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REVIEW ARTICLE

ACCELERATED ORTHODONTICS: A REVIEW

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ABSTRACT

Orthodontic treatment is a long and a complex procedure. During an orthodontic tooth movement, certain mechanical, chemical and cellular events takes place in teeth and its surrounding tissues allowing structural changes that cause orthodontic tooth movement. There is an increase in number of adult patients seeking orthodontic treatment in last three decades. Esthetics being their primary concern and secondary being short treatment period. So accelerating tooth movement is gaining more importance in orthodontic practice and many studies are being done. A brief review is discussed in this article.

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INTRODUCTION

Orthodontic treatment is a long and a complex procedure. During an orthodontic tooth movement, certain mechanical, chemical and cellular events takes place in teeth and its surrounding tissues allowing structural changes that cause orthodontic tooth movement. The basic mechanism is such that on the pressure side there is resorption which creates the space necessary for tooth movement and simultaneous deposition on the tension side to heal the path of the advancing socket. The commencement of tooth movement is marked by an acute inflammatory response accompanied by the vasodilation of the surrounding tissues. As the complete maneuver of orthodontic movement by cellular activities remains a mystery, a recent research has duly discovered some factors like cyclic adenosine monophosphate (cAMP), calcium, collagenase, and prostaglandins (PGs) which play an important role in tooth movement.

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Taking the above factors into consideration the following methods were introduced to accelerate the tooth movement and thus shorten the duration of treatment time. They are broadly classified into

1. Invasive methods
2. Non-invasive methods

Invasive methods	Non-invasive methods
Corticotomy	Laser
Piezocision	Photobiomodulation
Piezopuncture	Vibration
Micro-osteo perforations	Drugs
Distraction osteogenesis	Platelet rich plasma

Corticotomy and corticision

Brought into picture by L.C. Bryan in 1893. He proved that Corticotomy-facilitated tooth movement was indeed possible and was the first one to describe it. The conventional corticotomy procedure involves the usage of micromotor for executing the corticotomy cuts under continuous irrigation after the elevation of a full thickness of the mucoperiosteal flaps which may either be on the buccal and/or lingual segment.

Sometimes when the augmentation of bone is needed graft placement is also advised along with the corticotomy cuts. Heinrick Köle's combined radicular corticotomy/supraapical osteotomy technique which was first described in 1959[1] still remains popular till date as the currently used corticotomy procedures, which may be modified but are still on based on the same Heinrick Köle's ideology. In 2001, Wilcko *et al* 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 (Wilcko *et al*., 2001). The total treatment time was reduced to one-third to one-fourth that of traditional nonextraction and extraction orthodontic treatments (Hajji, 2000). The main idea on which corticotomy works is the intentional induction of the acute inflammatory process leading to increased levels of inflammatory mediators like prostaglandins, cytokines etc which in turn increases the rate of tooth movement.

Piezocision & piezopuncture

Reflecting the full thickness flap for the purpose of corticotomy was considered too invasive to overcome this drawback Dibart *et al* in 2009, introduced a flapless method of corticotomy, using piezosurgery (Dibart *et al*., 2011). In the technique described by them, the surgery was performed 1 week after placement of orthodontic appliance, under local anesthesia. Gingival vertical incisions, only buccally, were made below the interdental papilla, as far as possible, in the attached gingiva using a No.15 scalpel.

The main objective in this procedure was to make an incision deep enough so as to pass through the periosteum and contact the cortical bone. A BS1 insert Piezotome was used to perform the corticotomy cuts through the incisions made to a depth of 3mm. Once again if the bone reinforcement is required it can be done so by using an elevator at the areas requiring bone augmentation. The elevator is inserted between the incisions to create "tunnels" to establish sufficient space to accept the graft material. Suturing is not usually required unless the graft materials need to be stabilized. Patient is placed on an antibiotic, mouthwash regimen. Piezopuncture also gave similar results but with lesser insult to the bone and surrounding tissue (Young-Seok Kim *et al*., 2013).

Microosteoperforations

To achieve an orthodontic movement quick enough with minimum invasion in the surrounding tissues of the bone Propel Orthodontics introduced a device called "Propel". They literally puncture the bone to speed up the tooth movement, as various studies have already proven the positive outcome of micro-osteoperforation. They called this process as Alveocentesis, in the literal sense. (Alikhani *et al*., 2013) Micro-osteoperforations stimulates the expression of inflammatory markers, leading to increase in the osteoclastic activity which in turn leads to the increase rate of the tooth movement.

This device comes as ready-to-use sterile disposable device. The device has an adjustable depth dial and indicating arrow on the driver body. The adjustable depth dial can be positioned to 0 mm, 3 mm, 5 mm, and 7 mm of tip depth, depending on the area of operation.

Distraction osteogenesis

Distraction osteogenesis was used as early as 1905 by Codivilla1 and was later popularized by the clinical and research studies of Ilizarov (1988) in Russia. A detailed procedure was given by Iseri *et al*. (Haluk I˙s¸ eri *et al*., 2005; Kis¸nis¸ci R *et al*., 2002). A horizontal mucosal incision was made parallel to the gingival margin of the canine and the premolar beyond the depth of the vestibule. Cortical holes were made in the alveolar bone with a small, round, carbide bur from the canine to the second premolar, curving apically to pass 3 to 5 mm from the apex. A thin, tapered, fissure bur was used to connect the holes around the root. Fine osteotomes were advanced in the coronal direction. The first premolar was extracted and the buccal bone removed between the outlined bone cut at the distal canine region anteriorly and the second premolar posteriorly. Larger osteotomes were used to fully mobilize the alveolar segment that included the canine by fracturing the surrounding spongious bone around its root off the lingual or palatal cortex. The buccal and apical bone through the extraction socket and the possible bony interferences at the buccal aspect that might be encountered during the distraction process were eliminated or smoothed between the canine and the second premolar, preserving palatal or lingual cortical shelves. The palatal shelf was preserved, but the apical bone near the sinus wall was removed, leaving the sinus membrane intact to avoid interferences during the active distraction process. Osteotomes along the anterior aspect of the canine were used to split the surrounding bone around its root from the palatal or lingual cortex and neighboring teeth. The transport dentoalveolar segment that includes the canine also includes the buccal cortex and the underlying spongy bone that envelopes the canine root, leaving an intact lingual or palatinal cortical plate and the bone around the apex of the canine. The incision was closed with absorbable sutures, and an antibiotic and a nonsteroidal anti-inflammatory drug were prescribed for 5 days. The surgical procedure lasted approximately 30 minutes for each canine.

Laser and Biostimulation

It is well known that LILT can reduce discomfort and pain promoted by trauma or even by the forces applied on the teeth by a biostimulation effect in the irradiated area. This stimulation could also increase bone repair, which can be considered a way to accelerate post-surgery, orthopedics or implant procedures (Delma R. Cruz *et al*., 2004). Increased osteoblastic and osteoclastic activity after low-level laser therapy was observed in vivo and in vitro. The mechanism involved in the acceleration of tooth movement is by the production of ATP and activation of cytochrome C, as shown in that low-energy laser irradiation enhanced the velocity of tooth movement via RANK/RANKL and the macrophage colony-stimulating factor and its receptor expression. Some authors have analyzed the effects of LILT during orthodontic treatment in animals. Saito and Shimizu (1997) studied the effects of LILT on the expansion of midpalatal sutures in rats, comparing the bone regeneration obtained with and without laser treatment. Their results showed that the therapeutic effects of laser are dependent on the total dosage, the frequency, and the duration of the treatment. Their laser irradiated group showed 20–40% better results when compared to the CG. In another study, Kawasaki and Shimizu (2000) showed that the orthodontic movement of laser irradiated rats teeth was 30% quicker than the non-irradiated rats, due to

acceleration of bone formation as a result from the cellular stimulation promoted by LILT.

Biostimulation effects on the bone repair are directly dependent on the dose applied (Freitas *et al*., 2000). Different parameters have proven to be effective for several different lasers, inducing changes within cell cultures and leading to an increased healing effect. Nevertheless, the optimal parameters have yet to be determined (Baxter, 1994; Schindl *et al*., 2000). Luger *et al*. used doses of about 64 J/cm2 during 14 days and although this dose could be excessive within the focused area, the authors believe that the scattering reduces the energy level of the laser beams to between 3% and 6% of its original intensity (Luger *et al*., 1998). In this study, the dose of 5 J/cm2 at each of the different points around the tooth is lower than the used by Luger *et al*. (64 J/cm^2), but the distribution of energy into ten points surrounding the canine teeth could be more adequate due to a more homogeneous distribution of the energy. Vibration- Nishimura *et al*. (Makoto Nishimura *et al*., 2008) have clearly demonstrated the stimulatory effects of resonance vibration in accelerating the speed of tooth movement with no collateral damage to periodontal tissues. In addition, we have demonstrated the activation of the RANK RANKL signaling pathway in response to the loading of resonance vibration. It was reported that signaling molecules, such as c-fos, MAPK, and nitric oxide are increased in the PDL immediately after mechanical stimulation. Therefore, we considered it possible to activate PDL cells using an initial short-term stimulation (Yamaguchi *et al*., 2002; Matsuda *et al*., 1998; Kikuiri *et al*., 2000). Recently, a product by the name Acceledent has arrived at the market, which makes use of this technology. This device consists of an activator, which is the active part of the appliance that delivers the vibration impulses with a USB interface through which it can be connected to a computer to review the patient usage of the appliance, a mouthpiece that contacts the teeth. It is a portable device that can be charged similar to any other electronic device, and has to be worn for 20 minutes a day. Various case studies using this device have shown the treatment times to be reduced by up to 30-40%.

Drugs

During orthodontic treatment, drugs are prescribed to manage pain from force application to biological tissues, manage temporomandibular joint (TMJ) problems and tackle some infection throughout the course of treatment. Apart from these drugs, patients who consume vitamins, minerals, hormonal supplements, and other compounds for the prevention or treatment of various systemic 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.

Platelet rich plasma

Peripheral blood contains 94% of red blood cells (RBCs), 6% of platelets, and <1% of white blood cells (WBCs), while PRP contains 5% of RBCs, 1% of WBC, and 94% of platelets. PRP has been applied in dentistry for its capability of enhancing osseointegration of a dental implant and augmentation of alveolar bone height in maxillary sinus lift a suitable PRP for orthodontic purposes should be injectable and has a long lasting effect. To develop an injectable PRP with a prolong effect on the target tissue, a simple approach is to prepare the PRP without mixing with $CaCl_2$ and thrombin, so that it could be maintained in a liquid form and be injectable. A single injection of PRP lasts for 5–6 months clinically. It has been observed clinically that the fastest rate of acceleration is during the second to fourth month after the injection. The submucosal injection of PRP is a clinically feasible and effective technique to accelerate orthodontic tooth movement and at the same time, preserve the alveolar bone on the pressure side of orthodontic tooth movement, and the optimal dose of PRP for the best clinical performance is 11.0–12.5 folds.

Drugs increasing rate of tooth movement	Drugs decreasing rate of tooth movement
Prostaglandins	NSAID's
Vitamin D	Fluorides
PTH	Bis-phosphonates
Thyroid hormone	Estrogen
Corticosteroids Relaxin	Calcitonin
No effect on tooth movement-Acetaminophen	

Conclusion

As the human race is getting wiser and smarter, their needs keep increasing and the same goes in the field of orthodontics. The patients want to look better in the most obvious way and also demand a shorter duration of the treatment. This has been made possible by the advancing technology in our grounds by various methods like through an invasive way- Corticotomy, Piezocision, Piezopuncture, Micro-osteo perforations, Distraction osteogenesis and also through a non-invasive way- Laser, Photobiomodulation, Vibration, Drugs, Platelet rich plasma. With time there will surely be more advances but till then we have prepared a faster route to improve the way our patients look by the faster means of tooth movement.

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