

Understanding Aligner Treatment

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Abstract

Furthering our understanding of tooth movement accomplished with clear aligners is critical to improve our outcomes for our patients. Specifically, the use of attachments and aligner staging do impact our clinical outcomes. The purpose of this study was to examine the affect of age, sex, periodontal bone level, root length and alveolar bone quality on tooth movement. An upper central incisor in 15 subjects and moved with a series of 4 aligners programmed with 0.5 mm each of AP movement for a total of 2.0mm. Weekly impressions were taken and AP movement of the target tooth was measured from digital models with custom software. There was a statistically significant decrease in the amount of tooth movement as age increased which varied by sex. Other variables will be studied with this model which will give us a better understanding on how teeth react to forces from aligners but will also give us an overall better understanding of tooth movement.

Introduction

The use of clear removable aligners in treatment of orthodontic malocclusion has increased in use over the last ten years. While demand from the public may have stimulated some of this increase, the further development of the aligner and a better understanding of how to effectively move teeth with this treatment modality have led to more practitioners offering this product to their patients. When treating with clear aligners, there are other things to consider during treatment planning that are not usually considered with traditional fixed appliances such as placement and shape of attachments and factors that affect the staging of the tooth movement. Using a human model that measures tooth movement of a single tooth, we will examine the affect of age, sex, periodontal bone level, root length and alveolar bone quality on tooth movement.

Material and Methods

This was a prospective single center clinical trial involving 15 subjects. All subjects (including males and females) were between the ages of 18 and 40 years, in good health and had acceptable malocclusions as defined in the inclusion criteria (minor incisor malalignment). Use of concomitant medications for medical conditions were allowed, except for chronic daily use of any nonsteroidal anti-inflammatory or steroid medication or any other medication that the investigators felt would interfere with the biology of tooth movement. Smokers and pregnant women were excluded. A maxillary central incisor was selected as the target tooth which was not blocked out by the adjacent teeth and allowed AP movement of 2 mm. Photos, PVS impressions and a cone beam CT were taken. A series of 4 maxillary aligners were fabricated and programmed with 0.5 mm each of AP movement for the central incisor being studied. All study subjects were instructed to wear the appliance full-time. They were allowed to remove the appliance when eating, drinking, or brushing their teeth. Compliance with use of the appliance was monitored using a daily diary completed by the study subjects. Subjects were seen weekly and PVS impressions were taken to measure the weekly AP movement of the target tooth using digital models with ToothMeasure® software (Align Technology). At the final study appointment, a 2nd cone beam CT was taken of the maxilla only. A superimposition of the initial and final CT images was done with InVivo Dental® (Anatomage).

Results

As seen in Figure 1Top, the total mean tooth movement of the 15 subjects was 1.11mm (range 0.35-1.46) or 55.4% of the 2.0mm that was attempted. New active aligners were given to the subject on week 0, 2, 4, and 6. Figure 1 Bottom shows that on average 0.16- 0.24mm(33-49% of attempted) of the tooth movement took place during the first week of wear whereas only 0.04-0.09mm(9-18% of attempted) occurred during week 2 of wear. There was a

statistically significant decrease in the amount of tooth movement as age increased (Pearson $CC = -0.74$, $p = 0.0038$). This decrease in tooth movement was different in males and females with younger males moving more than younger females while older males moved less than older females. There were no significant differences noted in the amount of tooth movement when with root length or crown to root ratio.

Discussion

This study showed that the majority of tooth movement with an aligner that is worn for a two week period occurs during the first week of wear. What we don't know is if this second week is necessary for the biological repair to occur prior to further tooth movement occurring or whether a more active aligner could be given to continue the tooth movement process during this second week.

We also can learn from this study that when we attempt a 0.5mm translation movement per aligner of a tooth, on average we will only achieve approximately 50% of the attempted movement although this varies greatly between patients. Therefore, as we progress along with aligners at this rate, fit will be affected eventually which will necessitate fabrication of better fitting aligners. It is important to note that the 0.5mm rate is double the 0.25mm maximum rate used by Align Technology when staging treatment. We do not know if a higher percentage of attempted movement is achieved by using the decreased 0.25mm rate.

It has been previously shown in animal models that tooth movement rate decreases with age. Our study not only confirms this in the human, but shows that this tooth movement rate drops significantly at an earlier age than might be expected since our subjects ranged in age from 18 to 35 years old. We also observed differences in the change of this rate drop between males and females which could be due to hormonal changes. This information not only helps orthodontists in their decisions on how fast to move teeth with aligners which essentially effects the number of aligners a patient wears, but it also helps us to understand differences in tooth movement with any appliance.

Rate of tooth movement is undoubtedly affected by many variables. This tooth movement model will help us understand those variables which help us obtain better treatment outcomes for our patients.

Figure 1.

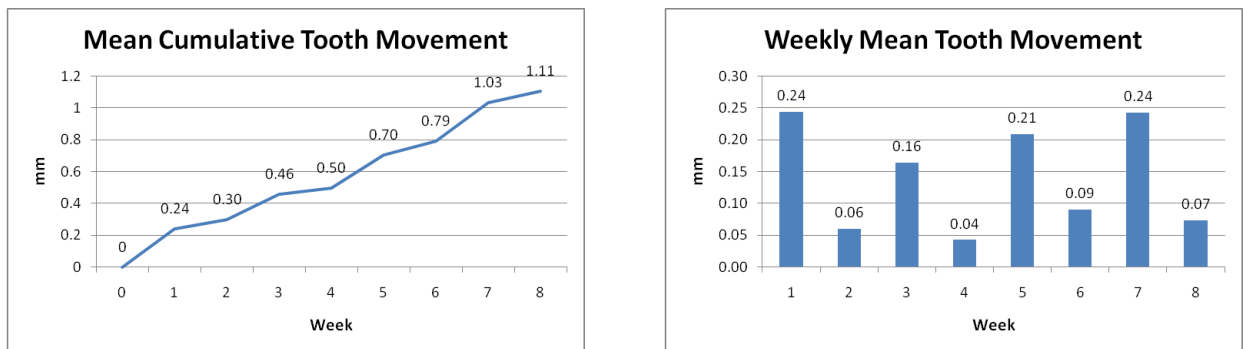


Figure 1 Legend

Top: Mean cumulative tooth movement for maxillary central incisor in 15 subjects with attempted total movement of 2.0mm.

Bottom: Mean weekly tooth movement for maxillary central incisor in 15 subjects with attempted total movement of 0.5mm every 2 weeks.