An Evaluation of Canine Retraction with and without Corticotomy- facilitated Orthodontics

Thesis

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بسم الله الرحمن الرحيم

"ربنا لا تؤاخذنا إن نسينا أو أخطأنا ربنا ولا تحمل علينا

إصرا كما حملته على الذين من قبلنا ربنا ولا تحملنا ما لا

طاقة لنا به واعف عنا و اغفر لنا و ارحمنا أنت مولانا

فانصرنا على القوم الكافرين"

صدق الله العظيم

سورة البقرة

الآية (286)

ABSTRACT

Introduction: The purpose of this study was to clinically evaluate mini-screw implant supported maxillary canine retraction with corticotomy-facilitated orthodontics. **Material and methods:** The sample consisted of thirteen adult patients (5 male, 8 female; mean age 19 years) exhibiting Class II division 1 malocclusion with increased overjet requiring the therapeutic extraction of maxillary first premolars, with subsequent retraction of the maxillary canines. Corticotomy-facilitated orthodontics was randomly assigned to one side of the maxillary arch at the canine-premolar region while the other side served as the control. Using mini-screws as anchorage, canine retraction was instituted via closed nickel-titanium coil springs applying 150 g of force per side. The following variables were examined over a four months follow up period: rate of tooth movement, molar anchorage loss, root resorption, plaque index, gingival index, probing depth, attachment loss and gingival recession. **Results:** The average daily rate of canine retraction was significantly higher on the corticotomy than the control side by 2 times during the first 2 months following the corticotomy surgery. This rate of tooth movement declined to be only 1.6 times higher in the third month and 1.06 times higher by the end of the fourth month. No molar anchorage loss occurred during canine retraction on both operated and non-operated sides. There was no statistically significant difference between pre- and post-operative measurements of plaque index, probing depth, attachment loss and gingival recession. **Conclusions:** Corticotomy-facilitated orthodontics can be a feasible treatment modality for adult patient seeking orthodontic treatment with reduced treatment times.

Key words: Corticotomy, canine retraction, root resorption, periodontal condition, rate of tooth movement.

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Introduction

Reduction of treatment time in Orthodontics is considered one of the important goals in the management of malocclusions. As the number of adult patients seeking orthodontic treatment increases, there appears to be an increased desire for completion of treatment in a relatively short period as possible.

One possible method for completing orthodontic treatment in a shorter duration is through an orthodontic treatment combined with

corticotomy; a surgical technique initially introduced by **Köle** in 1959 and has been subjected to modifications over years to eliminate its associated undesirable side effects. Corticotomy-facilitated orthodontics, with or without grafting, attempts at speeding up the rate of tooth movement by a process of physical weakening of bone as well as an initiation of a Regional Acceleratory Phenomenon (RAP). Moreover, it was reported to expand the potential for non-extraction treatment and, more importantly, enhance post surgical stability.

On the other hand, securing appropriate anchorage is one of the imperative factors for achieving the objectives of orthodontic treatment. Although the principle of orthodontic anchorage has been implicitly understood for decades, it does not appear to have been clearly articulated until 1923 when **Louis Ottofy** defined it as "the base against which orthodontic force or reaction of orthodontic force is applied". Anchorage loss often produces insufficient treatment results, particularly in patients who require maximum anchorage, and such a problem further produces the extension of orthodontic treatment period.

Skeletal anchorage has evolved as a mainstream orthodontic technique with the introduction of temporary anchorage devices (TAD) including fixation wires, bone plates, fixation screws, miniaturized dental implants as well as palatal onplants. These devices provided the clinician with an alternative anchorage system instead of the conventional extra-oral appliances that require full patient compliance. Titanium screws, especially, are currently in vogue and have been used as skeletal anchors because they can provide absolute anchorage without patient cooperation, are quite useful for various orthodontic tooth movements with minimal anatomic limitations and simpler placement techniques.

We are on the verge of a great change in the way we visualize the craniofacial complex in medicine and dentistry; the digital era in which new imaging technologies are being used to solve previous limitations of the patient's records. Computed tomography is an imaging technique allowing improved insight in understanding the spatial relationship between the different craniofacial structures. In addition to having short exposure duration, it helps to compensate for the 2-dimensional images drawbacks, assists in superimposition of teeth pre and post treatment and in simulation of different treatment options.

Root resorption and periodontal problems are frequently reported side effects of orthodontic treatment and their occurrence greatly detracts from the quality of the treatment outcome. Hence, it appears that providing efficient treatment, with minimum harm and discomfort, and of short duration would be of great benefit to both practitioners and patients.

Orthodontic treatment combined with corticotomy and placement of a TAD may provide the advantage of shortening the orthodontic treatment period especially in maximum anchorage situations. In this study, the feasibility of corticotomy-facilitated orthodontics as a method for facilitating rapid canine retraction will be evaluated, with particular focus on treatment efficiency and patient's well-being.

Review of literature

For the sake of clarity, the review of literature will be divided into:

I- Corticotomy-facilitated Orthodontics

- Histological findings underlying corticotomy-facilitated orthodontics

II- Mini-screw implants

A- Aiming devices

B- Clinical applications of orthodontic mini-screw implants

C- Success and failure rates

III- Computed Tomography

I- Corticotomy-facilitated Orthodontics

The conventional view of tooth movement is that of a cell-mediated process orchestrated predominantly within the periodontal ligament. Orthodontic tooth movement is based on forces induced within the periodontal ligament and alveolar bone remodeling. Mechanical stimuli exerted on a tooth cause a sterile inflammatory response in the periodontal tissues whereby inflammatory mediators are released triggering the biological processes associated with alveolar bone resorption and apposition. Mechanical, biological and genetic factors have been proposed to affect oral bone remodeling and tooth movement such that teeth move at a certain rate. This rate of tooth movement cannot, by conventional orthodontic mechanics, be significantly increased. Moreover, attempts at speeding up tooth movement by, for instance, increasing force magnitude, carry the risk of adverse side effects as excessive pain, root resorption and paradoxically, a slowing down of tooth movement rate.

On the other hand, rapid orthodontic tooth movement can be readily attainable without compromising treatment results. Many surgical procedures have been combined with conventional orthodontics for better treatment of dentoalveolar abnormalities. Among these procedures, surgical alveolar corticotomies have been used for years in the correction of malocclusions. Incorporating a corticotomy into orthodontic treatment

has been claimed to decrease the treatment time and increase the quality of services especially in adult patients.

Corticotomy is defined as the osteotomy of the cortical bone**.** This surgical technique includes gingival reflection followed by partial decortication of the cortical plates ending with primary flap closure **(Fischer T.J, 2007)** [25].

Heinrich Köle (1959)[51] is generally credited with the introduction of the corticotomy procedure combining orthodontic treatment with the corticotomy surgery. He reported on a combined inter-radicular corticotomy/supra-apical osteotomy technique for rapid tooth movement utilizing a "one stage" surgery, indicating that both the labial and lingual aspects were treated at the same appointment. According to **Kőle**, it was the continuity of the harder cortical layer of bone that presented the greatest resistance to tooth movement and that this was attributable to the slower remodeling process in the cortical bone in comparison to the medullary bone.

Köle speculated that the resistance to tooth movement could be overcome by creating "blocks of bone" that were connected to each other by medullary bone only, and that these "blocks of bone" could be moved using the crowns of teeth as the handles. He attributed the rapid tooth movement that was achieved to the decreased resistance offered by the softer medullary bone.

After reflecting a full thickness mucoperiosteal flap to expose the alveolar bone, inter-proximal (corticotomy) cuts were extended through the entire thickness of the cortical layer buccally and lingually, just barely penetrating into the medullary bone. These vertical cuts were connected

beyond the apices of teeth with a horizontal osteotomy cut extending through the entire thickness of the alveolus to include the buccal and lingual cortical plates as well as the interposed medullary bone, essentially creating "blocks of bone" in which one or more teeth were embedded. It is important, however, to note that **Köle** made no luxation of individual dentoalveolar blocks in an attempt to mobilize them.

In the upper posterior areas, the supra-apical osteotomies penetrated the mucous membrane of the maxillary sinuses. For that reason, to escape this, the supra-apical osteotomies were performed 10 mm beyond the apices of the teeth with extreme soft tissue reflection. In the lower posterior areas, the supra-apical horizontal cuts were not performed as an osteotomy because the neurovascular innervation in these areas precluded such a cut. Instead, it was done as a corticotomy.

Köle reported on no incidence of root resorption, no loss of teeth vitality and no pocket formation. He stated that leaving the medullary bone intact prevented devitalization of teeth; acting as the "nutritive pedicle" to the bone. Also, it prevented injury to the periodontium such as pocket formation. Vitality tests of the teeth, made six months post-treatment, were always positive. He attributed the lack of root resorption to the fact that it was not the tooth itself that was moved, but rather the alveolar block in which the tooth was embedded. Moreover, he suggested that healing of the edge of the cortical cuts should prevent relapse and that post treatment retention was only required for 6-12 months.

In 1972, Bell and Levy [6] questioned the appropriateness of the one-stage maxillary corticotomy performed bilaterally at the premolar and incisor regions in four rhesus monkeys. In their study, buccal and palatal

full thickness mucoperiosteal flaps were reflected. Unlike **Köle,** the vertical interdental corticotomy cuts extending 2-3 mm beyond teeth apices were also connected with a horizontal subapical corticotomy replacing the horizontal osteotomy described by **Köle.** The resulting dentoalveolar segments were immediately mobilized by malleting a chisel between corticotomy sites. Results revealed that the one-stage maxillary corticotomy had a disruptive effect on the maxillary central incisors. There was a damaging effect to the periodontium around these teeth. The intraosseous and intrapulpal circulation also appeared to be imperiled. According to the authors, the possibility of pedicling the cortical alveolar bone to a relatively small amount of spongy alveolar bone would presumably imperil the circulation to the mobilized dento-alveolar segment. Alteration of the circulation could reduce the viability of the bone and teeth, affect the bone healing capacity of the mobilized bone and have a destructive effect on the periodontium.

Dűker (1975) [21]**,** duplicated **Köle's** technique on six male beagle dogs. Vertical corticotomies were performed between the upper central and lateral incisors but not between the two upper central incisors. He speculated that by keeping the vertical corticotomies shy of the crest of the marginal bone, there would be less chance of damaging the marginal periodontium. The two vertical corticotomies were then connected beyond the apices with a horizontal osteotomy. With the use of heavy rubber bands, the segment of bone with the two central incisors was displaced about 4 mm in 20 days. The rubber bands were attached to a heavy facial arch wire, which served to hold the upper lip away from the incisors during the segmental movement. Using this surgical technique, **Dűker** concluded that rapid tooth movement can be achieved without any damage to neither the pulpal tissues nor the periodontium.