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Accelerated Orthodontics: A Comprehensive Review of Contemporary Approaches

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Abstract

Orthodontic treatment duration remains a significant concern for both clinicians and patients, often extending up to 24 months or more. Prolonged treatment increases the risk of complications such as root resorption, white spot lesions, and reduced patient compliance. Accelerated orthodontics aims to reduce treatment time by enhancing the rate of tooth movement through biological, mechanical, and surgical interventions. This review provides a comprehensive overview of the biology of tooth movement and critically evaluates various methods developed to accelerate orthodontic treatment. Emerging minimally invasive techniques and adjunctive therapies show promising results, although their long-term efficacy and safety require further investigation.

Keywords: Accelerated orthodontics, Corticotomy, Piezocision, Micro-osteoperforation, Low-level laser therapy, Tooth movement.

Introduction

Orthodontics has evolved into a biologically driven specialty focused on achieving optimal esthetics, function, and stability. Despite technological advancements, treatment duration remains a limiting factor. Conventional fixed appliance therapy typically requires 20–26 months, depending on case complexity [12].

Extended treatment duration is associated with increased risk of white spot lesions (WSLs), root resorption, periodontal complications, and reduced patient compliance. Studies report that up to 72.9% of patients develop WSLs during orthodontic treatment [3]. Therefore, accelerating tooth movement is not only desirable but clinically necessary.

Accelerated orthodontics encompasses biological, physical/mechanical, and surgical approaches aimed at enhancing the rate of orthodontic tooth movement.

Biology of Orthodontic Tooth Movement

Orthodontic tooth movement is a result of coordinated bone remodeling involving osteoclastic resorption on the pressure side and osteoblastic deposition on the tension side[1]. This process is mediated by an aseptic inflammatory response with the release of cytokines such as prostaglandins, interleukins, and RANKL [4].

The rate-limiting step in tooth movement is bone resorption. Frost's Regional Acceleratory Phenomenon (RAP) describes a localized increase in bone turnover following injury, forming the biological basis for many surgical acceleration techniques [5].

Methods to Accelerate Orthodontic Tooth Movement

1. Biological Approaches

Biological methods involve pharmacological agents that enhance cellular activity and bone remodeling.

Prostaglandins increase osteoclastic activity and accelerate tooth movement [4]. Vitamin D and parathyroid hormone (PTH) enhance bone metabolism, while relaxin improves periodontal ligament remodeling. RANKL gene therapy directly stimulates osteoclastogenesis and has shown promising experimental results[6]. Platelet-rich plasma (PRP) contributes to enhanced healing and remodeling.

However, these methods are limited by the need for repeated administration, patient discomfort, and lack of widespread clinical acceptance.

2. Physical/Mechanical Approaches

Non-invasive approaches utilize external stimuli to enhance bone remodeling.

Low-level laser therapy (LLLT) increases ATP production and cellular activity, resulting in faster tooth movement[7]. Vibration therapy enhances RANKL expression and periodontal remodeling [8]. Pulsed electromagnetic fields (PEMF) and electric current stimulation have also demonstrated the ability to stimulate bone turnover, although

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evidence remains inconsistent [9, 10].

These methods are advantageous due to their non-invasive nature and patient acceptability but show variable clinical effectiveness.

3. Surgical Approaches

Surgical methods are based on inducing RAP to accelerate bone remodeling.

Corticotomy, first introduced by Kole [11], was later developed into Periodontally Accelerated Osteogenic Orthodontics (PAOO) by Wilcko *et al* [12]. Piezocision is a minimally invasive alternative that avoids flap elevation [13]. Micro-osteoperforation (MOP) enhances cytokine activity and osteoclast recruitment [14], while corticision provides a flapless surgical option [15].

Distraction osteogenesis enables rapid tooth movement through mechanical bone stretching [16]. Fiberotomy reduces resistance from gingival fibers and aids in orthodontic movement.

Surgical approaches are the most effective in reducing treatment duration but are associated with increased invasiveness and patient discomfort.

Discussion

Accelerated orthodontics has gained prominence due to increasing patient demand for shorter treatment duration, particularly among adults.

Biological approaches demonstrate strong theoretical potential but are limited in clinical application. Mechanical methods are patient-friendly but yield inconsistent results. Surgical techniques remain the most effective, although invasive.

Minimally invasive techniques such as piezocision and micro-osteoperforation provide a balance between efficacy and patient acceptance [13, 14]. However, variability in study designs and lack of long-term data limit definitive clinical guidelines.

A comparative summary of various acceleration techniques is presented in Table 1.

Table 1: Summary and Comparison of Methods for Accelerating Orthodontic Tooth Movement

Method Category	Technique	Mechanism	Invasiveness	Effectiveness	Advantages	Limitations
Biological	Prostaglandins [4]	↑ Osteoclastic activity	Minimal	Moderate	Direct effect	Pain, injections
	Vitamin D	↑ Bone turnover	Minimal	Moderate	Enhances remodeling	Limited use
	PTH	↑ Bone resorption	Minimal	Moderate–High	Dose dependent	Systemic effects
	RANKL [6]	↑ Osteoclastogenesis	Minimal	High (exp.)	Targeted action	Experimental
	PRP	Growth factors	Minimal	Moderate	Healing support	Variable results
Physical	LLLT [7]	↑ Cellular activity	None	Moderate	Non-invasive	Variable evidence
	Vibration [8]	↑ RANKL	None	Mild–Moderate	Easy use	Compliance
	PEMF [9]	↑ Bone remodeling	None	Moderate	Safe	Limited data
	Electric [10]	↑ Cell activity	None	Mild	Biological effect	Technique sensitive
Surgical	Corticotomy [11]	RAP induction	High	High	Effective	Invasive
	PAOO [12]	RAP + graft	High	Very High	Stable results	Cost, morbidity
	Piezocision [13]	Cortical stimulation	Low	High	Minimally invasive	Skill sensitive
	MOP [14]	Cytokine release	Low	Moderate–High	Chairside	Temporary
	Corticision [15]	Flapless RAP	Low	Moderate–High	No flap	Discomfort
	Distraction [16]	Bone stretching	High	Very High	Rapid	Complex
	Fiberotomy	Fiber release	Low	Mild–Moderate	Prevent relapse	Limited effect

Conclusion

Accelerated orthodontics represents a significant advancement in modern orthodontic practice. While multiple techniques exist, no single method fulfils all criteria of safety, efficiency, and patient acceptance.

Surgical approaches remain the most effective, whereas non-invasive methods are more acceptable but less predictable. Future research should focus on long-term outcomes and the development of combination therapies tailored to individual patient needs.

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