Original Article

In Vivo Study on The Effects of Vibrations on Orthodontic Tooth Movement

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Abstract

Aim & Objective: To compare the orthodontic tooth movement rate between the experimental and control groups and to assess the effect of vibrations on the orthodontic tooth movement in patients undergoing fixed orthodontic treatment.

Materials and Procedures: On 37 fixed appliance therapy orthodontic cases with bilateral maxillary arch first premolar extractions, a split-mouth design study was conducted. All of the participants with type-1 active tiebacks had individual canine retractions. Vibration was given by Oral-B powered toothbrushes (125 Hz) for 10 minutes each day (splits into 5 minutes twice a day). At various time intervals, the tooth movement was clinically assessed using a calibrated digital vernier calliper (T0, T1 and T2). OPGs were collected at the predetermined intervals on a regular basis, and the tooth movement on OPGs was calculated using the grid method.

Results: Data were statistically analysed, and the p-value showed inconsequential difference between experimental side's rate of tooth movement and the control side's.

Conclusions: In individuals undergoing fixed orthodontic treatment, high-frequency vibratory stimulation combined with a fixed orthodontic appliance exhibit negative results. Vibrations from powered toothbrushes fails to speed up tooth mobility.

Keywords: Vibrations, Vibratory stimulation, Grid technique, Accelerated Orthodontics, Orthodontic tooth movement.

INTRODUCTION

Numerous ideas that aim to speed up orthodontic tooth movement and could potentially shorten treatment times have been discovered and are constantly being developed. 2
Magnetic fields, low laser irradiation, prostaglandin E2 injections, corticotomy, and other surgical and non-surgical techniques can all be utilised to speed up tooth movement. Vibration is one non-surgical technique that has gained acceptance and is now used in clinical settings with the potential to quicken tooth movement in orthodontics. 4, 5
A mechanical stimulus characterised by an oscillating motion is defined as vibration, also known as high frequency, low magnitude stimulation. Contrary to static loads from orthodontic appliances, which have a catabolic effect, vibration as a dynamic load has demonstrated osteogenic and anti-catabolic effects on bone.

Vibrations have been shown to be a safe, low-impact alternative that accelerates bone remodelling and have the advantage of having fewer adverse effects than other techniques of increasing tooth movement. 5 With the ultimate goal of generating physiologic tooth movement, Shapiro E, Roeber FW, et al. (1979)6 reported using pulsing force created by piezoelectricity for the very first time in their investigation.

According to a study by Rubin C, Recker R, et al. (2004)7, low level mechanical vibrations speed up the rebuilding process in mechanically loaded long bones. This idea is being employed to prevent osteoporosis by increasing bone metabolism and reducing bone loss in postmenopausal women. According to Kusano H, Tomofuji T et al. (2006)8, dogs' gingival fibroblasts proliferated and produced more collagen after using vibratory and ultrasonic toothbrushes.

Similar to this, a human study by Kau CH, Nguyen JT et al. (2010)10 found that short-duration, low-amplitude, high-frequency resonance vibrations paired with orthodontic force could improve tooth mobility without causing extra tissue injury. These are the strong arguments that supported the concept of boosting bone metabolism with mechanical vibrations in order to hasten orthodontic tooth movement.

MATERIAL & METHOD

This investigation was given the go-ahead by the Lucknow-based Saraswati Dental College's institutional human ethical committee and institutional research development committee. It was held at the Saraswati Dental College in Lucknow's Department of Orthodontics and Dentofacial Orthopedics and Department of Oral Medicine and Radiology. The pool of patients receiving fixed orthodontic treatment at the Saraswati Dental College in Lucknow's Department of Orthodontics and Dentofacial Orthopedics served as the study's subjects.

Based on specific inclusion and exclusion criteria, 50 fixed orthodontic treatment cases ranging in age from 18 to 28 years with bilateral first premolar extractions in the maxillary arch were chosen; however, only 37 subjects finished the study, and 13 subjects were dropped because they failed to show up for follow-up appointments or did not come.or had poor compliance or debonded brackets. The inclusion and exclusion criteria includes

- Patients receiving fixed orthodontic treatment requiring extraction of both first premolars in the maxilla.
- Patients with good oral hygiene and periodontal health.
- Individuals with a fully developed permanent dentition
- Exclusion standards comprise:-Patients with canine impacted teeth.
- Patients who practise bad oral hygiene.
- Patients suffering from any systemic illness.
- The patient taking an analgesic before the procedure.

These patients participated in a split mouth design trial, with one side designated as the experimental side and the other as the control side. In order to avoid confusion, the maxillary arch's right side was designated as the experimental side and the left side as the control side for all patients. Parents and patients were informed of the study procedure, and agreement was obtained.

After bilateral maxillary first premolar extraction, the fixed orthodontic treatment was started with a preadjusted edgewise 0.022" slot prescription bracket kit. Patients were told not to use any NSAIDs during treatment and that the maximum amount of anchoring preparation had been done. 0.019"x 0.025" SS archwires were used for canine retraction, and Type-1 active tiebacks were attached to both the experimental and control groups.

Dontrix gauge was used to standardise the active tieback's 150 gm force on both sides. The patients were given powered electric toothbrushes with 125 Hz vibration, and they were told to place and hold the brush on the right canine's lingual surface for 10 minutes each day (divided into two sessions of 5 minutes each) for three months (Fig 1). Clinical manual readings were made by using a digital vernier calliper to measure the tooth movement (calibrated) (Fig 2). The measurements were taken from the canine's distoincisal angle to the second premolar's mesio-occlusal angle and the canine's distoincisal angle to the first molar's mesio-occlusal angle.

OPGs were collected at T0, before the canine retraction, T1 - one month following the start of the canine retraction and T2, three months following the start of the canine retraction.

Standardized OPGs were produced using the same equipment (Kodak 8000C Digital Panoramic and Cephalometric machine operating with Kodak Dental imaging Software and Cephalometric Acquisition Interface Module) at a fixed distance and the same exposure parameters (73 kVp, 08 mA, exposure time 13.9 sec) with 100% magnification. The Fujifilm Medical Dry Imaging film (10 x 8 inches in size) and the Fujifilm Dry pix plus printer were used to print the x-rays. The same operator manually traced the required structures using lead acetate paper and a 4H tracing pencil after occasionally obtaining OPGs. Maxillary landmarks were identified. The same exposure conditions (73 kVp, 08 mA, exposure period 13.9 sec) were used on the canines, maxillary 2nd premolars, and maxillary 1st molars to generate standardised OPGs. At T0, T1 and T2 on OPG, measurements were taken from the long axis of the maxillary canine to the long axis of the second premolars and from the long axis of the maxillary canine to the long axis of the buccal cusps of the first molars on both the experimental and control sides. Periodically, data were collected, and a master chart was created for the final readings.

Fig-1: Battery powered toothbrush used for vibrations

Fig -2: vernier calliper used for measuring tooth movement

RESULTS

Results were obtained and compared using the Paired t-test. There is no statistically significant difference (p=0.28) between the experimental side (2.62 with SD 0.17mm) and the control side (2.58 with SD 0.15 mm) (Table -1)in terms of the monthly rate of canine retraction as assessed from the canine to the second premolar (T0-T1). Comparing tooth mobility between the experimental and control sides from T0-T2 similarly reveals no significant difference (p=0.17) between the experimental side (4.75 with SD 0.20 mm) and the control side (4.69 with SD 0.18 mm) (Table -2).The findings showed that, when assessed from 13–15 and 23–25 in orthodontic patients, the rate of orthodontic tooth movement between the experimental side and control side did not significantly differ at T0-T1 and T0-T2.

Table-1: Comparative values of tooth movement between experimental and control sides for time interval To-T1

Side	Movement (in mm) (Mean±SD)
Experimental side	**2.62±0.17**
Control side	**2.58±0.15**
p-value1	**0.28***

1Paired t-test, *non-Significant

Table-2: Comparative values of tooth movement between experimental and control sides for time interval To-T2

Side	Movement (in mm) (Mean±SD)
Experimental side	**4.75±0.20**
Control side	**4.69±0.18**
p-value1	**0.17***

1Paired t-test, *non-Significant

DISCUSSION

Numerous research have shown that using vibrational forces to fix orthodontic tooth movement is a painless, non-invasive treatment. Numerous studies have demonstrated the benefits of vibrational pressures for quickening orthodontic tooth movement. In contrast to this study, research by Pavlin D. 8 reveals that vibrations can positively affect the mobility of teeth during orthodontic treatment. However, Study conducted by Bowman S. J. (2016) 9 revealed that vibration had no effect on the speed of tooth movement. More evidence investigations have not been able to demonstrate an accelerator effect of vibrational forces, which is in evidence of the proposed study, according to Uribe F. (2017) 10 in a review article. According to Alikhani M et al.11, who noted that high-frequency vibration has a significant impact on orthodontic tooth movement, the vibrational frequency of 125Hz is chosen in the proposed study.

In accordance with study by Leethanakul C et al. 12, which also employed battery-powered toothbrushes to predict the pace of orthodontic tooth movement, patients were given battery-powered toothbrushes (125Hz) for vibratory forces. The patient was kept pain-free thanks to this incredibly low force. The planned study included patients between the ages of 18 and 28 years, which is consistent with research by Azeem M et al (2019)13 that shows how vibrational force affects tooth movement in patients.

Measurements taken for the proposed study's canine retraction demonstrate that the experimental side moved 2.62 mm as compared control side, which moved 2.58 mm, in terms of the monthly rate of tooth movement from T0-T1 time period. The p-value for the time period in question indicates non-significant results (p=0.28), indicating that there isn't much of a difference in tooth movement when vibrational force is applied. This study is in line with the research done by Woodhouse NR (2015)14, who found that using vibrational force in conjunction with an edgewise fixed appliance did not significantly speed up initial tooth movement or shorten the time required to achieve final alignment.

In a similar vein, the contrast between the monthly measurements between the experimental and control sides for the rate of canine retraction measured at T0-T2 from the canine to the second premolar. The mean value on the experimental side was 4.75 mm, with a standard deviation of 0.20 mm, and 4.69mm, with a standard deviation of 0.18 mm, on the control side. The vibrational force does not significantly increase speed orthodontic tooth movement, as shown by the non-significant results (p=0.17) from the calculation of the p-value.

These outcomes confirmed previous research by Woodhouse N. R. et al. (2015)14, Miles P. (2012)15 showing vibrations did not speed up tooth movement.

CONCLUSIONS

The current investigation demonstrates that vibrational force has no positive effects.The results of the current study indicate that vibrational force delivered by battery-operated toothbrushes at a frequency of 125Hz (10 minutes per day for three months) has no beneficial effect on the rate of orthodontic tooth movement in patients who are not growing.

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