure.[16]

According to Wilcko et al., bone graft material should be applied to the decortication sites and is typically made up of a mixture of bovine bone (xenograft) and either mineralized freeze-dried bone allograft (FDBA) or demineralized freeze-dried bone allograft (DFDBA); ideally, DFDBA should make up at least 50% of the volume of the mixture.[17] The patient is seen every two weeks for orthodontic adjustments following graft placement. It is advised that the surgical procedure be carried out a week after the placement of the fixed orthodontic appliance and that the appliance be in use when the surgery is done.[17]

The success of this technique depends on the practitioner. Because complex osteotomies are often performed at anatomically or technically difficult sites, it requires surgical expertise to ensure the safety of nearby structures. In periodontal surgery, the mucosa, gingiva, and roots of the teeth are vulnerable to damage.[17]

5. Discussion

According to Han et al in their study, PAOO could improve a quantity of periodontal hard and soft tissues in patients with class III skeletal malocclusion with insufficient amount of soft tissue, including gingival thickness and keratinized gingival width. They used a digital 3D model based on the combination of digital intraoral scanning and CBCT data to digitally measure gingival thickness with high precision and reliability.[18] In the same light, and despite the limits of the study, Chen et al have obtained results showing that the PAOO technique is beneficial to periodontal conditions in terms of increased soft and hard tissue. PAOO can be a safe and effective treatment for orthodontic patients with bone dehiscence and fenestration. This is no longer an intervention limit in patients with weakened periodontitis.[16]

The surgical techniques examined and described in the article of Keser et al. all accelerate orthodontic movement at different speeds. It was not possible for the authors to clearly compare the time savings obtained by these different techniques because of the weakness of the available data. Some of the described techniques are gaining popularity (Micro-osteoperforations MOPs, piezocision), while others (canine rapid retraction, corticision) are no longer popular, due to limited applications, patient discomfort, or the invasivity of the technique. Piezocision and PAOO have the advantage of grafting during surgery, improving hard and soft tissue and preventing periodontal defects that may occur due to thin alveolar bone. Piezocision, MOD and corticision are flapless approaches and are less invasive than PAOO. The use of Mallet in corticision is traumatic for the patient.[19] MODs seem to be the least invasive technique. PAOO seems to be the most invasive one. The use of the piezoelectric knife seems to have a greater effect on bone metabolism and creates a greater response compared to other techniques. The depth of the injury created has a direct impact on the phenomenon of the RAP. Therefore, it plays a very important role in the effectiveness of the approaches.[19]

However, Amit G et al report that PAOO can cause adverse effects on the periodontal after corticotomy, such as bone and gingival resorption, periodontal defects observed in cases with a short interdental distance. In addition, the post-operating effects can be present for several days: oedema, pain, subcutaneous hematomas of the face and neck were also reported after intensive corticotomies. No effect on pulp vitality of teeth adjacent to the corticotomy site was reported.[20]

The prospective cohort study conducted by et al revealed that on the first post-operative day, the patient experiences high levels of pain and discomfort, with moderate to severe levels of swelling and difficulty in chewing, which reduces jaw movement. However, patient satisfaction with the PAOO procedure was high; the level of pain decreased statistically significantly after one week of surgery. The ability to extrapolate results may be limited, as it included patients with specific malocclusion with a particular age group. More controlled cohort studies of different cases of malocclusion are preferable to generalize results.[21]

According to the scientific evidence presented in the systematic review of Alsino et al, PAOO has been effective in reducing the duration of orthodontic treatment. The evidence was extracted from several studies with different levels of risk of bias, This indicates the need for more high-quality randomized controlled clinical trials on the efficacy of PAOO compared to the accelerated conventional orthodontic method or accelerated treatments using other methods.[22] The systematic review of Vannala et al, also raised the importance of randomized tests in humans to confirm the benefits of this procedure and evaluate its long-term clinical decline.[23]

6. Conclusion

The literature has covered the PAOO technique in great detail. In fact, this method enables a demanding adult patient to shorten the length of orthodontic treatment. This strategy should not be used, though, unless there are clear indications of its advantages, which should always outweigh any possible risks.

7. Conflict of Interest

None.

8. Source of Funding

None.

References

1. Frost HM. The biology of fracture healing. An overview for clinicians. Part I. *Clin Orthop Relat Res*. 1989;(248):283–93.
2. Sebaoun JD, Kantarci A, Turner JW. Modeling of trabecular bone and lamina dura following selective alveolar decortication in rats. *J Periodontol*. 2008;79(9):1679–88. doi:10.1902/jop.2008.080024.

3. Wilcko WM, Wilcko MT. Accelerating tooth movement: The case for corticotomy-induced orthodontics. *Am J Orthod Dentofacial Orthop*. 2013;144(1):4–12. doi:10.1016/j.ajodo.2013.04.009.
4. Sebaoun JD, Kantarci A, Turner JW. Modeling of trabecular bone and lamina dura following selective alveolar decortication in rats. *J Periodontol*. 2008;79(9):1679–88. doi:10.1902/jop.2008.080024.
5. Wilcko MT, Wilcko WM, Pulver JJ, Bissada NF, Bouquot JE. Accelerated osteogenic orthodontics technique: a 1-stage surgically facilitated rapid orthodontic technique with alveolar augmentation. *J Oral Maxillofac Surg*. 2009;67(10):149–59. doi:10.1016/j.joms.2009.04.095.
6. Adusumilli S, Yalamanchi L, Yalamanchili PS. Periodontally accelerated osteogenic orthodontics: An interdisciplinary approach for faster orthodontic therapy. *J Pharm Bioallied Sci*. 2014;6(Suppl 1):2–5. doi:10.4103/0975-7406.137244.
7. Frost HM. Skeletal structural adaptations to mechanical usage (SATMU): 1. Redefining Wolff's law: the bone modeling problem. *Anat Rec*. 1990;226(4):403–13. doi:10.1002/ar.1092260402.
8. Hattner R, Epker BN, Frost HM. Suggested sequential mode of control of changes in cell behaviour in adult bone remodelling. *Nature*. 1965;206(983):489–90. doi:10.1038/206489a0.
9. Verna C, Dalstra M, Melsen B. The rate and the type of orthodon- tic tooth movement is influenced by bone turnover in a rat model. *Eur J Orthod*. 2000;22(4):343–52. doi:10.1093/ejo/22.4.343.
10. Roberts WE, Huja S, Roberts JA. Bone modeling: biomechanics, molecular mechanisms, and clinical perspectives. *Semin Orthod*. 2004;10(2):123–61.
11. Seeman E. Bone modeling and remodeling. *Crit Rev Eukaryot Gene Expr*. 2009;19(3):219–33.
12. Hassan AH, Al-Saeed SH, Al-Maghlouth B, Bahammam MA, Linjawi AI, El-Bialy TH, et al. Corticotomy-assisted orthodontic treatment. A systematic review of the biological basis and clinical effectiveness. *Saudi Med J*. 2015;36(7):794–801. doi:10.15537/smj.2015.7.12437.
13. Hassan AH, Fraidi AA. Corticotomy assisted orthodontic treatment. *Open Dent J*. 2010;4:159–64. doi:10.2174/1874210601004010159.
14. Venkataramana V, Anilkumar K, Manchala SR, and RSS. Periodontal Accelerated Osteogenic Orthodontics Technique for Rapid Orthodontic Tooth Movement: A Systematic Review. *J Pahram Bioallied Sci*. 2019;11(2):97–106.
15. Wilcko MT, Wilcko WM, Bissada NF. An Evidence Based Analysis of Periodontally Accelerated Orthodontic and Osteogenic Techniques: A Synthesis of Scientific Perspectives. *Semin Orthod*. 2008;14(4):305–6.
16. Chen Z, Zhou H, Zhang K. The clinical efficacy of periodontally accelerated osteogenic orthodontics in patients with bone fenestration and dehiscence: a retrospective study. *Head Face Med*. 2022;18:40. doi:10.1186/s13005-022-00344-z.
17. Wilcko MT, Ferguson DJ, Makki L, Wilcko WM. Keratinized gingiva height increases after alveolar corticotomy and augmentation bone grafting. *J Periodontol*. 2015;86(10):1107–15. doi:10.1902/jop.2015.150074.
18. Han Y, Miao L, Liu J. Periodontal soft tissue increase induced by periodontally accelerated osteogenic orthodontics surgery. *BMC Oral Health*. 2022;22:506. doi:10.1186/s12903-022-02566-8.
19. Keser E, Naini FB. Accelerated orthodontic tooth movement: surgical techniques and the regional acceleratory phenomenon. *Maxillofac Plast Reconstr Surg*. 2022;44(1). doi:10.1186/s40902-021-00331-5.
20. Amit G, Jps K, Pankaj B, Suchinder S, Parul B. Periodontally accelerated osteogenic orthodontics (PAOO) - a review. *J Clin Exp Dent*. 2012;4(5):e292–6. doi:10.4317/jced.50822.
21. Alsino HI, Hajeer MY, Alkhouri I, Murad RMT, Khattab TZ. Evaluation of the Levels of Pain, Discomfort, Functional Impairments and Satisfaction With the Periodontally Accelerated Osteogenic Orthodontics (PAOO) When Leveling and Aligning Crowded Teeth: A Prospective Cohort Study. *Cureus*. 2022;14(2):e22623. doi:10.7759/cureus.22623.
22. Alsino HI, Hajeer MY, Burhan AS, Alkhouri I, Darwich K. The Effectiveness of Periodontally Accelerated Osteogenic Orthodontics (PAOO) in Accelerating Tooth Movement and Supporting Alveolar Bone Thickness During Orthodontic Treatment: A Systematic Review. *Cureus*. 2022;14(5):e24985. doi:10.7759/cureus.24985.
23. Vannala V, Katta A, Reddy MS, Shetty SR, Shetty RM, Khazi SS. Periodontal Accelerated Osteogenic Orthodontics Technique for Rapid Orthodontic Tooth Movement: A Systematic Review. *J Pharm Bioallied Sci*. 2019;11(Suppl 2):S97–106. doi:10.4103/JPBS.JPBS_298_18.

Author biography

Amal El-Aouame, Professor

Kenza Khamlich, Resident https://orcid.org/0000-0002-3332-1236

El Quars Farid, Professor and HOD

Cite this article: El-Aouame A, Khamlich K, Farid EQ. Periodontally accelerated osteogenic orthodontics: A narrative review. *IP Int J Periodontol Implantol* 2023;8(2):61-64.