FAST TRACK ORTHODONTICS

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INTRODUCTION

The orthodontic patient's number one concern has always been "how long will I have to wear the braces for?" Recent developments in the field of orthodontics has made it possible to increase the speed and efficiency of orthodontic tooth movement such that there is a dramatic decrease in treatment time. Various pharmaceutical, surgical, mechanical/physical simulation methods have been utilized in an attempt to enhance the periodontium's response to orthodontic forces, and subsequently accelerate tooth movement.

BIOLOGICAL APPROACH

Exogenous M-CSF
(Brooks et al, 2011)

Vitamin D3
(Collins and Sinclair, 1988)

Prostaglandin E2
(Yamasaki et al, 1984)

Osteocalcin
(Kobayshashi et al, 1998)

Thyroxine
(Tyrovola and Spyropoulos, 2001)

Long term/High dose Corticosteroid Therapy
(Gonzales et al, 2009)

Local RANKL gene transfer
(Kanzaki et al, 2006)

Positive effects on osetoclastic numbers and activity on the pressure side

Positive effects on bone metabolism

Accelerates orthodontic tooth movement

Current orthodontic research aims to develop methods of increasing the tissue concentration of these molecules

As of now, no biologically active molecule exists that can safely accelerate tooth movement without causing side effects

Systemic delivery results in unwanted systemic adverse effects

Local delivery requires repeated painful injections of the biologically active molecule

ADVERSE EFFECTS

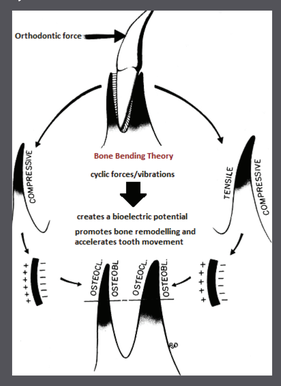
PROSTAGLANDINS
Root resorption with higher concentrations
Hyperalgesia on local injection

VITAMIN D3
Increased serum levels of LDH and CPK enzymes when injected in the periodontal ligament

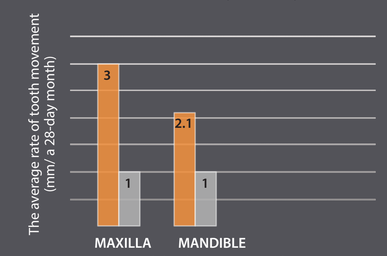
CORTICOSTEROIDS
Osteoporosis
Tooth movement is less stable

PHYSICAL/ MECHANICAL STIMULATION
(DEVICE ASSISTED)

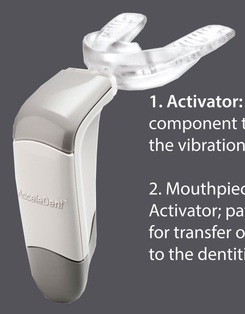
Cyclic forces/vibrations



The use of resonance vibration to accelerate orthodontic tooth movement in humans (Kau et al)



- Patients who used the device 20 mins/day at vibration rate of 20-30Hz
- Conventional wisdom regarding the normal rate of orthodontic tooth movement



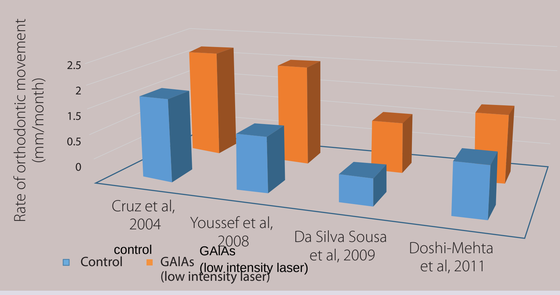
1. Activator: small extraoral component that generates the vibrational force

2. Mouthpiece: connects to Activator; patient bites onto for transfer of pulsing force to the dentition

Device, FDA approved since 2009

Low Level Laser Therapy (LLLT) - Photobiomodulation

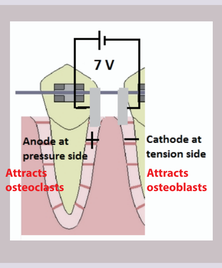
The results of human studies conducted to study effect of Low Level Laser Therapy on orthodontic tooth movement



Light Accelerated Orthodontics

FDA approved device which uses low intensity near infra-red light (850 nm continuous wavelength) technology to accelerate tooth movement by a factor of 2.29 times (Kau et al 2013), thereby reducing treatment time.

The effect of Direct Electric Current on orthodontic tooth movement (Davidovitch et al, 2009)



Result

- Accelerated bone remodeling
- Accelerated orthodontic tooth movement

Limitations of the study
Bulkiness of the devices and source of electricity – problematic to carry out the study in humans

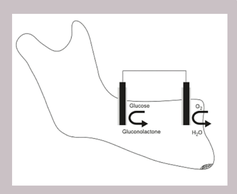
Potential solution
The development of **biocatalytical fuel cells**

Schematic diagram of a microfabricated fuel cell (enzyme battery) placed on the gingiva near alveolar bone.

Using an organic fuel and enzymes (biocatalyst), it generates electricity to accelerate orthodontic tooth movement:

$Glucose + O_2 \longrightarrow Gluconolactone + H_2O/H_2O_2$

Chemical energy $\longrightarrow$ Electrical energy



Limitations with the development of the fuel cell

Issues with:
- enzyme stability
- electron transfer rate
- enzyme loading

Which results in a battery with:
- a shorter lifespan
- poor power density

SURGICALLY ASSISTED ORTHODONTICS

Corticotomy facilitated orthodontics enables treatment to be completed in ⅓ to ¼ the time required for traditional orthodontics (Wilcko et al, 2009)

Rationale
Physical injury evokes a regional acceleratory phenomenon which results in temporary osteopenia responsible for the rapid tooth movement. (Dibart et al, 2010)

Corticotomy assisted orthodontics - Periodontally accelerated osteogenic orthodontics

- Involves the decortication of bone adjacent to malposed teeth (without entering cancellous bone) using slow speed. burs and irrigation, and particulate grafting (if required) in areas that have undergone corticotomy.
- Heavy orthodontic forces can be applied 1 week before to 2 weeks after surgery.
- Can reduce orthodontic treatment time by 75%, as well as increase the alveolar process width.

Indications and Clinical Applications

1. Resolve crowding and shorten treatment time
2. Accelerate canine retraction after premolar extraction
3. Enhance post-orthodontic stability
4. Facilitate eruption of impacted teeth
5. Facilitate slow orthodontic expansion
6. Molar intrusion and Open Bite correction
7. Manipulation of Anchorage

Complications and Adverse Effects

- Invasive
- Periodontal defects, slight interdental bone loss and loss of attached gingiva
- Some post-operative swelling and pain can be expected for several days
- Intensive corticotomies may result in subcutaneous hematomas of the face & neck

Not suitable for patients with active periodontal disease/ gingival recession

Wilcko brothers (late 1990s)

Park et al (2006)
Kim et al (2009)

Flapless corticotomy - Corticision

Involves the use of a reinforced scalpel and mallet to go through the gingiva and cortical bone without raising a flap bucally and lingually.

Drawbacks:

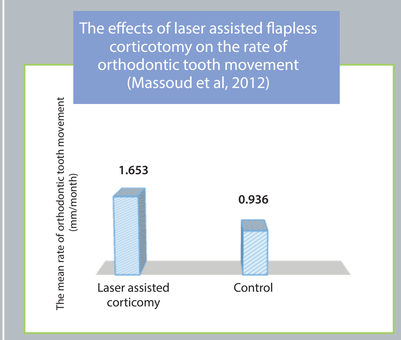
- Not able to graft soft/ hard tissues during the procedure to correct inadequacies and reinforce periodontium
- Repeated malleting can result in dizziness/ benign paroxysmal positional vertigo post-surgery
- Patients find the procedure quite aggressive.

Dibart et al (2009)

Massoud et al (2012)

Laser assisted flapless corticotomy

Laser assisted flapless corticotomy can enhance orthodontic tooth movement without jeopardizing the healing process of the soft tissue and the hard tissue.



Mani Alikhani (2013)

Monocortical tooth dislocation and ligament distraction technique

- Uses piezosurgery, instead of burs, after flap elevation, to create an environment conducive to rapid tooth movement.
- The piezoelectric knife has a micrometric and selective cut, allowing for safe and precise osteotomies without causing any osteonecrosis. It works only on mineralized tissues, thus sparing soft tissues and their blood supply.
- The average treatment time with the MTDLD technique in the mandible and maxilla can be reduced by upto 60% and 70%, respectively, when compared to traditional orthodontics, without causing any periodontal defects. (Vercelotti and Podesta, 2007)

Piezocision
(Minimally invasive procedure)

- Flapless corticotomy using bucally placed micro incisions and the use of a piezoelectric knife. Selective tunneling is also possible for soft/hard tissue grafting, if required, making it quite versatile.
- It demonstrates similar clinical outcome when compared to classic decortication approach but has the added advantages of being quick, minimally invasive, and less traumatic to the patient.
- It takes typically 1 hour to complete both arches as compared to 3 to 4 hours with earlier methods.
- The effect of piezocision can extend to 1.5 teeth from each side of the surgical site, therefore decorticating every other tooth is a viable option.

Micro osteo perforations
(alveocentesis)

- Micro-osteoperforation is an effective, comfortable, and safe procedure to accelerate tooth movement and significantly reduce the duration of orthodontic treatment.
- Not as invasive as corticotomy with flap elevations or even microincisions.
- A ready-to-use sterile disposable device is used to place 2-3 micro perforations placed between each tooth in the cortical bone through the gingival tissue.
- This procedure can significantly increase the rate of orthodontic tooth movement by up to 2.3-fold, without causing any significant pain or discomfort during or after the procedure, or any other complications.

CONCLUSION

The administration of certain exogenous biological molecules during animal experiments and clinical trials, to accelerate orthodontic tooth movement, has shown promising results. However, at present, there is no exogenous biological molecule that can be safely administered without causing any adverse effects on systemic or local application, thereby limiting the scope of future research via human trials, until a safer alternative can be developed.

The low level laser therapy, as one of the mechanical methods to increase the rate of orthodontic tooth movement, has shown the most favorable outcome. Although, further investigations are warranted in order to determine the optimum energy level and duration of therapy at which higher success rates can be achieved.

Corticotomy assisted orthodontics still remains the most predictable method of speeding up orthodontic tooth movement, however, due to its aggressiveness, its clinical application has been limited. Developments and modifications to this approach, has given rise to less invasive techniques, such as the recent introduction of piezocision, which clinically, has resulted in better periodontal tissue response and esthetics.

Further clinical research is necessary in order to safely endorse a particular method of accelerating orthodontic tooth movement. However, the way has been paved forward for this new frontier in orthodontics, which will not only reduce the duration of treatment, but will also decrease the predisposition to dental caries, gingival recession and root resorption during orthodontic treatment, which are some of the disadvantages posed by current treatment times.

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