



ISSN: 0975-833X

Available online at <http://www.journalcra.com>

International Journal of Current Research
Vol. 11, Issue, 03, pp.1999-2002, March, 2019

DOI: <https://doi.org/10.24941/ijcr.34542.03.2019>

INTERNATIONAL JOURNAL
OF CURRENT RESEARCH

REVIEW ARTICLE

PERIODONTALLY ACCELERATED OSTEOGENIC ORTHODONTIC AN ORTHODONTIC PERIODONTAL INTERFACE: A REVIEW

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ARTICLE INFO

Article History:

Received 03rd December, 2018
Received in revised form
26th January, 2019
Accepted 11th February, 2019
Published online 31st March, 2019

Key Words:

Wilcodontics, Alveolar corticotomies, PAOO, Orthodontic tooth movement.

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Citation: Dr. Anuradha Khakre, Dr. Monica Mahajani, Dr. Chandrahas et al., 2019. "Periodontally accelerated osteogenic orthodontic an orthodontic periodontal interface: A review", *International Journal of Current Research*, 11, (03), 1999-2002.

ABSTRACT

Periodontally accelerated osteogenic orthodontics (PAOO) or Wilcodontics is a clinical procedure that combines selective alveolar corticotomy, particulate bone grafting and the application of orthodontic forces. Wilcodontics has solved the dilemma of rapid orthodontic movement by exploiting the dynamics of bone physiology and redirecting the emphasis in tooth movement to the manner in which the supporting bone responds to accelerate the tooth movement the orthodontists and the periodontists together have worked out a success formula which is termed Periodontally Accelerated Osteogenic Orthodontics (PAOO) or wilcodontics. Theoretically this procedure is based on the healing property of bone known as (RAP) regional acceleratory phenomenon. This procedure involves the surgical demineralization of the cortical bone (corticotomy) thereby decreasing the resistance offered by the cortical bone of the teeth to the orthodontic force applied and use of particulate bone grafting. This method not only enhances the width of the alveolar bone but also decreases the duration of the treatment and chances of apical root resorption. It also increases the stability of the treatment by reducing the chances of relapse. A proper case selection, careful surgical procedure and accurate orthodontic movements are important for the success of wilcodontics orthodontic forces.

INTRODUCTION

Periodontally Accelerated Osteogenic Orthodontics (PAOO) or Wilcodontics is otherwise called corticotomy facilitated osteogenic orthodontics. This clinical procedure combines selective alveolar corticotomy, particulate bone grafting and the application of orthodontic forces (Wilcko et al., 2001). Orthodontic treatment, in addition to its benefits, has also associated risks and complications. Periodontal health is an important factor that may be used to evaluate the success of orthodontic therapy. Periodontal complications are reported to be one of the most common side-effects linked to orthodontics (Krishnan et al., 2007). Aligned teeth are easier to clean, and perhaps correct occlusion may promote healthier periodontium. Orthodontic and periodontics specialities have always worked miracles in treating patients together. Periodontal regenerative treatment like tissue engineering, create rapid orthodontic tooth movements (Little, 1996). Synergistic treatment between specialist helps in developing harmony that results in less damage to components of periodontium, the soft tissue around crown and the attachment apparatus that connects the root to bone. So, specialists worked together in a technique called wilcodontics that allows teeth to be moved 2-3 times further in 1/3rd to 1/4th the time required for traditional orthodontic treatment (Wilcko et al., 2008).

This is based theoretically on the healing pattern of bone known as regional acceleratory phenomenon (RAP) (Pham-Nguyen, 2006). Wilcodontics results in the following: a) An increase in width of alveolar bone, (Twaddle et al., 2002) b) Shorter treatment time, (Hajji, 2001) c) Greater post treatment stability, (Nazarov et al., 2004) d) Decreased apical root resorption. (Machado et al., 2002). The purpose of this review is to highlight the orthodontics and periodontics interface in clinical practice for optimized treatment outcomes.

Histological background: Surgically assisted orthodontic tooth movement has been used since the 1800's. In 1893, Cunningham presented "Luxation, or the immediate method in the treatment of irregular teeth" at the International Dental Congress in Chicago. Corticotomy facilitated tooth movement was first described by LC Bryan in 1893 published in the textbook by SH Guilford. It was Henrich Kole's publication in 1959, however that set the stage for evolution of corticotomy facilitated orthodontics (Köle, 1959). Kole believed that it was the continuity and thickness of the denser layer of cortical bone that offered the most resistance to tooth movement. He theorized that by disrupting the continuity of this cortical layer of bone, he was actually creating and moving blocks of bone in which teeth were embedded. He postulated this theory as "bony block movement" (Kole, 1959).

But because of invasive nature of Kole's technique, it was never widely accepted (Kole, 1959). In the early 1960s; craniofacial surgeons began using DO techniques to rapidly expand palates in growing patients. Generson *et al* in 1978 revised Kole's technique with a one stage corticotomy without the supraapical osteotomy (Mostafa *et al.*, 2009). In 1980s, Harold Frost; a distinguished orthopedist realized that there was a direct correlation between the degree of injuring a bone and the intensity of its healing response. He called this the Rapid Acceleratory Phenomenon (RAP). (Frost, 1983) Dr. Thomas Wilcko (Periodontist) and William Wilcko (Orthodontist), of Erie, PA in 1995 further modified the corticotomy assisted orthodontic technique with the addition of alveolar augmentation and named the procedure as Periodontally Accelerated Osteogenic Orthodontics (PAOO) (Wilcko *et al.*, 2008). later patented as "Wilckodontics" based on the emerging concepts of Wilcko brothers. In May 1998 the AOOTM procedure was introduced at the 98th Annual Session of the American society of Orthodontists. Hajji SS (2000) reported that the active orthodontic treatment period in patients with corticotomies were 3 to 4 times more rapid compared with patients without corticotomies. According to his research, average orthodontic time was 6.1 months for non-extraction PAOO and 18.7 and 26.6 months for non-extraction and extraction therapies without PAOO. In 2001, Wilcko *et al.* (2003) reported a revised rapid orthodontic corticotomy-facilitated technique that included periodontal alveolar augmentation; which demonstrated acceleration of orthodontic treatment to one third of the usual time (Hajji *et al.*, 2009). Wilcko *et al.* (2003) mentioned, in cases of rapid orthodontics with corticotomies, that corticotomies could increase tooth movement by increasing bone turn over and decreasing bone density (Wilcko *et al.*, 2003).



Dr. William wilcko



Dr. Thomas wilcko

Biomechanics of Wilcodontics: Regional Acceleratory Phenomenon (RAP) Herald Frost collectively mentioned the events in physiologic healing and called it as "The Regional acceleratory phenomenon" (RAP)(14). He was the first to find that surgical wounding of osseous tissues resulted in tissue stimuli adjacent to the site of the injury, which results in faster than normal regional regeneration and remodeling process (Frost, 1983). RAP causes bone to heal 10-50 times faster. Following surgical injury in human long bone, RAP begins within a few hours, maximum action is usually reached in 1-2 months and usually may take 6-24 months to complete (Frost, 1983). Application of orthodontic force can stimulate or trigger mild RAP activity. RAP can be maximized when selective decortication is combined with tooth movement. Wilcko brothers (2001) revised the bony block technique and attempted two cases of crowding with selective decortication. To sum up, surgically assisted periodontally driven orthodontic treatment is a combination of bone regeneration (somatic cell therapy) and gene therapy (alteration of gene expression). Tissue engineering principles and periodontal regeneration in PAOO, is an entirely new technology in dentofacial orthopedics, to obtain a steady state tissue response to accomplish orthodontic tissue movements rapidly.

Patient Selection Criteria: Proper patient selection is crucial for the success of the procedure. Both the orthodontist and the periodontist should agree upon the need for corticotomy, treatment plan and the extent and location of the decortication cuts (Kim *et al.*, 2009).

- This procedure has been shown to be particularly effective in treating moderate to severe crowding, in Class II malocclusions requiring expansion or extractions, and mild Class III malocclusions.
- As long as healthy periodontium is present,
- PAOO can be done at any age (from 11 years to 77 years of age)¹.

Following cases are not considered for this technique

- Patient having active periodontal disease is not a candidate for PAOO.
- PAOO should not be considered in patients having dental bone loss, root damage or poor roots (Mathews and Kokich, 1997).
- Patients having Rheumatoid Arthritis which requires regular doses of NSAIDs may not be a good candidate for PAOO (Kole, 1959).
- PAOO should not be used in cases where bimaxillary protrusion is accompanied with a gummy smile. Segmental osteotomy is a preferred choice
- Should not be considered as an alternative for surgically assisted palatal expansion in treatment of severe crossbite.
- Class III condition in which lower jaw is too long relative to the rest of face and the chin has many physical constrains which make them unsuitable for PAOO (Lee *et al.*, 2007).

Surgical Technique

Flap design: Full access to the surgical site is the ideal requisite of flap design. Mesial and distal extension is decided and vertical releasing incisions are avoided. Gingival collars

are preserved on both palatal and buccal gingiva. Full thickness flap is elevated towards the coronal aspect and partial thickness towards the apical portion to avoid tension at the time of closure. The ideal design should allow full accessibility to the corticotomy site, provide full coverage for graft material and enhance aesthetics wherever required (Murphy *et al.*, 2009).

Decortication: Corticotomies are done in mid interdental areas, using no 2 carbide bur which are connected with circular cuts. Corticotomies should be performed on both labial and palatal aspects of alveolar bone. No mobile segments of bone should be created to initiate RAP. Instruments used are commonly hand piece or a piezosurgical knife. Care should be taken on all anatomic structures and one has to follow all general principles of surgery (Murphy *et al.*, 2009).

Bone grafts: Commonly de-proteinized bovine bone, decalcified free-dried bone allograft and autogenous bone grafts are used solely or in combination within or with platelet concentrations such as platelet rich plasma in corticotomy areas. Around 0.25 to 0.5 ml of graft material is required per teeth. Barrier membrane use is usually discouraged (Murphy *et al.*, 2009).

Modifications in grafting: In certain cases due to thin gingival biotype as well as thin cortical plate of bone, exposure of root surface can be seen in some cases. In such cases use of autogenous soft grafts such as connective tissue grafting (gold standard) can be included under full thickness flap. Connective tissue graft can be harvested from palate. Platelet rich plasma, platelet rich fibrin, and growth factors can also be included under the flap along with bone grafts to increase the stability of the graft (Murphy *et al.*, 2009).

Primary closure: For predictable bone augmentation, flap should be closed without excessive tension. Flap is usually sutured at the mid line in the interproximal areas followed by other areas. Suture material of choice is non resorbable sutures. Suture removal is carried out usually in 7-14 days postoperatively. Periodontal pack is not usually preferred.

Computed Tomographic Scan (Wilcko *et al.*, 2009): A composite shows the dentoalveolar defecting that has been filled with new bone. Wilcko *et al.* (2009) explained a comparison of the pre-treatment and post-treatment surface computed tomographic scans of the lower arch. They concluded that the bone grafting has eliminated the Dentoalveolar deficiency and increased thickness of cortex, which will provide an increased stability after orthodontic treatment.

Patient management: The time taken for surgery may vary according to the individual cases. Complicated bimaxillary cases may take several hours which may demand sedation of the patient. Antibiotics, analgesics and NSAIDs can be given for patient comfort and clinical healing enhancement. NSAIDs should not be given for long term as they are considered to be interfering with RAP. Narcotic pain killers can be prescribed for a week. Common post-surgical complications include pain, edema and ecchymosis. Ice packs can be applied for suppressing swelling. Chlorhexidine mouthwash can also be prescribed.

Orthodontic adjustments after PAOO surgery: Orthodontist adjust the braces every 2 weeks, after complete recovery from surgical procedure. Completion can take 3-9 months depending up on the case. A retainer will have to be used for at least 6 months. According to the patient selection a metal or ceramic bracket can be used.

Benefits of Wilckodontics

- Rapid tooth movement, Lesser treatment time and lesser relapse than conventional orthodontics
- More bone to support teeth and less periodontal problems around teeth
- Less root resorption, less furcation invasion, less chances of gingival recession and subsequent cervical abrasion following orthodontic treatment and no effect on the vitality of the pulps of the teeth in the area of corticotomy was reported.
- There is less need for appliances and headgear (depending on the case)
- Adverse effects to the periodontium after corticotomy, ranging from no problems to slight interdental bone loss and loss of attached gingiva, to periodontal defects observed in some cases with short interdental distance. Other side effects include:
- It is a mildly invasive surgical procedure. Patient may experience some pain, swelling, and the possibility of infection.
- Some form of anesthesia must be used.
- Patients who take NSAIDs on regular basis or have some chronic health problems cannot be treated with this technique.
- It does not lend itself to Class III malocclusion cases

Modifications in the Pao technique: One of the drawbacks faced in the technique is the exposure of the root surfaces in some areas which can be due to the thin gingival biotype as well as thin cortical plate of bone. Hence, the usage of autogenous soft tissue graft such as connective tissue grafting which is still considered to be the gold standard among all other soft tissue grafting techniques can be included under the full thickness flap reflected. The graft can be harvested from the keratinized palatal side. Platelet rich plasma, platelet rich fibrin, and growth factors can also be included under the flap. The usage of platelet rich fibrin increases the stability of the graft.

A study conducted by Sebaoun and coworkers on 36 healthy adult rats showed an increased turnover of alveolar spongiosa was seen after alveolar decortication which is likely to be the biology underlying rapid tooth movement after selective alveolar decortication. 2 cases of decrowding were reported by Wilcko and coworkers which demonstrated selective alveolar decortication, bone augmentation and orthodontic treatment. Rapid tooth movement was achieved in both cases without any significant apical root resorption. The authors suggested that the regional acceleratory phenomenon to be responsible for the tooth movement in these patients. Recently, the application of piezoelectric decortication in 187 labial or lingual PAOO of maxillary and mandibular anterior teeth were evaluated. It was shown that there were significantly less alveolar fenestration and bony dehiscence after the ultrasonic decortications were performed.

Novel approaches in PAOO

Lasers: Flapless corticotomy assisted by lasers reduces treatment time and damage to the periodontium, as this is a non-invasive procedure. Orthodontic tooth movement is enhanced by cortical bone layer reduction. Erbium, Chromium doped Yttrium Scandium Gallium Garnet (ErCr: YSGG) laser irradiation, without surgical flap reflection (Seifi *et al.*, 2012). Are commonly used lasers.

Piezo-electrics: Dibart *et al.* (2009) described the tunneling approach using piezoelectric bone cuts to solve a mild crowding case within 17 weeks. Here several vertical incisions are placed on the attached gingiva using piezoelectric vertical corticotomies. Bone graft were placed using tunneling approach (Dibart *et al.*, 2009).

Monocortical tooth dislocation and ligament distraction (MTDLD) technique: two different dental movements work simultaneously and separately on opposite root surface in MTDLD technique. Using a piezosurgical micro saw, vertical and horizontal microsurgical corticotomies are performed around each tooth root to eliminate cortical bone resistance, on the root surface corresponding to the direction of movement. Rapid dislocation of the root and cortical bone is produced by immediate application of strong biomechanical forces. The dislocation force produces rapid distraction of periodontal ligament fibers on the root surface opposite to the direction of movement (Tomaso Vercellotti, 2007).

Micro-Osteoperforations (Mop): To further reduce the invasive nature of surgical irritation of bone, a device called Propel, was introduced by Propel Orthodontics. They called this process as Alveocentesis, which literally translates to puncturing bone (Shenava *et al.*, 2014).

Conclusion

A successful treatment by Wilckodontics or PAOO technique can be achieved by proper coordination between the orthodontist, periodontist, oral & maxillofacial surgeon and proper case selection. Conventional orthodontic treatment typically takes between 18-24 months, the relatively new procedure wilckodontics takes only 3-9 months without compromising the treatment quality. Periodontal accelerated osteogenic orthodontic has shown increased in alveolar bone thickness due to the inclusion of bone grafts, significantly reduces treatment time, better post orthodontic stability and incidence of root resorption is decreased compared to the conventional orthodontic treatment. However, long term treatment outcome of PAOO is still unavailable as the technique is still relatively new.

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