Periodontally Accelerated Osteogenic Orthodontics using piezosurgery with and without bone grafting

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إنما يخشى الله من عباده العلماء

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Dedication

This work is dedicated to …

My beloved Parents, to whom I owe everything I ever did in my life.

And my sister that loved me more than anything in the world.

And my wife for being the light of my life.

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List of abbreviations

PAOO	Periodontally Accelerated Osteogenic Orthodontics
AOO	Accelerated Osteogenic Orthodontics
RAP	Regional Acceleratory Phenomenon
SPSS	Statistical Package For Social Science
SAD	Selective Alveolar Decortications
CBCT	Cone-Beam Computed Tomography
TM	Tooth Movement
CT	Computed Tomography

Introduction

The 21st century is referred to as the “Century of the Biologists”.

The dento-facial dimension of the orthodontic specialty is a front stage player in the script of the scientific progress. Over the last two decades, the refinements of an attempt to engineer an “optimal response” of alveolar bone to applied “optimal force” has propelled both the periodontal and the orthodontic specialties directly into the field of surgical dento-facial orthopedics. Hence, distraction osteogenesis and the publication of the human genome have made clinical and medical orthopedics more biologically sophisticated in their mechanical therapeutic manipulation.

Specifically, the molecular dynamics of osteogenesis in stressed bone defines pathways similar to steady-state homologues not yet fully defined (1).

Orthodontic tooth movement is achieved by biologic events in bone remodeling such as resorption and apposition of the alveolar process supporting teeth with involvement of the roots (2).

The attempt to identify an orthodontically ideal, long-lasting and equilibrated position of the teeth that will not cause periodontal problems, future articular pathologies, or crowding relapse and will be esthetically pleasing has included the possible determination of the hard and soft tissue limitations to orthodontic tooth movement.

Among the hard tissue limitations are areas of sclerosed bone as well as the labial and lingual cortical plates at the level of the root apex (2).

Awareness of the anatomical factors that limit the movement of teeth lowers the risk of potential damage to teeth roots and alveolar bone when moving teeth orthodontically. Iatrogenic problems related to orthodontic tooth movement that have been thoroughly discussed in the literature include root resorption, mucogingival changes, fenestration and dehiscence (2).

Corticotomy is defined as the osteotomy of the cortical bone. In adult patients, this technique dramatically reduces the treatment time since the resistance of the dense cortical bone to orthodontic movement is reduced. In addition, corticotomy-facilitated orthodontics enables the limitation of the undesirable adverse effects of the orthodontic therapy, such as root resorption and periodontal damage (3-6).

However, patients often forgo orthodontic treatment due to its long duration. Traditional orthodontic movement is the result of periodontal ligament compression, which produces histological and bio-molecular modifications of the periodontal tissues that activate dynamics of crestal bone resorption and apposition. Thus, orthodontic movement is considered a "Periodontal Phenomenon" because all the periodontal tissues are involved. For this reason, preservation of the integrity of the periodontium is generally difficult to achieve and is associated with a long duration of treatment. Although traditional orthodontic therapy is the gold standard for treating many adult dental mal-positions, it can be problematic when applied to patients with a thin periodontal biotype, who may experience root dehiscence and/or recession.

Furthermore, orthodontic tooth movement may be anatomically limited in cases of severe jaw discrepancy. The treatment of dental-skeletal discrepancies generally requires a combination of orthodontic and orthognathic techniques that must be performed under general anesthesia.

Unfortunately, patients often agree to undergo maxillofacial surgery only to correct the most severe skeletal discrepancies and they avoid surgical procedures in cases of borderline dental skeletal mal-occlusions.

Traditional orthodontic therapy in adult patients often results in protracted treatment time to allay periodontal tissue concerns. The increase in orthodontic forces does not accelerate root movement, because the periodontal tissue cannot overcome the resistance of the alveolar bone without damage to the periodontal ligament and/or root resorption (6).

Bone turnover is well known to be accelerated after bone fracture, osteotomy or bone grafting (8). This could be explained by the “Regional Acceleratory Phenomenon” (RAP), osteoclasts and osteoblasts increase by local multicellular mediators mechanisms containing precursors , supporting cells, blood capillaries and lymph (9).

Review of Literature

To simplify the review of literature it will be divided into:

1-Alveolar Bone Morphology

2- Corticotomy

A. History of corticotomy

B. Accelerated Osteogenic Orthodontics

C. Histologic findings in corticotomy

3-Bone graft

4-Piezosurgery

5- Cone Beam Computed Tomography (CBCT)

1-Alveolar Bone Morphology

The characteristics of the alveolar structure of the tooth bearing region of the jaws are relevant to dental movement and its consequences in orthodontic treatment (10).

According to the definition of Carranza et al., (11) fenestration is an isolated area in which the root is denuded of bone and the root surface is covered only by periosteum and overlying gingiva. Dehiscence is a bony defect in which the denuded area involves the alveolar bone margin.

The presences of these buccal alveolar bone defects decrease the bony support for the teeth. It is well documented that under certain conditions (e.g., plaque-induced inflammation) a lack of bony support during

orthodontic movement can be detrimental to the health of the teeth and the periodontium(12). In addition, orthodontic tooth movement can create alveolar bone defects (13). Until recently, bony dehiscence and fenestrations could not be visualized by traditional 2-dimensional radiography because of the superimposition of the contra-lateral cortical bony or dental structures (14). The development of “Computed Tomography” (CT) and especially CBCT has provided the means to visualize these defects 3 dimensionally (15). The literature has reported the accuracy of CT and CBCT for measuring and identifying artificially created alveolar bone defects (16). An undiagnosed buccal alveolar bone defect could occur in few patients and cause greater potential for treatment relapse (17) or gingival recession resulting in an unaesthetic outcome of orthodontic treatment (18).

The movement and position of the mandibular incisors play an important role in the diagnostic and orthodontic treatment plan. It is first necessary to establish proclination limits before treatment, especially in patients with severe skeletal discrepancies or with arches that can accommodate only a limited number of teeth.

These limits to proclination refer to biological factors, such as characteristics of the periodontal tissues in the area.

Studies have assessed periodontal recession in the mandibular incisors after orthodontic proclination and human studies (19) have shown the development of periodontal recession after this type of movement.

Vanzin et al. (20) suggested that excessive proclination of the mandibular incisors during orthodontic treatment in young patients is not necessarily related to periodontal recession, whereas the risk in adult patients is much greater. Melsen and Allais (21) showed that only 15% of mandibular