



Accelerated orthodontic tooth movement-A current review

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Abstract

There is an increased demand for orthodontic treatment with higher awareness regarding malocclusion and esthetic perception. There is also a higher pressure for decreased treatment duration i.e. shorter treatment times. Increased orthodontic treatment time can lead to issues such as white spots, gingival recession, root resorption, etc. and therefore decreased treatment time is beneficial. Various techniques, both surgical and non-surgical have been investigated for decreasing the treatment time. The current review evaluates several of the currently available options for acceleration of tooth movement. The review discusses the effects of surgical methods such as micro osteoperforations, and surgery first as well as non-surgical methods such as low level laser therapy and drugs for acceleration of tooth movement.

Keywords: accelerated tooth movement, micro osteoperforations, corticotomy, orthodontics, low level laser therapy

Introduction

The treatment time for orthodontic treatment has a wide range based on the complexity of the case, the skills of the orthodontist, and the biological response of the individual. The average treatment time in contemporary orthodontics requires more than 24 months. [1] The factors that play a role in the duration of orthodontic treatment is the type of treatment whether extraction or non-extraction treatment is performed. The compliance of orthodontic patient with elastics, regular appointment recall, and breakage of brackets is also a big factor in the overall treatment duration of the patient. [2] The type of malocclusion such as Angle's Class I, II or III also affects the treatment duration. Research shows that Class II correction of malocclusion requires more time than treatment of Class I malocclusion. [3] The important factor in class II malocclusion is the degree of overjet that requires higher time for the treatment. [4] With increased treatment duration, there is a higher risk of root resorption and enamel decalcification. Enamel decalcifications manifest as white spot lesions on the surface of the teeth. For these reasons, there is a huge push in the orthodontic research field and the orthodontic providers to identify different ways of accelerating orthodontic treatment and decreasing the orthodontic treatment duration. The techniques of accelerating orthodontic tooth movement can be classified as either surgical or non-surgical. [5] Surgical techniques to accelerate orthodontic tooth movement affect the biological response of the tissues. Whereas other techniques focus on the biomechanical application of force to the teeth. This review article will provide the current evidence regarding these methods and its effects.

NON-Surgical Methods of Acceleration of Tooth Movement

Biomechanical advancements

Different Brackets design have been brought into orthodontic market to decrease the duration of orthodontic treatment and allow better treatment. Self-ligating brackets are one such innovation in bracket design. Although self-

ligation brackets have been in use since a long time. The self-ligating brackets can be labelled as passive meaning the wire experiences low friction, and active meaning the closing door actively pushes on the arch wire. As these brackets do not require an elastomeric module over the bracket, it has been proposed that there is reduced friction between the arch wire and bracket. This reduced friction can help in arch wire sliding easily even in crowded teeth. Even though a few initial studies found some difference in the treatment times with self-ligation brackets, the prospective randomized trials have rejected such claims. It has been reported that the treatment duration is no different between self-ligation brackets and regular twin brackets. [6-9] An important consideration is the application of the right biomechanics for the patients depending on their skeletal maturation. The skeletal maturation of the patient can be identified from the cervical maturation status (CVMI) and plays an important role in identifying they will grow favorably or not. [10]

An important advancement in the non-surgical orthodontic techniques is the introduction of mini-implants. With mini-implants, enmass space closure can be done instead of two step space closure which can potentially save time during treatment. Also, mini-implant based appliances such as mini-screw assisted rapid palatal expansion appliances (MARPE) have been found to effectively expand the maxilla. [11] Also at the same time such appliances can be used for wearing elastics and correction of other types of malocclusion such as class III. [12] The versatility of mini-implants in orthodontics helps to save time in making different appliances and achieve efficient tooth movement. The innovative appliance design created with mini-implants of U-MARPE has shown expansion of maxilla on only one side and thus reducing side-effects on the other side. [13] This can be a useful tool in decreasing the treatment duration.

Drugs that can affect orthodontic tooth movement

The biological response of the teeth can be affected by certain drugs that can modulate the bone resorption and

formation by osteoclasts and osteoblasts. These drugs can alter the orthodontic tooth movement. ^[14, 15] Some drugs can interfere and decrease the movement of the teeth and thus knowledge about such drugs is important for orthodontists to prevent an unexpected increase in the treatment duration. ^[14-18] Raloxifene is one such drug that can reduce the rate of orthodontic tooth movement. ^[19] The effect of raloxifene can be beneficial for the retention of patient. ^[19] As such drugs can decrease the tooth movement, the relapse rate at the end of orthodontic treatment is reduced. Certain hormones such as corticosteroid hormones, Vitamin-D3, parathyroid-hormone (PTH) have shown an increase in the rate of tooth movement. ^[14-17] the use of prostaglandin has also shown some positive results on decreasing the rate of orthodontic tooth movement. ^[18] However, the disadvantage of prostaglandin is that the injection of prostaglandin gives rise to pain, which acts as a deterrent for patient acceptance. Certain other factors such as platelet-derived growth factor (PDGF) can also lead to decrease in the orthodontic treatment time, however studies have shown conflicting results.

Low level laser therapy

Low level laser therapy leads to two different response in the alveolar bone, either the piezoelectric response or the osteogenic response. ^[20, 21] It is been shown that the low level laser therapy results in an increase in the levels of RANKL (Receptor Activator of Nuclear Factor Kappa B Ligand). This results in a higher rate of differentiation of precursor cells into osteoclasts. Due to a higher number of osteoclasts, it is assumed that there will be associated higher rate of orthodontic tooth movement. THE protocol of laser density affects the results of the rate of tooth movement. In a study with corticotomy and low level laser therapy, it was found that there is an increase in the rate of tooth movement. ^[5] However, another trial with a different laser density has not shown acceleration of tooth movement with laser therapy. Therefore, better quality randomized clinical trials with a study design of a long follow up and control group should be done in the future to observe the effects of low level laser therapy. There is an interplay of multiple factors when orthodontic tooth movement is performed which favor some patients in faster tooth movement. Artificial intelligence has been used in recent years for identification of radiographic structures in orthodontics. ^[22] With more advancements, it could be used to identify which patients would be respond favorably to such interventions for acceleration of tooth movement.

Surgical methods of acceleration of tooth movement

Surgical techniques for accelerating tooth movement include surgery-first, corticotomies, piezocision, and micro-osteoperforations.

Micro-osteoperforations

Micro-osteoperforations is a relatively less invasive method of inducing surgical trauma for the purpose of acceleration of tooth movement. With micro-osteoperforations, the surgical insult is performed by penetrating the soft-tissue mucosa and bone between the teeth. This method does not require a flap or incision and that is why, it is less invasive than other methods of surgical insults. Osteoperforations have been investigated with different force levels to identify how they affect the rate of orthodontic tooth movement. It

has been reported that with higher amount of force, increase rate of tooth movement is observed. ^[23] Similarly, performing osteoperforations also increases the rate of orthodontic tooth movement. ^[23] These findings have been replicated by other authors that used osteoperforations and found that there is an increase in the rate of orthodontic tooth movement. ^[24-27] Although, osteoperforations increased the rate of orthodontic tooth movement, It was also found that with osteoperforations and increased force, there was an increased amount of root resorption. Reserachers have been investigating methods to increase the rate of root resorption while at the same time decrease the amount of root resorption. A recent study seems to have found this breakthrough. ^[28] Mehta *et al.* studied the effects of osteoperforations at different distances from the molar teeth to find an answer to this question. ^[28] The authors showed that when osteoperforations are performed distant or farther from the roots of molar teeth at 5mm distance, there is an increase in rate of orthodontic tooth movement but there is no significant root resorption compared to when the osteoperforations are performed closer to the teeth, which results in increase tooth movement and increased root resorption. Therefore, performing osteoperforations farther from the teeth may be helpful in reducing treatment duration without the side effects of root resorption. ^[28]

Surgery First

In patient with complex malocclusion, surgical treatment can be performed with a surgery-first approach in which surgery is performed prior to orthodontic treatment. The surgery first technique manages poor facial esthetics and occlusion initially and then is followed by orthodontic treatment which is undertaken for alignment of teeth and occlusal detailing. ^[29] Surgical orthodontics can also be performed with either fixed appliances or aligner therapy. ^[30] It is indicated in patients with well aligned teeth in upper and lower arch, minimal curve of spee, mild proclination or retroclination of anterior teeth and minimum transverse issues. The higher the extent of surgical insult, the higher is the inflammatory response and therefore, higher the acceleration of tooth movement. ^[31]

Conclusions

There is limited evidence that low level laser therapy may be beneficial for acceleration of tooth movement, but further studies are required to identify the effects of low level laser therapy. Mini implants in orthodontics have been useful in achieving the desired tooth movement effectively. Certain drugs can affect the rate of tooth movement and therefore, it is useful to note a detailed medical history before starting orthodontic treatment. Osteoperforations may be beneficial for accelerating orthodontic tooth movement.

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