Three dimensional assessment of a newly designed distalizer (Bidirectional Distalizer)

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Abstract: Aim: The study was designed to three dimensionally assess the effects of a newly designed distalizer: bidirectional distalizer. **Method:** Ten patients suffering from Class II molars were included. Force was applied from the buccal and palatal sides. Cone beam CTs were taken before and after distalization. The cone beam images were then transferred to Mimics Dicom 10.01. The pre and post distalization images were superimposed and the difference was calculated. Depending on three reference planes, each cusp and root of the distalized molar was three dimensionally assessed. In addition, the loss of anchorage in the anterior region was inspected. Moreover, the plane in which most movement took place was detected by taking the centre of the crown and centre of the triangle connecting the three roots as references. **Results:** The crowns moved distally, laterally and occlusally while the roots moved distally, medially and occlusally. Anteroposterior movement was almost triple rotation and four times intrusion. Mesio-buccal cusp moved laterally. Disto-buccal cusp showed maximum antero-posterior movement. Maximum extrusion and intrusion were presented in Mesio-buccal and Mesio-palatal cusps respectively. Lateral movement was equal among Mesio-buccal & Palatal roots. Palatal root extruded. Maximum antero-posterior movement was found in disto-buccal root. Mean distal molar tipping was 1.68°. Protrusion of anterior incisors in relation to SN plane indicated loss of anterior anchorage. **Conclusion:** Bidirectional distalizer proved to be effective in molar distalization

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Keyword: Distalization, three dimensional analysis, Cone beam.

1. Introduction

Molar distalization is an important strategy for correction of molar relation in Class II malocclusion. Various modalities have been used including trans-palatal arch, head-gear, removable distalizing plate, inter-arch appliances and intra-arch appliances.

Trans-palatal arch (Goshgarian arch) is a very useful and simple method for unilateral molar distalization. If bilateral distalization is required, then one side is distalized followed by the other side[1].

The removable distalization plate (Cetlins plate) is also simple. The major drawbacks of these appliances are the need for patient compliance that could not be always ensured. In addition, the resultant movement is usually a tipping movement that requires further molar uprightning[2].

Similarly, the head-gear is a very efficient method that can be used with fixed or removable orthodontic appliances. However, it also requires patient compliance[3].

Inter-arch appliances such as Jasper jumper, Herbst appliance, Twin force and many others are mainly used as fixed functional appliances for correction of skeletal Class II cases. Distalization is a side effect that is favourable.

Intra-arch appliances are very helpful in molar distalization as they eliminate the need for patient compliance. The type of tooth movement is one of the most important factors that affect the operator's choice. Since force application is mostly on coronal portion of the molar, thus the resulting movement is *tipping movement* rather than bodily movement.

Byloff and Darendeliter[4] proved that Pendulum appliance tipped the molars distally. The results were in accordance with those conducted by Bussick and McNamara.[5] In their study of assessing changes consequent to maxillary molar distalization with the pendulum appliance, Fuziy et al [6] and Polat-Ozsoy et al[7] revealed same results. Many modifications were performed by osteo-integrated implant combination to improve the type of molar movement.[8,9,10]

Mini screws were used as additional anchorage[11,12,13] Franzulum appliance was a new appliance that was based on the idea of Pendulum[14] Viewing Wilson distalizer, distal tipping movement of the molars took place.[15] Same results were also obtained when using Jones-Jig appliance.[16,17,18,19] Consequently, the NiTi springs and repelling magnets were used for molar distalization. Similarly, both produced molar tipping.[20]

Distal-jet is a commonly used distalizer. It also resulted in tipping movement. [21] Various modifications such as having additional support from mini screws to prevent loss of anchorage had been done.[22]

Keles distalizer resulted in bodily molar movement as the forces were applied at the level of centre of resistance.[23] However, the results were controversial. Mini screws were again used to provide additional anchorage. [24]

From all the previously mentioned, no perfect distalizer design was attained in terms of molar tipping, extrusion, rotation, bite-opening beside the anchorage loss. A new design for a distalizer was to be achieved.

Accordingly, Saad * and Sherbini ** invented a new distalizer: Bidirectional distalizer *** in order to minimize or eliminate these problems. The study conducted at Minia University proved the efficacy of this distalizer.[25] For further assurance, the effect of this distalizer had to be assessed three-dimensionally. This study was conducted to highlight this aim.

2. Materials and Methods

The study was conducted over 10 adult cases with ages between 15-25 years. Patients had Skeletal Class I or mild Class II. Class II molar relationship was presented bilaterally. Horizontal growth pattern had to be present. Also, the selected cases were not indicated for extraction.

Ethics regulations:

- The whole treatment procedure was explained to the patients. Any unexpected outcomes were clarified. The patients were also informed that the new appliance will be inserted in their mouth. (Fig 1 &2)
- Treatment consent was signed by the patient or parents.

Fig 1: Bidirectional distalizer (Intra-oral view)

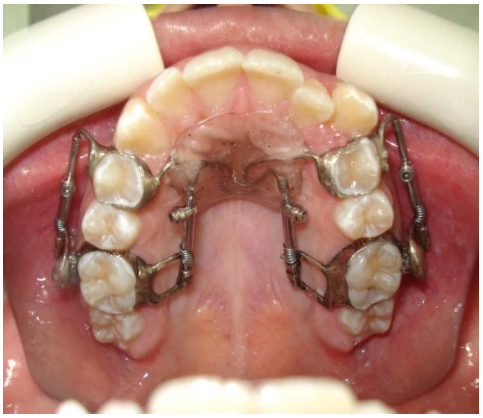

Fig 2: Bidirectional distalizer (Intra-oral view)

Construction of the appliance:

Proper sized bands were selected and fit to the right and left first premolars as well as for the right and left first permanent molars. This was done after separation of the first premolars and first molars.

An alginate impression was then taken with bands in patient's mouth. Proper seating of the bands in place was carried out. The impression was then poured with dental stone into a working cast.

Lab work:

Assuming the the idea of applying force through the center of resistance of molars (Trifurcation). The appliance consisted of the following: (Fig 3).

- ***Connectors:***

The metal connectors were fabricated of 1.1mm.stainless steel wires. They had a trapezoid shape. They were soldered to the molar bands both buccally and palatally. 2mm of clearance was present between the connectors and palatal tissues.

- ***Metal sleeves***

These were soldered to the metal connectors.

- ***Trans-palatal arch***

A trans-palatal arch connecting the two premolar bands was constructed from 0.8 mm. stainless steel wire and soldered to the premolar bands.

- ***Buccal Force applying component***

The buccal force applying component was constructed of metal tubes of Distal-jet soldered to the buccal surface of the premolar bands.

- ***Palatal force applying component***

The palatal force applying component was constructed of wire extension of Distal-jet tube imbedded in large acrylic button together with the transpalatal arch.

During wire bending, the height of the mesial end of buccal and palatal force applying components were designed to be ***one millimeter*** less than the connectors soldered to the molar bands.

The acrylic button was extended to the incisive papilla anteriorly, till about 2 mm. from gingival margin laterally and posteriorly till region between second premolar and first molar. Solders and acrylic were finished and polished.

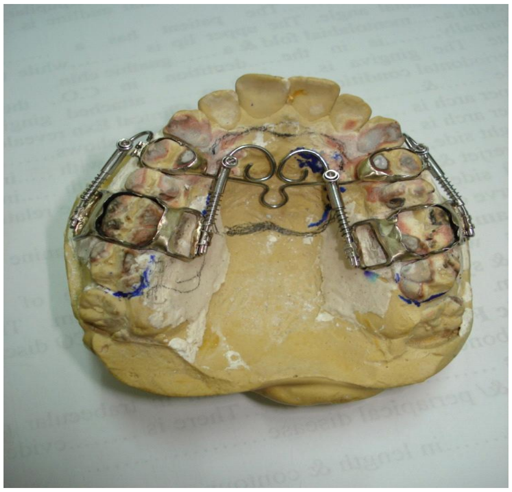

Fig 3: Distalizer with all metal components and soldres complete before curing of acrylic button.

Fitting of appliance:

After trying to ensure proper seating and absence of complains, teeth to be banded were isolated and dried. The distalizer was then cemented using glass ionomer cement. The excess cement was removed.

Concerning activation, the Alan Key was unlocked. NiTi coil springs were compressed. Alan keys were then closed. The total force level was measured using force gauge to be 200gm for both sides buccal and palatal. Patients were then scheduled for four weeks interval visit for follow up and reactivation.

The target of the distalization was considered to be achieved when Class I molar relation was obtained. Once Class I was achieved,, the distalizer was removed. .The post treatment records were then taken immediately.

Three-dimensional assessment:

Preoperative and postoperative Cone beam CTs were taken for each patient. The cone beam images were then transferred to Mimics Dicom 10.01 to be measured and extract the readings of the movement. Cross sectional view (Fig 4 A & B), coronal (Fig 5 A & B), sagittal (Fig 6 A & B) and panoramic ones (Fig 7 A & B) were depended upon to assess the movement of each cusp and root of the upper first molars.

Fixed planes were added to the 3D image to be used as reference for measurements. This enabled to accurately detect the movement of both crowns and roots in the three planes (Figs 8, 9, 10& 11). The facial axis plane Na-Pog was selected to measure the distalization movement antero-posteriorly. The plane SN was selected to measure intrusion or extrusion. SN plane also helped in inspecting incisor position after distalization. Concerning rotation, the distance between the mesio-buccal cusp tips and the apicies of the mesio-buccal roots was linearly measured. Superimposition of pre & post 3D reconstructions was performed to exactly show the molars movements and the loss in anterior anchorage. (Fig 12).

For comparison between the movements in each plane, another calculation was carried out. A rectangle representing the outline of the crown and a triangle connecting the roots apicies were drawn. The centre of the square and the triangle were identified. Superimpositon of the pre and post distalization images revealed the difference. The centre of the rectangle was extended to form a line dividing the rectangular to two equal halves. Superimposition allowed the calculation of the distal tipping. (Fig 13).

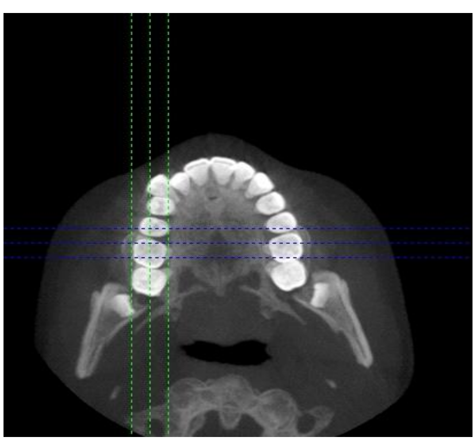

Fig 4A

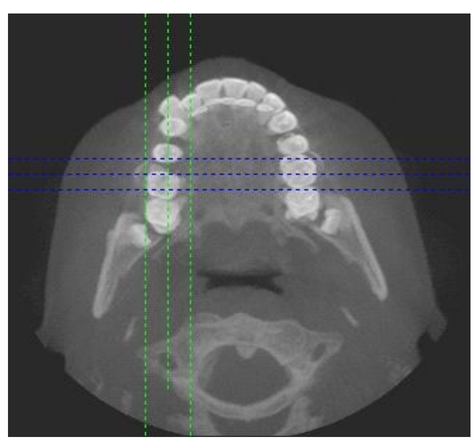

Fig 4B

Fig 4: Cross sectional view A: preoperative B: postoperative

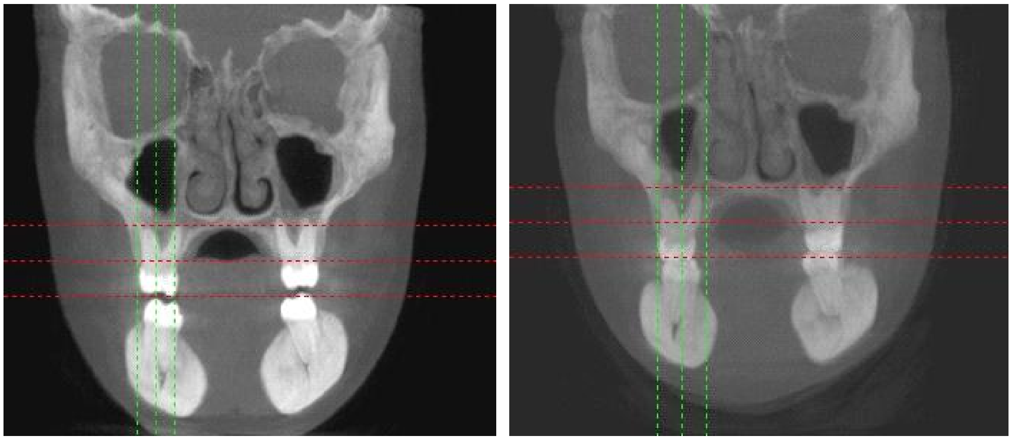

Fig 5A Fig 5B

Fig 5: Coronal view A: preoperative B: postoperative

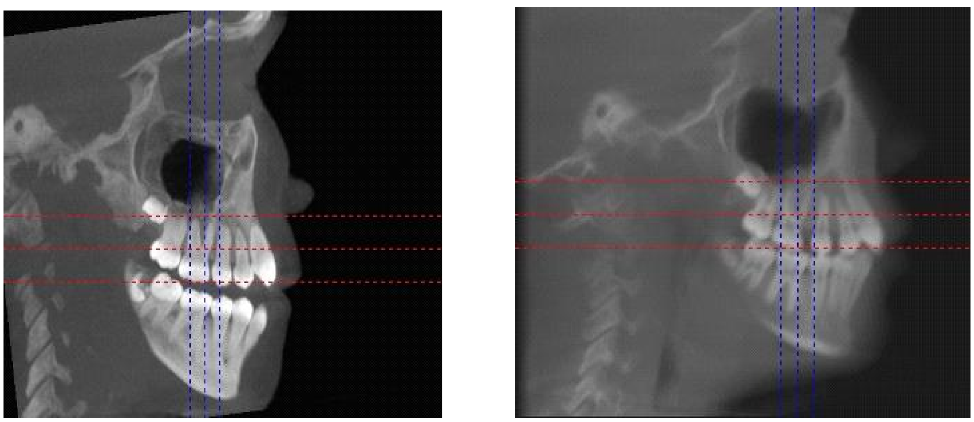

Fig 6A Fig 6B

Fig 6: Sagittal view A: preoperative B: postoperative

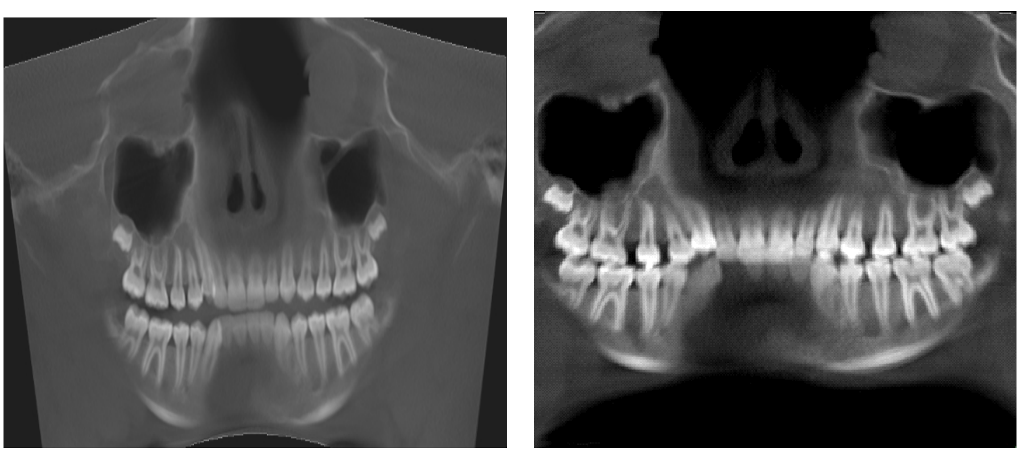

Fig 7A Fig 7B

Fig 7: Panoramic view A: preoperative B: postoperative

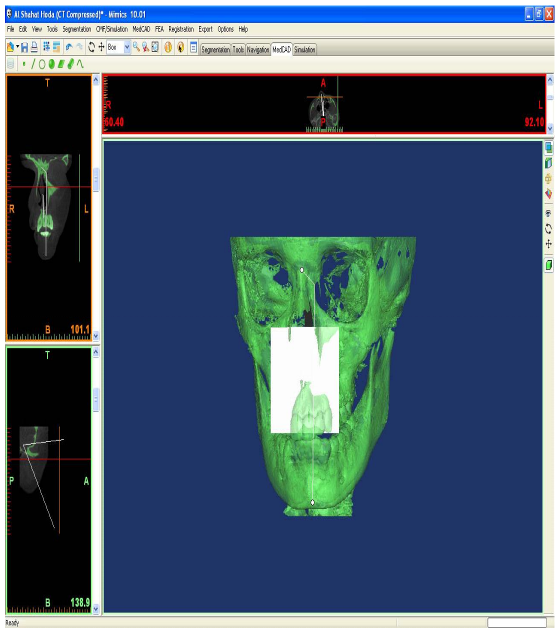

Fig 8: Antero-posterior facial axis plane N-Pog

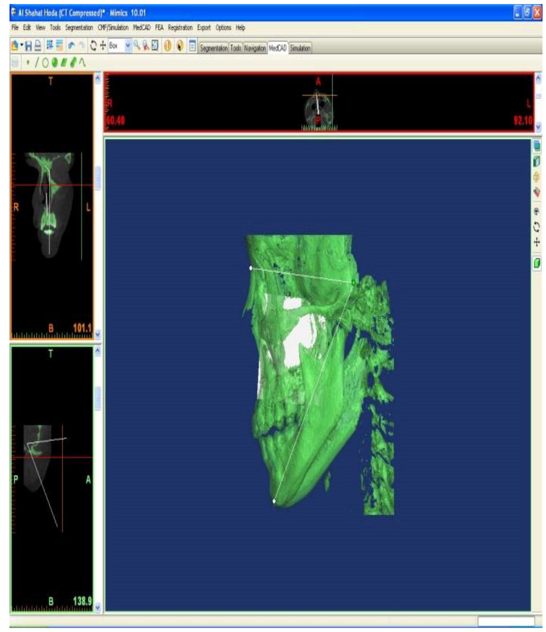

Fig 9: Lateral view of SN plane

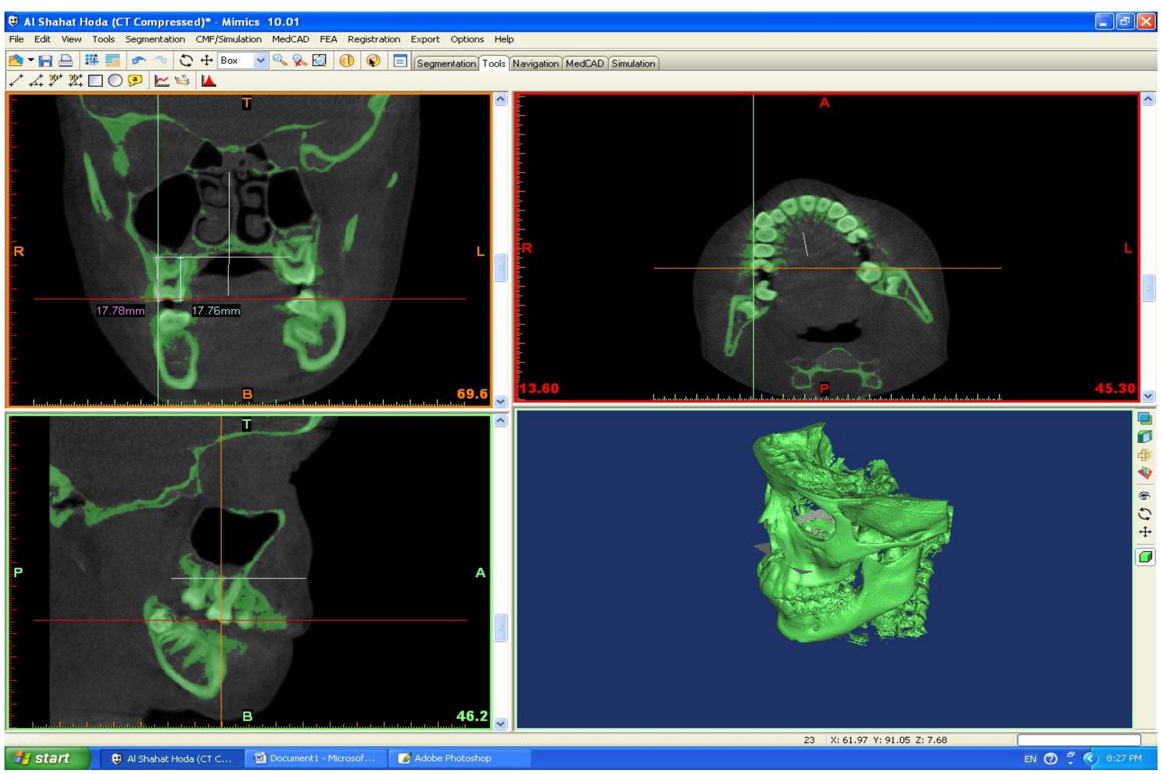

Fig 10: Rotation calculation by defining MB cusp tip and MBR apex.

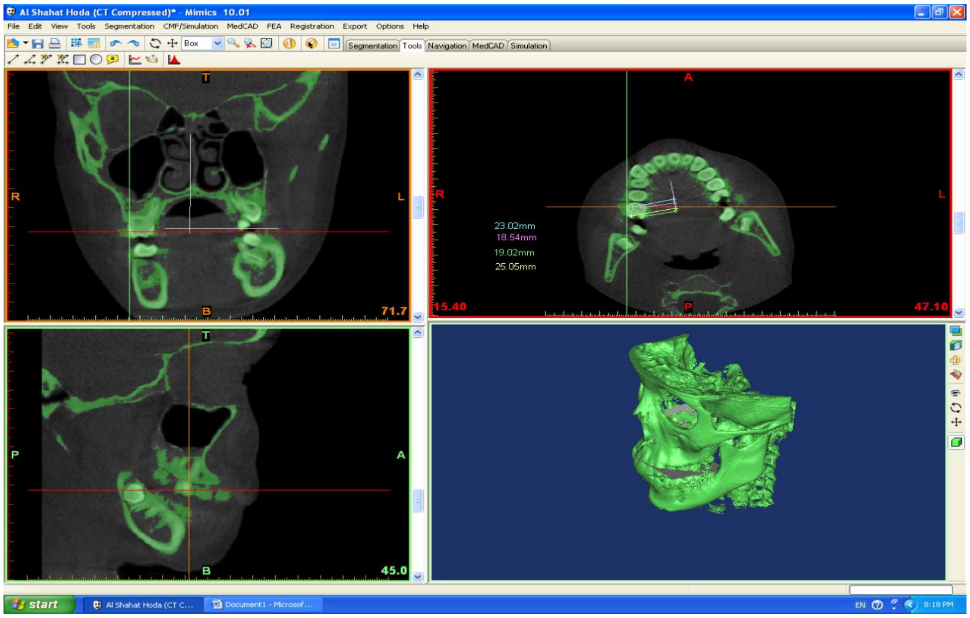

Fig 11: Postoperative rotation calculation.

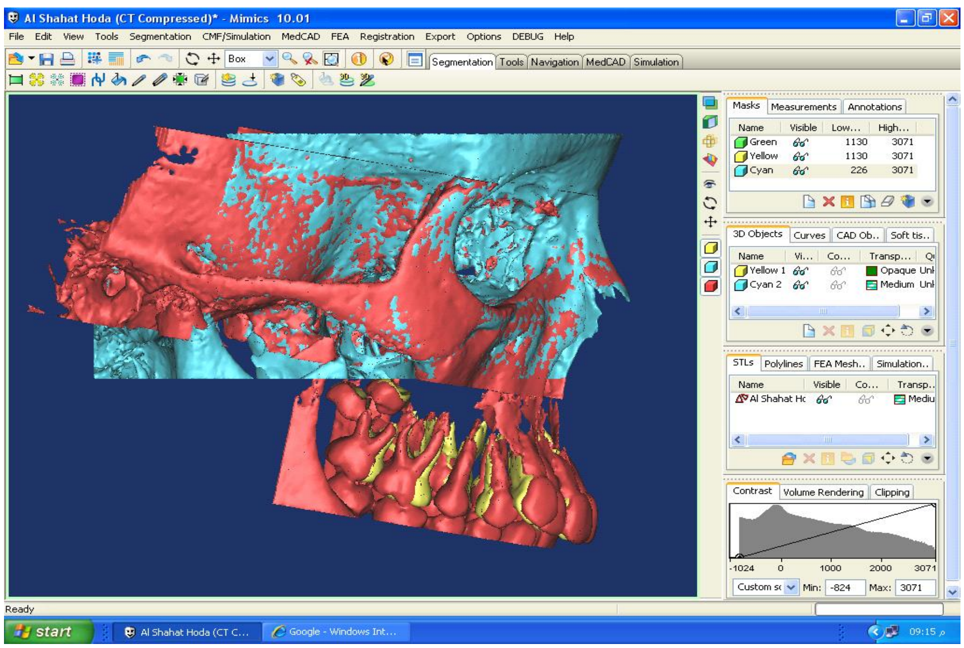

Fig 12: Superimposition of pre & post 3D reconstructions (Yellow color indicates preoperative position of the molars and the red one indicates the postoperative position).

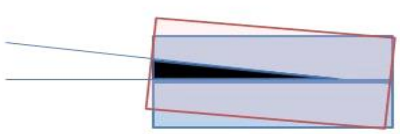

Fig 13: Schematic presentation of the calculation of the distal tipping.

3. Results

Concerning crown movement (Fig 14), each cusp was inspected separately. Maximum transverse movement occurred in Mesio-buccal cusp. Disto-buccal cusp showed maximum antero-posterior movement. Maximum extrusion and intrusion were presented in Mesio-buccal and Mesio-palatal cusps respectively. Analyzing the whole crown movement, it can be denoted that the crowns moved laterally, distally and occlusally.

Examining root movement (Fig 15) it was observed that transverse movement was equal in both Mesio-buccal & Palatal roots with minimal movement in Disto-buccal root. Vertical movement was found to be extrusive in palatal root. Maximum antero-posterior movement was found in disto-buccal root. Accordingly, roots moved medially, occlusally and distally. The superimposition of the pre and post distalization photos revealed protrusion of anterior incisors in relation to SN plane indicating loss of anterior anchorage. (Fig 12 & 18). The results are illustrated in Table 2. The mean distal molar tipping was 1.68° with a maximum value of 3.56° .and a minimum value of 0.0°.

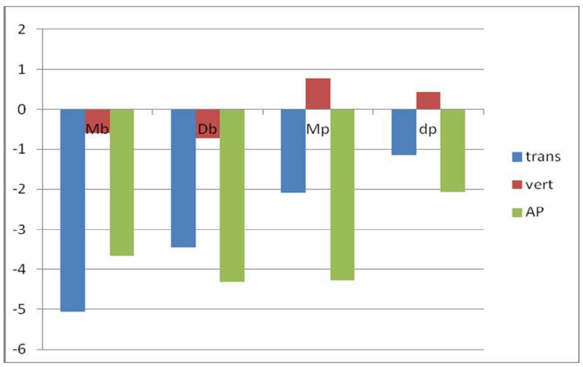

Fig14: Crown movement in the 3 planes of space. Mb: mesio-buccal cusp, Db: disto-buccal cusp, Mp: mesio-palatal cusp, DP: disto-palatal cusp.

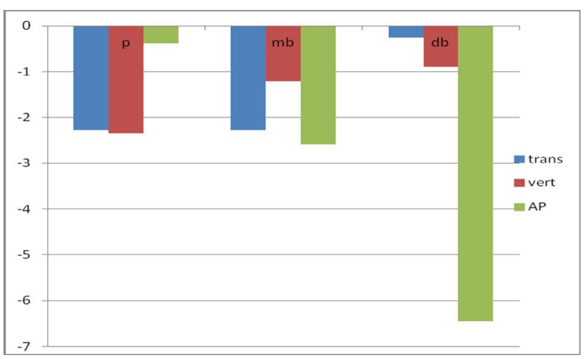

Fig 15: Root movement in the 3 planes of space. P: palatal root, mb: mesio-buccal root, db: disto-buccal root.

Comparison of crown movements: distalization, rotation and intrusion revealed that anteroposterior movement was almost triple the vertical one. It was also greater by four folds than the transverse movement (Fig 16). Same results were observed when comparing roots movement (Fig 17). The mean and standard deviation of both the crowns and roots movements in the 3 planes are illustrated in Table 1.

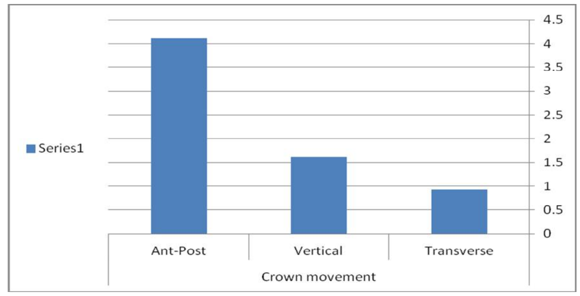

Fig 16: Crown movement (mm) in the three planes.

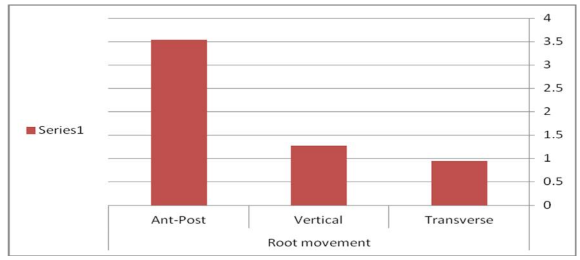

Fig 17: Root movement (mm) in the three planes

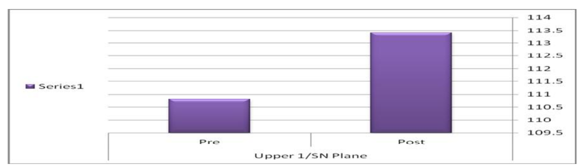

Fig 18: The pre and post distalization of the angulation of upper incisor in relation to SN plane

Table 1: Crown and root movements (mm) in the three planes.

Root			Crown			
Transverse	Vertical	Ant-Post	Transverse	Vertical	Ant-Post	
0.94	1.26	3.54	0.925	1.62	4.11	Mean
0.60	0.81	2.02	0.53	0.85	2.18	St Dev

Table 2: Change in incisor angulation

Maximum	Minimum	ST Dev	Mean	
119.4	104.2	5.99	110.8	Pre
121.7	105.8	6.44	113.4	Post

4. Discussion:

Three dimensional computed tomography (the Cone Beam System) has been used for diagnostic purposes in orthodontic treatment.[26] Cevidanes *et al*[27] stated that cone- beam computed tomography (CBCT) provides simulation tools that can help bridge the gap between imaging types

CBCT is used to determine the optimal locations and angulations for miniscrews used as skeletal anchorage in orthodontic treatment.[28,29,30] It is also useful in the Assessment of orthognathic surgeries,[31] rapid palatal expansion [32,33] and temporary anchorage devices. [34, 35]

In the present study CBCT was depended upon to assess upper first molar distalization. The distalizer: bidirectional distalizer is a newly designed one.

Forces were applied buccally and palatally in order to obtain a resultant force through the centre of resistance of the first maxillary molar. Thus, bodily movement can be obtained which eliminates the need for further molar uprightning.

Although, the appliance construction requires multiple steps, it is less complicated than the bulky and hardly controlled magnets.[36] The construction steps are similar to those of the Distal-jet.[37]

In the contrary to Jones-jig Appliance[38] no bite opening was observed. Also, no molar uprightning was required. However, anchorage loss was obvious from the protrusion of the upper incisors in relation to SN plane. This was the issue with nearly all the distalizers: Pendulum,[39] Jones-Jig,[16] NiTi coil-springs, Rare earth magnets,[20] Distal-Jet [21] and Keles distalizer,[23,24]

The presence or absence of the third molar was also put into consideration. Previous research revealed that extraction of upper third molar is recommended to provide enough space for the distalization. [25]

Concerning results, not only, the whole tooth movement was assesed but also the movement of each cusp and each root. The loss of anchorage in the anterior region was also inspected.

Results revealed movement of the molar in the three planes. Anteroposterior movement was greater than the vertical and transverse movements. Intrusion of molar helped in preventing bite opening. In addition, molar uprightening was not needed not only due to the dominance of anteroposterior movement but also due to the minor distal tipping. Another positive result is the buccal movement of the crown. This denotes that the design help the molar to follow the arch perimeter during distalization.

5. Conclusions:

Bidirectional distalizer proved to be effective in molar distalization.

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