



CYCLIC LOADING - ACCELERATING ORTHODONTIC TREATMENT

Dr. Rachna Darak*

MGM Dental College and Hospital, Navi Mumbai, Maharashtra, India.

*Corresponding Author

Dr. Prathamesh Fulsundar

Scientific Officer Head- Maharashtra State, IADS.

ABSTRACT The major drawbacks of orthodontic treatment which are responsible for patient dropouts are the long span of treatment and associated pain. Various advancements have been made in order to overcome these drawbacks which include medicines, corticotomy techniques, laser therapy, photobiomodulation etc. One such advancement is the introduction of vibrations in orthodontics. Vibrations have been used in the medical field since a very long time for bone modification procedures. Recent studies have shown that vibrations can also be used in orthodontics to accelerate tooth movement, thereby reducing the overall treatment time. Apart from this, it also has the advantage of reducing the pain associated with the treatment making it more acceptable to patients. However this technology is still in its infancy and more clinical studies and research is required to prove its efficacy.

KEYWORDS : Orthodontics, Tooth Movement, Accelerated, Vibrations

INTRODUCTION

Orthodontic treatment has become increasingly popular in the recent times. However the major drawbacks of the same are the long span of treatment and the pain associated with the same. The long span of treatment is also associated with various other complications such as white spot lesions, periodontal diseases and external root resorption.¹ In order to overcome these drawbacks various advancements have come to core. Various surgical and non surgical methods have been introduced to accelerate orthodontic tooth movement. Surgical procedures such as corticotomy and micro-osteoperforations are less acceptable to patients owing to the invasive nature of the procedure and associated post surgical discomfort.² There are also various non surgical procedures to aid the same such as laser therapy, vibrations, photobiomodulation etc.¹ Systemic medicines can be nonspecific and may produce unwanted side effects in addition to accelerating tooth movement.

NSAIDs (Non Steroidal Anti Inflammatory Drugs) have been used extensively for pain control in orthodontics. However research shows certain disadvantages. NSAIDs have been shown to slow down tooth movement in orthodontics thereby increasing the overall treatment time.³

One of the recent advances for accelerating tooth movement is vibrations. Vibrations are an easy to apply technique which can be used to reduce overall treatment time and pain in orthodontics.

VIBRATIONS

Vibration also called high frequency low magnitude stimulation is a mechanical stimulus with an oscillatory motion. It can be described by using the following terms:

- i) Frequency (measured in Hertz; the number of Hz shows the number of complete up and down movements per unit time)
- ii) Amplitude (the extent of the oscillatory motion, measured in mm)
- iii) Direction of the vibration movement.⁴

The application of cyclic loading (vibration) of 0.25 N (25 g) at the frequency of 30 Hz, as an adjunct to treatment with a fixed orthodontic appliance, significantly increases the rate of orthodontic tooth movement.⁵

DEVICE

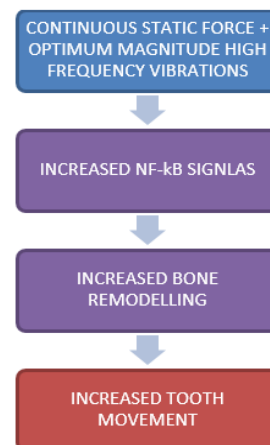
(Figure 1. Cyclic Loading Device with Charging Port)

The device consists of four parts as follows:

- i) Activator – generated micro pulses/ vibrations for effect
- ii) Mouthpiece – held between the two arches. Comes in various sizes for different arch forms.
- iii) Travel shell – used to store the device after use
- iv) Charging port – used for electrical charging of the device⁵

The device is prescribed by the orthodontist for home use. It can be combined with any orthodontic treatment such as braces or clear aligners. It should be used only by a single patient and should be disposed off once the treatment is finished.

The patient turns on the activator and bites on the mouthpiece for 20 minutes every day during the course of orthodontic treatment. The device is light weight and should be held in place by gentle bite pressure only.⁵

MECHANISM OF ACTION

(Figure 2. Mechanism Underlying Cyclic Loading)

Vibrations have been used advantageously in the field of medicine since a very long time. The effects of vibrations have been found to be based on Wolff's law where the trabecular bone adapts to its mechanical environment. Supplemental vibrational therapy causes anabolic effects on bone metabolism hence promoting suture growth and remodeling in craniofacial region.⁶

Orthodontic tooth movement is a consequence of tissue remodeling within periodontium induced by external forces. Vibrations can promote orthodontic tooth movement by promoting alveolar bone

remodelling.⁷ They act by causing stimulatory changes in the periodontal apparatus thereby reducing the lag phase of orthodontic tooth movement.

It has also been found that vibrations stimulate inflammation and possess the potential to alter periodontal apparatus or create osteogenic effects through genetic expression, cytokine activity and cellular changes, thereby enhancing tooth movement.⁸

Apart from acceleration of tooth movement, vibrations have also been found to reduce pain associated with orthodontic treatment. Vibrations help to relieve the compression of periodontal ligament (PDL) which promotes normal circulation and prevents build-up of inflammatory by-products, thereby reducing pain.⁵

Another possibility is the "gate control" theory, which suggests pain can be reduced by simultaneous activation of nerve fibers that conduct non-noxious stimuli. The effect of vibration has been shown to be consistent with the "gate control" theory, causing activation of rapidly adapting mechanoreceptors in the skin, periosteum, muscle and bone, and an interaction between large fibers and small pain fibers. Hence the receptors activated by vibration mask the pain signals and prevent them from reaching the central nervous system (CNS).⁵

INDICATIONS:

- In cases of fixed orthodontics to reduce the treatment time
- As an adjunct to clear aligners
- In management of mild to moderate cases with orthodontic forces.

CONTRAINDICATIONS:

- In patients on osteoporosis drugs
- In cases with poor oral hygiene
- In the presence of periodontal disease that is not under full control at least 3 to 4 months prior to start of treatment

ADVANTAGES

Following are the advantages of vibrations

- Ease of use.
- Not a skilled procedure can be performed easily by layman.
- Non invasive. Hence readily accepted by patients.
- Decreases the overall treatment time in orthodontics.
- Decreases the pain associated with orthodontic treatment.
- Minimal side effects in comparison to other means of accelerating orthodontic tooth movement.

DISADVANTAGES

Following are the disadvantages of vibrations

- Requirement of special equipment for use.
- Requires patient compliance.
- Must be used on a regular basis for appropriate results.
- It cannot be used alone. Should be combined with an orthodontic therapy such as braces or clear aligners.

CLINICAL STUDIES

- A double-blind, prospective, randomized, controlled trial was conducted by Dubravko Pavlin et al on 45 patients undergoing orthodontic treatment with space closure of 3 mm following extraction of permanent maxillary first premolars. The selected subjects were randomly divided into two groups, the study group with 23 subjects and the control group with 22 subjects respectively. The study group received vibrations 20mins/day with force of 0.25 N and frequency of 30 Hz while the control group did not received any vibrations, the monthly rate of maxillary canine retraction was measured. The study group receiving vibrations showed greater rate of canine retraction as compared to the control group. The study concluded that vibrations accelerate the rate of orthodontic tooth movement.⁹
- A retrospective evaluation of the effects of vibration on the time required for mandibular leveling and alignment was done by Dr. Bowman which included 117 consecutively treated Class II non extraction patients (47 male, 70 female) who underwent maxillary molar distalization and concurrent mandibular leveling and alignment. The patients were divided into 3 groups the control group, the study group receiving vibration and the pre-vibrational control group. Each patient in the study group was directed to use the device 20 minutes per day during the entire course of orthodontic treatment. On comparing the results, the average time

needed to achieve leveling in the study group was 160 days--48 days less than that in the control group (30% faster) and 55 days less than that in the pre-vibrational control group (35% faster). The study concluded that the amount of time required in achieving both dental alignment and leveling in Class II non extraction treatment was reduced by using an AcceleDent device to apply vibration.⁸

- Chung How Kau and colleagues conducted a study to determine the clinical effects of a cyclical force generating device on tooth movement and overall orthodontic treatment time. Fourteen patients completed the study. Subjects undergoing active fixed orthodontic treatment were included in this study. The patients received vibrations for 20 minutes/day for 6 consecutive months. The rate of tooth movement for the mandibular arch was 2.1 mm/month, while that for the maxillary arch was 3.0 mm/month. The study concluded that there was a significant increase in the rate of tooth movement in patients receiving vibrations, patient compliance with use of device was 67%; and patient acceptance of and compliance with the device was clinically significant.¹⁰
- A randomized clinical trial was conducted by Dr William Dunn et al. A total of 58 selected patients undergoing orthodontic treatment were randomly divided into experimental group and study group with 29 subjects in each group respectively. The amount of pain following orthodontic archwire placement was measured at equal intervals. The experimental group received vibrations using Micropulse device 20 minutes/day. The overall pain and bite pain perception was measured for 4 months. On comparing the results, the experimental group showed lowered pain perception as compared to that of the control group. The study concluded that vibrations reduce the pain experience associated with orthodontic treatment.⁵

FUTURE SCOPE

Vibration in orthodontics is still in its infancy. Initial studies have shown vibrations to be effective in increasing the rate of tooth movement. Another advantage of the use of vibrations is the reduction of pain associated with the treatment. The use of vibrations became further accessible and hence widely used by patients with the development of the AcceleDent device. More clinical studies and research are required to completely study the use of vibrations in orthodontics.

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