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TREATMENT

Different methods of accelerating tooth movement

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Abstract The increased demand for rapid orthodontic treatment, especially by adult patients, has led to the development of different methods to accelerate the rate of tooth movement. Here we summarize these different approaches by categorizing them according to their target. Some of these methods try to enhance the body's natural pathways activated during tooth movement, while others use agents that stimulate an artificial pathway. All approaches attempt to increase bone resorption as a key rate-controlling factor in orthodontic tooth movement.

Keywords Tooth movement · Accelerating methods · Bone resorption · Orthodontics

Quick reference/description

The increased demand for fast orthodontic treatment has led researchers in the field to focus on manipulating jaw biology to produce accelerated tooth movement. Bone resorption resulting from osteoclast activation is the key biological factor

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controlling the rate of tooth movement. Any treatment that increases the rate of bone resorption increases the rate of tooth movement.

Overview

The following is a summary of different methods of accelerating tooth movement, some of them use agents to stimulate an artificial pathway while other enhance the body's natural pathways:

Method of accelerating tooth movement			Mechanism of action	Advantages	Limitations
I. Stimulating the artificial pathway to increase the rate of tooth movement	Chemical agents	Parathyroid hormone (PTH)	Increases the concentration of calcium in the blood by stimulating bone resorption	Accelerates tooth movement	Intermittent short elevations of PTH levels are anabolic for the bone
		Other hormones (thyroxin, calcitonin, estrogens)	Thyroxin affects intestinal calcium absorption	Increase the rate of tooth movement	Calcitonin and estrogens can also decrease the rate of tooth movement
		Vitamin D3 (1,25-dihydroxycholecalciferol)	Promotes intestinal absorption and reabsorption of calcium and phosphate in the kidneys Promotes bone deposition and inhibits PTH release	Local injections increase the rate of tooth movement	
		Osteocalcin and corticosteroids	Attract osteoclasts into the area	Causes rapid tooth movement	The effect of corticosteroids on tooth movement can vary based on the dosage
	Physical stimulation	Mechanical stimulation	High-frequency, low-magnitude forces (vibration) applied to the teeth being moved)	Non-invasive approach that can increase tooth movement	
		Heat, light, electric currents, and magnetic fields and laser	Application of heat, light, minute electric currents and electromagnetic field during orthodontic tooth movement	Can increase the rate of tooth movement	Inconsistent results
		Low-level laser therapy (LLLT)	Uses low-level lasers or light-emitting diodes to alter cellular function	Anti-inflammatory effect	Mechanism of action not clear
II. Stimulating the natural pathway to increase the rate of tooth movement	Corticotomy		Expose the alveolar bone by reflecting an extensive gingival tissue flap, followed by numerous deep cuts and	Accelerates tooth movement High level of cytokine release	Invasive traumatic technique Generates massive inflammatory response

continued

Method of accelerating tooth movement	Mechanism of action	Advantages	Limitations
	perforations into the cortical and trabecular bone in between the dental roots	and extensive bone remodeling Benefit in cases of mild to moderate crowding	Time-consuming procedure Can jeopardize anchorage
Piezoincision	Use of a vertical incision in through the soft tissue mesial and distal to the tooth to be moved	Accelerates tooth movement Less invasive than corticotomy	Trauma Inflammation Not practical in daily orthodontic practice
Micro-osteoperforations	Small and shallow perforations are placed on the surface of the buccal or lingual cortical plates	More efficient approach to accelerate tooth movement Less invasive than piezoincision or corticotomy Repeatable as needed by orthodontist Limited pain or discomfort	

Procedure

I. Stimulating the artificial pathway to increase the rate of tooth movement

Chemical agents

Parathyroid hormone (PTH) Parathyroid glands secrete PTH, which causes an increase in the concentration of calcium in the blood by stimulating bone resorption. Continuous elevation of PTH leads to bone resorption; intermittent short elevations of PTH are anabolic for the bone, which may be related to the biphasic effect.

Increase in the rate of tooth movement by exogenous PTH occurs in a dose-dependent manner.

Other hormones (thyroxin, calcitonin, estrogens) Thyroxin affects intestinal calcium absorption. It increases the rate of tooth movement by increasing bone resorption. It is indirectly involved in bone turnover and induction of osteoporosis.

Vitamin D3 (1, 25-dihydroxycholecalciferol) Vitamin D3 regulates calcium and phosphate serum levels by promoting their intestinal absorption and reabsorption in the kidneys. It promotes bone deposition and inhibits PTH release. It can increase the rate of tooth movement if injected locally.

Osteocalcin and corticosteroids Local injection of osteocalcin causes rapid movement due to attraction of numerous osteoclasts into the area.

In the presence of cytokines, such as IL-6, they stimulate osteoclastogenesis and cause osteoporosis.

The effect of corticosteroids on tooth movement can vary based on the dosage and whether they are administered before the expression of cytokines (induction period) or after their presence. The anti-inflammatory effect of corticosteroids can decrease the rate of tooth movement.

Physical stimulation

Mechanical stimulation Recent research shows very positive results for application of high-frequency, low-magnitude forces (vibration) to increase the rate of tooth movement. This is a non-invasive and safe technique, designed for home usage during orthodontic treatment, which increases and prolongs osteoclast activity in the periodontal ligament.

Heat, light, electric currents, and magnetic fields and laser Application of heat, light, minute electric currents, and an electromagnetic field during orthodontic tooth movement has demonstrated an increase in the rate of tooth movement.

Low-level laser therapy (LLLT) LLLT uses low-level lasers or light-emitting diodes to alter cellular function. The effects of LLLT appear to be limited to a

specified set of wavelengths, and administering LLLT below a dose range does not appear to be effective.

II. Stimulating the natural pathway to increase the rate of tooth movement

Corticotomy

This technique involves exposing the alveolar bone by reflecting an extensive gingival tissue flap, followed by numerous deep cuts and perforations into the cortical and trabecular bone between the tooth roots using a rotary high-speed drill. Due to significant bone trauma, corticotomy generates a massive inflammatory response that can compromise anchorage during orthodontic treatment. It is beneficial in cases of mild to moderate crowding where only simple leveling and aligning mechanics are required.

Piezoincision

Piezoincision requires a vertical incision in the soft tissue mesial and distal to the tooth to be moved and use of a piezoelectric blade to create linear incisions in the bone along the soft tissue openings. This increases levels of inflammation and bone remodeling.

Micro-osteoperforations

This procedure consists of small and shallow osteoperforations that are placed on the surface of the buccal or lingual cortical plates. Application of a few shallow osteoperforations in the proximity of the moving tooth results in a significant increase in inflammation, osteoclast activation, bone remodeling, and tooth movement.

Micro-osteoperforations can preserve anchorage if applied only around moving teeth and can be repeated as dictated by the biomechanical needs. Microperforations can be delivered by orthodontists during routine visits.

Pitfalls and complications

- Chemical agents: chemical agents have systemic effects that raise questions about their safety during clinical application.
  The majority of chemical agents have a short half-life. Therefore, multiple applications of the agents are required, which is not practical.
  Uneven distribution of the chemical agents can change the pattern of resorption, thereby uncontrollably altering the biomechanics of tooth movement.
- Physical stimulation: the magnitude of the increase in the rate of tooth movement by physical stimulation is not significantly high enough to be clinically relevant and justify their application in daily orthodontic practice.

- Corticotomy: this is an aggressive and invasive procedure that makes it difficult for the patient to accept repeated applications at different stages of treatment.

This is not an economical approach, it is time-consuming with the longest recovery time of the accelerated tooth movement treatment options.

The catabolic effect produced by this method is massive and may be beyond what is needed at the stage of its application. In addition, it can jeopardize anchorage.

The anabolic effect that follows will be as massive as the catabolic effect, which then promotes bone formation that can interfere with tooth movement during subsequent stages of treatment.

While corticotomy may be an option in orthognathic camouflage cases where patients refuse orthographic surgery treatment, it is important that patients be made aware that minimally invasive approaches are also available.

Further reading

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