

A Different Method to Accelerate Orthodontic Tooth Movement- Randomized Controlled Trial

SUMMARY

Background/Aim: Since both patients and orthodontists want orthodontic treatment to be completed in a short time, various methods have been developed to accelerate orthodontic tooth movement. Vibration applications and interrupted force are noninvasive applications that are easily accepted by the patient. Aim of this study is researching modified interrupted force and vibration together how effect orthodontic tooth movement rate and pain perception that occurs during canine distalization. **Material and Methods:** Twenty patients (10 males and 10 females) with Class II div 1 malocclusion were selected for this study. The Hycon device on the right side activated by routine protocol, but on the left side activation protocol modified. The patients were randomly divided into 2 groups and one group was applied vibration with AcceleDent device. Each patient was provided with a chart to score the pain they experienced during canine distalization. **Results:** Fastest tooth movement was measured in the modified protocol(HL)+AcceleDent group (1.44 mm/monthly). The results showed that the orthodontic tooth movement in the groups which AcceleDent device used was faster than the Hycon groups only. Faster movement was observed in the left canines which Hycon device activated by modified protocol compared to right canines. These differences between groups were found statistically significant. Pain over time exhibited similar patterns in all groups. **Conclusions:** Using modified interrupted force protocol gave more rapid extraction space closure. The application of vibration, as an adjunct to treatment with a fixed orthodontic appliance, significantly increases the rate of orthodontic tooth movement. Vibrational force and modified activation protocol do not have significant effect on pain perception.

Key words: Accelerating Orthodontic Tooth Movement, Vibration, Modified Protocol, Pain Perception

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Introduction

The canines are very important in terms of both oral functions and aesthetics. The positions of the canine teeth in the oral cavity connect the anterior and posterior teeth, which is especially important for their orthodontic movement in cases with premolar extraction¹.

The treatment time of cases treated by premolar extraction usually is longer than nonextraction cases². Prolonged orthodontic treatment can have many side

effects such as pain, discomfort, dental caries, gingival problems and root resorption³. In addition, many adult patients want to finish orthodontic treatment quickly because of aesthetic and social reasons⁴.

There are several methods for accelerating orthodontic tooth movement, but there is no clinically accepted method. For that reason, tolerable and non-invasive methods that can be used effectively have been sought⁵. Methods of accelerating orthodontic tooth movement in general are drugs, surgical methods,

physical and mechanical stimulation methods. Various drugs can be used to accelerate orthodontic tooth movement, but all of these drugs have some undesirable side effects⁶. Surgical methods have been used by many clinicians to accelerate orthodontic tooth movement⁷. However, surgical techniques have many disadvantages such as being invasive, rejection by the patient, pain, infection etc. Physical and mechanical techniques have become popular because they are noninvasive⁶. These methods include low level laser, cyclical force (vibration), therapeutic sound, light emitting diode and direct electric current⁷. Vibration applications in orthodontics are noninvasive applications that are easily accepted by the patient and shorten the treatment time⁸.

AcceleDent device (AcceleDent Aura, OrthoAccel Technologies, Inc. USA) generates vibration signals. This device is rechargeable, easy to use and requires 20 minutes of use per day. In several studies, treatment time has been reported to be reduced by 30-40% with this device^{8,9}. In addition, lower pain scores were reported in patients using AcceleDent device¹⁰.

Space closure with distalizing the canine tooth is one of the important stages of orthodontic treatment. There are many options for closing extraction spaces. Various force systems, such as coil springs, elastomeric chains, elastic modules, lacebacks and nickel titanium springs have been used effectively^{11,12}. Hycon device (Adenta Company, Gutenbergstr. 9-11, 82205 Gilching, Germany)

was developed to close the extraction space, which has a small screw-shaped design, has been reported to increase bone turnover and accelerate orthodontic tooth movement. Activation of Hycon device applies interrupted force on the teeth¹². At the study conducted by Karsli and Yagci, about pressure occurring in blood vessels at force application, they found faster tooth movement occurred with modified interrupted force application¹³. At this study we modified activating protocol of Hycon device.

In that study, we search application of Hycon device with modified protocol and AcceleDent device together how effect orthodontic tooth movement rate and pain perception that occurs during canine distalization.

Material and Methods

Approval for the study was obtained from the Local Ethics Committee of the Faculty of Medicine at Erciyes University (2018/337). This study was planned as a prospective, split-mouth, single-blinded, randomized controlled clinical trial. ClinicalTrials.gov registration was performed prior to start of the study (NCT03968263). The present study involved a sample size of 20 patients, undergoing treatment in Erciyes University, Faculty of Dentistry, Department of Orthodontics (Table.1).

Table 1. Split mouth design and average ages

Group	Number of patient	Number of teeth	Mean Age
Group A - Routine protocol(HR)+AcceleDent	10	10	15.23 ± 1.43
Group B - Modified protocol (HL)+AcceleDent	10	10	16.05 ± 1.19
Group C - Routine protocol (HR)	10	10	
Group D - Modified protocol (HL)	10	10	

HR: Hycon right, HL: Hycon left

The inclusion and exclusion criteria for the study are as follows:

Inclusion criteria

- Twenty patients (10 males and 10 females) with in the age group of 14 to 18 years
- Class II malocclusion with maxillary protrusion from the cephalometric values
- Indication of extraction for first premolars in the maxilla
- Cases with absolute anchorage
- No previous orthodontic treatment with fixed or removable appliances
- Minimum crowding in lower arch
- No deciduous, congenitally missing, supernumerary or extracted teeth
- No systemic disease

Exclusion criteria

- Canines placed in excessive palatoversion or excessive labioversion

- Canines with severe rotation and or tipping
- Abnormal curvature of the canine roots
- Uncooperative patients

Twenty patients (10 males and 10 females) with an age group ranging from 14 to 18 years with Class II div1 malocclusion were selected for this study by a power analysis. Routine treatment records, which included photographs, dental models and radiographs, were taken pre-treatment, after levelling and after canine distalization for all patients included in the study. Pre-adjusted metal brackets (American Orthodontics, Washington, USA) which had values of the Roth prescription (slot 0.018 inch; American Orthodontics) were bonded. The bands with an auxiliary tube cemented on the upper 1st molar teeth.

The Hycon device (Adenta Company, Gutenbergstr. 9-11, 82205 Gilching, Germany) was adapted to auxiliary tube on the 1st molar teeth of all patients. In maximum anchorage cases, it is recommended to activate the screw

half a turn (180 degrees). Thus, the screw will be activated 0.175 mm and will apply 205g of force¹². This study was planned in split mouth design by activating the Hycon devices on the right and left sides differently. The Hycon device on the right side (Hycon right-HR) of all patients was activated half a turn (180 degrees) once in 3 days, as recommended by the manufacturer, until the extraction space was closed. The use of the Hycon device on the contralateral side (Hycon left-HL) has been modified by us. Accordingly, the Hycon device was activated half a turn (180 degrees) on the first day, half a turn (180 degrees) was activated on the second day, and half a turn (180 degrees) was deactivated on the third day. Thus, the Hycon device on both sides was activated 1 half turn (180 degrees) in total after 3 days.

The patients were randomly divided into 2 groups and one group was applied vibration with AcceleDent device (AcceleDent Aura, OrthoAccel Technologies, Inc. USA). Patients used this device every day at a frequency of 30 Hz for 20 min.

All models were scanned with a 3D laser model scanning device (3 Shape, R 700 Desktop Scanner, Szczecin, Poland) and digitalized (3Shape Ortho Analyzer™ 12) (Figure 1). The amount of canine distalization compared with this software (Figure 2). In addition, each patient was provided with a chart to score the pain they experienced during canine distalization. A visual analog scale (VAS) was used to evaluate pain, scored in a range of 0 to 10 with "0" corresponding to "no pain" and "10" corresponding to "unbearable pain".

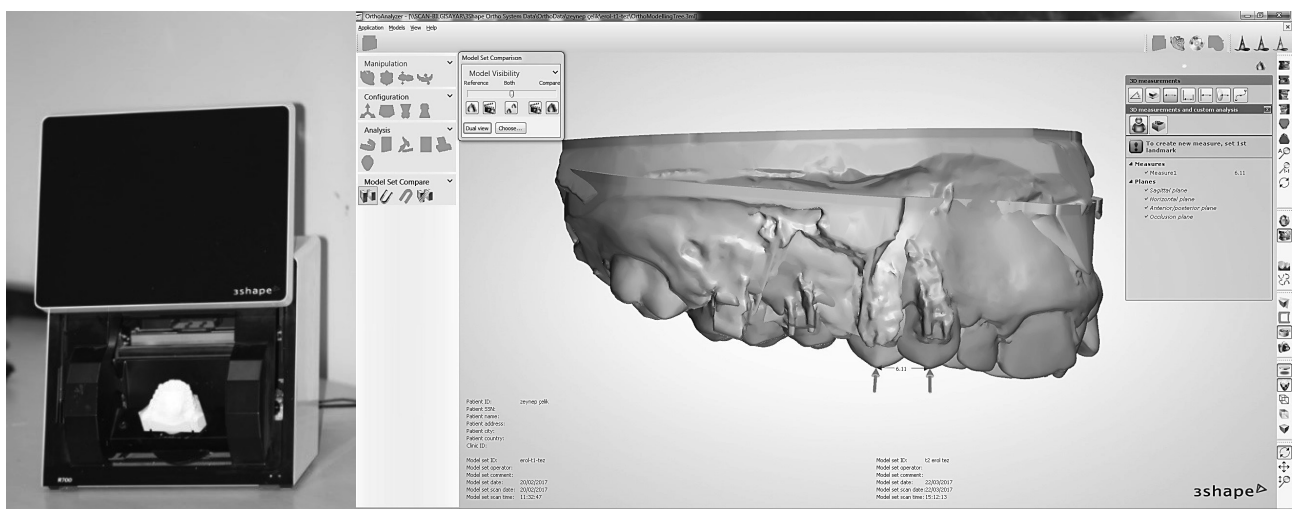


Figure 1. 3D laser model scanning device and 3D digital models

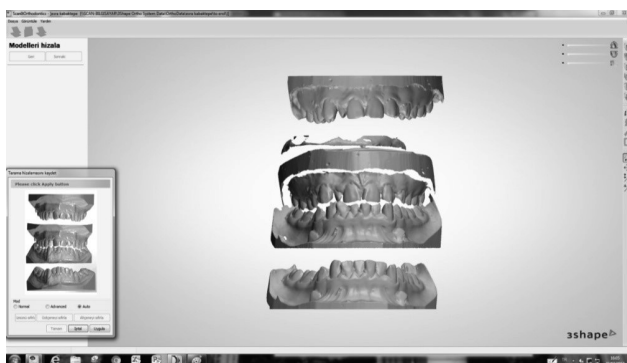


Figure 2. Measurement of canine distalization on a 3D model

Results

A total of 40 canine teeth were successfully distalized in the 4 groups. In this study, the fastest tooth movement was measured in the left canine teeth of patients in whom

the AcceleDent device was used (Group B-1.44mm/monthly). Slowest distalization rate was measured in the right canines of patients which did not use AcceleDent device (Group C - 1.29 mm/monthly) (Table 2). The 0.15 mm/monthly difference between these groups were found statistically significant ($p \leq 0.001$). The results showed that the orthodontic tooth movement in the groups which AcceleDent device used (Group A and B) was faster than the Hycon groups only (Group C and D). This differences between groups was found statistically significant (A-C $p \leq 0.01$, B-D $p \leq 0.01$). In the patients using AcceleDent device, faster movement was observed in the left canines which Hycon device activated by modified protocol compared to right canines (A-B). This difference was found statistically significant ($p < 0.05$). Also in the patients who did not use AcceleDent device, faster movement was observed in the left canines which Hycon device activated by modified protocol (C-D). This difference was found statistically significant ($p < 0.05$) (Table 3).

Table 2. Comparison of mean canine distalization between groups (monthly)

Variable	Group	N	Mean	Std. Dev
Distal movement (mm/monthly)	Group A - Routine protocol(HR)+ AcceleDent	10	1.41	0.31
	Group B - Modified protocol(HL)+ AcceleDent	10	1.44	0.38
	Group C - Routine protocol (HR)	10	1.29	0.11
	Group D - Modified protocol (HL)	10	1.32	0.05

N: number of teeth, HR: Hycon right, HL: Hycon left

Table 3. Intergroup comparisons (rate of tooth movement)

Difference of distal movement/monthly			
Groups	p value	Groups	p value
A-B	0.03*	B-C	< 0.001***
A-C	0.008**	B-D	0.007**
A-D	< 0.01**	C-D	0.02*

(* $p < 0.05$, ** $p \leq 0.01$, *** $p \leq 0.001$)

Comparison of pain levels among the patients revealed that the severity of pain generally increased from the time the devices were first inserted up to 24 h later and peaked at the 24th hour. After that point, the severity of pain decreased and reached low levels after day 3. Fluctuation of pain over time exhibited similar patterns in all groups.

Discussion

In recent years, orthodontists and patients have become increasingly receptive to techniques that might accelerate tooth movement and therefore reduce treatment duration¹⁴. There are several methods for accelerating orthodontic tooth movement. Among nonsurgical methods, vibrational force can be applied directly by the patient, using removable/portable devices, in the comfort of their homes and at convenient times. AcceleDent device delivers 0.25 N (25 g) forces at a frequency of 30 Hz. The theory behind AcceleDent is that low-frequency vibratory forces (30 Hz) will stimulate cell differentiation and maturation, leading to quicker bone remodeling and tooth movement⁸.

In this study, faster orthodontic tooth movement was observed in the groups using vibration. Our findings are similar to previous studies investigating vibrational force application and tooth movement. Significant effects have been found over the short term in animal models^{15,16}, and some clinical data demonstrated that AcceleDent

increased rates of tooth movement in subjects undergoing fixed appliance therapy^{8,17,18}.

It has been previously shown in the literature that the Hycon device accelerates orthodontic tooth movement^{11,19}. In absolute anchorage cases, activating the screw 180 degrees will provide tooth movement without interrupting blood flow in the surrounding tissues¹². In the presented study, we aimed to further accelerate the orthodontic dental movement by modifying the procedure of using Hycon device. By increasing and decreasing blood flow which may stimulate inflammatory cells, we expected more bone remodeling and more orthodontic tooth movement²⁰. According to the results we obtained, faster tooth movement occurred in the groups where we modified use of the Hycon device. This results were consistent with the results that Karsli and Yagci¹³. This modified activation protocol is a non-invasive method that can be used to accelerate orthodontic tooth movement.

In the presented study, orthodontic tooth movement was further increased by using Hycon device and AcceleDent device together. According to these results, AcceleDent and Hycon devices have a synergistic effect on each other.

Comparison of pain levels between patients revealed that the severity of pain generally increased from the time the device was first installed up until 24 h later and peaked at the 24th hour. After that point, the severity of pain decreased and reached low levels after day 3, with similar pain severity in all groups. Several researchers have reported that the application of vibration during orthodontic treatment reduced the severity of pain experienced by patients^{21,22}, while others have reported that vibration had no effect on the experience of pain²³⁻²⁵. In the present study, we found that the application of force and vibration under different protocols had no statistically significant effect on the severity of pain.

Conclusions

Using modified interrupted force protocol may give more rapid extraction space closure. This method may provide clinical benefit as a non-invasive method to close the extraction space faster. The application of cyclic loading (vibration), as an adjunct to treatment with a fixed orthodontic appliance, significantly increases the rate of orthodontic tooth movement. The use of Hycon device and AcceleDent device together created synergistic effect and faster orthodontic tooth movement occurred. Vibrational force and modified activation protocol do not have significant effect on pain perception in patients undergoing orthodontic treatment.

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