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Review

Methods and Technology Used to Accelerate Dental Movements in Orthodontic Treatments

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Abstract

Due to the overwhelming desire among adults for shorter orthodontic treatment times, there is a growing trend in research that focuses on accelerating procedures for tooth movement. Unfortunately, lengthy orthodontic treatment times come with a number of adverse effects, including an increased risk of tooth decay, gingival recession, and root resorption. Finding the greatest way to maximize tooth motion with the least drawbacks is now more important than ever. The surgical method provides the most dependable results, but its invasiveness limits its use. Corticotomy is one of the commonly used techniques in practice for acceleration of orthodontic tooth movement. Numerous corticotomy methods have been successful in causing accelerated tooth movement. Through the use of these approaches, local acceleratory phenomena are activated, fostering an ideal milieu for tooth movement acceleration. In order to expedite orthodontic tooth movement while adhering to a specified surgical and orthodontic regimen, the piezocision treatment appears to be the ideal compromise. In cases of dehiscence and/or fenestration on the alveolar bone linked to moderate to severe overcrowding, piezocision surgery enables the inclusion of biomaterials. Low-level laser therapy and orthognathic surgery-first are also methods used to accelerate tooth motion among various others. However, further research should be done to ascertain the optimal way to accelerate tooth movement because each approach has benefits and drawbacks. The purpose of this research is to review the available information about methods and technology used to accelerate dental movements in orthodontic treatments.

Keywords: *accelerate, tooth, movement, orthodontic*

Introduction

Nowadays, individuals especially those in need of dental rehabilitation, have a growing propensity to seek orthodontic treatment since face appearance has a significant impact on one's attractiveness and self-esteem as it has an impact on one's health and ripple effects on social, emotional and professional connections. Esthetics play a vital role in people's life (1). Orthodontics has advanced significantly in its ability to produce the desired outcomes at a clinical and technical level. This is especially true when new technologies are used, such as translational goods and stimulation software that can help with treatment planning. In present times, it remains quite difficult to shorten the time required for orthodontic procedures and is one of the frequent challenges that orthodontists encounter as it irritates patients and raises the risk of cavities, gingival recession, and root resorption. To get faster outcomes, numerous attempts have been made to develop novel preclinical and clinical methodologies (2).

Longer treatment times come with a higher risk of decalcification and root resorption. However, because patients desire treatments that last only 6 to 12 months, there is a strong incentive for orthodontic service providers to research ways to accelerate the process. There has been a sharp rise in the number of orthodontic training programs for general dentists that provide faster procedures, as well as a rise in the popularity of goods that promise to accelerate tooth movement. The two types of interventions that might be used are surgical and non-surgical. In turn, the interventions may have an impact on two fundamental elements of orthodontic tooth movement: the biological reaction of the dentoalveolar tissues to this force and the mechanics of applying force (3). Orthodontic tooth movement is caused by a sterile inflammatory process described as bone remodelling, which causes bone resorption and deposition. The primary focus of non-surgical therapies for accelerating tooth movement is on bone cells involving osteoclasts and osteoblasts that are responsible for remodelling. This is due to the concept that these therapies may function as a biostimulus to boost bone cell activity. The rate of tooth movement may increase due to the enhanced bone remodelling, which could shorten the course of orthodontic treatment (4).

Modern orthodontics is constantly evolving due to technological advancement and the advent of new therapeutic techniques. Growing numbers of orthodontic patients are working adults who demand effective treatment outcomes as quickly as feasible, underscoring the significance of strategies that accelerate tooth movement. Particularly noteworthy are the pharmaceuticals used in conservative therapy, including growth hormone, parathyroid hormone, thyroxine, and vitamin D. They use a number of strategies to encourage osteoclasts to promote resorption. Physical stimuli, such as vibrations or photobiomodulation, are also useful techniques. The majority of research describing the effects of pharmaceuticals used animal models, which may mean that their therapeutic relevance is questionable. Particularly in adults, including patients with periodontal disease, corticotomy and its variations based on the regional acceleratory phenomenon may show to be a helpful addition to orthodontic treatment (5). To date, various cutting-edge techniques, such as low-level laser therapy, pulsed electromagnetic fields, electrical currents, corticotomy, distraction osteogenesis, and mechanical vibration, have been reported to accelerate orthodontic tooth movement. Inconclusive and imprecise data, however, may skew physicians' perceptions and cause errors in clinical practice (6). The purpose of this research is to review the available information about methods and technology used to accelerate dental movements in orthodontic treatments.

Methodology

This study is based on a comprehensive literature search conducted on December 16, 2022, in the Medline and Cochrane databases, utilizing the medical topic headings (MeSH) and a combination of all available related terms, according to the database. To prevent missing any possible research, a manual search for publications was conducted through Google Scholar, using the reference lists of the previously listed papers as a starting point. We looked for valuable information in papers that discussed the information about methods and technology used to accelerate dental movements in orthodontic treatments. There were no restrictions on date, language, participant age, or type of publication.

Discussion

Over the past ten years, orthodontics has become interested in methods to accelerate tooth mobility. Because increased decalcification, dental cavities, root resorption, and gingival irritation are all associated with prolonged orthodontic treatment, it may be advantageous for the patient in many ways to shorten the course of treatment. The rising interest in adult orthodontics is another factor contributing to the surge in interest in accelerated tooth movement. The mentioned approaches still need to be optimized, but some of them seem to have

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the ability to hasten orthodontic tooth movement and enhance results in carefully chosen situations. The concept of speeding up tooth movement through surgery is not new. The practice of surgically accelerating tooth movement began at the turn of the 20th century after being modified earlier. In 1893, L.C. Bryan published the first description of orthodontic tooth movement helped by surgery. Later, in 1931, Bichlmayr devised a surgical technique for patients older than 16 years old that would expedite the repair of severe maxillary protrusion and lessen relapse. The procedure involved cutting out bone wedges to lessen the amount of bone that would allow for root mobility (7).

Various methods and techniques used for accelerating orthodontic tooth movement are briefly discussed below.

Corticotomy

The surgical procedure corticotomy was developed to accelerate orthodontic treatment. The cortical bone which severely resists orthodontic force in the jaw is removed during a corticotomy, but the marrow bone is left in place to maintain blood flow and the continuity of the bone tissues, which lowers the risk of necrosis and facilitates tooth movement. Corticotomy has been used in more cases in the 21st century as a result of the emergence of the idea of the regional acceleratory phenomenon and the development of the skeletal anchorage system using screw and plate, which allowed application of orthopedic force beyond conventional orthodontic force (8). Corticotomy-accelerated orthodontics is the only modality that has been shown to shorten orthodontic treatment times. According to the literature, corticotomy-accelerated orthodontics has a number of benefits that are not always acknowledged by the profession or documented in the literature, including an acceleration of the orthodontic treatment rate of up to three times on average. In addition to reducing the length of orthodontic treatment, corticotomy-accelerated orthodontics also improves multidisciplinary outcomes beyond what can be achieved with standard treatment alone (9).

Improved tooth movement rates and limitations, fewer extractions required, shorter treatment times, increased alveolar volume, and a more structurally complete periodontum were determined to be among the key benefits of corticotomy compared to typical orthodontic treatments including correction of pre-existing bony dehiscences and fenestrations. Therapy time can be cut by between 6 and 8 months by using corticotomy, which can be finished in a third or a quarter of the time needed for conventional orthodontic treatment. Additionally, segmental issues like molar intrusion or forced eruption of impacted teeth can be treated more quickly when used in conjunction with conventional orthodontics. Space closure, open bite correction, moderate or severe crowding, dento-alveolar bimaxillary protrusion treatments, class II malocclusions requiring moderate expansion or extraction, and mild class III malocclusions are other indications for the use of corticotomy procedures (10). Results of a systematic review concluded that according to all study's findings, corticotomy performed before orthodontic therapy shortens the overall length of the treatment. Although this was only briefly evaluated, there were no adverse effects in the form of periodontal damage (11). Similarly, results of another systematic review concluded that the rate of orthodontic tooth movement can temporarily increase with few adverse effects following corticotomy procedures, producing statistically and clinically significant increases (12).

Despite the fact that corticotomy may be less invasive than osteotomy-assisted orthodontics or surgically assisted rapid expansion, there have been a number of reports describing unfavourable effects on the periodontium following corticotomy, ranging from no problems to minor interdental bone loss and loss of attached gingiva to periodontal defects seen in some cases with short interdental distance. Following extensive corticotomies, subcutaneous hematomas of the face and neck have been documented. Additionally, some post-operative pain and swelling are anticipated for a few days. The vitality of the tooth pulps in the corticotomy area was unaffected, as per various reports. With any orthodontic tooth movement, some root resorption is often predicted. Increased root resorption and the amount of time the applied force was present were shown to be related. Root resorption risk may be decreased by the shorter corticotomy therapy period (13).

Piezocision

It is a novel, minimally invasive surgical method intended to correct/prevent mucogingival abnormalities by grafting bone and/or soft tissues, and to aid in achieving rapid orthodontic tooth movement. To allow the piezoelectric knife to cause the bone injury that will result in temporary demineralization and subsequently faster tooth movement, microsurgical interproximal holes are made in the buccal gingiva. This method can be applied to the entire mouth, performing the cuts simultaneously at the maxilla and the mandible referred

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as generalized Piezocision, or to specific dentition segments termed as localized Piezocision, in order to get localized outcomes including intrusion, extrusion, distalization of teeth among certain others (14). This innovative approach can locally alter alveolar bone metabolism to produce quick and stable orthodontic results when used in conjunction with appropriate treatment planning and an understanding of the biological events involved. With piezocision, severe malocclusions can be corrected quickly without the risks associated with invasive corticotomy operations (15).

Papadopoulos et al. demonstrated in their findings that on the surgery side, there was shown to be a high association between the rate of tooth movement and root resorption, whereas the control side only exhibited a modest correlation. Piezocision increases root resorption and hastens orthodontic tooth movement. After piezocision, the root resorption score and loss of root length were both noticeably more evident than previously. (16). Yi et al. concluded that results from all studies showed accelerated tooth movement, and three of them showed a significantly shorter treatment time for the piezocision group. Any adverse effects on periodontal health, pain perception, satisfaction, root resorption, or anchoring control. However, weak data suggests that piezocision is a safe adjunct to speed up orthodontic tooth movement, at least in the near term, based on the currently available information hence more high-quality clinical trials are required to make more trustworthy conclusions more high-quality clinical trials are required to ascertain the long-term effects and ideal piezocision technique (17). Canine retraction stage immediately following flapless corticotomy in piezocision group and laser-assisted flapless corticotomy group is illustrated in **(Figure 1)** (18).

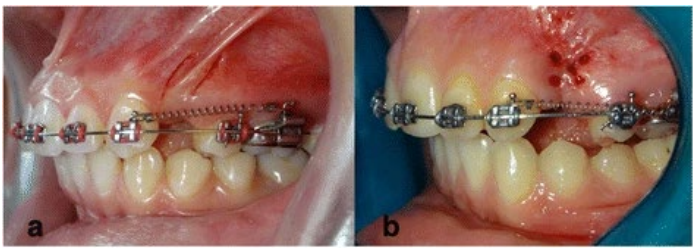

Figure 1*: Canine retraction stage immediately following flapless corticotomy a) Piezocision group. b) Laser-assisted flapless corticotomy group (18)*

Low-level laser therapy

Due to its limited invasiveness and safety, physical therapy such as low-level laser therapy has been recommended as a preferable option for reducing the length of treatment. Temperatures above 36.5°C, or the average body temperature, are prevented by low-level laser therapy modest energy output. The majority of earlier investigations on animals and humans have demonstrated that laser irradiation can dramatically speed up tooth movement. On the other hand, according to certain research, low-level laser therapy had no impact on the rate of orthodontic tooth movement. A limited number of research have also examined how bone remodelling variables react to orthodontic force and low-level laser therapy (19). Results of a meta-analysis concluded that the low-level laser therapy has the ability to shorten treatment times by accelerating the rate of human canine tooth movement. For fixed orthodontic treatment, low-level laser therapy serves as an appropriate adjuvant therapy (20). Findings of another meta-analysis concluded that in 7 days and 2 months, the low-level laser therapy could accelerate tooth movement for orthodontic treatment. Furthermore, a comparatively lower energy density than 20 and 25 J/cm $^{(2)}$ and even greater ones appeared to be more efficient (21). However, contradictory to this, Long et al. reported in their findings that although low-level laser therapy is safe for periodontal and root health, it cannot accelerate the movement of teeth in orthodontic treatment (6). These contrasting results advocate the dire need for further research.

Orthognathic surgery-first

Orthognathic surgeons have long seen increasing rates of tooth mobility after such procedures. By utilizing the widespread regional acceleratory phenomenon osseous effect, surgery-first orthodontics drastically reduces the length of time that patients who require orthognathic surgery must undergo therapy. Additionally, the treatment's quality is acceptable based on face symmetry, dental occlusion, and the stability of the outcomes. Additionally, face esthetics and dental occlusion frequently improve right away following surgery, which is extremely beneficial for the patient's psychology and compliance. This aspect must be taken into serious consideration while formulating a treatment plan for patients requiring orthognathic surgery. However, careful patient selection, exact treatment planning, and practical experience in the field of orthognathic surgery are necessary for both the surgeon and the orthodontist (22). Liou et al. concluded that following orthognathic surgery, the dentoalveolus has a 3- to 4-month period of increased osteoclastic activity and metabolic alterations, which may hasten postoperative orthodontic tooth movement (23). Further research comprising of clinical

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trials are needed to elaborately study and define the effectiveness of methods and techniques for accelerating orthodontic movement since this field is still in its emerging phase and the available literature is quite limited.

Conclusion

Acceleration of orthodontic tooth movement is an evolving topic in the field of modern dental practice era. Currently, surgical procedures have the best supporting evidence and can be considered to be effective methods. Unfortunately, they involve significant, albeit steadily declining invasiveness, subjecting the patient to more anxiety and postoperative discomfort hence further research can be beneficial in developing safe, effective and less invasive methods for tooth acceleration.

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Conflict of interest

There is no conflict of interest

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Data availability

Data that support the findings of this study are embedded within the manuscript.

Author contribution

All authors contributed to conceptualizing, data drafting, collection and final writing of the manuscript.

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