

Original article

# Distalization of Maxillary Molars using Clear Aligners without Auxiliaries

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## ABSTRACT

**Background and aims.** Clear aligners are used frequently to treat Class II malocclusions when distalization of the upper first and second molars is an important option. There is a little evidence to support the predictability of these movements and the outcome that doctors have predicted may not be achieved, particularly in the absence of auxiliaries attached to teeth needed to be moved. The aim of this study was to evaluate the possibility of distalization with transparent splints only. **Methods.** 3D software was used to superimpose digital models of pre-treatment, post-treatment, and virtual plan (ideal post-treatment) measurements of a 24-year-old patient. The software from B&B Dental was used to calculate the achieved tooth movement. **Results.** The total distal displacement for the first and second molars was 2.15 mm. Overlays could not achieve 100% ideal result after processing; Therefore, improvement planning is often required. **Conclusion.** Clear aligners can be considered an attractive option for distalization of first and second molars.

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## INTRODUCTION

Class II patients often require distalization of the upper molars without extraction. Dissolution of Class II molar relationships by distalization of the upper molars may be indicated in patients with minor skeletal abnormalities [1]. Maxillary molars can be distalized by external or intraoral forces [2]. In recent years, various techniques have been developed to reduce dependence on patient compliance, such as B. intraoral appliances with and without skeletal anchorage. However, these devices can also cause undesirable tilting of the upper molars and/or loss of anterior anchorage during distalization [3-9]. In recent decades, more and more adult patients have sought orthodontic treatment and expressed a desire for esthetic and comfortable alternatives to conventional fixed orthodontic appliances [10, 11].

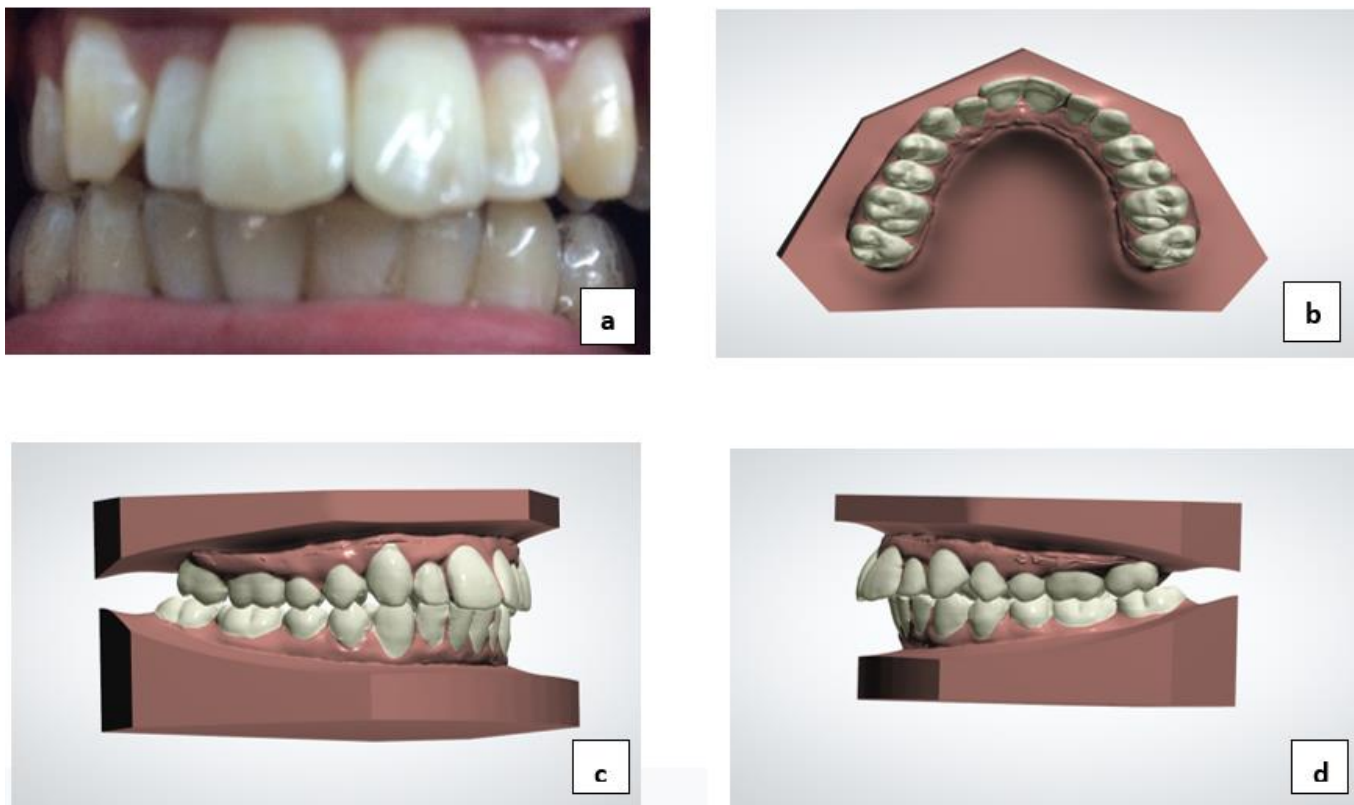
Invisalign, Clear aligner (CA) or Clear path is an orthodontic system that was introduced in response to this need. Several case reports [12-14] have demonstrated the possibility of achieving Class II correction with sequential distalization of the maxillary molars in growth-arrested individuals. However, a sound clinical judgment must always be based on superior evidence. Simon et al. [15] reported high accuracy (88%) of body movement of the splinted upper molars when a mean distal movement of 2.7 mm was prescribed. The authors found the greatest accuracy when movement was aided by the presence of a bracket on the tooth surface. In addition, they emphasized the importance of stage for predictability of treatment. However, a detailed analysis of the underlying skeletal and dental changes induced by aligners during class II treatment in adult patients is still lacking.

Based on these considerations, The purpose of this work was to investigate the effectiveness of orthodontic treatment with the Invisalign® system. Particularly, without the influence of auxiliaries (Attachments) and the stage of progress (movement through number of thermoplastic aligners) on the effectiveness of the treatment protocol in adult patient. The study was conducted to test the hypothesis that distalization of upper molars with aligners without auxiliaries is not possible.

## METHODS

A 24-year-old male presented with Class II malocclusion in both left and right sides, midline deviation, and crowding of the anterior segments in the upper and lower jaws (Fig. 1). The patient met the following inclusion criteria (1) age is more than 18 years old (2) absence of mesial rotation of the upper first molar according to Ricketts [16] (3) end-to-end class II first molar relationship bilaterally (4) standardization of the treatment protocol (5) mild crowding in the upper anterior teeth ( $\leq 4$  mm) (6) extraction of the upper wisdoms (7) good compliance during the treatment (wearing time of aligner  $\geq 20$  h per day).

This work was conducted at Zendah Dental Laboratory in Tripoli-Libya. To resolve Class II malocclusion, the treatment plan included pre-treatment with extractions in wisdoms in both sides of the upper jaw (Fig. 1b). An Impression in polyvinylsiloxane (addition silicone) and bite registration were recorded. The impressions are scanned (destructive scan) and 3D version of the patient's dental arches and occlusions are created on the computer so, virtual corrections can be made using Computer Aided Design (CAD). Meastro 3D ortho studio software (Italy) was used for moving teeth without using virtual auxiliaries. The treated case was planned in order to obtain a sequential distalization on the upper arch, and the staging was set at 0.25 mm per aligner. The stages were divided into three setups. First setup was for moving molars distally and then followed by premolars. Finally, aligning the anterior teeth. In addition to distalization, there was movement of teeth to buccal side ranged from 0.8mm to 1.4 mm in molars, premolars and canines respectively. The virtual planned file was sent for verification by the practitioner. The planned treatment may require changes before approving the protocol of treatment.



**Figure 1.** Initial position of teeth (a) frontal image (b) occlusal view (c & d) right and left views of the teeth

After confirmation of treatment planning, which was generated by the software, a 3D printer (Ultimaker, Holland) was used to print out the models. It is a fused deposition modeling (FDM) printer and it uses thermoplastic materials (Polylactic acid PLA) for creating models (Fig 2). Clear Aligners (preform, USA) were vacuumed upon the PLA models. Clear Aligner® treatment involved 29 upper and 7 lower aligners. The patient was instructed to change the aligners every 14 days. The statistical measurement of the maxillary molar distalization was performed using B&B Guided software and comparison was operated with other studies found in the literature.

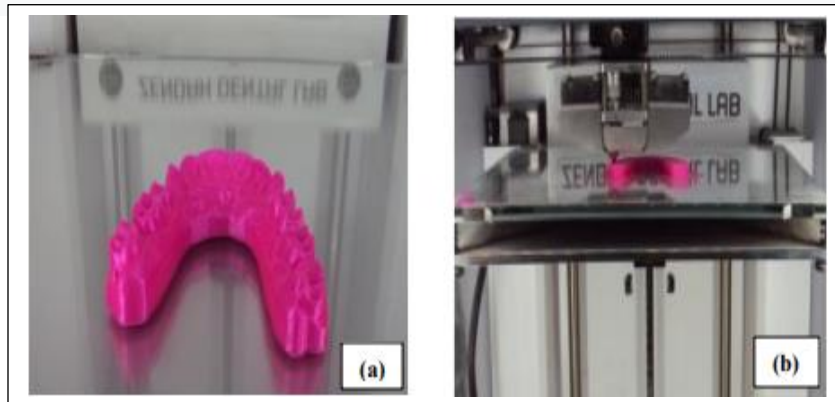
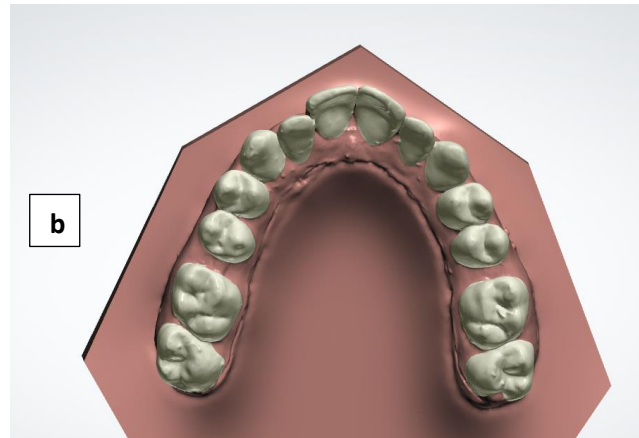
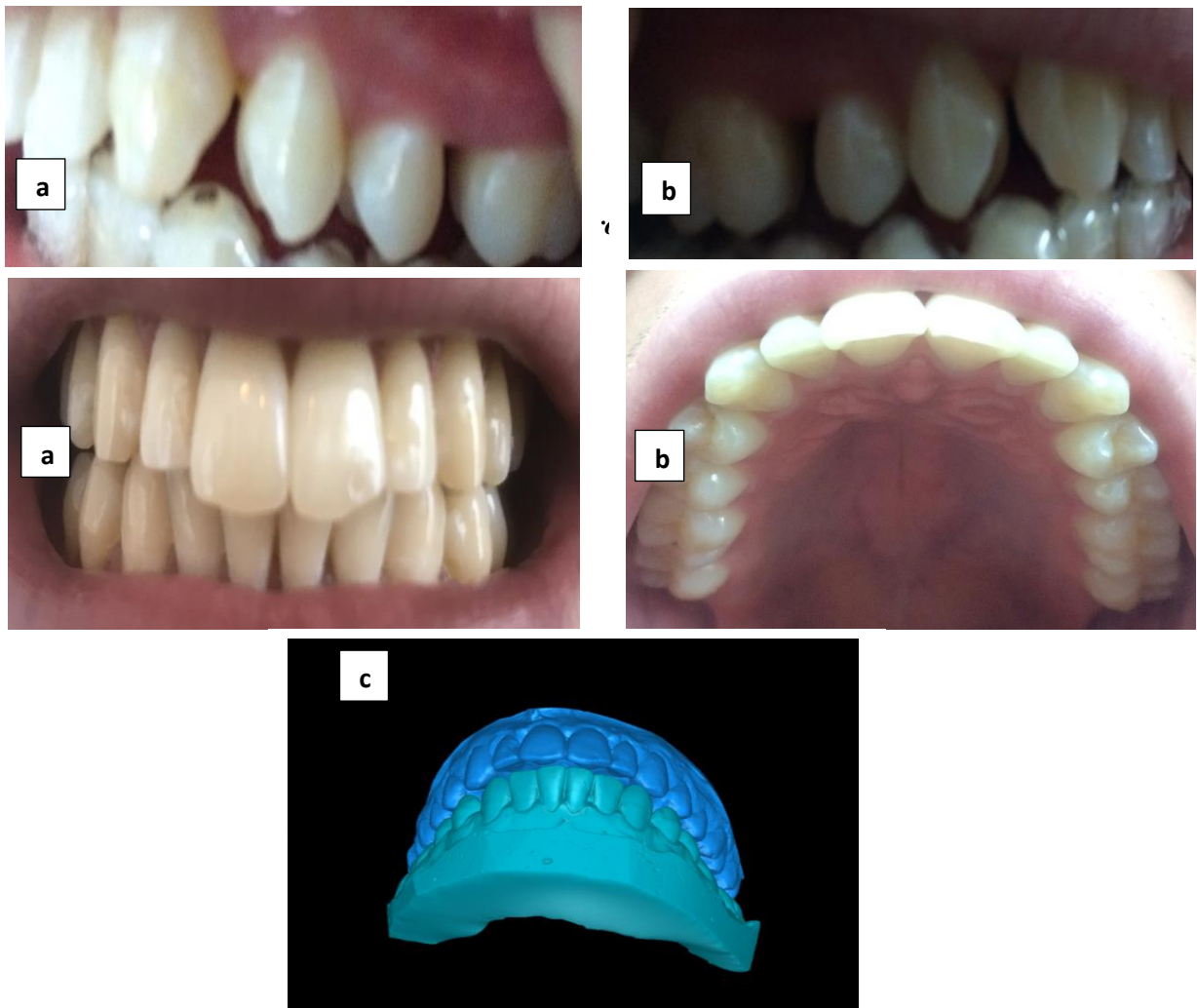


Figure 2. (a) PLA 3D model (b) FDM printer

## RESULTS

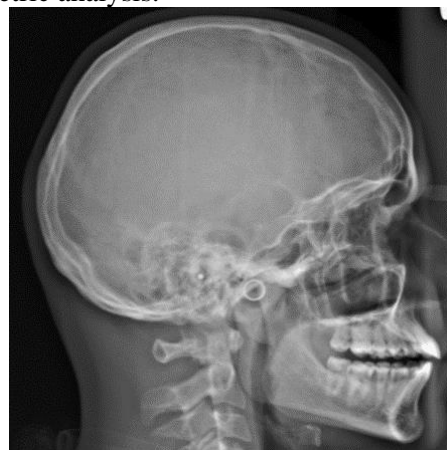
In the first stage movement, changes in the positions of upper molars were noticed after distalization. Impression was taken and cast was fabricated. Then the cast was scanned to measure the amount of movement in the upper molars. The average movement was approximately 2.15 mm in the upper right molars and 2.02 mm in the upper left molars (Fig 3).





**Figure 5. Post treatment (a) frontal image (b) occlusal view of the upper arch(c) Relationship of upper and lower jaws**

Cephalometric image was taken after treatment (Fig 6) in order to compare the values of the studied case to the normal values that might found in an ideal case. Table 1 illustrates the figures of both current studied cases post treated and the normal range of reading of the Cephalometric analysis.



**Figure 6. Post treatment Cephalometric X-ray.**

**Table 1. Post treatment Cephalometric analysis for the case compared with normal ranges**

Label	Relation	Unit	Value	Normal range
<b>FMA</b>	FrankfortHorizontal Plane,Mandibular Plane	degree	26.0	25°±5°
<b>FMIA</b>	FrankfortHorizontal Plane,Lower Incisor Axis	degree	46.0	65°±5°
<b>IMPA</b>	Lower Incisor Axis,Mandibular Plane	degree	73.0	90°±5°
<b>S-N-A</b>	S-N-A	degree	82.7	81°±3°
<b>S-N-B</b>	S-N-B	degree	79.0	78°±3°
<b>A-N-B</b>	A-N-B	degree	-3.6	3°±2°
<b>AO</b>	A,Occlusal Plane	mm	21.5	Less than 1mm of BO
<b>BO</b>	B,Occlusal Plane	mm	19.3	more than 1mm of AO
<b>OP-FH</b>	Occlusal Plane, FrankfortHorizontal Plane	degree	5.0	5.5-12.1
<b>Chin Thickness (TC)</b>	Pog',N-B	mm	21.3	10-12mm
<b>UpperLipThickness (UL)</b>	LS,N-B	mm	29.3	11.23±2.01mm
<b>AnteriorFacialHeight (AFH)</b>	Me,Palatal Plane	mm	59.6	67.65 – 71.24
<b>PosteriorFacialHeight (PFH)</b>	Co,Mandibular Plane	mm	40.6	48.83 – 51.84

## DISCUSSION

The purpose of this study was to evaluate the effect of Clear Aligner splints on distalization of maxillary molars without auxiliaries. The result indicates the possibility of translational movement of the upper molars, at least when minimal sagittal correction is required. Therefore, the research hypothesis was rejected. The distal range of movement of the maxillary molars achieved in this study (2.15 mm) was comparable to that obtained in other studies [15-17]. However, moving molars was with assistance of attachments in the above-mentioned studies. Another difference in the techniques used was the method of printing models. The thermoplastic models from fused deposition modeling (FDM) printer were used in this study, which might affect on final result of the case. This kind of material is sensitive to temperature after applying the CA sheets upon the models. In the contrary, resin 3D models are the standard materials used in other studies [15-18]. Factors associated with using PLA models and aligners without attachment were to some extent a cause in the longevity of treatment period if compared to similar other studies [19]. It was expected to complete moving all teeth in a period of nearly 15 months for the upper jaw. Nevertheless, the process took time longer than what was allocated in the software. This delay could be resulted from various underlying reasons: it might be the resistance of molars to the aligners. Perhaps, thermoplastic models which could easily be affected by the heat during vacuum, and finally will affect to somehow on the final shape of the model. Also, it has been noticed that some cracks on the aligners after wearing them for approximately one week. To compensate some of these issues, some solutions have been made during treatment for instance using 1mm thickness instead of 0.8 mm aligners for moving posterior teeth and keeping PLA models in the fridge before vacuuming procedure to withstand the heat source from the vacuum machine.

Cephalometric analysis was carried out after finishing treatment (Table 1) and it is found that some of the readings are similar to the normal range, but other readings indicated that class II classification still exist in the case such as A&B Occlusal Planes findings. Consequently, Clear Aligners have not treated the case completely. On the other hand, Aligners have achieved to certain extent a development in the case in terms of expansion and distalization for approximately 2.15 mm in the maxillary right molar and nearly 2.02 mm in the left maxillary molars. It could have better result if attachments were included in the treatment and models with better qualities were used.

## CONCLUSION

Within the limitations of the current study, it has been concluded that, using clear aligners without auxiliaries are relatively effective in distalizing maxillary molars without significant vertical and mesiodistal tipping movements. As a consequence, the lower facial height did not change at the end of the treatment. Therefore, clinicians can consider the use of clear aligners in treatment planning for adult patients requiring up to 2.15 mm of maxillary molar distalization without auxiliaries taking into consideration the long time period for treatment.

## Acknowledgments

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## Conflict of Interest

There are no financial, personal, or professional conflicts of interest to declare.

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## تحريك الأضراس العلوية للجهة الوحشية باستخدام التقويم الشفاف بدون استخدام الأدوات المساعدة على الحركة

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### المستخلص

**الخلفية والأهداف.** يتم استخدام التقويم الشفاف بشكل متكرر لعلاج سوء الإطباق من الدرجة الثانية (التصنيف الثاني لأنجل) عندما يكون هناك حاجة لتحريك الأضراس العلوية الأولى والثانية لناحية الجهة الوحشية للفك. هناك القليل من الأدلة التي تدعم إمكانية التنبؤ بهذه الحركات والنتيجة التي توقعها الأطباء قد لا تتحقق، خاصة في غياب الأدوات المساعدة المرتبطة بالأسنان اللازمة لتحريك الضروس. كان الهدف من هذه الدراسة هو تقييم إمكانية حركة الضروس العلوية وحشياً باستخدام المقومات الشفافة فقط. **طرق الدراسة.** تم استخدام برنامج ثلاثي الأبعاد لعلاج حالة تعاني من التصنيف الثاني لسوء الإطباق وتم عمل النماذج الرقمية بعد العلاج والخطة الافتراضية (المثالية بعد العلاج) لمريض يبلغ من العمر 24 عامًا. تم استخدام البرنامج من B&B Dental لحساب حركة الأسنان المحققة. **النتائج.** كان إجمالي الإزاحة للجانب الوحشي للأضراس الأولى والثانية 2.15 ملم. لم تتمكن المقومات الشفافة من تحقيق نتيجة مثالية بنسبة 100% بعد المعالجة؛ لذلك، غالبًا ما يكون التخطيط للتحسين مطلوبًا. **الخاتمة.** يمكن اعتبار المصفقات الشفافة خيارًا جذابًا لحد ما لتحريك الأضراس الأولى والثانية. **الكلمات الدالة.** التقويم الشفاف، دقة الحركات، عدم التباعد، تقويم الأسنان، التقويم ثلاثي الأبعاد.