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WILCKODONTICS:A QUICK CORRECTION OF CROWDING BY WILCKO BROTHERS.A REVIEW

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ABSTRACT

The systematic interdisciplinary treatment approach is shared by several dental specialties especially periodontics. In the present era where a lot of people are seeking orthodontic treatment, the multidisciplinary treatment approach for quick and better results cannot be overlooked. Also, orthodontic treatment frequently results in undesirable periodontal changes since the teeth are confined to the nonflexible alveolar bone. To accelerate the tooth movement the orthodontists and the periodontists together have worked out a successful formula which is termed Periodontally Accelerated Osteogenic Orthodontics (PAOO) or this method has been suggested to enhance tooth movement and, consequently, reduces orthodontic treatment time as a whole. 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, reducing the chances of relapse. A proper case selection, careful surgical procedure, and accurate orthodontic movements are important for the success of wilckodontics. Thus, this article attempts to review the historical perspective of these therapeutic approaches, discusses the biological reasons underlying its use, mentions its main indications and contraindications and its modifications. Keywords: Periodontics, orthodontic tooth movement, periodontally Accelerated Osteogenic Orthodontics

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1. INTRODUCTION

'Wilckodontics', also known as Periodontally Accelerated Osteogenic Orthodontics (PAOO) or Alveolar Osteogenic Orthodontics, is a relatively new treatment in the dental realm. It is a clinical procedure that combines selective alveolar corticotomy, particulate bone grafting and the application of orthodontic forces. Basically it is a combination of selective decortication facilitated orthodontic technique and alveolar augmentation.¹ This technique allows teeth to be moved 2-3 times further in 1/3rd to 1/4th the time required for traditional orthodontic treatment. This procedure is theoretically based on the bone healing pattern known as the regional acceleratory phenomenon (RAP).² This procedure increases the alveolar volume and enhances the periodontium, enhances the stability of orthodontic treatment outcome, increases the scope of treating malocclusion otherwise treated by orthognathic surgery and decreases the active orthodontic time over three folds thus augmenting facial and gingival esthetics.³

II. HISTORICAL REVIEW

In 1950's Russian orthopedic surgeon Dr. Gabriel Ilizarov perfected the technique of Distraction Osteogenesis (DO) – growth of new bone by means of surgically "distracting" the bone. Corticotomy facilitated tooth movement was first described by L.C. Bryan in 1893 published in a textbook by S. H. Guilford.⁴ As early as the 1950s, periodontists began using a corticotomy technique to increase the rate of tooth movement. In 1959, Henrich Kole was the first to describe modern day corticotomy assisted orthodontics. 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.⁵ 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 supra-apical osteotomy.⁶ 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).² 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)⁷ 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. According to Hajji SS (2000) 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 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.⁸ Wilcko et al mentioned, in cases of rapid orthodontics with corticotomies, that corticotomies could increase tooth movement by increasing bone turn over and decreasing bone density.⁹

III. BIOLOGICAL RATIONALE

Rapid tooth movement was thought to be due to the movement of bony blocks of bone after decortication. Regional acceleratory phenomenon was developed by Frost and Jee in 1983.² The clinical technique involves selective alveolar decortications of bone, a form of periodontal tissue engineering that results in an increased turnover of alveolar spongiosa with areas of alveolar demineralization.¹⁰ This results in osteopenia, where its mineral content temporarily

decreased which enables teeth to be moved more rapidly and further through the collagenous soft tissue matrix of the bone^{11, 12}. Shih and Norrdin¹¹ demonstrated that when intraoral cortical bone was injured by corticotomy, RAP accelerated the normal regional healing processes by transient bursts of hard and soft-tissue remodelling. Conceptually, increase in tissue turnover begins within a few days of injury, typically peaks at 1–2 months, usually lasts 4 months in bone and may take 6 to more than 24 months to subside.^{1, 10} Osteopenia is a condition that favours rapid tooth movement. When RAP dissipates, the osteopenia disappears and the radiographic image of normal spongiosa reappears.¹²

IV. PRINCIPLE OF PAOO

Following surgical wounding of cortical bone, RAP potentiates tissue reorganization and healing by way of a transient burst of localized hard and soft tissue remodeling.¹¹ This is an intensified bone response (increased osteoclastic and osteoblastic activity, and increased levels of local and systemic inflammation markers) in areas around cuts that extend to the marrow. The duration of RAP depends on the type of tissue, and usually lasts about 4 months in human bone. This phenomenon causes bone healing to occur 10–50 times faster than normal bone turnover.¹² Surgical injury causes transient osteopenia in alveolar bone (i.e., a temporal and reversible decrease in bone mineral density).^{13,14} This reduces the biomechanical resistance and enables rapid tooth movement through trabecular bone. This phase of transient osteopenia can be prolonged with loading orthodontic application. This is why it is essential to adjust the orthodontic appliance every 2 weeks.¹⁵

V. BIOMECHANICS OF PAOO PROCEDURE

Heinrich Krole in 1959 reported that decortications would lead to movement of bone blocks leading ultimately to rapid tooth movement.⁹ The RAP is a local response of

tissues to noxious stimuli by which tissue regenerates faster than normal in a regional regeneration/remodeling process. The decortication of bone results in an increased turnover of alveolar spongiosa with areas of alveolar demineralization. This results in osteopenia, where its mineral content temporarily decreased which enables teeth to be moved more rapidly and further through the collagenous soft tissue matrix of the bone.¹² Following the completion of orthodontic treatment, remineralization takes place resulting in greater stability in the orthodontic treatment outcome. 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. Application of orthodontic force can stimulate or trigger mild RAP activity. RAP can be maximized when selective decortication is combined with tooth movement. 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.¹²

The healing phases of RAP have been studied in the rat tibia. There is an initial stage of woven bone formation, which begins in the periosteal area and then extends to medullary bone, reaching its maximal thickness on day seven. This cortical bridge of woven bone is a fundamental component of RAP, providing mechanical stability of bone after injury. From day seven, the woven bone in the cortical area begins to undergo remodeling to lamellar bone, but woven bone in the medullary area undergoes resorption, which means transitory local osteopenia. It seems that medullary bone needs to be reorganized and rebuilt after

establishment of the new structure of cortical bone, and to adapt to the reestablishment of cortical integrity (three weeks in rats). There is also a systemic acceleratory phenomenon (SAP) of osteogenesis due to systemic release of humoral factors.¹³

VI. INDICATIONS

- a. Resolve crowding and shorten treatment time.
- b. Accelerate canine retraction after premolar extraction
- c. Enhance post orthodontic stability
- d. Facilitate eruption of impacted teeth
- e. Facilitate slow orthodontic expansion
- f. Molar intrusion and open bite correction

VII. CONTRAINDICATIONS

- a. Patients with severe active periodontal disease.
- b. Patients with inadequately treated endodontic problems.
- c. Patients on long term medications which will slow down bone metabolism, such as bisphosphonate and NSAIDs. NSAIDs lead to prostaglandin inhibition resulting in reduced osteoclastic activity thus disturbing bone remodeling.
- d. Patients on long term steroid therapy due to the presence of devitalized areas of bone.

VIII. 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.¹⁶ 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:

1. Patient having active periodontal disease is not a candidate for PAOO.
2. PAOO should not be considered in patients having dental bone loss, root damage or poor roots.¹⁷

3. Patients having Rheumatoid Arthritis which requires regular doses of NSAIDs may not be a good candidate for PAOO.⁵

4. PAOO should not be used in cases where bi-maxillary protrusion is accompanied with a gummy smile. Segmental osteotomy is a preferred choice.

5. Should not be considered as an alternative for surgically assisted palatal expansion in treatment of severe crossbite.

6. Class III condition in which lower jaw is too long relative to the rest of face and the chin has many physical constraints which make them unsuitable for PAOO.¹⁸

IX. STEPS IN PAOO

Orthodontic appliances are placed one week prior to the surgery. Crevicular incision is made buccally and lingually extending at least two to three teeth beyond the area to be treated. Full thickness flap is reflected on both buccal and lingual aspects beyond the apices of the teeth if possible. Any interdental papillary tissue remaining interproximally should be left in place. Selective decortications can be performed on both buccal and lingual sides. Vertical corticotomy cuts are made between the roots using a diamond round bur. Bone graft materials are then placed over the decorticated areas. The mucoperiosteal flap is then sutured with interrupted sutures. Suture removal after 2 weeks.¹⁹

X. SURGICAL TECHNIQUE

1) 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.

2) Decortication: Corticotomies²⁰ 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.

3) 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.

4) 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 autogeneous 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.

5) 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.

6) 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 complication include pain, edema and ecchymosis. Ice packs can be applied for suppressing swelling. Chlorhexidine mouthwash can also be prescribed.

7) 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.²¹

8) Modification of CAO procedure:

A) Compression osteogenesis (CO): Procedures like molar intrusion may be designated with CO instead of CAO (corticotomy accelerated osteogenesis), as the medullary bone and overlying mucosa supports the tooth bone block. The CO concept is similar to CAO concept, but uses corticotomy instead of corticotomy. CAO causes movement of teeth in the weakened alveolar bone but CO causes movement of bone block along with teeth. Kanno et al, used CO procedure to treat severe open bite case and obtained desired results in 6 months by moving the upper posterior bone tooth segments 7mm in a posterior direction and using anchor plates and elastics after 3 weeks of surgery.²²

B) Alveolar corticotomies (ACS): The incision must pierce the cortical layer and should penetrate minimally into bone marrow, in ACS. Thus ACS is defined as a surgical intervention limited to the cortical portion of the alveolar bone. In osteotomies, considerable amount of both cortical and trabecular bone material is removed.

XI. CLINICAL APPLICATIONS^{1, 3, 4, 7, 23}

1. Facilitate eruption of impacted teeth
2. Facilitate slow orthodontic expansion
3. Accelerate retraction of canine after premolar extraction

- 4.Resolve crowding and shorten treatment time.
- 5.Enhance stability after orthodontic treatment
- 6.Open bite correction and molar intrusion
- 7.Manipulation of anchorage

XI.BENEFITS OF WILCKODONTICS

- 1.Rapid tooth movement, Lesser treatment time and lesser relapse than conventional orthodontics
- 2.More bone to support teeth and less periodontal problems around teeth
- 3.No hospital visit and less cost as with orthognathic surgery²⁴
- 4.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. ²⁵
- 5.After PAOO, there is more bone to support teeth and no change in facial profile
- 6.There is less need for appliances and headgear (depending on the case)
- 7.Both metal and ceramic brackets can be used
- 8.It can be used with temporary anchorage devices (TADs) to aid in tooth movement.
- 9.Use as a part of biologic orthodontic therapy.
- 10.Complications and Side Effects.
- 11.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.²⁴
- 12.Subcutaneous hematomas of the face and the neck in some cases.²⁵

XIII.ADVANTAGES¹⁹

- 1.Reduced time of the treatment to one-third the time of conventional orthodontics.
- 2.Due to decreased resistance of cortical bone there is less root resorption
- 3.More bone support due to the addition of bone graft.

- 4.Frequency of relapse reported to be very low.
- 5.Extra-oral appliances and headgear are not very necessary
- 6.Good patient outcomes

XIV.DISADVANTAGES¹⁹

- 1.Expensive procedure due to surgical intervention
- 2.Crestal bone loss and recession may occur post surgically.
- 3.Post surgical complications like pain, swelling and infection are common.

XV.NOVEL APPROACHES FOR PAOO LASERS

Laser assisted flapless corticotomy is a useful non - invasive procedure for reducing treatment time and damage to periodontium. It enhances the orthodontic tooth movement by reducing the cortical bone layer (resistant to bone resorption relative to spongy bone) following Erbium, Chromium doped Yttrium Scandium Gallium Garnet (Er-Cr: YSGG) laser irradiation, without surgical flap reflection.²⁶

XVI.MONOCORTICAL TOOTH DISLOCATION AND LIGAMENT DISTRACTION (MTDLD) TECHNIQUE

The MTDLD technique combines two different dental movements that work separately but simultaneously on opposite root surfaces. On the root surface corresponding to the direction of movement, vertical and horizontal microsurgical corticotomies are performed around each tooth root with a piezosurgical microsaw to eliminate cortical bone resistance. The immediate application of strong biomechanical forces produces rapid dislocation of the root and the cortical bone together. On the root surface opposite the direction of movement, the dislocation force produces rapid distraction of ligament fibers. During the osteogenic process that follows, application of normal orthodontic biomechanics achieves the final tooth movement.²⁷ The greatest amount of dental movement occurs in

approximately the first 30% of total treatment time with the MTDLD technique.²⁸

VII.COMPLICATIONS AND SIDE EFFECTS

Subcutaneous hematomas of the face and the neck have been reported after intensive corticotomies.²⁹ In addition, some post-operative swelling and pain is expected for several days. No effect on the vitality of the pulps of the teeth in the area of corticotomy was reported. Long-term research on pulpal vitality after rapid movement has not been evaluated in the literature. In an animal study, Liou et al.³⁰ demonstrated normal pulp vitality after rapid tooth movement at a rate of 1.2 mm per week. However, pulp vitality deserves additional investigation. It is generally accepted that some root resorption is expected with any orthodontic tooth movement. An association between increased root resorption and duration of the applied force was reported.^{31,32} The reduced treatment duration of PAOO may reduce the risk of root resorption. Ren et al.³³ reported rapid tooth movement after corticotomy in beagles without any associated root resorption or irreversible pulp injury. Moon et al.³⁴ reported safe and sufficient maxillary molar intrusion (3.0 mm intrusion in two months) using corticotomy combined with a skeletal anchorage system with no root resorption. Long-term effect of PAOO on root resorption requires further study.

VIII.SUMMARY AND 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. This technique puts orthodontics on a fast track by incorporating the changes in the structure of surrounding bone to accompany the repositioning of the teeth. Considering the increasing demand of adult orthodontics patients to decrease their treatment time, this technique will lead to an increase in the number of patients accessing to orthodontic treatment. This technique requires utilization of numerous modified diagnostic and

treatment parameters, but once these are mastered, this is a powerful new treatment option for the patients.

Wilckodontics effects and mechanism are confirmed by recent well designed histological studies. However, long term treatment outcome of Wilckodontics is still unavailable as this technique is still relatively new. More clinical research is needed to determine the optimal and long term effects of this technique.

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