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# Accelerated Orthodontics

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**ABSTRACT:**
The prolonged duration of traditional orthodontic treatment has long been a concern due to its association with adverse effects such as decalcification, caries, root resorption, and gingival inflammation. With the growing demand for adult orthodontics and an increased focus on improving both oral health and aesthetics, there has been a surge of interest in methods to accelerate orthodontic tooth movement (OTM). This review explores a wide range of innovative strategies aimed at reducing treatment time while enhancing patient outcomes and minimizing complications.

## 1. Introduction

Orthodontic treatment often represents the longest dental procedure in terms of duration. The extended timeframe required for orthodontic care frequently discourages adult patients from pursuing treatment, leading many to seek quicker but less effective alternatives[1]. Research by Tayer revealed that 33% of adult patients avoided orthodontic treatment specifically due to concerns about treatment length, discomfort, and the inconvenience of wearing appliances[2]. Adult patients typically prioritize both shorter treatment times and more aesthetically pleasing orthodontic options.Extended orthodontic treatment doesn't just test patients' patience—it comes with real health concerns. The longer braces stay on, the higher the risk of problems like weakened enamel, root damage, cavities, gum issues, and even jaw pain. That's why orthodontists have been searching for ways to speed up tooth movement. Faster treatment would be a win all around: patients spend less time in the chair, results tend to last longer, and we avoid many of the complications that come with years of wearing braces. Simply put, accelerating orthodontic treatment could make the whole experience better for everyone involved[2].Since the 1890s, dental professionals have been exploring ways to speed up tooth movement by boosting how our bodies respond to orthodontic forces. Today, we have several approaches—ranging from non-invasive to minimally invasive and invasive techniques—that can dramatically cut treatment time, in some cases by as much as 70% [1].When orthodontic pressure is applied, something fascinating happens in the periodontal ligament (the tissue connecting your tooth to your jawbone). The body triggers a biological response that breaks down bone on one side while building it up on the other. This natural process involves complex signals between cells and the release of inflammatory molecules like TNF-alpha and interleukins. By understanding and working with these natural mechanisms, we can help teeth move more efficiently through the bone, getting patients to their perfect smile faster and with fewer complications[3].Dental researchers have developed several innovative ways to speed up tooth movement. These range from using light therapy (photobiomodulation) and gentle vibrations to creating tiny, strategic perforations in the bone around teeth. Other approaches include ultrasound treatments, medication-based methods, and specialized surgical techniques like corticision and piezocision.All these approaches tap into the body's natural healing response. When we create controlled, minor irritation to the jawbone, it triggers an inflammatory cascade—think of it as your body rushing healing resources to the area. This natural process, known as the Regional Acceleratory Phenomenon (RAP), stimulates cells that break down bone (osteoclasts), allowing teeth to move more quickly through the jawbone[3]. It's essentially working with your

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body's own healing mechanisms to achieve faster orthodontic results.

## 2. History

Back in 1959, Heinrich Kole pioneered the concept of using strategic bone cuts to speed up orthodontic treatment[4]. He believed the dense outer layer of jawbone was what primarily slowed tooth movement. His theory? By making selective cuts in this cortical bone, you could create "blocks" of bone that would move more easily, dramatically reducing treatment time.Fast forward to 2001, when Wilcko offered a different explanation. He discovered that rapid tooth movement wasn't just about physically freeing up bone blocks—it was about triggering a natural cycle of bone breakdown and rebuilding. Taking this insight further, he combined targeted bone cuts with bone grafting to enhance results and support the surrounding structures[5].Then in 2006, Park and his team developed a gentler approach called "corticision." This minimally invasive technique achieved similar acceleration effects with less surgical intervention, making faster orthodontic treatment more accessible to patients who wanted quicker results without extensive surgery[5].In 2007, Vercelotti and Podesta pioneered a breakthrough approach combining ultrasonic piezosurgery with traditional flap procedures to speed up tooth movement. This was just the beginning of innovation in this field[6].Two years later, Dibart and colleagues refined the technique into what we now call "piezocision." Their clever modification preserved the inner bone surfaces (palatal and lingual cortex), making the procedure less invasive while maintaining its effectiveness[6].Then came 2011's game-changer: alveocentesis. This minimally invasive technique works by stimulating the body's natural healing messengers—cytokines—to accelerate bone remodeling. Building on this concept, the PROPEL system introduced targeted micro-perforations that trigger these same cytokines to help teeth move more predictably and significantly faster into their ideal positions. By working with the body's natural processes rather than against them, these techniques have transformed how we approach orthodontic treatment timing.

## 3. Techniques ( Table 1 )

| CATEGORY | SUB-CATEGORY | TECHNIQUE |
|---|---|---|
| **INVASIVE** | | Distraction osteogenesis |
| | | PAOO(Wilckodontics0 |
| | | Conventional corticomy |
| | | |
| **MINIMALLY INVASIVE** | | Piezocision and decision |
| | | Microsteoperforation |
| | | |
| **NON INVASIVE** | Device assisted treatment | Cyclic vibrations |
| | | Lasers |
| | | Low-level laser therapy(photomodulation) |
| | | Direct light electric current |
| | | |
| | Medications | NSAIDS, Acetaminophen (paracetamol), Corticosteroids, Bisphosphonates, Herbal medicine biomaterials (Asperosaponin VI) |
| | | |
| | Biologic Approach | Systemic and local administration of biological substances and hormones such as Parathyroid hormone, prostaglandins, thyroxine, and calcitonin, relaxin, 1,25 dihydroxycalciferol (vit D3 or calciferol) |
| | | Neurotransmitters |
| | | |
| | Synthetic Biomaterials | Graphene oxide |

Table 1 : Different techniques for accelerating tooth movement

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## 4. Invasive Techniques

### 4.1 Regional Acceleratory Phenomenon (RAP):

When Harvard researcher Harold Frost first described the Regional Acceleratory Phenomenon (RAP), he uncovered something fascinating about how our bodies heal. Think of RAP as your body's emergency response team—when tissues are injured, your body doesn't just repair the damage; it temporarily supercharges the entire healing process in that specific area. This natural response affects both soft tissues and bones, essentially putting normal tissue processes into overdrive as a protective and healing mechanism[3].

**How RAP Affects Bones**

The intensity of this response varies from person to person and depends on how significant the initial stimulus was. In your jawbone, RAP temporarily decreases bone density because cells are working overtime at remodeling the bone. Frost noticed something particularly interesting—even stiff, resistant joints became more flexible in the months following major bone surgery. This suggests that tissues become more adaptable during this RAP period, which is exactly what makes accelerated orthodontics possible[3].

**Scientific Evidence**

Research by Bogoch demonstrated RAP's effects using rabbits. After creating a partial cut in the jaw joint and tracing new bone formation, he discovered a dramatic five-fold increase in new spongy bone filling the surgical gap after just four weeks. While the total bone volume stayed the same, the rate of bone turnover skyrocketed—proof that RAP significantly speeds up the body's natural remodeling process[3].

**Important Considerations for Extensive Procedures**

While these biological insights have led to promising treatments, extensive surgical approaches come with several important considerations[3]:

- **Time commitment**: Comprehensive procedures on both upper and lower jaws can require 3-4 hours in the dental chair
- **Recovery challenges**: The extensive nature of the surgery often leads to noticeable swelling, bruising, and discomfort during healing
- **Aesthetic concerns**: Treatment may result in "black triangles" appearing between teeth where gum tissue doesn't completely fill the spaces
- **Limited popularity**: Due to these factors, both dentists and patients often prefer less invasive alternatives, reducing widespread adoption of the most extensive surgical approaches

### 4.2 Corticotomy and Osteotomy:

Corticotomy is a surgical technique where only the outer layer of jawbone (cortical bone) is carefully cut and perforated, while leaving the inner spongy bone (medullary bone) untouched. This strategic approach reduces the dense cortical bone's resistance, allowing teeth to move more quickly through the jawbone during orthodontic treatment, as Nimeri explained in 2013.

In contrast, "osteotomy" is a more extensive procedure where surgeons cut completely through both the outer and inner layers of bone. This creates a fully separated bone segment that can be repositioned as a single unit. This technique dates back to Kole's pioneering work in 1959, which achieved remarkable results—completing tooth movements in just 6-12 months. Later, Grenerson and colleagues successfully adapted this approach to treat open bite cases, where the upper and lower teeth don't meet properly.

**Benefits Worth Considering**

- **Proven acceleration**: Multiple clinical studies have confirmed these techniques genuinely speed up tooth movement, potentially cutting treatment time significantly.
- **Protective bone building**: These procedures allow for simultaneous bone augmentation (adding bone material), which can prevent periodontal problems in areas with naturally thin jawbone.

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**Important Considerations**

- **Recovery intensity**: These procedures involve significant recovery compared to standard orthodontic treatment.
- **Surgical risks**: As invasive procedures, they require careful planning to avoid nearby vital structures like nerves and blood vessels.
- **Post-surgical challenges**: Patients typically experience pain, swelling, and face potential complications including infection and, in rare cases, avascular necrosis (bone tissue death due to poor blood supply).
- **Patient hesitation**: Many patients understandably prefer less invasive alternatives when given the choice.

These surgical approaches represent important options in the orthodontist's toolkit, particularly for complex cases where treatment speed is a priority and the benefits outweigh the temporary discomfort and recovery period.

**5. Minimally Invasive Techniques**

**5.1 Piezocision**

Both patients and orthodontists often view traditional corticotomies as too invasive—they simply involve too much surgery for comfort. Piezocision, introduced by Dibart in 2009 as a game-changer in orthodontic acceleration. This clever technique eliminates the need to fold back the gum tissue (flap elevation) while still delivering the benefits of both corticotomy and Periodontally Accelerated Osteogenic Orthodontics (PAOO).[6]

The piezocision approach is refreshingly straightforward: the orthodontist makes tiny incisions in the outer gum tissue and uses a specialized piezoelectric knife to create precise cuts in the outer layer of jawbone. These strategic micro-injuries trigger the body's Regional Acceleratory Phenomenon (RAP)—that remarkable healing response that temporarily supercharges bone remodeling, allowing teeth to move more quickly.[6]

What makes this technique particularly valuable is its versatility. Through selective tunneling under the gum tissue, the orthodontist can also add grafting materials to address gum recession or bone deficiencies—all without extensive surgery.

The Science Behind Piezoelectric Technology

The magic behind this technique lies in the unique properties of piezoelectric surgery. The device uses ultrasonic microvibrations that selectively cut bone while sparing soft tissues like nerves, blood vessels, and gums. This happens because mineralized tissues like bone respond to lower frequencies than soft tissues do—meaning the instrument can precisely target bone without damaging surrounding structures.This selective cutting creates a procedure that's remarkably safe, incredibly precise, and avoids the bone-damaging heat that can occur with traditional cutting instruments. Patients benefit from gentler treatment that requires less force and causes significantly less discomfort.

Practical Benefits and Considerations

From a practical standpoint, piezocision offers impressive advantages:

- Quick procedure time
- No need for extensive gum tissue flaps
- Minimal post-procedure pain
- Simple recovery

While stitches are generally recommended to minimize scarring, the overall healing process is much simpler than with traditional approaches.

The main limitation worth noting is that the orthodontist makes these cuts without being able to directly see the bone surface. This creates some risk to nearby structures, particularly tooth roots. To address this challenge, many practitioners use navigation tools or custom-made surgical guides (stents) to ensure precise, safe placement of the cuts.

**5.2 Micro-osteoperforations:**

Among the newest innovations in speeding up orthodontic treatment, micro-osteoperforations (MOPs)—sometimes called alveocentesis—stands out for its simplicity. Unlike more invasive procedures, MOPs require no cutting or folding back of gum tissue. Instead, this technique creates small, strategic perforations directly through the gum and into the

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underlying bone, triggering the body's natural healing response.[7]

**The Science Made Simple**

The concept behind MOPs is elegantly straightforward. Orthodontic devices like the Propel system (created by Propel Orthodontics in the USA) create tiny, precise injuries to the jawbone. These small perforations stimulate your body to release inflammatory markers—the same natural chemicals that drive regular tooth movement during orthodontic treatment, but at higher levels. This biological boost helps teeth move more quickly through the bone.[7]

**Real-World Results**

Researcher Alikhani demonstrated the effectiveness of MOPs in a clinical study involving 20 adult patients with Class II Division 1 malocclusions (a common bite problem where the upper teeth significantly overlap the lower teeth). In this study, patients received three small perforations placed behind their canine teeth six months after having premolars extracted. These strategic micro-injuries were performed under local anesthesia and successfully accelerated tooth movement.

**Important Considerations**

While MOPs offer a less invasive option for accelerated orthodontics, there are several practical limitations worth understanding:

- **Short-term effect**: Since the bone injury is minimal compared to other techniques, the Regional Acceleratory Phenomenon (RAP) it triggers may not last as long, potentially requiring repeat treatments.
- **Precision challenges**: Because practitioners can't directly see the bone while performing the procedure, careful planning using imaging is essential to avoid accidentally damaging tooth roots.
- **No grafting option**: Unlike some other acceleration techniques, MOPs don't create space for adding bone or tissue grafts, making them less suitable for patients who might benefit from additional periodontal support.
- **Practical constraints**: The procedure can be unexpectedly time-consuming, especially in the lower jaw where bone density is greater. The potential need for repeated treatments every few weeks can increase both the overall treatment cost and the time spent in the dental chair.

**6.Non Invasive Techniques**

**6.1 Devise assisted treatment**

**6.1.1 Cyclic vibrations:**

Cyclic vibration is a technique that applies gentle, alternating mechanical forces to the teeth using controlled vibrations. It has proven effective by triggering cellular responses to mechanical stress in vitro within just 30 minutes[10]. The system used for this method includes key components such as a vibration controller, charge amplifier, vibrator, force sensor, and accelerometer. The accelerometer and force sensor send signals to the vibration controller, which then activates the vibrator using amplified sound signals. This setup ensures a consistent acceleration of 1.0 meters per second squared ($m/s^2$) through precisely regulated vibrations, managed by the power amplifier in response to the accelerometer's output. The vibrator's tip is attached to the tooth using adhesive. During typical five-minute vibration sessions, the vibration controller displays resonance curves that illustrate the frequency-force relationship.

**AcceleDent**

AcceleDent is a convenient and straightforward device that features a mouthpiece designed to fit over your current braces. The device is used for 20 minutes each day, emitting mild vibrations[11]. It is portable and includes a charging connector, similar to other electronic gadgets, for easy operation. This treatment method offers multiple advantages, such as reducing the likelihood of root resorption, minimizing mini-implant failures, and enhancing patient adherence to the treatment plan.

**6.1.2 Low-level laser therapy (LLLT) (photobiomodulation):**

Photobiomodulation therapy, or Low-Level Laser Therapy (LLLT), has proven to be one of the most effective methods for accelerating tooth movement. The

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use of laser light plays a crucial role in influencing bone remodeling and speeding up tooth movement by stimulating the activity of key bone-related cells, such as osteoclasts, osteoblasts, and fibroblasts[12]. The mechanisms behind this accelerated movement involve processes like ATP production, cytochrome C activation, and the regulation of important factors including RANK/RANKL, macrophage colony-stimulating factor, and its receptor.

6.2 **Biological Approach:**

This includes the systemic or local use of biological substances, hormones, neurotransmitters, and medications, which have been widely studied in the context of accelerating orthodontic tooth movement (OTM). Orthodontic forces, by distorting the matrix and cells and causing fluid shifts within the periodontal ligament (PDL), trigger bone remodeling, a key process that supports tooth movement. Some of the most commonly used pharmacological agents to accelerate tooth movement and shorten treatment times include parathyroid hormone (PTH), Vitamin D, prostaglandins, and relaxin[13].

**6.2.1Parathyroid Hormone:**

Parathyroid hormone (PTH) is a major regulator of bone remodeling and calcium balance in the body. It plays a crucial role in enhancing calcium absorption from the small intestine, which raises blood calcium levels[14]. This process stimulates the release of calcium from bone, leading to bone resorption. Studies by Soma and his team on rodents have shown that continuous PTH administration can effectively speed up orthodontic tooth movement (OTM).

**6.2.2Prostaglandins:**

Prostaglandin E2 (PGE2) is one of the most extensively studied substances in orthodontic research due to its significant effects on tooth movement. Several studies have shown that PGE2 accelerates orthodontic tooth movement (OTM) by promoting bone resorption through its action on osteoclasts, especially when administered externally over an extended period. However, earlier research has highlighted a potential drawback of PGE2 use. Local injections of PGE2, particularly at varying doses and concentrations, have been linked to an increased risk of root resorption when used alone[16].

**6.2.3Thyroxine & Calcitonin:**

Thyroxine and calcitonin, two critical hormones produced by the thyroid, are essential for regulating calcium reabsorption. The use of thyroxine has been shown to increase bone remodeling while reducing bone density. Additionally, thyroxine stimulates the production of Interleukin 1 (IL-1B), a cytokine that plays a crucial role in osteoclast activation and bone formation. When applied locally, thyroxine can accelerate orthodontic tooth movement (OTM) by stimulating osteoclasts, which enhances the effectiveness of orthodontic treatments.[16]

**6.2.4Relaxin**

Relaxin, a hormone typically associated with the relaxation of pubic ligaments during childbirth, also has additional roles in the body. It impacts collagen turnover, promotes angiogenesis, and exhibits anti-fibrotic effects. A noteworthy study conducted on rats demonstrated that local application of human relaxin can accelerate orthodontic tooth movement (OTM). However, this increased speed of movement came with some unintended consequences. It disrupted the structure of the periodontal ligament (PDL) and weakened its mechanical strength, which resulted in greater tooth mobility. These findings highlight the need to consider potential drawbacks when evaluating relaxin's use in orthodontic treatment.[17]

**6.2.5 1,25 Dihydroxycholecalciferol (vitamin D3 or calcitriol):**

An in vivo study conducted on dogs found that local administration of calcitriol significantly accelerated orthodontic tooth movement (OTM). A 25 pg dose of calcitriol resulted in a nearly 51% faster movement rate compared to the control side, while doses of 15 pg and 40 pg led to about a 10% increase in OTM speed. Importantly, periapical radiographs showed no adverse effects of calcitriol on the surrounding tissues. When comparing local injections of PGE2 and vitamin D in rats, no significant difference in OTM acceleration was observed. However, the vitamin D group exhibited a higher number of osteoblasts on the pressure side, suggesting that vitamin D may promote bone turnover more effectively[16].

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**6.2.6 Neurotransmitters**

The trigeminal ganglion neurons supply innervation to dental and periodontal tissues and contain neuropeptides such as substance P, calcitonin gene-related peptide (CGRP), and vasoactive intestinal polypeptide (VIP). These neuropeptides remain inactive in a neutral state but are triggered and released during orthodontic treatment when mechanical forces are applied. This release initiates local inflammation and influences bone remodeling, as well as increasing vascular permeability[19].

**6.3 Medications:**

**6.3.1 NSAIDS:**

NSAIDs are commonly used in orthodontic treatment to relieve pain and discomfort that occurs after applying mechanical forces to the teeth. Research consistently indicates that these drugs can reduce the rate of orthodontic tooth movement (OTM), with the extent of the effect depending on the dosage and frequency of administration, typically over a short duration. NSAIDs work by inhibiting the inflammatory response triggered by prostaglandins (PGs), with cyclooxygenase (COX) enzymes playing a critical role in regulating this process and influencing the remodeling of both vascular and extravascular matrices[17].

**6.3.2 Acetaminophen (Paracetamol):**

Although acetaminophen shares a similar chemical structure with NSAIDs, it lacks anti-inflammatory effects. Numerous studies have consistently demonstrated that paracetamol does not significantly affect the rate of orthodontic tooth movement (OTM). As a result, it is considered a preferred and safe option for pain relief during orthodontic treatment[17].

**6.3.3.Corticosteroids:**

Corticosteroids can influence bone development and accelerate tooth movement, but they also have a major drawback. They hinder the formation of new bone, which can compromise the stability of tooth movement and, as a result, reduce the success rate of orthodontic treatment[17].

**6.3.4Bisphosphonates (BPNs):**

Biphosphonates (BPNs) play a crucial role in regulating bone metabolism and calcium balance. Research has shown that BPNs can slow down the rate of orthodontic tooth movement (OTM), leading to delays in progress. However, when administered locally, BPNs may offer benefits, particularly in helping to anchor teeth and maintain their position throughout orthodontic treatment[17].

**6.3.5.Herbal medicine biomaterials (Asperosaponin VI):**

Asperosaponin VI (ASA VI), the active ingredient in *Dipsacus asper* Wall extract, a well-known Chinese herbal remedy, has been found to enhance bone density and promote the formation of trabeculae, leading to improvements in bone histomorphology. In an animal study, rats that received local, submucoperiosteal, and buccal injections of ASA VI showed a significant increase in orthodontic tooth movement (OTM) compared to the control group. ASA VI appears to facilitate bone resorption on the pressure side of the tooth while promoting bone formation on the tension side, as demonstrated by increased bone density and widened trabecular spacing[18].

**6.4 Synthetic biomaterials (graphene oxide):**

Jiao et al. developed a biocompatible form of graphene oxide, modified with gelatin to improve its solubility. In vitro studies showed that this functionalized material had excellent biocompatibility. Additionally, it was found that when used correctly, gelatin-reduced graphene oxide (GOG) creates a localized hypoxic environment that encourages the differentiation of mesenchymal stem cells into angiogenic cells, promoting bone and tissue regeneration. In a rat model, those treated with submucosal GOG injections exhibited greater orthodontic tooth movement (OTM), which was driven by enhanced osteoclastogenesis, osteoblastogenesis, and angiogenesis, ultimately leading to faster osteogenesis, compared to the PBS-treated control group[19].

**7. Conclusion**

Surgical techniques to accelerate tooth movement have a long history, dating back to 1893, and have seen continuous development over time. In recent years, these

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methods have gained increased popularity, with ongoing innovations aimed at minimizing drawbacks and enhancing both patient and clinician acceptance. Modern advancements include modifications to corticotomy procedures, with research comparing traditional flap-raising methods to newer flapless approaches. A notable shift has also occurred toward using piezoelectric knives instead of burs for decortication. These updates are focused on reducing patient trauma and chair time. However, to fully evaluate the effectiveness, side effects, and long-term outcomes of these various techniques, well-designed, long-term clinical trials in humans are still needed.

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