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Orthodontic Movements Acceleration Auxiliaries – A Bibliographic Review.

Chinchillas-Ramírez Carlos Armando[1], Valenzuela-Ruiz Laura Roxana[2], Pérez-Cortez Guillermo[2], Gómez-Flores Mara[2], Hermida-RojasMaikel[2]

[1]*Dental Surgeon, Mexicali School of Dentistry, Autonomous University of Baja California, Mexico*
[2]*Associate Professor, Mexicali School of Dentistry, Autonomous University of Baja California, Mexico*
Corresponding Author: Chinchillas-Ramírez Carlos Armando

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ABSTRACT: Orthodontic treatments are one of the most solicited treatments in odonatological consultation and in the recent years there has been an increase in adults seeking for treatments in which aesthetic and duration of treatment play a major role, that's the reason why patients want to have a faster treatment and there is where orthodontic movements accelerators come to solve that problem. The objective of this bibliographic review is to give the reader the knowledge of the most effective techniques that can help improve orthodontic movements in order to help them make a decision on which treatment can help them the most to satisfy all patient´s needs. A total of 24 articles searched in medical databases were review to analyze the options that a dentist has to offer the patients that are looking for a faster orthodontic treatment which resulted in numerous alternatives that include invasive treatments (surgical), non-invasive treatments (non-surgical) and biological factors for orthodontic movements improve. Resulting in surgical orthodontic movements accelerators being the most efficient, studied and used auxiliaries to shorten duration of treatments but having the disadvantage of involving trauma and time of recovery to patients, in the other hand non-invasive treatments are very promising but future studies have to be made..

KEYWORDS: Accelerated orthodontics, Accelerated orthodontic treatment, invasive orthodontic teeth movement accelerator, non-invasive orthodontic teeth movement accelerator.

I. INTRODUCTION

Orthodontics is defined as an odontology discipline dedicated to detect, analyze problems of malocclusions or malfunctions in the stomatognathic system in order to solve them and make a treatment plan. The necessity of a short duration treatment in all patients specially grown ones has made specialist seek for auxiliaries to shorten treatment time in order to satisfy the patient´s necessities. Orthodontic movements accelerators techniques are defined as all the invasive (surgical) and non-invasive (non-surgical) methods that improve teeth movement through the dentoalveolar complex and they have come to solve those time problems.

The average orthodontic treatment time takes from 18 to 24 months if the patient follow all instructions and is disciplined, if not, the treatment can take longer than usual. (1) Orthodontic treatments often involve a long period of time to achieve it´s final goal, that process usually represents an obstacle for patients. (2)

In recent years there has been an increase of adult patients seeking for treatments not only for the necessity of malocclusion correction but also for aesthetic reasons and due to the common thinking that braces are only for adolescents they are looking for a faster treatment.

Having all these reasons in consideration motivated to make a bibliographic review in order to know what are the alternatives that dentist have to offer patients in order to satisfy their needs and give them the best option personalized to each one of the people that seeks for professional help. (3)

One of the main preoccupations of a patient in an orthodontic treatment is how to reduce treatment time. Surgical techniques used to shorten treatments induce local trauma into the bone, increasing healing activity and because of that, dental movements are faster. (4) Non-surgical techniques seek to have the same effect on orthodontic movements, one of the main advantages of orthodontic treatments compared to other dental treatments is being a non-invasiveness treatment, because of that is that non-invasive techniques for the acceleration of teeth movements have been studied. (5)

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II. MATERIAL AND METHOD

Multiple articles and literature using medical databases like PubMed and Google scholar from the year 2012 to 2022 and one from 2008 were reviewed using the key worlds "accelerated orthodontics", "accelerated orthodontic movement", "invasive and non-invasive teeth movement acceleration" to make a systematic review to compare all the different points of view of all the alternatives to make an orthodontic treatment shorter.

24 articles were found, all of them were included and had the necessary information to be able to carry out the documentary research.

III. DEVELOPMENT

Fig 1.- The orthodontic treatment. Source: Mexicali School of Dentistry.

Orthodontic tooth movement.

When a tooth is loaded with an orthodontic force it compresses the periodontal ligament (PDL) in some areas and in the other side of the PDL it exerts tension, this makes that blood flow decreases in the compression sides and increases on the tension one, causing an alteration in oxygenation of tissues promoting bone resorption on the compression side due to osteoclasts and bone formation on the tension side due to osteoblasts. [1]

The movement of teeth in an orthodontic treatment is due to a combination between dentoalveolar complex adaptations to mechanical tension that does a little reversible injury to periodontium. There are 3 phases in the teeth movement, first there is a fast movement in the PDL after the application of the orthodontic mechanic force, after 24 to 48 hours there is a lag period where there is necrosis and hyalinization in the PDL and alveolar bone due to the mechanical stress and thus minor movement, this stage lasts between 20 and 30 days, and lastly there is a phase where bone remodeling occurs, there is osteoclastic activity in the compression side of the PDL and osteoblastic activity in the tension one followed by an angiogenesis process, the movement increases gradually or suddenly and this process repeats during the orthodontic treatment. [6, 7]

Biological factors

There have been several experiments done in humans and animal trying diverse molecules to accelerate teeth movement.

1. Cytokines:

They help in acceleration of teeth movement due to their capacity to change the procedure of bone remodeling and inflammatory process, also assisting in different behaviors of PDL and bone cells. [8]

High concentrations of this molecules has been found to be present in bone remodeling. They have numerous benefits in teeth movement as they can stimulate osteoclast function and can also promote osteoclastogenesis. [6]

2. Prostaglandins.

Prostaglandins have shown to increase orthodontic tooth movements by 1.6 times more than normal movements, they mediate inflammatory process increasing osteoclastic activity and stimulating osteoblasts proliferation. [8]

Based on experiments on rats the use of prostaglandins have shown that it can cause the same amount of acceleration of tooth movements no matter how many times they were injected or

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the concentration of prostaglandin, but there has been a relation between the times prostaglandin was injected or concentration and root resorption but if it is administrated in the presence of calcium it stabilizes root resorption while accelerating tooth movement. [6]

3. Vitamin D3.

Dihydroxy vitamin D3 is a form of vitamin D present in the small intestine causing calcium resorption, in bone it can have a similar behavior and cause bone resorption. If it is administrated directly on the PDL it can increase the presence of osteoclast on the pressure side. [8]
It can accelerate tooth movement by 60%. [6]

4. Parathyroid hormone.

When parathyroid hormone is elevated it can stimulate bone resorption when it is elevated continually elevating calcium concentration on blood. It is more effectively when administrated locally than systematic administration inducing local bone resorption and increasing by 1.6 times the tooth movement when it is used in an injectable gel than when it is used dissolved in saline. [8]

5. Relaxin.

Relaxin is a hormone that helps women widening the pubic symphysis when they give birth and also acts on soft tissue remodeling it, when it is used it elevates the presence of collagen on the tension side of the PDL and decreases it on the compression one. [6]

Invasive acceleration techniques.

There are also surgical techniques that makes teeth movement faster. The purpose of those techniques is to induce a faster PDL and alveolar bone remodeling, such purpose is achieved after bone grafting, fracture or osteotomy. [6]

1. Corticotomy.

In corticotomy procedures as the name says, the cortical bone is cut and perforated but not medullary bone. [6]
Selective alveolar decortication is a procedure that improves dental movement through alveolar bone reducing cortical bone density and making orthodontic moves easier [9] that movement is done because a reaction called regional accelerated phenomenon (RAP), a tissue reaction to a stimulus that increases the healing capacity in the affected sites [10] where the movements are due to a process where the bone remodelates itself at the surgical site. [6] The capacity of bone to regenerate after a corticotomy is about 10 to 50 times faster than regular bone, and depending on size or intensity of the stimulus it persist for months on the bone. [9] Bone will reduce its resistance caused by cortical bone. [8]

This procedure increases not only the amount of osteoclasts but also the activity in the zone and it also increases the apposition of cortical bone about 1 month after the surgery and stimulates trabecular bone formation 1.5 faster than normal. [11, 12]

2. Corticision.

Due to corticotomy´s invasiveness, procedures like corticision have been proposed to accelerate orthodontic movements. [9] In this procedure there is no need to open a flap, there is used a scalpel as a thin chisel separating interproximal cortices through the gingiva promoting anabolic remodeling activity. [13]

3. Piezocision.

This is one of the latest techniques described to accelerate tooth movement, in this procedure the first step is to make an incision on the buccal gingiva and then using the Piezo surgical knife to make incision in the buccal cortex to initiate RAP. Instead of making thick flaps only small vertical incisions are done to reach cortical of the bone making it a procedure where there is not damage to periodontum making it one of the techniques with better aesthetic. [6, 8, 11]

This is an innovative and minimally invasive procedure that offers less invasion to tissues due to its less traumatic surgical procedure. [14]

4. Micro osteoperforations.

This procedure being one of the less invasive treatments in order to make teeth movement faster. Transmucosal holes are made in the cortical bone, it is done with a special device called PropelTM without the necessity to lift a mucoperiosteal flap causing an increase in the osteoclast activity increasing the teeth movement by 2.3 times while conserving the integrity of the hard and soft tissues. [15, 4]

5. Inter septal alveolar surgery

Also called distraction osteogenesis generates new bone due to the distraction of the healing fractures in the alveolar bone after an osteotomy. [16]
In this procedure there is done a cut in the interseptal bone by 1 to 1.5 mm reducing the resistence on the site.

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Noninvasive acceleration techniques.

1. Electric current.

Electrical currents have also been used to accelerate orthodontic movements, electricity has the potential to stimulate osteogenesis. When applying a daily dose of 20 microamperes for 5 hours daily there was 30% more teeth movement. [17] Besides accelerated tooth movement there are also wider and more areas of bone deposition, as an increase of osteoblast on the tension side of the PDL. [5]

2. Electromagnetic field.

Due to magnetic fields there is an elevation in the activity of bone cells and bone deposition on the tension side of the PDL. Also it helps to differentiate cells into osteoblasts. [11] Only one study has been done to determinate the effectiveness of electromagnetic fields on orthodontic movements but it was poorly conducted, it showed that electromagnetic fields can elevate the teeth movement to 0.3 mm per month. [17]

3. Low-level laser therapy.

This method causes stimulation on cells increasing the proliferation and differentiation of osteoblasts, osteoclasts, fibroblasts and PDL cells thus accelerating teeth movement in an orthodontic treatment. [18, 8]

Also it has beneficial effects causing acceleration of the regeneration on soft tissues and bone, reducing pain due to fixed orthodontic appliances after the adjustment and reducing inflammation. [19, 20]

A poor study was once made but it showed that low level laser therapy increased tooth movement in 54%. [17]

This technique is very promising due to its no adverse effects in the human body. [21]

4. Resonance vibration.

Vibrations are applied to teeth and after 30 minutes, due to the vibration there is more expression of osteoclasts formation in the PDL increasing the tooth movement by 15%, having no collateral damage. [5]

IV. CONCLUSION

- Orthodontic treatments have emphasis on technology, (22) there are numerous of techniques to improve teeth movement in an orthodontic treatment, invasive methods consist most of the times on surgery and post recovery time showing a very high efficiency like corticotomy which stands as the most efficient surgical method for orthodontic movements acceleration. (23)
- Other treatments are less invasive like micro osteoperforations and they also show great results.
- With so much less invasive like low level laser therapy which positively affects bone remodeling and doesn't have cytotoxic effects on cells involved in teeth movements (24) we can promote a faster teeth movement.
- Each patient is different and we cannot offer everyone the same, we have to make a decision on which of the techniques is the best for our patients considering different factors in their environment that can affect the decision taken.

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