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Review Article

Walking Ahead and Walking Faster with Wilckodontics: A Review of Literature

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Abstract

The major concern of any patient undergoing orthodontic procedure is duration of the treatment. Therefore any technique or intervention which can bring down the duration of the treatment will create a positive attitude towards the orthodontic specialty. Wilckodontics also called as periodontal accelerated osteogenic orthodontics is a novel technique which is used for accelerated orthodontic tooth movement. It is a patented technique and is based on concepts of Wilcko brothers. In this technique surgical corticotomy of the alveolar bone is done to reduce the resistance of the cortical bone during orthodontic movement of the teeth. As for any procedure success depends on the proper case selection, proper treatment planning and execution of the treatment plan. This article talk about the applicability, evaluation of Wilckodontics, biomechanics, case selection, treatment planning, surgical technique and its future.

Keywords: Wilckodontics; Regional Acceleratory Phenomenon; Corticotomy; Bone Augmentation

Introduction

Orthodontics is a specialized branch of dentistry which mainly deals with movement of teeth for esthetic and functional reasons. This involves both mineralized and non mineralized tissues - gingiva, alveolar bone, periodontal ligament and cementum. Out of this alveolar bone is most mineralized tissue which cannot be malleable easily. It has own dynamicity and is the rate controlling factor for orthodontic tooth movement.

The trend of patients seeking orthodontic treatment has changed over the past decade. Now more and more adult patients who have completed growth are consulting for orthodontic problems [1]. Correction of malocclusion in adult patients not only brings about esthetic changes but also has positive effects on the periodontium and psychosocial status [2]. Orthodontic treatment for adults is totally a different ball game due to various reasons: 1. Stoppage of dentoalveolar development after adolescence, 2. periodontal hyalinization, 3. Loss of alveolar flexibility, 4. Hypovascularisation of Periodontal ligament (PDL). Various other problems include: 1. Increased treatment time required, 2. Problem of increased chances of root resorptions and other periodontal pathologies following orthodontic treatments. Periodontal problems can be addressed with the help of optimum orthodontic force. Regarding the problem of duration of the treatment very few options are present. It is estimated that average treatment duration for an adult patient requires about 18.7 to 30 months depending on the severity of the malocclusion [3,4]. This time duration is significantly higher than growing adolescent. Disadvantages of increased treatment duration leads to various complications: gingival inflammation leading to periodontal diseases, root shortening and resorption, psychological disadvantages including esthetics especially for adult patients, problems of patient compliance. Research efforts directed towards development and modification of orthodontic appliances and bracket system has not lead to a significant improvement in respect to treatment duration. Various other attempts to accelerate tooth movements includes use of drugs like Vitamin D, prostaglandin, corticosteroids, use of lasers, direct electric current, electromagnetic field, piezopuncture. Few of these procedures

were effective but had undesired side effects and other had inconsistent results. These factors lead to the shifting of focus more towards surgical techniques which can help in reducing treatment duration. Surgically assisted orthodontic tooth movement is not a recent phenomenon.

In 1893 Bryan was first to describe corticotomy for tooth movement in a textbook. More recently a new concept of periodontally accelerated osteogenic orthodontics has come up. This technique is patented by Dr. Thomas Wilcko (Periodontist) and William Wilcko (Orthodontist) as Wilckodontics. Various terms are used for Wilkodontics which includes: corticotomy facilitated osteogenic orthodontics, accelerated osteogenic orthodontics (PAOO), regional acceleratory phenomenon (RAP), Accelerated orthodontics. This technique involves a synergetic association between two specialities orthodontics and periodontics to bring about rapid tooth movement. This technique is basically based upon the tissue engineering concept of periodontal tissues.

Historical review

The concept of surgically assisted tooth movement is more than 2 century old. Bryan was first to described corticotomy to assist tooth movement in a book called Orthodontia': Malposition of the Human Teeth, Its Prevention and Remedy [5]. Wilckodontics is said to be indirectly based upon the concept of Distraction osteogenesis (DO). DO was first used by Dr. Ilizarov during 1950s to correct and repair defects of arms and legs. He concluded that stressing the bone increases its metabolic activity and cellular generation i.e., leads to bone remodelling. However it was the works of Heinrich Kole's which finally laid the foundation for the subsequent development of decortications facilitated orthodontics. He theorized that the continuous dense cortical bone offers resistance to tooth movement and disrupting the continuity of the cortical bone will offer less resistance to tooth movement. This concept was called as bony block movement [6]. In Kole's procedure interdental cuts were made only through the cortical bone and subapical horizontal cuts were made penetrating the full thickness of alveolus. Due to highly invasive procedure, this technique was not widely accepted. Subsequently many reports of modification of Kole's technique were reported. Many of these had disappointing results especially in space closing procedures.

First experimental study for alveolar corticotomy was published in 1972 by Bell and Levy. Their study was conducted on 49 monkeys. The experiment was a sort of osteotomy rather than corticotomy because the vertical cut was placed through and through leading to complete mobilization of the dento osseous segments [7]. In 1975 Duker and his collegues conducted experiments on beagle dogs. They investigated the affect of corticotomy on the marginal periodontium and tooth vitality. Finally they concluded that preservation of margical crest while performing interdental cuts and it should be 2mm short of the alveolar crest [8]. In 1978 Generson., *et al.* again revised Kole's technique. Their technique consisted of one stage corticotomy without supra-apical osteotomy [9]. Similar modifications were also given later by Anholm., *et al.* (1986) Gantes., *et al.* (1990) and Surya (1991) [10-12].

In 1990s Wilcko brothers Dr. Thomas Wilcko (Periodontist) and William Wilcko (Orthodontist), of Erie, PA using CT (computed tomography) concluded that rapid tooth movement due to corticotomy was due to reduced mineralization of the alveolar bone. In 1995 they further modified the corticotomy technique by addition of alveolar augmentation and named it as PAOO (Periodontally Accelerated Osteogenic Orthodontics) and got it patent [13]. Goldie and King demonstrated enhanced tooth movement in lactating rats with an osteoporosis state with depleted calcium intake hence experimentally approving the PAOO technique [14]. Similarly Bogoch., *et al.* and Sebaoun., *et al.* demonstrated an increase in resorption and apposition near corticotomy sites in rat alveolar spongiosa [15,16].

In 2000 Hajji SS., *et al.* reported that Wilckodontics help in orthodontic movement of tooth more rapidly, tooth movement is 3-4 times faster as compared to conventional technique. The similar finding were reported by Yaffe., *et al*. in 1990 in periodontal literature [17]. Recently in 2008, Wilcko., *et al.* again revised the technique making it as a selective decortication with alveolar augmentation. This was called as AOOTM (accelerated osteogenic orthodontic tooth movement).

Biomechanics of Wilckodontics

Periodontal ligament and alveolar bone are the basic tissue affected during orthodontic tooth movement. These tissues have variety of cells and extracellular substances which causes various cellular and molecular events and create a microenvironment for remodelling in both mineralized and non mineralised tissues [20,21]. The bone turnover is maintained by catabolic and anabolic processes. Catabolic activity is mediated by osteoclasts and anabolic by osteoblasts. In this the catabolic activity of osteoclasts is the rate limiting phase during orthodontic tooth movement.

Historically, the pressure tension theory stated that application of orthodontic force leads to two types of reaction on the tooth. PDL on one side of tooth is compressed leading to local bone resorption. Compression leads to disturbance of blood flow leading to cell death called as hyalinization. This hyalinised tissue is later resorbed by macrophages along with bone resorption by osteoclasts leading to tooth movement. PDL on other side is tensed leading to bone formation by activation of increased blood flow along with increased osteoblastic activity.

It is a controversial topic that formation of hyalinised tissue occur during initial phase or later stages also [22,23]. Present day the OTM is said to be based upon a combination of mechanics and molecular genetic cellular interventions mainly the gene expression of osteoblasts and osteoclasts [24]. Discoveries of OTM related gene mutations which regulate osteoclast mediated bone matrix acidification and osteoblast mediated bone matrix mineralisation support the above concepts. Various studies have proven the molecular genetic cellular concept [25,26].

When corticomoty or osteotomy is done it induces a different type of alveolar bone reactions. When OTM forces are applied on corticotomy, it causes transient bone resorption around the roots which gets replaced by bone in around 60 days whereas osteotomy induced a DO like reaction. The success or the rapid tooth movement after corticotomy in Wilckodontics is possible because of a response of tissues called as Regional Acceleratory Phenomenon. It was first mentioned by Herald Frost as a series of events which occurs during physiologic healing [18,19]. According to this phenomenon surgical wounds results in tissue stimuli near the site of injury leading to faster regional regeneration and remodeling process. Surgical injury in human long bones causes RAP within few hours and maximum action is reached in 1-2 months and takes 6-24 months to complete. It is estimated that RAP causes bone to heal 10-50 times faster. When orthodontic force is applied on teeth, the force causes mild RAP activity on underlying bone. RAP is intensified when decortications is done extending to the marrow which act as anxious stimuli leading to increased osteo plastic- osteoclastic activity and inflammatory markers. The intensity of RAP depends on the size, duration and intensity of the stimulus and type of tissue. RAP act as a physiological emergency mechanism and leads to transient burst of localized remodeling and tissue reorganization [27-29]. All these factors leads to calcium depletion and diminished bone density thereby decreasing the mechanical strength of the bone resulting in rapid tooth movement [30-33]. With use of OTM this phenomenon (RAP) can be prolonged for 3-4 months. Therefore with optimal orthodontic force mainly tensional stress can help in accelerated tooth movement. For orthodontic procedures corticotomy is preferred over osteotomy because it prevents injury to the peridontia, prevent pocket formation, maintain tooth vitality and nutritive function of bone and therefore prevent bone necrosis.

Clinical considerations

Indications

This procedure can be used for various clinical conditions which include:

- Acceleration of routine orthodontic treatments like to facilitate complex orthodontic tooth movements, slow orthodontic expansion, molar intrusion, canine retraction and open bite correction.
- To facilitate the camouflage of moderate to severe skeletal malocclusions and enhance long term post treatment orthodontic stability.

Contraindications

The contraindications for this procedure are

- Patients with severe periodontal disease
- Patients with inadequate endodontic treatment
- Patients who receive long term treatment with medications such as bisphosphanate and NSAIDs, which can slow down bone metabolism.
- Patients on long term steroid therapy.

Case selection and treatment planning

In PAOO, case selection and treatment plan is based on multidisciplinary approach. The orthodontist determines the plan for tooth movement, expansion and contraction of arch segment and anchorage units, whilst periodontal status and esthetic requirements of the patient is determined by periodontist [34]. Orthodontic bracket bonding and activation of arch wire should be performed within two weeks in order to take full advantage of RAP procedure. A long delay will fail to take full advantage of the limited time interval during which RAP takes place. In patient's with Class II malocclusion anchorage must be established before PAOO procedure. Adjustments should be done at 2-week interval, during active orthodontic treatment period to minimize the likelihood of recalcification in middle of treatment. Muco-gingival surgical procedures if required should be performed before bracketing.

PAOO Procedures

Corticotomy-assisted orthodontics is a therapeutic procedure that helps in orthodontic tooth movement by accelerated bone turnover. The treatment can be considered as intermediate therapy between orthognathic surgery and conventional orthodontics [35]. There are several advantages associated with corticotomy when compared to osteotomy. Cortocotomy prevents post-operative tooth devitalization, injury of the periodontium, pocket formation, and shortens time of treatment. The nutritive function of the bone is maintained through primary spongiosa, avoiding the possibility of bone aseptic necrosis [35].

Surgical Technique

- **Flap design:** A good flap design with delicate manipulation of the soft tissue is an ideal requisite for successful surgery. The ideal flap should provide full accessibility to the corticotomy site and full coverage for graft material. Mesial and distal extension are marked 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.
- **Decortication:** Corticotomies [36] are done in interdental areas. Corticotomies should be performed on both labial and palatal aspects of alveolar bone. For initiation of RAP, mobile segments of bone should not be created.
- **Bone grafts:** Commonly allograft and autogenous bone grafts are used solely or in combination with platelet concentrations such as platelet rich fibrin in corticotomy areas. However, in certain cases exposure of root surface can occur due to thin gingival biotype as well as thin cortical plate of bone. In such cases, connective tissue graft which can be harvested from palate can be included under full thickness flap. Growth factors such as platelet rich plasma, platelet rich fibrin, can also be included under the flap along with bone grafts to increases the stability of the graft.
- **Orthodontic adjustments after PAOO surgery:** Adjustment of braces are done every 2 weeks, after complete recovery from surgical procedure and 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 [37].
- **Modification of CAO procedure:** A) Compression osteogenesis (CO): Procedures like molar intrusion may be designated with CO instead of CAO (corticotomy accelerated osteogenesis), as autogenous tooth bone block is supported by medullary bone and overlying
- mucosa. The concept of CO has similar principals to CAO, but with corticotectomy instead of corticotomy. CAO causes movement of teeth in the compromised alveolar bone but CO causes movement of bone block along with teeth.
- **Alveolar Corticotomies (ACS):** ACS is defined as a surgical procedure limited to the cortical portion of the alveolar bone. The incision must penetrate the cortical layer and bone marrow minimally in ACS. In osteotomies, considerable amount of both cortical and trabecular bone material is removed.

Novel approaches for PAOO

Lasers

Laser assisted flapless corticotomy is a useful non-invasive procedure which provides reduction in treatment time and prevents damage to periodontium. It enhances the orthodontic tooth movement by reducing the layer of cortical bone following Erbium, Chromium doped Yttrium Scandium Gallium Garnet (Er-Cr: YSGG) laser irradiation, without surgical flap reflection [38].

Advantages of PAOO Surgery

- Less time than traditional orthodontic procedures,
- Less likelihood of root resorption,
- Less need for appliances and headgear (depending on the case)
- History of relapse is very low

Disadvantages of PAOO Surgery

- Expensive procedure, mildly invasive surgical procedure and like all surgeries, there are post-operative implications such as swelling and possibility of infection.
- Patients who take NSAIDs on a regular basis or have other chronic health problems cannot be treated with this technique. NSAIDs lead to prostaglandin inhibition resulting in reduced osteoclastic activity thus disturbing bone remodeling
- Patients on long term steroid therapy due to the presence of devitalized areas of bone, it does not lend itself to severe class III malocclusion cases.

Monocortical tooth distraction (MTDLD) technique

The MTDLD technique is a combination of two different dental movements that work independently 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 to eliminate cortical bone resistance. The immediate application of extensive biomechanical forces produces dislocation of the root and the cor-

tical bone together. On the surface of root opposite to the direction of movement, dislocation force produces rapid distraction of ligament fibers. During the osteogenic process that follows, application of normal orthodontic biomechanics achieves the final tooth movement [39].

Vercellotti and Podesta., *et al.* have developed a new surgical-orthodontic technique to maximize the rapidity of movement and prevent damage to the periodontal tissues which may may be achieved with a piezosurgical technique that permits microsurgical corticotomy around each root and the immediate application of biomechanical force. This technique avoids involvement of the periodontal tissue fibers, which is necessary in traditional orthodontic movement, thereby preventing periodontal and bone resorption. The greatest amount of dental movement have been seen in first 30% of total treatment time with the MTDLD technique [40,41].

Discussion

Based on the information reviewed on wilckodontics, this article also discusses the recent views and controversies on wilckodontics.

The role of ACS in acceleration of tooth movement

The effects of ACS on the acceleration of tooth movement was documented in rats [42,43], dogs, cats [44] and humans [45,46] based on split mouth study designs. The outcome of these experiments indicated that rate of tooth movement was increased two fold on the corticotomy treated site.

Mechanism of corticotomy produced accelerated tooth movement

Wilcko postulated that the rate of tooth movement is primarily due to localized demineralization-remineralisation processs that occurs in the cancellous bone surrounding the tooth socket and secondarily due to alterations within the periodontal ligament. This was measured and examined using surface computed tomography scan.

Many studies [44,47,48] documenting the histologic and physiologic effects of initial stages of tooth movement have demonstrated that hyalinization of the periodontal ligament occurs on the pressure side. This hyaline formed inhibits bone resorption in the periodontal ligament, hyaline is gradually removed from periodontal ligament by macrophages that differentiate from mesenchymal cells that migrate to that area. This process can take upto four weeks however during this initial period no tooth movement occurs [47]. So, during alveolar corticoytomy, RAP has shown to accelerates the appearance of macrophages that remove hyaline as early as one week after initiation of orthodontic forces [44,47]. This removal of hyaline allows early bone resorption and rapid tooth movement.

Duration of RAP after Corticotomy

Studies [42] comparing the rate of tooth movement showed that rate of tooth movement was greatest at 22-25 days and then reduced. During this three week period, corticotomy facilitated side moved twice than the control side. Similar results were obtained in a study conducted in adults to retract maxillary canines following premolar extractions [49]. Based on the outcome of these studies the length of RAP was four months, after which the rate of tooth movement returns to normal.

Effect of corticotomy on the treatment time for adults:

Many studies [4,44-46,50-53] suggest corticotomy shortens the treatment time. However, one cannot measure treatment time without measuring treatment quality. The American Board of orthodontics has developed a detailed grading system to assess the quality of orthodontic treatment [54].

Role of grafting of alveolus in enhancing orthodontic treatment

Data from previous research [13,45,55] claims that bone grafting enhances the stability of orthodontic treatment results. Some cases report a greater volume of bone in Computed tomographic Scans [55]. In a study, newly formed bone incorporated into native cortical plate was evaluated. The results suggested it as a fibroosseous encapsulation [55]. However major disadvantage of this procedure are the additional cost, invasive nature and morbidity associated with the surgery [45].

Conclusion

Wilckodontics is an alliance of orthodontics collaborating with periodontics on the same osseous platform. The interdisciplinary orthodontic tooth movement can synchronize with tissue engineering principles of periodontal regenerative surgery to create rapid orthodontic movement and overcome its side effects. This has proved to be beneficial in the treatment of clinical situations like decrowding, molar intrusion etc. PAOO is effective in accelerating tooth movement, by reducing orthodontic treatment time. The effect of bone grafting along with corticotomies to accelerate or facilitate dental movements can reduce time of treatment and therefore the unwanted effects associated with prolonged treatments.

However, review of literature has not established significance of the selection of osteotomy or corticotomy although the later has proved to be advantageous. Thus, understanding the biomechanics of bone remodelling may increase the applications of corticotomy facilitated osteogenic orthodontics with or without alveolar augmentation.

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