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Periodontally Accelerated Osteogenic Orthodontics: Brief Review

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Abstract

Periodontally accelerated osteogenic orthodontics (PAOO) or Wilckodontics is a clinical procedure that combines selective alveolar corticotomy, particulate bone grafting and the application of orthodontic forces. This procedure is based on the bone healing pattern known as the regional acceleratory phenomenon (RAP). Understanding the biomechanics of bone remodelling may increase the clinical applications of corticotomy facilitated orthodontics with or without alveolar augmentation. The aim of this article is to provide an overview of PAOO.

Keywords: regional acceleratory phenomenon, wilckodontics, alveolar bone, decortication.

Introduction

The alveolus is a component of primary palate and is formed by the fusion of the maxillary prominences around the fifth to sixth weeks of gestation. Nose, lip, prolabium are the structures that arise from the primary palate and are present anterior to the incisive foramen.[1]

The alveolar bone, periodontal ligament (PDL) and cementum are intimately related structures in development and functions. Collectively, they form the periodontium that is of critical relevance not only to orthodontic tooth movement, but also periodontal disease.[2]

The alveolar bone is a mineralized connective tissue; consisting of 23% mineralized tissue, 37% organic matrix (which mostly consists of collagen) and 40% water. It is connected to the teeth via PDL.[3]

Alveolar bone constitutes the most labile structure of the periodontium subject to continuous remodeling process owing to its high sensitivity to external mechanical stimuli. [4]As such, in the presence or absence of forces generated, the natural dentition potentially influence bone 'quantity' as well as 'quality'.[5]

Orthodontic tooth movement is typically divided into three phases by clinical observation: the initial phase, the lag phase, and the postlag phase.[6]

A better name for the alveolar bone is dental bone or tooth bone as tooth loss leads to disappearance of the alveolar bone. Although the bulk of the alveolar bone is trabecular bone, it does contain a plate of compact bone adjacent to the periodontal ligament called the lamina dura. The PDL pierces through the lamina dura and anchors to the alveolar bone, with the other end connected to the cementum. [7]

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Multiple cell types are responsible for the homeostasis and functions of the alveolar bone. The most obvious cell types are osteoblasts, osteocytes and osteoclasts. However, other cell types are also important, including adipocytes, endothelial cells that form the lining of blood vessels and immune competent cells such as macrophages.[2]

Two interrelated processes in orthodontic tooth movement are deflection (bending) of the alveolar bone and remodeling of the periodontium: the periodontal ligament, alveolar bone and cementum.[8]

The rate of orthodontic tooth movement is affected by multiple factors such as the magnitude, frequency, and duration of mechanical forces that are applied to the teeth or bone. Mechanical forces change vascularity and blood flow, resulting in the synthesis and release of molecules such as neurotransmitters, cytokines, growth factors, colony-stimulating factors that regulate leucocyte, macrophage, and monocyte lines. [9],[10]

Terminology

Certain terms should we must know before heading to the details of Wilckodontics. Hence enlisting a few terms that have been defined by The American Academy of Periodontology (AAP) [11]:

- Decortication: Removal of cortical bone.
- Demineralization: Decalcification; loss of mineral salts.
- Ostectomy (osteotomy): The excision of a bone or portion of a bone. In periodontics, ostectomy is done to correct or reduce deformities caused by periodontitis in the marginal and interalveolar bone and includes the removal of bone that is attached to the tooth.
- Osteoblast: A fully differentiated cell, arising from mesenchymal progenitors, that is reponsible for the

production of bone matrix and the resorptive remodeling of bone.

- Osteoclast: A large, multinucleated cell, arising from mononuclear precursors of the hematopoietic lineage that is associated with bone resorption.
- Osteocyte: An osteoblast that has become embedded within the bone matrix.
- Osteogenic: Any tissue or substance with the potential to induce growth or repair of bone.
- Regeneration: Reproduction or reconstitution of a lost or injured part.
- Osseous surgery: Procedures to modify bone support altered by periodontal disease, either by reshaping the alveolar process to achieve physiologic form without the removal of alveolar supporting bone, or by the removal of some alveolar bone, thus changing the position of the crestal bone relative to the tooth root.
- Repair: Healing of a wound by tissue that does not fully restore the architecture or the function of the Part.

How It All Started..?

As mentioned previously, there are four types of bone remodelling techniques that include [12]:

- 1. Osteotomy (complete cut through cortical and medullary bone),
- 2. Corticotomy (partial cut of cortical plate without penetrating medullary bone),
- 3. Ostectomy (removal of an amount of cortical and medullary bone) and
- 4. Corticotectomy (removal of an amount of cortex without medullary bone)

Table I [13]-[22] describes the sequential events thatoccurred leading to the development of PeriodontallyAccelerated Osteogenic Orthodontics (PAOO).

Table I: Evolution of PAOO Technique

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Principle

Modifying the balance between the resorption and opposition and there by bypassing the waiting time for the alveolar process to resorb and move the teeth farther without causing irreversible damage to periodontium has been the focus of many research projects.[23]

The catabolic activity mediated by osteoclasts is the limiting factor in the rate of tooth movement in which periodontal ligament plays a crucial role. [24]

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. Following the completion of orthodontic treatment, remineralization takes place resulting in greater stability in the orthodontic treatment outcome. [25-27]

Corticotomy-assisted or corticotomy-facilitated orthodontics is a therapeutic procedure that helps orthodontic tooth movement by accelerated bone metabolism due to controlled surgical damage. It is considered as an intermediate therapy between orthognatic surgery and conventional orthodontics. [23]

Conditions Apply

Table II highlights the various indications andcontraindications for PAOO technique.

Table II: When to use PAOO Technique

Indication [28]-[32]	Contraindication [21],[33]
To accelerate orthodontic treatment.	Signs of active periodontal disease
	(such as alveolar bone loss/ decreased
	attached gingiva)
To facilitate the implementation of	Presence of endodontic problems.
mechanically challenging orthodontic	
movements	
To enhance the correction of	Patients on prolonged use of
moderate to severe skeletal	corticosteroids (presence of
malocclusions.	devitalized bone areas)
Successful use of in the enhanced	Persons under medications (that slows
correction of severe bimaxillary	down bone metabolism) such as
protrusion	bisphosphonates and NSAIDs
Closure of complex skeletal open	Severe Class III malocclusion
bites	
Intrusions and molar uprighting	
combining Alveolar Corticotomy and	
mini-implants.	
Optimization of treatment of patients	
with cleft lip and palate	

Technique

PAOO consists of 5 steps viz. flap reflection, decortication, particulate grafting, closure and orthodontic force application. [34] **Flow chart I** explains the technique involved to achieve Periodontally Accelerated Osteogenic Orthodontics.



Flow Chart I: Technique Of Paoo

It is of importance to note that vertical cortical scaring incisions are performed interproximallly, extending well beyond the dental apices. A sub apical horizontal osteotomy is done at 10 mm supra apical to the anterior teeth penetrating the buccal and lingual cortical plates and in the post medullary bone. This connects vertical incisions to facilitate what is characterised as "Bony Block concept" that results in a shorter treatment time (6-12 weeks). It is generally accepted that heavier forces must be applied in cases of "bone block" movement after corticotomy to move the tooth–bone block.[35]

Moreover, bracketing can also be done up to 1–2 weeks post surgery. If delayed, the advantage of RAP could fail to occur. The orthodontist has 4–6 months as window period for rapid movement. After which finishing movements occur with normal speed.[36]

Post-Op Care [20], [34]

Recovery from the procedure takes about 7 to 10 days. Swelling can be expected post surgery and may require use of ice packs. Analgesics can be prescribed for one week and during this time mouthwash is prescribed.

Orthodontist adjusts the braces about every 2 weeks. Depending on case, braces are put for 3 to 9 months. After the braces are removed, a retainer for at least 6 months is usually recommended. The same types of braces and retainers are used in PAOO as in traditional orthodontics.

Recent Advances

A new surgical-orthodontic technique to maximize the rapidity of movement and prevent damage to the periodontal tissues (preventing periodontal and bone resorption) can be achieved with a piezosurgical technique that permits microsurgical corticotomy around each root and the immediate application of biomechanical force. [37]

Nowzari et al. reported for the first time the use of particulate autogenous bone grafts with coticotomy-assisted rapid orthodontic procedure. They concluded PAOO with autogenous bone graft as effective treatment approach for orthodontic treatment in adults. [38]

Rapid orthodontic tooth movement can be achieved by selective labial and lingual decortication of alveolar bone in the area of desired tooth movement using a technique called accelerated osteogenic orthodontics TM (AOOTM) orthodontic forces as proposed by the Wilcko brothers.[39]

Micro-osteoperforations (MOP) placed 1mm apical to mucogingival junction proves least invasive. Device, PROPEL has markings of varying lengths on disposable tips that can be used accordingly.[40]

Discussion

Alveolar Corticotomy-assisted orthodontic treatment is a technique that is gaining wide acceptance and is recorded as effective means of accelerating orthodontic treatment that reduces treatment time, minimizes chances of relapse and also attains post treatment stability.

Long et al. [41] suggested that corticotomy is a safe method that accelerates orthodontic tooth movement and periodontal-dentoalveolar distraction is promising for accelerating movement.

Hoogeveen et al. [42] emphasized treatment planning is required for orthodontics associated with corticotomy and more continuous check-ups. He commented that this procedure is not associated with complications.

Kalemaj et al.[43] noticed corticotomy accelerates tooth movement during the first months but then, the long-term effects are questionable.

Orthodontic treatment combined with modification in conventional Wilkodontic technique, wherein a Modified Widman Flap approach was planned in a patient to accelerate tooth movement and shorten the treatment time with an anterior open bite and flared and spaced upper and lower incisors was attempted by *Awasthi et al.*[44]

Kumar et al.[45] reported a case where, on periodontal intervention in a patient undergoing orthodontic treatment for the past one year, a buccal plate thickening was encountered in between premolars and canine that involved elective alveolar decortication in the form of dots performed around the teeth that were to be moved. Author suggested that, the decortication was carried out to induce a state of increased tissue turnover and a transient osteopenia, which further helps in faster rate of orthodontic tooth movement.

Conclusion

In the current era of esthetic dentistry coupled with increased expectations of patients for a quick treatment, Periodontally Accelerated Osteogenic Orthodontics stands as one of the treatment modalities that reduce the clinical dilemma from clinician and patient perspective.

The corticotomy results in the Regional Acceleratory Phenomenon (RAP) which is needed to significantly reduce treatment time. Corticotomy assisted orthodontics seems to be a promising adjuvant technique though invasive, expensive and cannot be advocated in patients using NSAIDs/corticosteroids, still suited for many situations where traditional orthodontics fail to produce tooth movement or in the orthodontic treatment of adults without active periodontal pathology. It is a novel technique to achieve rapid orthodontic tooth movement and hence more research towards the modifications and long-term follow-up should be performed.

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