

Accelerating Tooth Movement: What Options We Have?

Review Article

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Abstract

With a better understanding of the molecular and cellular basis of orthodontic tooth movement, now, the focus is on surgically assisted rapid tooth movement. This requires the collective effort of orthodontists and periodontists. Clinically, corticotomies and osteotomies have been devised to fasten the orthodontic tooth movement (OTM). Besides these, this article highlights various newer methods of enhancing the rate of tooth movement, like, low level laser therapy, use of electric current, periodontal tissue activation by vibration, photobiomodulation, Pulsed electromagnetic fields etc. Recent research has shown that these methods effectively increase the rate of OTM.

Introduction

Duration of treatment is one of the main concerns of patients undergoing orthodontic treatment. Fixed orthodontic treatment lasts up to 2 to 3 years increasing the risk of external root resorption, periodontal problems and patient compliance [1]. Clinicians are constantly striving towards developing strategies to enhance the rate of orthodontic tooth movement. An increase in in-depth knowledge of the alveolar topography [2] has been a major aid in accelerating tooth movement. Corticotomies and multiple tooth osteotomies have been the main stay of surgically assisted rapid tooth movement. Corticotomy was first described in 1892 [3]. The concept of using a "positive system" for active canine retraction using a screw was proposed by Farrar [4]. Distraction osteogenesis in tooth movement was given by Liou and Huang [5]. Wilcko and Ferguson [6] demonstrated that tensional stress on a moving tooth through a surgically healing site led to faster tooth movement periodontally accelerated osteogenic orthodontics or Wilckodontics. In a systematic review by Hu Long [7], it was concluded that corticotomy is a safe and effective means of increasing the rate of tooth movement. Following corticotomy, there is alveolar osteopenia, followed by new bone deposition and osteoid formation, which can be supplemented using a bone graft [8]. Frost [8] called it regional acceleratory phenomenon whereby, regional healing response led to accelerated tooth movement. Several newer techniques like low level laser therapy, use of electric current, periodontal tissue activation by vibration, photobiomodulation have been discussed in this article.

Corticotomy

Kole et al. [9] gave the concept of corticotomy combined with orthodontics to accelerate tooth movement in order to decrease the treatment duration. He advocated the use of interproximal corticotomy cuts extending through the cortex, which were further connected with horizontal osteotomy cuts, thereby forming bony blocks which lead to quicker tooth movement and better stability.

Wilckodontics-periodontally accelerated osteogenic orthodontics

Wilcko et al. [10] introduced a corticotomy facilitated

technique which involved alveolar augmentation. The surgical technique included reflection of labial and lingual alveolar flaps which was accompanied with limited selective corticotomy. Bone grafting leads to two advantages, firstly, it lead to lateral bone augmentation and expansion, secondly, it helped in tooth movement by providing biochemical factors needed for tooth movement [11]. Accelerated tooth movement in case of corticotomy is due to increased bone turnover and decreased bone density [12].

Corticision

Park et al. [13] introduced a modified version of corticotomy, a technique named corticision in which, scalpel and mallet were used to cut the bone through the gingiva without the reflection of a surgical flap, i.e. a trans-gingival approach was used. The trauma to the bone induced regional acceleratory phenomenon leading to accelerated tooth movement. This method had several shortcomings including poor precision and it was associated with dizziness in the patients due to repeated malleting. However, Kim et al. [14] reported that corticision can be used safely for rapid tooth movement based on histology and histomorphology of paradental tissues.

Periodontal distraction

Liou et al. [5] suggested that rapid orthodontic tooth movement is a form of distraction osteogenesis of the periodontal ligament. Liou conducted a clinical experiment in 1998 and demonstrated faster distalization of twenty six canine teeth in humans by distraction of the periodontal ligament. This technique was referred to as dental distraction. A dental distractor is placed which has a distraction screw and a sliding rod. New bony trabeculae are formed parallel to the direction of force being applied and rapid alveolar remodelling takes place [15]. A disadvantage from biomechanical perspective is the distal rotation of the canine being retracted [16].

Dentoalveolar distraction

Dentoalveolar distraction utilizes the principle of distraction osteogenesis. Corticotomy is performed only on the alveolar side

sparing the palatal side to maintain adequate blood flow and to maintain bone support. The teeth move in the alveolar bone without any damage to the periodontal tissues [17,18].

Peizocision

Peizocision was introduced by Dibart et al. [19]. It involves piezoelectric microincisions with concomitant tunneling for placement of alveolar bone grafts. This leads to surgical stimulation of local inflammatory processes, additionally placement of grafts results in a rapid orthodontic response.

Low level laser therapy

The effects of low level therapy were tested by Kim et al. [20] in a study comparing the rate of orthodontic tooth movement in groups which were divided on the basis of corticotomy, low level laser therapy and conventional methods. It was observed that the ratio of second premolar to canine movement was greater by 2.08 fold in groups in which low level laser therapy was given compared to conventional treatment. A number of human trials have been conducted using low intensity diode lasers during orthodontic treatment. These studies have shown an increased rate of tooth movement along with reduced pain when orthodontic forces were applied [21,22].

Periodontal tissue activation by vibration

Nishimura et al. [23] evaluated the effect of application of vibratory forces adjunctive to orthodontic forces. They performed his study on an animal model, rate of orthodontic tooth movement in maxillary molars of wistar rats was observed. It was observed that there was greater tooth movement in experimental groups as compared to conventional groups and the difference was statistically significant. Any additional damage to periodontal tissues such as root resorption and bone loss was not reported. On the basis of effect of vibratory cyclical forces a device has been developed to accelerate tooth movement which enhances the rate of bone remodelling [24].

Electrical currents

Electrical currents have been tested experimentally on animal models and have been found to show accelerated tooth movement response [25]. Electrical currents generated piezoelectrically or direct currents have been shown to enhance the rate of tooth movement. The bulkiness of the devices used to generate electric currents is a major shortcoming of these procedures resulting in their lack of application during routine practice.

Pulsed electromagnetic fields

An integrated circuit produces pulsed electromagnetic fields which is placed in a removable denture (1Hz, 0.5 mT, 8 hours per day overnight). It was reported by Showkatbakhsh et al. [26] that Pulsed electromagnetic fields significantly enhance tooth movement.

Photobiomodulation

A low level light therapy also referred to as photobiomodulation has been used in the form of near infrared light with specific wavelength and intensity. The low intensity light leads to

increased ATP at the site which in turn would enhance the cell turnover and vascularisation increasing the remodelling process. A clinical trial [27] was conducted using this therapy in which low intensity light was directed at the cheeks of orthodontic patients. The results showed better tooth movement response measured in the form of little's irregularity index.

Molecular methods

Biological factors like prostaglandins, RANKL, vascular endothelial factors etc have been tested in various experimental models as non invasive means of enhancing tooth movement. An increased rate of tooth movement has been shown in animals on exogenous administration of prostaglandin highlighting its role in bone resorption during alveolar bone remodelling [28]. Recently human trials have been conducted showing greater tooth movement in extraction cases when prostaglandin was administered [29]. Gene therapy has also been proved to be useful during orthodontic treatment. 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 [30]. RANKL is a membrane-bound protein on the osteoblasts that bind to the RANK on the osteoclasts and causes osteoclastogenesis [31].

Conclusion

Rapid orthodontics is still in its initial phase of development and requires further research in the form of clinical trials. Of the various methods surgical means provide better results but have the drawback of being invasive in nature. The scope for the non-invasive methods including molecular therapies is vast and further explorations in this field would prove to be beneficial for both the clinicians and the patients.

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