

Peizocision Assisted Orthodontics - An Interdisciplinary Approach for Speedy Orthodontics – A Review Article

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Abstract

The past decade has witnessed a surge in the number of adult patients seeking orthodontic treatment to enhance their smile. In this present era where aesthetics play a very important role , there is found to be steady increase in the number of patients seeking orthodontic treatment to enhance their smile and thereby their aesthetics. But often the long duration of treatment pose to be a matter of concern to these patients specially the adult. Hence accelerated orthodontics came up that promised to decrease the treatment time. Many methods are available of which piezocision is the most recent one. It is a minimally invasive procedure consisting of microincision with selective tunnelling that allows hard and soft tissue grafting. It has successfully proven to reduce treatment time by 70% and also reduce the morbidity associated with corticotomy procedure that is also done to accelerate tooth movement.

Keywords: Piezocision, Corticotomy, Regional Acceleratory Phenomenon, Tooth Movement.

Introduction

The demand for adult orthodontics ,the need for an aesthetically appealing appliance and shorter treatment time have grown over the years .^{1,2} The genesis of Invisalign appliances , lingual orthodontics and aesthetic brackets have fulfilled the requirement of aesthetic orthodontics. The past decade has seen a surge in innovations aimed at shortening the length of treatment time in adult patients ². Despite various advancement in different areas of orthodontics, still accelerated tooth movement is research work of academic interest. Because of longer treatment time, there is a chance of increased periodontal insult, decalcification, dental caries and resorption of the root ³. The best way to reduce treatment time is to speed up or accelerate tooth movements. Estimated teeth movement is 0.8 -1.2 mm per month when

continuous force is applied. Sequential remodelling of alveolar bone and periodontal ligament in the presence of mechanical stimulus leads to orthodontic tooth movement. A cellular response in the periodontal ligament is induced by orthodontic forces, that brings about bone deposition on the tension side and bone resorption on the pressure side. The microenvironment around PDL is changed by application of force on the teeth due to alteration of blood flow. This happens via induction of osteoclasts via the RANK-RANKL pathway and presence of various inflammatory mediators such as IL-1, IL-8, TNF-alpha etc.^{4,8} Surgical methods have been used to accelerate the tooth movement that is based on the principle that when the bone is irritated surgically, an inflammation cascade is initiated which caused increased osteoclastogenesis, hence causing faster tooth movement^{8,9}. The treatment procedures that were attempted to shorten the treatment time was rapid distraction of the canines and corticotomy facilitated treatment.

Methods to Accelerate Tooth Movement:

There are various methods to accelerate tooth movement during orthodontic treatment.³

They are:

1. Biological / pharmacological
2. Physical / biomechanical stimulation methods
3. Surgical

Biological / pharmacological methods:

A wide variety of drugs have been tested to accelerate orthodontic tooth movement and have achieved successful result. Examples of these drugs are eicosanoids , thromboxanes , NSAIDs , corticosteroids, etc. But these drugs do have some or the other unreliable adverse effect. For example : vitamin D when injected in the periodontal ligament raises the levels of LDH which is an inflammatory mediator and Prostaglandins that cause an increase in inflammation hence root resorption.¹⁰

Also most of these drugs have been experimented only in animals and hence lack clinical relevancy. Therefore currently no drugs exists that can safely accelerate the orthodontic tooth movement.

Physical / biomechanical stimulation methods:

These are the non- invasive methods performed to accelerate tooth movement during orthodontic treatment. They include lasers , vibration , direct electric current , etc.

Low level laser therapy (LLLT): is one of the potential approaches today for the increase in the rate of tooth movement. The bio-stimulatory effect on bone regeneration by Laser is seen in the mid palatal suture during rapid palatal expansion of the maxilla . The mechanism involved is that LLLT enhances the velocity of tooth movement via RANK / RANKL with macrophage colony stimulating factor and receptor expression.^{10,11}

Mechanical stimulation: it is a non-invasive and safe technique .¹² Mechanism by which vibration showed an increase in orthodontic tooth movement is that there occurred as increase in RANKL expression in the fibroblasts and osteoclasts of periodontal ligament .

Acceledent is the product that is commercially available which uses this technology. Various studies using this device have shown that the treatment time has reduced by 30 – 40 % .⁸

Surgical methods

Bichlmayr in 1931 put forth a surgical technique for rapid correction of severe maxillary protrusion with orthodontic appliances. In 1959 , Kole added on this philosophy by including space closure and cross bite correction.

The concept that , corticotomy results in faster tooth movement , prevailed till 2001 when Wilcko et al showed a transient remineralisation – demineralisation process taking place after corticotomy that was termed as Periodontally Accelerated Osteogenic Orthodontics

(PAOO).¹³ This concept was earlier described by Frost in 1983 as Rapid acceleratory phenomenon (RAP)⁹

Several surgical approaches have been tried to accelerate the tooth movement and they include – corticotomy , wilkcodontics , micro osteoperforations , minimally invasive rapid orthodontics , dentoalveolar distraction , peizocision .

Corticotomy

The conventional corticotomy procedure involves raising of full thickness mucoperiosteal flap buccal and lingual , followed by placing the deep corticotomy cuts into cortical and trabecular bone between tooth roots using a rotary high speed drill.

Advantages

- a. It has proved to accelerate tooth movement.
- b. as a result of thin alveolar bone, periodontal defects can arise ,that can be prevented by augmenting the bone

Disadvantages¹⁴:

- a. High morbidity associated with the procedure
- b. Invasive procedure.
- c. Chances of damage to adjacent vital structures.
- d. Post-operative pain, swelling, chances of infection, avascular necrosis. e. Low acceptance by the patient.⁸

Wilkcodontics

It was put forth by Wilkcos brothers where by the procedure of corticotomy also include alveolar augmentation. The principle behind this rapid tooth movement is because of increased rate of bone turnover and bone thickness^{10,15}

Micro-osteoperforations

Another method to further reduce the invasive nature of surgical irritation of bone , a device called Propel was introduced by Propel Orthodontics. This process was called as alveocentesis that directly translates to puncturing bone.⁸ . Micro osteoperforations significantly increases the expression of cytokines and chemokines

known to recruit osteoclastic precursors and stimulate osteoclastic differentiation.

The process consists of placing small and shallow osteoperforations on buccal and lingual cortical plate surface. These osteoperforations are placed in the proximity of moving tooth and cause an increase in the osteoclastic activation , bone remineralisation and hence tooth movement.¹²

Minimally invasive rapid orthodontics:

In 2013 , Jofre et al introduced the minimally invasive rapid orthodontics method of accelerating tooth movement where metal markers are used as radiographic references for precise placement of incision and corticotomy cuts.^{3,16}

Dentoalveolar distraction (DAD):

It is done by placing single cortical aperture on alveolar bone circumscribing the canines followed by distracting the cuspid utilizing distractors.¹⁰

Peizocision

An insignificantly invasive flapless strategy involving piezo surgical cortical micro incision cuts along with buccal cortex only with specific tunnelling that allows both hard and soft tissue grafting.^{10,14}

The Procedure

1. A week following placement of the fixed orthodontic appliance the surgery is performed.
2. After local anaesthesia , using a microsurgical blade or a blade No. 15 , vertical interproximal incisions are made below the interdental papilla, on the buccal aspect of each jaw.
- 3 Except in the areas of bone grafting ,these incisions are usually kept minimal(microincisions).
4. The incisions go through the periosteum, which allows the blade to reach the alveolar bone.
5. The cortical alveolar incision is made with a Piezo surgical knife (BS 1 insert, Piezotome™, Satelec Acteon

Group, Merignac, France) that is used to create the gingival micro-opening to a depth of approximately 3 mm.

6. When the corticotomies are finished, the areas requiring bone or soft tissue augmentations are tunnelled using a small periosteal elevator through the vertical incisions followed by grafting in the tunnelled areas. Using a resorbable 5-0 suture the vertical incisions are closed.

7. The areas that have not been “tunnelled” do not need suturing.

8. Under antibiotic and analgesic cover if the patient is comfortable he / she may go home.^{15,17}

Mechanism

As the bone is injured, a dynamic healing process called as regional acceleratory phenomenon occurs at the site of bone injury.¹⁴ The regional acceleratory phenomenon (RAP) is a tissue reaction to different noxious stimuli¹⁸ that can be evoked in the normal body by any regional noxious stimulus and is directly proportional to the magnitude and nature of the stimulus. Decreased regional bone density and accelerated bone turnover, which are believed to facilitate orthodontic tooth movement, are the two main features of RAP in bone healing. The RAP, usually lasts 4 months in bone, beginning within a few days of injury that typically peaks at 1–2 months and may take 6 to more than 24 months to subside.¹⁹

After the bone is injured surgically there is a localised surge in osteoclastic and osteoblastic activities in the early phases that result in a decrease in bone density with an increased bone turnover. This transient osteoporotic condition facilitates tooth movement. Piezocision and the use of the piezotome at specific vibration frequency settings appeared to induce a more extensive and diffuse demineralization followed by increased remineralization effect on the bone than on the bur. This could be due to

the additive effect of the osteocytes response to micro vibrations created by ultrasonic handpiece.

Although RAP is transient, continuous mechanical stimulation of the teeth would prolong the osteopenic effect induced by the procedure. Hence, it is imperative to see the patient and adjust the orthodontic appliance every 2 weeks.¹⁷

Discussion

Surgical injury to the alveolus induces transient osteopenia that enables rapid tooth movement. The teeth move in the bone that has temporarily lost its original density but not its volume. Adding a bone graft to the technique has allowed an increase in alveolar volume and enhancement of the existing periodontium. The inherent disadvantage of corticotomies that are performed using burs are damaging of the teeth and bone along with probability of impairing bony regeneration and producing marginal osteonecrosis. Piezoelectric incisions recently have been reported to be safe and effective in osseous surgeries. The piezoelectric knife is said to have safe and precise osteotomies without any osteonecrosis because of its micrometric and selective cut. Furthermore, it spares soft tissues and their blood supply working only on the mineralised tissues. It is also used for periodontally accelerated orthodontic tooth movement where extensive periodontal flaps and incisions from a buccal and lingual approach were performed, that had great clinical results but also lead to increased chair-side time and patient discomfort. The Piezocision has the added advantages of being quick, minimally invasive, and less traumatic to the patient when compared to classic decortication approach. The technique allows soft-tissue grafting at the time of surgery to correct mucogingival defects if needed, as well as bone grafting in selected areas by using localized tunnelling and hence is quite versatile.¹⁷ Chavaret et al in 2018 reported that upto 3 years after the completion of

treatment periodontal problems or root resorption were not detected neither was any gingival recession reported, but scars related to piezocision were slightly visible in the lower arch where the surgery was performed.²⁰

Keser et al, 2013, have stated a more evolved technique where selected areas or segments of the arch is demineralised at different times during the orthodontic treatment to help achieve specific results and this was called as segmental / sequential piezocision.¹⁵

New techniques

Milano et al. described a method for combining piezocision with computed tomography. After creating a 3D model of the arch, the corticotomies are planned and transferred to a resin surgical guide by using a numerically controlled milling machine. The main disadvantage of this technique is the laboratory phase, which could cause an error. Furthermore, the surgeon must add resin to stabilize the guide during surgery.²¹ In 2017, Cassetta et al employed a 3D-printed surgical guide using CAD/CAM that reduced the risk of damage to the anatomical structures. This possibility of virtually planning the incisions provides a safer means to selectively cut the bone and facilitate the preservation of root integrity. When limitations such as root proximity, root convexity, or abnormal root angulations are present, the use of a surgical guide is the only way to maximize root safety. Moreover, although full flap elevation does entail increased morbidity for the periodontium, it does not add to the safety or precision of the procedure because tooth roots are still concealed by the cortical bone. This technique seems particularly indicated in adults with gingival recessions and a thin gingival biotype, because it does not interfere with the marginal periodontium, involves significantly less trauma to the periodontal tissues, and does not involve hard or soft-tissue grafting²²

Conclusion

Piezocision is a newer, minimally invasive technique that provides for rapid orthodontic tooth movement with the advantage of no extensive and traumatic surgical approaches. This innovative technique also allows the possibility for hard and/or soft tissue augmentation, leading to an enhanced periodontium and an increased scope of tooth movement.

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