Review Article

RAPID TOOTH MOVEMENT - A REVIEW

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ABSTRACT:
Due to increased demand of orthodontic treatment amongst adult patients there has been a rise in the development of methods to accelerate the orthodontic tooth movement and reduce the overall treatment time. Long orthodontic treatment time poses several disadvantages like higher predisposition to dental caries, gingival recession and root resorption. Therefore there was need to find a better method to increase rate of tooth movement with the minimal disadvantages. Several methods have been introduced to increase the rate of tooth movement which includes the use of surgical means like corticotomy, dentoalveolar distraction, periodontal distraction, peizocision, molecular therapies and drugs. Hence, this article aims to review the variou methods to accelerate orthodontic tooth movement.
Key words: Bone resorption, Orthodontic treatment, Rapid orthodontics.

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INTRODUCTION:

In present era there is precipitously increase in demand for orthodontic treatment especially among adult patients. The greatest challenge amongst the patients undergoing orthodontic treatment is the increased treatment duration. Fixed orthodontic treatment usually lasts up to 2 to 3 years which further increase the risk of periodontal problems, root resorption etc. [1]

Orthodontic tooth movement occurs in the presence of a mechanical stimuli sequenced by remodeling of the alveolar bone and periodontal ligament (PDL). Bone remodeling is a process of both bone resorption on the pressure site and bone formation on the tension site.[2] Orthodontic tooth movement can be controlled by the size of the applied force and the biological responses from the PDL. The force applied on the teeth will cause changes in the microenvironment around the PDL due to alterations of blood flow, leading to the secretion.

Orthodontic force induces a cellular response in the periodontal ligament, which brings about bone resorption on the pressure side and bone deposition on the tension side. 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.[3-6] Clinicians are constantly striving towards developing strategies to enhance the rate of orthodontic tooth movement.

Present article aimed to discuss various surgical and non- surgical techniques to expedite the process for orthodontic treatment.

Various methods to accelerate orthodontic tooth movement can be discussed under the following categories:

1. Surgical Methods.
2. Physical/ Mechanical stimulation methods.
3. Molecular Methods
4. Drugs

SURGICAL APPROACH

The surgical technique has been documented in many case reports. It is a clinically effective technique used for adult patients, where duration of orthodontic treatment may be critical in selected groups of patients. The PDL and alveolar bone remodeling are the important parameters in tooth movement, and bone turnover is known to increase after bone grafting, fracture, and osteotomy.

INTERSEPTAL ALVEOLAR SURGERY

Interseptal alveolar surgery or distraction osteogenesis is divided into distraction of PDL or distraction of the dentoalveolar bone; example of both is the rapid canine distraction. In the rapid canine distraction of PDL, the interseptal bone distal to the canine is undermined surgically at the same time of extraction of the first premolars, thus, this will reduce the resistance on the pressure site. In this concept the compact bone is replaced by the woven bone, and tooth movement is easier and quicker due to reduced resistance of the bone.[7,8]

In this technique the interseptal bone is undermined 1 to 1.5 mm in thickness distal to the canine after the extraction of the first premolar, and the socket is deepened by a round bur to the length of the canine. The retraction of the canine is done by the activation of an intraoral device directly after the surgery. It has been shown that it took 3 weeks to achieve 6 to 7 mm of full retraction of the canine to the socket of the extracted first premolars.[7,8] However, contradictory results have been portrayed regarding of the electrical vitality test of the retracted canines.[8] Liou et al[8] reported 9 out of 26 teeth showed positive vitality, while Sukurica[9] reported that 7 out of 20 showed positive vitality after the sixth month of retraction. So there are still some uncertainties regarding this technique

CORTICOTOMY AND OSTEOTOMY:

The conventional corticotomy is one of the surgical procedures that is commonly used in which only the cortical bone is cut and perforated but not the medullary bone suggesting that this will reduce the resistance of the cortical bone and accelerate tooth movements.

Wilckodontics - periodontally accelerated osteogenic orthodontics: In 2001, Wilcko et al introduced a corticotomy facilitated technique involving alveolar augmentation. The technique includes labial and lingual alveolar flaps accompanied with limited selective corticotomy. He reported that a surface-computed tomographic evaluation of corticotomized patients clearly showed a transient localized demineralization-remineralization process consistent with the accelerated wound-healing pattern of the regional acceleratory phenomenon.[10] Sebaoun et al[11] explained the histological mechanism following corticotomy using a rat model. He suggested that there was a rapid Sciee in the catabolic and anabolic activity in the alveolar bone and periodontium three weeks after the corticotomy procedure. The induced increase in bone turnover and decrease in mineral content of the bone (demineralization) are conducive to accelerated tooth movement.

PIEZOCISION:

Piezocision assisted Orthodontics is a recently introduced, minimally invasive procedure, combining micro incisions with selective tunnelling that allows hard or soft tissue grafting and piezoelectric incisions. This novel approach leads to short orthodontic treatment time, minimal discomfort, and great patient acceptance, as well as stronger periodontium.[12]

SURGICAL STEPS[13]

1. The surgery is performed 1 week following placement of the fixed orthodontic appliance.
2. After local anaesthesia, vertical interproximal incisions are made, below the interdental papilla, on the buccal aspect of each jaw using a microsurgical blade or a blade No. 15.
3. These incisions are kept minimal (microincisions) except when made in the areas of bone grafting.
4. The incisions go though the periosteum, which allows the blade to reach the alveolar bone.
5. A Piezo surgical knife is used to create the cortical alveolar incision through 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 tunneled using a small periosteal elevator through the vertical incisions followed by grafting in the tunneled areas. Vertical incisions are then closed using a resorbable 5-0 suture.
7. The areas that have not been “tunneled” do not need suturing.

The Piezocision demonstrated similar clinical outcome when compared to classic decortication approach but has the added advantages of being quick, minimally invasive, and less traumatic to the patient. This technique is quite versatile because it 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 tunneling.

PERIODONTAL DISTRACTION

Liou et al[8] suggested that rapid orthodontic tooth movement is a form of distraction osteogenesis of the periodontal ligament. In 1998, they conducted a clinical experiment and demonstrated the rapid

distalization of 26 canine teeth in humans using distraction of the periodontal ligament. This technique was referred to as dental distraction. This procedure is performed in patients requiring premolar extractions, during which the interseptal bone distal to the canine is undermined with a bur. Customized distracters are used to retract the canines into the extraction space. Canines can be distalized upto 6mm into the extraction space during a short period of 3 weeks using this procedure.

MOLECULAR METHODS:

Prostaglandins, RANKL, VEGF etc molecules are emerging molecules which enhance tooth movement. Exogenous administration of prostaglandin increases rate of tooth movement by inducing bone resorption. Prostaglandin has a direct action on osteoclasts in increasing their numbers and their capacity to form a ruffled border and effect bone resorption. Prostaglandins couple bone resorption and formation, increasing the turnover of bone cells and thus accelerating the orthodontic tooth movement

Gene therapy has also been proved to be useful during orthodontic treatment. RANKL is a membrane bound protein on the osteoblasts that bind to the RANK on the osteoclasts and causes osteoclastogenesis.[14]

OPG, protoagonist of RANKL is a decoy receptor produced by osteoblastic cells, which compete with RANK for RANKL binding. The biologic effects of OPG on bone cells include inhibition of terminal stages of osteoclast differentiation, suppression of activation of matrix osteoclasts, and induction of apoptosis. Thus, bone remodeling is controlled by a balance between RANK RANKL binding and OPG production. It was demonstrated that the transfer of RANKL gene to the periodontal tissue induced prolonged gene expression for the enhancement of osteoclastic activity and acceleration of tooth movements in rats. Thus a balanced delivery of genes such as RANKL and OPG, to the oral tissues can prove to be beneficial in managing the rate of the orthodontic treatment. These modalities have also been shown to reduce relapse, and pain and root resorption caused due to orthodontic forces.[14-16]

DRUGS AFFECTING TOOTH MOVEMENT

Drug is any substance or product that is used to modify or explore physiological systems or pathological states for the benefit of the recipient. (WHO) During orthodontic treatment, drugs are prescribed to manage pain from force application to biological tissues, manage TM joint) problems and tackle some infection throughout the course of treatment. Besides this, patients who consume vitamins, minerals, hormonal supplements, and other compounds for the prevention or treatment of various diseases can also be found in every orthodontic practice. Some of these drugs may have profound effects on the short- and long-term outcomes of orthodontic practice. Prostaglandins, Thyroid hormones, Vitamin D3, Nitric Oxide, Corticosteroids increases the rate of orthodontic tooth movement.[17-19]

CONCLUSION:

Rapid orthodontics is still at its emerging phase and need further research in the form of clinical trials. Surgical means have provided better outcome but being invasive in nature lead to poor patient compliance. Other advanced molecular therapies requires further explorations would prove to be beneficial for both the clinicians and the patients as they have advantages such as reduced rates of relapse, reduced orthodontic pain and reduced root resorption.

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