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ACCLERATED ORTHODONTICS – A REVIEW

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Review Article

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Abstract:

Orthodontic treatment faces major challenges considering the treatment duration because prolonged treatment time causes problems like discomfort to the patient as well as periodontal diseases, caries, root resorption. Various methods like surgical, mechanical/physical stimulation, drugs have been introduced to accelerate orthodontic treatment , these procedures allow structural alteration and help in tooth movement. These methods proved to reduce treatment time. Hence, this article reviews various methods to accelerate orthodontic treatment.

Keywords: accelerated orthodontics, surgical approach, accelerated.

INTRODUCTION

In orthodontics, treatment duration is a one of the major challenges that needs to be given attention because patients will be willing to seek orthodontic treatment if the treatment duration is favourable. Various methods have been introduced to accelerate the tooth movement as prolonged treatment duration causes inconvenience to the patients and may also cause periodontal complications, caries and root resorption.[1]

Different methods of Accelerated orthodontics:

1. Biologic approach.

2. Surgical approach.
3. Device assisted / mechanical stimulation.

Biologic approach:

Several experiments have been carried out on different molecules like prostaglandin E, cytokines, Receptor activator of nuclear factor kappa B ligand (RANKL), (MCSF), vitamin D3, parathyroid hormone etc to accelerate the velocity of tooth movement.[2-4]

Cytokines

Cytokines aid in accelerationof the tooth movement by changing the procedure of bone remodelling and inflammatory process during the time of tooth movement. They assist in differentiation, activation, and apoptosis of bone and PDL cells.[1]

IL-1, IL-2, IL-3 IL-6, IL-8, and tumor necrosis factor alpha (TNF) play major role in process of remodelling, IL-1 stimulates the action of osteoclasts through its receptors. Along with Interleukins and TNF alpha, RANKL present on the osteoblasts binds with RANK on the osteoclasts and causes osteoclastogenesis**.**[5]

Inhibition of this osteoclastogenesis is carried out due to binding of Osteoprotegerin (OPG) to the binding site as it competes with RANKL. This processes maintains equilibrium between RANKL, RANK and OPG during bone remodelling.[6,7]

Prostaglandins-

Prostaglandins (PGs) are a type of inflammatory mediator. PGs increase the osteoclastic activity and stimulate osteoblastic cell proliferation. Studies evaluating PGs' effects on OTM acceleration and root resorption have mostly been conducted on animals. In these studies, PGs have reportedly increased OTM speed 1.6 times more than control side.[8]

Vitamin D3

Vitamin D has similar function as parathyroid hormone by calcium reabsorption. 1,25 dihydroxy vitamin D3, is the active form of vitamin D that act on small intestine causing calcium reabsorption. It has a similar action on bone and thus leads to bone resorption. Local administration of vitamin D in to PDL causes increase in LDH and CPK enzymes.[9] It was observed that the number of osteoclasts on the pressure side, which was reinforced by vitamin-D was more than on the PGE2 side, indicating that vitamin-D plays a major role in bone turnover.[10]

Parathyroid hormone

PTH stimulates bone resorption, which results in an increase in the calcium concentration in the blood. Bone resorption occurs as a result of continuous elevation of PTH. Local administration of PTH is more useful than systemic administration, as locally administered PTH causes local bone resorption. PTH can also be used in an injectable gel form for slow release as local application of it increases the rate of tooth movement by 1.6 times when compared to daily injection of PTH dissolved in saline. This occurs in a dose dependent manner.[11]

Chemokines

These are heparin binding cytokines. They activate the osteoclast and increase bone resorption leading to acceleration of tooth movement

Osteocalcin

Histological findings indicate that osteocalcin increases the number of osteoclasts. On local administration OTM was accelerated by the effect of osteocalcin due to the enhancement of osteoclastogenesis on the pressure side.[12]

Growth factor

Growth factors are substances that engage to specific receptors present on the surface of their target cells, stimulating cell proliferation, migration and differentiation. GF acts locally affecting the remodeling of the bone and also orthodontic tooth movement.[1]

Thyroxin

It affects the calcium absorption process in the intestines. It enhances bone resorption causing an increase in the rate of tooth movement. It has an indirect effect on the bone turnover and osteoporosis induction.[1]

Relaxin

It causes widening of the pubic ligaments in women during parturition. It is also present in cranial sutures and PDL. Relaxin causes remodeling of soft tissue rather than the bone tissue. The rate of tooth movement is increased as the amount of collagen is increased on the tension side. The remodeling of PDL by relaxin might reduce the rate of relapse after orthodontic treatment.[13]

Surgical approach:

It is a clinically effective technique used for adult patients, where duration of orthodontic treatment may be critical. Periodontal ligament (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. Several surgical approaches that have been tried in order to accelerate tooth movement are.[14]

Corticotomy

Corticotomy is the procedure in which there is a cut and perforation given involving only the cortical bone as this will accelerate the tooth movement as it will reduce the reisitance caused by cortical bone.It was first tried in orthodontics by Kole.The bony blocks that are created as a result of the corticotomy, cause faster tooth movement.[15]

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.[16]

Advantages-

Bone can be augmented as a result of which periodontal defects can be prevented. Orthodontic treatment duration is decreased. Root resorption is known to be very less. There was change in cephalometric positions of point A and point B. AOO procedure can be used to treat fenestrations over the root prominences. Comparable tooth movements are accomplished in 2 weeks as compared to 6- to 8- week intervals of conventional orthodontics.

Disadvantages –

High rate of morbidity, invasive procedure, risks similar to other surgeries, damage to surrounding vital structures, post-operative pain, swelling, infection and necrosis of tissues, expensive procedure.

Corticision

corticision which is also known as minimally invasive rapid orthodontics(MIRO) was established by Kim and his coworkers. In orthodontic therapy it was initiated as a supplemental dentoalveolar sugery with less surgical intervention.

Procedure: Separation of the inter-proximal cortices with a reinforced scalpel is used as a thin chisel and a mallet transmucosally without reflecting a flap. With 45°-60° an inclination to the gingiva at the long axis of the canine a reinforced surgical blade with a minimum thickness of 400 µm should be located on the inter-radicular attachment.The surgical injury should be 2 mm from the papillary gingival margin in order to preserve the alveolar crest and should be 1 mm beyond the mucogingival junction. The blade should be pulled out by a swing motion. Studies concluded corticision effectively fastens tooth movement similar to corticotomy and is advantageous because of its less invasiveness.[17,18]

Piezocision

Piezocision is a procedure which is a combination of piezosurgical cortical microincisions with selective tunnelling that helps in soft tissue or bone grafting.Dibart et al introduced piezocision which was minimally invasive. The micro incisions were limited to the buccal gingiva for the use of piezoelectric knife to give osseous cuts on buccal cortex to initiate RAP. This technique allows rapid tooth movement by maintaining benefits of soft tissue or grafting associated with a tunnel approach and there is no suturing required.[19,20] They later combined this technique with invisalign and found to be more effective and esthetic.

Micro-Osteoperforations (MOPs)

Propel orthododntics launched a device called PropelTM which reduced the invasive nature of surgical irritation of bone and the procedure was popularized as alveolocentesis which means puncturing of bone. The device which comes as sterile disposable device consists of an adjustable dept dial which can be adjustable at 0 mm, 3 mm, 5 mm, and 7 mm of depth and also an indicating arrow. The soft tissue flap in premolar and molar region is raised and about 0.25mm perforations are made using round bur. Alikhani et al. reported that MOPs increased the rate of movement by 2.3 times compared to the unaffected tooth in humans.[21,22]

Inter-septal alveolar surgery

This is also called as distraction osteogenesis as it involves displacement of fractures that are created surgically in a controlled and gradual manner and is termed as sub-periosteal osteotomy by incremental traction as it leads to expansion of soft tissue and bone volume because of mechanical stretching of the site. It is divided into the distraction of the dentoalveolar bone or distraction of periodontal ligament.[23]

Procedure: the interseptal bone distal to canine is undermined by 1 to 1.5mm surgically during extraction of first premolar resulting in reduced resistance on pressure site. A stainless steel custom made toothborn device is used for distraction. The surgery causes acceleration of the tooth movement especially in first week and also becomes easier because the compact bone is replaced by woven bone.[24] Studies showed due to reduced resistance the pathway of canine movement is more effective.

Device assisted / mechanical stimulation:

Electric current

Histological studies have shown that electric current leads to an increase in the number of osteoblasts owing to increased cellular activity in PDL.[25] Electric currents can cause certain complications like ionic reactions which leads to damage of tissues and displacement of the bone connective tissue. Kim et al. suggested that the exogenous electric current from the electric device might accelerate OTM by one third.[26] The current evidence about this is inadequate. Due to the reliability issue of this method, it does not seem applicable in humans at present.

Electromagnetic Field

Electromagnetic field increases the level of a group of enzymes responsible for the regulation of intracellular metabolism, therefore, cellular proliferation by altering the rate of sodium-calcium exchange in the cell membrane. Histological studies have shown that alveolar bone remodeling increases not only the bone cell activity in the magnetic field, but also the formation of new bone in the stress zone.[27]

Cyclic vibrations

Light alternating forces act on the teeth through mechanical radiations where the initial response to stress occurs within 30 min. Signals are transferred to the vibration controller through force sensor and accelerometer. These signals are then transferred to the vibrator which causes excitation. The acceleration is maintained at 1.0 meter per square second (m/s2). The top of the vibrator is fixed on the tooth with an adhesive. Studies showed effective increase in the rate of tooth movement.[28,29]

Low-level laser therapy

Photo biomodulation or low-level laser therapy (LLLT) is one of the most promising approaches today. Laser light stimulates the proliferation of osteoclast, osteoblast and fibroblasts and thereby affects bone remodelling and accelerates tooth movement. The mechanism involved in the acceleration of tooth movement is by the production of ATP and activation of cytochrome C[30] and improve the velocity of tooth movement via RANK/RANKL and the macrophage colony-stimulating factor and its receptor expression.

Studies showed LLLT has the potential to increase the rate of tooth movement. The variation amongst the studies seems to arise from variations in frequency of application of laser, intensity of laser, and method of force application on the tooth.[31]

Conclusion:

Now a days, we have methods and resources of superior quality which not only enable us to provide quick but also comfortable orthodontic treatment to both children and adults. Although these techniques have certain drawbacks associated with them, they are a step closer to quicker orthodontic treatment making them close to orthodontics success

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