



ACCELERATING ORTHODONTIC TOOTH MOVEMENT – A REVIEW

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ABSTRACT

Wilckodontics combines two major philosophies of orthodontics. The mechanical nature i.e. the brackets and wires and the biological/ augmentative nature i.e. the bone and gums around the teeth. The amalgamation of these philosophies has resulted in a new orthodontic treatment named as "Accelerated Osteogenic Orthodontics." Methods of accelerating orthodontic tooth movement (AOTM) can be broadly categorized into biological, physical, biomechanical, and surgical approaches. It is useful in adult patients due to increase chance of hyalinization during treatment whereas the cell mobilization and conversion of collagen fibers is much slower in adults when compared to children and are more prone to periodontal complications as the teeth are confined in non-flexible alveolar bone. Long term follow up studies need to be performed to evaluate the effectiveness of different AOTM procedures in terms of retention and stability.

KEYWORDS : Accelerating Orthodontic Tooth Movement, Platelet Rich Plasma, Cyclic Vibrations, Microosteoperforations, Corticotomy.

INTRODUCTION

Greater development in Orthodontics has been achieved by obtaining the desired results both clinically and technically by using new technologies, like stimulation software that can assist in treatment planning and translational products. In addition, greater improvements with the use of modified wires and brackets as a result of the biomechanical efficiencies in orthodontics has greatly improved. Hence the need to develop new methods to accelerate teeth movement has been put forth. A number of attempts to achieve quicker results have been made to create different approaches both preclinically and clinically but still there are a lot of uncertainties and unanswered questions towards most of these techniques.

METHODS OF ACCELERATING ORTHODONTIC TOOTH MOVEMENT (AOTM)

Methods of (AOTM) to can be broadly studied under the following categories:

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

Surgical Methods

Direct injury to alveolar bone by (AOTM) induces regional acceleratory phenomenon (RAP), as a wound healing process, which is based on clinical procedures such as corticotomy-assisted orthodontics, Piezocision-aided orthodontics, and surgery-first orthodontics¹. 2. Bichlmayr³ introduced a surgical technique for hasty rectification of severe maxillary protrusion with available orthodontic appliances. Kole⁴ suggested a technique of creating bony blocks through the corticotomy to enhance the faster tooth movement. For the next 50 years this concept prevailed until Wilcko and co-workers⁵, reported a transient demineralization remineralization procedure enchanting after corticotomy, which was termed as a periodontally accelerated osteogenic orthodontics (PAOO).

1. Inter-septal Alveolar Surgery

Inter-septal alveolar surgery or distraction osteogenesis involves controlled and gradual displacement of surgically

created fractures which is termed as sub-periosteal osteotomy that results in simultaneous expansion of bone volume and soft tissue due to mechanical stretching of the osteotomy site by incremental traction. It is divided into the distraction of the dentoalveolar bone or distraction of periodontal ligament⁶.

2. Corticotomy

Based on interseptal alveolar surgery, due to reduced resistance of the bone the compact bone is replaced by the woven bone and tooth movement is easier and quicker. It was found that especially in the first week these rapid movements are during the initial phases of tooth movement. In some cases rapid canine distraction may be performed by the same principle of the distraction of periodontal ligament with the addition of more dissection and osteotomies performed at the vestibule⁷. Studies conclude that there is reduction in treatment time by 28%-33% and a 2-3-fold increase in velocity of tooth movement when compared with conventional orthodontic tooth movement⁸⁻¹¹.

3. Corticision

Kim¹² and co-workers established a technique called corticision with minimal surgical intervention also called as minimally invasive rapid orthodontics. Corticision was initiated to achieve AOTM as a supplemental dentoalveolar surgery in orthodontic therapy with minimal surgical intervention. Numerous clinical studies concludes corticision as effective as corticotomy in (AOTM) with an advantage of being less invasive.

4. Piezocision

It is a minimally invasive flapless procedure that involves piezo surgical cortical micro incisions with selective tunnelling that allows soft tissue or bone grafting. Vercelotti and Podesta¹³ create an environment conducive for the rapid tooth movement by established the use of piezo surgery instead of burs, in conjunction with the conventional flap elevations. Dibart and colleagues^{14, 15} introduced a minimally invasive flapless procedure and concluded that Piezocision allows (AOTM) without the drawbacks of traumatic conventional corticotomy procedures in severe

malocclusion cases.

5. Microosteoperforations (MOPs)

A device called Propel TM, was launched by Propel Orthodontics to further reduce the invasive nature of surgical irritation of bone and was popularized as alveocentesis, which literally means puncturing bone¹⁶. This device has an adjustable depth dials at 0 mm, 3 mm, 5 mm, and 7 mm of tip with depth indicating arrow on the driver body. MOPs should be close to the target tooth to get increased recruitment of osteoclasts (catabolic effect), deep perforations are required (5–7 mm), where increased recruitment of osteoblasts is required (Anabolic effect) then shallow perforations (1 mm) spread over a large area is required.

Device assisted therapy or mechanical stimulation methods Direct electric currents, low level laser therapy, static magnetic field, resonance vibration and pulsed electromagnetic field, were the methods used to accelerate tooth movement. The concept of using physical approaches causes bone bending (bone bending theory) and development of bioelectrical potential by applying orthodontic forces. With the application of discontinuous forces the bioelectrical potential is created, which leads to the idea of trying cyclic forces and vibrations.

1. Direct Electric Current

Direct electric current was placed in the extracted tooth region by an electric appliance to generate bioelectric potentials causing local responses and acceleration of bone modelling. An effective tooth movement was found by the similar procedure performed by some researchers on living animals. Subsequently, Kim¹⁷ found 30% acceleration of tooth movement in comparison to conventional technique by performing a clinical trial on humans.

2. Cyclic Vibrations

The cyclic vibratory method works by using light alternating forces on the teeth via mechanical radiations (Kau et al., 2010)¹⁸. The initial response of cells occurs within 30 minutes to mechanical stress in vitro. Researchers have carried out numerous clinical trials on human population by using oral vibrating devices such as Acclident TM® and electric tooth brushes and found it to be effective in (AOTM).

3 Low-level Laser Therapy (LLLT)

Photo bio modulation or (LLLT) is one of the most promising approaches today. (LLLT) stimulates the proliferation of osteoclast, osteoblast and fibroblasts, and thereby affects bone remodelling and accelerates tooth movement. The mechanism involved is by the production of ATP and activation of cytochrome C that improves the velocity of tooth movement via RANK/RANKL and the macrophage colony-stimulating factor and its receptor expression. Studies performed by numerous investigators found LLLT has the potential to increase the rate of tooth movement.

Drugs

Various drugs like parathormone, vitamin D, prostaglandins and relaxin etc. are used since long to (AOTM), and have achieved successful results. But, all of those drugs have some or the other unwanted adverse effect. For example, vitamin D when injected within the PDL increases the levels of CPK and LDH enzymes; prostaglandin causes a generalized increase in the inflammatory state and causes root resorption. Hence, as of today, no drug exists which safely (AOTM) ¹⁹.

1. Parathyroid Hormone (PTH)

It causes absorption of calcium ions from bone and results in bone resorption. This mechanism takes advantage of (AOTM). Soma²⁰ and co-workers conducted experiments on rats and suggested that continuous administration of PTH results in accelerating orthodontic tooth movement.

2. Vitamin D

Vitamin D has similar function as that of (PTH) by calcium reabsorption. 1, 25 dihydroxy vitamin D₃, is the active form of vitamin D that act on small intestine and causes calcium reabsorption. It has a similar action on bone resulting in bone resorption.

3. Prostaglandins (PGE)

Yamasaki²¹ and colleagues studied the effect of PGE in animal models by local administration and performed a clinical trial on humans and concluded that local administration of PGE, may cause safe and effective orthodontic tooth movement. Selfi²² and associates investigated PGE₂ in association with the calcium ions in controlling root resorption whereas significant (AOTM)

4. Relaxin

Authors concluded that the human relaxin might not (AOTM) in rats, as studies were performed on animal models; it can reduce the amount of PDL, reduce the mechanical strength of PDL, and increase mobility of the tooth at early time points. Mc Gorry²³ and associates found in clinical trials that local doses of relaxin might be too low to (AOTM) or short term relapse.

Platelet Rich Plasma (PRP)

For orthodontics, an injectable form is considered more suitable without the use of calcium chloride and thrombin to maintain it in liquid form for a longer lasting effect²⁴. Application of PRP in orthodontics has a potential to (AOTM), accelerate wound healing and reducing post-surgical pain in patients treated with (PAOO). It is also used to potentially promote bone formation in alveolar cleft repair patients²⁵.

CONCLUSION

The overall comprehensive orthodontic treatment time may be reduced by (AOTM) facilitated surgically. Current literature indicates different procedures might reduce the overall treatment time but further controlled trials are required to raise the level of the evidence in support so as to be used routinely with prescribed practice guidelines that may enhance the overall treatment outcome.

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