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Fast but not furious: Accelerated orthodontic tooth movement

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Abstract

One of the major limitation of any orthodontic treatment is the length of the treatment which is about two to three years. Lengthy orthodontic treatment not only prompts patients, to avoid treatment or to find other shorter alternative procedures which can compromised the results but also can lead to complications like gingival recession, root resorption or a higher predisposition to caries. Hence, many methods to accelerate the tooth movements were proposed, which can be grouped in to surgical, device assisted or mechanical stimulation and drugs. Each method has their own advantages and disadvantage. The aim of the current study is to critically analyze all the approaches in accelerating the tooth movement and to highlight the latest techniques.

Keywords: dental implants, periimplantitis, oral hygiene, maintenance, long term success

Introduction

The Prolonged treatment duration is one of the major limitation of the orthodontics therapy leading to many complications like gingival recession, root resorption and enamel demineralization which increases predisposition to dental caries. Patients who cannot undergo a lengthy orthodontic treatment either avoids treatment or opts shorter alternate procedures which can compromise the over-all results of the treatment. Hence a lot of researches are focusing in the treatment options aimed to decrease the treatment timings without affecting the outcome of the orthodontics therapy ^[1]. The aim of the current article is to enumerate and discuss the various methods which can be used to accelerated orthodontic tooth movement (AOTM) and to critically analyze them.

The methods used to AOTM can be divided into the following three categories.

- A. Surgical Methods.
- B. Mechanical stimulation methods.
- C. Drugs.

A. Surgical Methods

The use of surgical technique to increase the orthodontic tooth movement was first introduced by Bichlmayr in 1931, which was later expanded by Kole in 1959 ^[2]. It was Frost In 1983 who used the term Regional Acceleratory Phenomena for surgical acceleration of the orthodontics tooth movement. He proposed that the healing is increases 2-10 times than the normal physiologic healing when there is Regional Acceleratory Phenomena (RAP).

A lot of case reports are available in the dental literature documenting the surgical techniques available for AOTM. It is an effective clinical method that can be used in adult patient where the duration of the treatment is of most important. Corticotomy ^[3] and Piezoscision ^[4] technique are two of the commonly used surgical techniques for AOTM.

Corticotomy

In conventional corticotomy procedure, a full thickness mucoperiosteal buccal and/or lingual flaps are elevated and corticotomy cuts were placed using either micromotor under irrigation, or piezosurgical instruments, followed by the placement of bony graft. The placement of bone graft is not mandatory, but recent study have shown that concomitant placement of bone graft along with the corticotomy have advantages like reduced risk of marginal bone resorption and fenestration ^[3].

Piezocision technique

Piezocision is one of the most recent technique available for the AOTM [5]. This technique was first introduced by Dibart *et al* in 2009. In this method, the deep primary incisions were placed below the interdental papilla on the buccal surface till the attached gingiva using a surgical blade No. 15. Corticotomy cuts up to 3 mm were placed in these incisions using an ultrasonic instrument. Sutures were not required. Studies have concluded that there is no periodontal damage [6] and when used along with Invisalign, the results are faster and aesthetically better [7].

Discision method

In 2018, Buyuk *et al*, introduced a new method as an alternate to the Piezocision. He proposed that instead of using an ultrasonic instrument for corticotomy procedure, a 'Disc Saw' can be used as its easily available and simple to use [8].

Interseptal alveolar surgery

Interseptal alveolar surgery or distraction osteogenesis is mostly carried out for rapid canine distraction. In this method the interseptal bone distal to the canine is surgically undermined 1 to 1.5 mm with a round bur up to the length of the canine while the first premolars were extracted which results in reducing the resistance on the pressure site. Here, the woven bone replaces the compact bone, which causes easier tooth movement as the resistance is less in the former. These rapid movements are during the initial phases of tooth movement especially in the first week. The orthodontics tooth movement is started immediately after the surgery and usually full retraction of the canine happens 3 weeks [9].

Micro-Osteoperforations (MOP)

Micro-osteoperforations or alveocentesis which means puncturing bones was introduced by Propel Orthodontics as a novel less invasive surgical procedure for AOTM. It is theorized that there is increase in the expression of the inflammatory markers which are usually seen during orthodontics tooth movement in this technique [10]. A study by Alikhani *et al* have concluded that there is 2.3 fold increase in the tooth movement when the micro-osteoperforations were used [11]. A recent study by Chan *et al* (2018), reported that micro-osteoperforations resulted in 42% greater orthodontic root resorption than the conventional method [12].

B. Device assisted therapy or Mechanical stimulation methods

Device assisted therapy or mechanical stimulation method were developed as an alternate option for AOTM as it is less invasive when compared with the surgical procedures available. Several techniques were introduced, among them direct electric current, static magnetic field, resonance vibration, pulsed electromagnetic field and low-level laser have shown promising results.

Low-level laser therapy

Low-level laser therapy (LLLT) for AOTM is one of the most promising approaches available in the device assisted category for rapid orthodontics tooth movement. LLLT has the property to induces the proliferation of osteoclast, osteoblast, and fibroblasts which can in turn affect bone remodeling and tooth movement. LLLT can increase the production of ATP and the activation of cytochrome C. They can also activate the RANL/RANK and macrophage colony-stimulating factor and receptor expression which can enhance

the tooth movement [13].

In 2018, Guram *et al* reported that LLLT not only increases the orthodontic tooth movement but also reduces the pain experienced by the patient during the orthodontics treatment [14]. A recent histological study by Abtahi *et al* have shown that the LLLT increases the number of resorption lacuna which increase the resorption activity in alveolar bone resulting in AOTM [15]. The combination of corticopuncture and LLLT was evaluated by Suzuki *et al* in 2017. In that study, they concluded that the combination of corticopuncture and LLLT increases the tooth movement and reduces root resorption at the compression site [16].

Electrical currents and Pulsed electromagnetic fields

Experiments on animal models have shown that the electrical currents have the property to AOTM. Electrical currents generate piezoelectricity or direct current which enhance the rate of orthodontic tooth movement. The main disadvantage of this procedure is that the devices that produces these piezoelectricity or direct current are bulky limiting its use in normal clinical practice [17].

C. Drugs

Several drugs have been tried to accelerate the orthodontics tooth movement and many have achieved that goal. These includes drugs like Analgesics like NSAIDs [18], vitamin D [19], fluorides [20], and Bisphosphonates [21]. Hormones like estrogens [22], thyroid hormones [23], relaxin [24], Calcitonin, Parathyroid hormone [25], corticosteroids [26], prostaglandins, Interleukin antagonists, TNF- α antagonists and Echistatin and RGD peptides [27] have also been tried to increase the tooth movements. Immunomodulatory drugs like leflunomides [28], anticancer drugs like cyclophosphamide [28], anticonvulsants drugs like phenytoin [29] and immunosuppressants drugs like cyclosporine A [30] have also been tried to reduce the orthodontic treatment timing.

An animal study by Kaipatur *et al*, published in 2013 have concluded that the use of bisphosphonates can produce bone burden which will significantly inhibit the orthodontic tooth movement [31]. A recent study by Abtahi *et al* reported that the treatment with triamcinolone acetonide have shown to increase the tooth movement due to the increased resorptive activity in the alveolar bone [32]. A recent animal study by Akhouni *et al* concluded that the use of valproic acid and carbamazepine can reduce the density of the bone which can in turn accelerate the tooth movement [33]. A recent systemic review by Corrêa *et al* have concluded that the use of paracetamol to increase the orthodontic tooth movement have less influence [34]. The main disadvantages of the use of drugs in orthodontic treatment is the side effects of the drug used. Therefore, it is important for the orthodontists to pay attention to the drug history of each patient before starting the orthodontic treatment.

Conclusion

The concept of accelerating the orthodontic tooth movements have been gaining importance in the recent years. Lot of techniques have been proposed till now. Even though the use of LLLT and Piezocision techniques are gaining importance because of many positive studies, there is no single method that is universally accepted. Further randomized controlled studies are required to end the search for a universally accepted protocol for AOTM.

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