

## REVIEW ARTICLE

# Periodontally-Accelerated Osteogenic Orthodontics

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## Abstract

Nowadays an increasing number of adults are seeking orthodontic treatment in order to improve self-confidence. However, orthodontic treatment takes a long period of time, accelerating tooth movements are one of the major concerns of nowadays orthodontics. Periodontally-accelerated osteogenic orthodontics combines selective decortication and alveolar augmentation. This procedure is based on the regional acceleratory phenomenon, which allows rapid tooth movements based on the bone healing pattern. Periodontally-accelerated osteogenic orthodontics reduces the treatment 3 to 4 times when compared to conventional orthodontics. This technique results in increased alveolar width, post-treatment stability, and decreased the amount of apical root resorption. Alveolar augmentation allows maintaining the bone support to the root surfaces, and providing more intact periodontium. The purpose of this article is to review the periodontally-accelerated osteogenic orthodontic procedure.

**Keywords:** Periodontally accelerated osteogenic orthodontics, corticotomy, regional acceleratory phenomenon.

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## Introduction

Dental and facial aesthetics is one of the most important characteristics of physical attractiveness and it has been proven that malocclusion hurts social and psychological well-being<sup>1,2</sup>. Comparing adolescents and adults who come for orthodontic treatment, adults' social and emotional quality of life is more affected by malocclusion<sup>3</sup>. For this reason, there is an increasing number of adults seeking orthodontic treatment. Studies show that patients who receive orthodontic treatment have a higher score of health-related quality of life, as well as increasing psychosocial factors, such as self-esteem and self-confidence<sup>1,4</sup>. Oral related quality of life is strongly associated with teeth alignment. Typically, well-aligned teeth after orthodontic treatment raise the quality of life. However, orthodontic treatment of adults compared to children is more challenging due to several factors: periodontal problems, tooth wear, higher frequency of temporomandibular disorder, and absence of growth<sup>5</sup>. Usually, orthodontic treatment takes 2-3 years<sup>6</sup>. A long duration of treatment is among the greatest

concerns people have about orthodontics. Also, wearing fixed orthodontic appliances for such a long time results in a higher risk of caries, enamel wear, pulpal reactions, root resorptions, and gingival inflammation<sup>7,8</sup>. Shortening the treatment time and accelerating tooth movements are the most desired purpose of nowadays orthodontics. One approach for decreasing orthodontic treatment time is periodontally-accelerated osteogenic orthodontics.

## History

Surgical interventions that affect tooth movements have since the 1800s. Corticotomy-facilitated tooth movements were first introduced by L. C. Bryan in 1893<sup>9</sup>. Heinrich Kole's publication in 1959 was the first to introduce modern corticotomy procedures<sup>10</sup>. The technique involves full thickness flaps that expose buccal and lingual bone, and the vertical cuts are then made through the cortical bone and almost penetrating the medullary bone. Vertical cuts connected by horizontal osteotomy cuts created bone blocks that involve one or more teeth. Kole used orthodontic forces to move the

blocks of bone rather than individual teeth. The most rapid tooth movements were reported in 6 to 12 weeks. Kole did not report any of the complications of this technique<sup>10</sup>. Today, most of the corticotomy-assisted orthodontic treatments are based on modifications of Kole's technique. In 2001, Wilcko and colleagues presented a new method called periodontally-accelerated osteogenic orthodontics or accelerated osteogenic orthodontics<sup>11</sup>. These authors combined selective decortication and alveolar augmentation in one procedure.

### **Rapid Tooth Movements and Regional Acceleratory Phenomenon**

Kole believed that tooth movements are increased by moving 'blocks of bone' connected only by medullar bone<sup>10</sup>. However, after radiographic analysis, Wilcko and colleagues discovered that the rapid tooth movements were the result of the demineralization/remineralization phenomenon<sup>11</sup>. They showed that the remaining collagenous soft tissue matrix could be moved with the root surfaces, which they describe as 'bone matrix transportation' rather than 'bony block transportation'<sup>12</sup>. Selective decortication induces the scarring of alveolar bone, which increases tissue turnover this process is called the regional acceleratory phenomenon (RAP). Frost introduced RAP in 1983<sup>13</sup>. Decorticating of the alveolar bone accelerates the normal healing process, known as the regional acceleratory phenomenon. The regional acceleratory phenomenon is described as a local response to selective decorticating of the alveolar bone that creates a stimulus, by which the tissue regenerates quicker than usual<sup>14</sup>. The phenomenon initiates the activity of osteoblasts and osteoclasts and local inflammatory mediators, which allows a quicker healing process compared with the physiological healing process. The total regional acceleratory phenomenon usually takes about 4 months in human bone, and the peak is reached at 1-2 months<sup>12,15,16</sup>. In a case of five rats with selective alveolar bone, decortication showed an increased remodeling of alveolar bone adjacent to the decortication site. Anabolic modeling was 1.5-times higher at 3 weeks in the test group adjacent to decortication site comparing to control group<sup>17</sup>.

The regional acceleratory phenomenon includes decreased bone density or localized osteopenia and increased bone turnover, which accelerates tooth movements. Osteopenia is a reversible condition, that results in rapid tooth movements. Decreased bone density is important because the tooth is moved through trabecular bone. Pham-Nguyen et al.; investigated 28 rats, in which selective decortication buccal and palatal were performed in a split-mouth design, and the tooth movements were initiated by a 25g Sentalloy spring which was secured to a microscrew. Micro-computed tomography was used to evaluate structures of the bone. These authors reported that that bone density in the test group was significantly lower than in the control group. This study showed that tooth movements were prolonged due to the osteopenic effect created by the decortication<sup>18</sup>.

### **Periodontally- Accelerated Osteogenic Orthodontics**

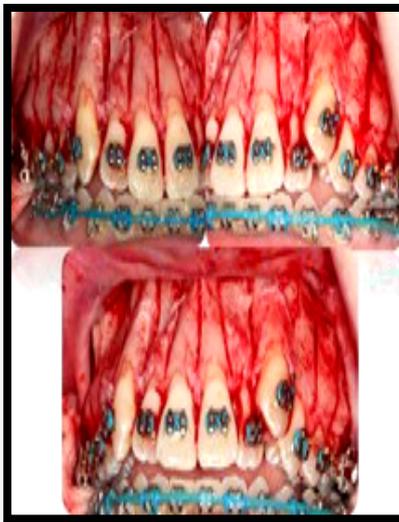
The periodontally-accelerated osteogenic orthodontic technique was first described in 2001 by Wilcko and colleagues in two case reports, the authors demonstrated 3 to 4-times greater tooth movements than with conventional treatment. Both patients presented with a Class I (from moderate to severe) crowding malocclusion. In these cases, following full-thickness flap reflection, selective decorticating or bone activation was performed around all the teeth in both buccal and lingual sides. These vertical cuts were connected by horizontal cuts beyond the apices. Perforations were made in the cortical layer to enlarge the penetration of the marrow. Bone augmentation using demineralized freeze-dried bone allograft was performed. Orthodontic forces were applied after 2 weeks. The total treatment time from bracketing to debracketing in both cases were 6 months and 2 weeks<sup>11</sup>. There were no complications reported as a loss of tooth vitality and a significant reduction in the radiographic height of the alveolar bone. Both patients were satisfied by esthetic outcomes<sup>11</sup>. Below we describe the surgical steps of the periodontally-accelerated osteogenic orthodontic technique<sup>19</sup>. Usually, orthodontic brackets are placed 1 week before the surgery<sup>20</sup>. First, the full-thickness flap is elevated. A split-thickness dissection is performed to ensure the mobility of the flap.

Next split-thickness dissection is done, and the periosteum is elevated to expose alveolar bone surface (Pic. A)<sup>20</sup>. The following step is decortication, which is made in the alveolar bone using high-speed hand-piece or implant drill. Vertical corticotomies are placed in the interradicular space 3mm beyond the crestal level and extend about 2mm beyond the apices of the roots. Vertical corticotomies are connected by circular corticotomies. If the alveolar bone has a thickness >1-2 mm, perforations are made in the alveolar bone. The purpose of the decortication is not to create movable bone blocks and initiate the regional acceleratory phenomenon (Pic. B)<sup>20</sup>. Decorticating sites are grafted by deproteinized bovine bone, autogenous bone, or decalcified

freeze-dried bone allograft. Grafting material is usually wet in bacteriostatic water solution (clindamycin phosphate or minocycline)<sup>16,19,21</sup>. It is important not to place an excessive amount of bone graft, which might interfere with flap placement. Recession in the teeth can be treated with connective tissue graft or dermal matrix allograft (Pic. C, in this case, mineralized particulate allograft was mixed with minocycline and a resorbable collagen membrane was placed over the bone graft). The final step is suturing: gingival flaps closure should be closed without excessive tension. Non-resorbable sutures are typically used for suturing (Pic. C)<sup>20</sup>. Orthodontic forces should be started within 2 weeks after the surgery<sup>20</sup>.



(Pic. A)<sup>20</sup>



(Pic. B)<sup>20</sup>



(Pic. C)<sup>20</sup>

## Discussion & Conclusion

Periodontally-accelerated osteogenic orthodontic is a combination of corticotomy surgery and alveolar augmentation. The efficiency of these techniques have been shown in Class I moderate and severe crowding, Class II for expansions, post-extraction space closure, and mild Class III malocclusions. However, periodontally-accelerated osteogenic orthodontic approaches require the co-operation of the surgeon and orthodontist to ensure a successful outcome<sup>20</sup>. This is a sensitive procedure and requires an experienced and well-trained surgeon. There are many advantages related to PAOO, including increased bone thickness, reduced treatment time and improved

post-treatment stability. The average treatment time for the periodontally-accelerated osteogenic orthodontics is one-third or one-fourth of traditional orthodontics typically conventional orthodontics takes 2-3 years<sup>6,22</sup>. Wilcko et al; reported an average of 6 months of treatment with the periodontally-accelerated osteogenic orthodontic technique<sup>11,12,15,16</sup>. Also, Wilcko and colleagues reported that space closure after tooth extraction - that usually prolongs the orthodontic treatment time- is achieved within 3 to 4 weeks when using the periodontally-accelerated osteogenic orthodontics gap closure method<sup>15</sup>. At part of her Master's thesis study, Hajji evaluated mandibular arch de-crowding by comparing conventional non-extraction, extraction and

corticotomy facilitated non-extraction orthodontic therapies. The mean time of the corticotomy assisted orthodontic treatment was 6.1 months compared with 18.7 for non-extraction and 26.6 months for extraction therapies. These studies demonstrate that treatment time is reduced by 3 or 4 times in comparison with conventional treatment<sup>23</sup>. This increases patient satisfaction and also reduces the risks of caries, enamel wear, and root resorption. Ferguson and colleagues showed that corticotomy-assisted orthodontic treatment takes 2.7 times less when compared to traditional non-extraction orthodontics<sup>24</sup>. Apical root resorption is one of the most common complications resulting from orthodontic treatment. Sanjijeh et al; in work done on five foxhounds in a split-mouth experimental study, showed that tooth movements were significantly accelerated after corticotomy, peaking at 22-25days. Apical root resorption is significantly reduced when compared to conventional orthodontics<sup>25</sup>. Selective decortication produces localized osteoporosis when mineralized bone content is temporarily decreased this allows rapid tooth movements without significant apical tooth resorption. Ferguson et al; evaluated two groups of 27 people one group underwent conventional non-extraction orthodontic treatment, and the test group underwent corticotomy surgery. These authors found 1.1mm greater apical root resorption in conventional treatment when compared to the corticotomy group<sup>26</sup>.

Periodontal augmentation using bone grafts improves the thickness of the alveolar bone, and Ferguson and colleagues have shown that on cephalometric analysis point A<sup>26</sup>. Using autologous bone materials, fenestrations can be covered, and the formation of dehiscences can be minimized. Wilcko et al; showed at the re-entry of periodontally-accelerated osteogenic orthodontics sites after 7.5 years, fenestrations and dehiscences are filled with new bone after. An increase of the bone volume not only covers the bony defects, but also decreased the need for extraction, and increased intact periodontium<sup>16</sup>. However, complications, such as incorporated autologous bone grafts, have been reported. At re-entry, after approximately 15 months, the particles of allograft were not incorporated in the buccal bone<sup>11</sup>. However, although most

cases are completed in 6 to 8 months, a combination of selective alveolar decortication with alveolar augmentation and orthodontic treatment increase the price, which might be unacceptable for many patients<sup>11,12,15,16,26</sup>. Orthodontic adjustments are made at about 2-week intervals until the treatment is completed, whereas conventional treatment orthodontic appointments are at 6- to 8-week<sup>20</sup>. Orthodontic treatment is one of the main factors for the prevalence of gingival recession. The risk of recession is greatly increased after dental arch expansion, which is mandatory due to dental crowding<sup>27,28</sup>. Periodontally-accelerated osteogenic orthodontics includes alveolar augmentation, which increases alveolar bone volume and strengthens the intact periodontium after dental arch expansion. Also, root surface remains covered by bone. This technique is effective to ensure post-treatment root and bone stability, decreasing the prevalence of gingival recessions. In addition, pre-existing recessions can be treated by connective tissue graft or dermal matrix allograft<sup>11,12,15,16,19,26</sup>.

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