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CBCT EVALUATION OF MODIFIED MINI-IMPLANT AIDED TRANS-PALATAL ARCH ON MAXILLARY MOLAR DISTALIZATION

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Abstract:

Objectives: *the aim of this study was to evaluate the effect of modified mini-implant aided trans-palatal arch on maxillary molar distalization using CBCT.*

Methods: *10 adult patients with Angle class II molar relation were submitted to maxillary first molar distalization using modified mini-implant aided trans palatal arch (MIA-TPA), after completing the essential orthodontic records, CBCT was taken before distalization at T0, then trans-palatal arch (TPA) of 1mm diameter passing anterior on the palate was cemented and 2 miniscrews were inserted between the maxillary 2nd premolar and 1st molar on the palatal side. NiTi closed coil spring was applied between TPA anterior and mini- implant to produce distalization force of 250g/side parallel to the occlusal plane. Dental changes of maxillary molars were compared using cone beam computed tomography CBCT after achieving class I molar relation at T1.*

Results: *According to the dental linear and angular measurements, the maxillary first molar showed statistically significant bodily distal movement without significant distal tipping. Vertically, the maxillary first molar showed statistically significant intrusion.*

Conclusion: *MIA-TPA is efficient for bodily maxillary molar distalization movement. Distalization using MIA-TPA produced significant molar intrusion but no vertical skeletal changes occurred.*

Introduction:

Class II malocclusion is one of the most frequent and popular malocclusions that we face in our daily practice, the impact of this type of malocclusion is reflected on the patient profile, esthetics, and psychology.[1]

Treatment of non-growing class II patients is more challenging than growing class II patients.[2] Class II treatment modalities rely on patient's growth potential; if the patient is growing, growth modification appliances should be used to redirect the growth of either maxilla or mandible, but in non-growing patients, three treatment strategies are possible, orthognathic surgery, camouflage treatment, and/or maxillary molar distalization.[3]

Maxillary molar distalization provide promising results regarding esthetics with prevention of over retraction of anterior teeth.[4] However, one main disadvantage that most of these appliances used that they rely heavily on patient cooperation.[4] Maxillary molar distalization requires reduction of molar resistance to tooth movement, avoidance of distal crown tipping, good

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vertical control, and maintenance of anterior anchorage, which may be a challenge to every orthodontist.[4,5] To overcome these challenges associated with maxillary molar distalization, temporary anchorage devices (TADs) have been used.[6] They are relatively easy to place, causes fewer traumas to the oral tissues, are stable under normal degrees of forces, relatively inexpensive and can be loaded immediately after insertion so reduce treatment time.[6]

Therefore, the aim of this study was to investigate the effect of using modified mini-implant-aided transpalatal arch (MIA-TPA) on maxillary first molars during distalization.

Methods:

Sample

A total of 10 patients were recruited from the out-patient clinic of the Orthodontic Department, Faculty of Dentistry Ain Shams University. Inclusion criteria: Adult patients with age ranging from 20-30 years, presence of all permanent teeth excluding the third molars, Bilateral Class II molar relationship, increased overjet, normal overbite and normal mandibular plane angle. Exclusion criteria: Medical problems that can affect tooth movement, previous orthodontic treatment, open bite, high mandibular plane angle and bad oral hygiene.

An informed consent was signed by each patient before their enrollment in the current study. The ethical committee at the Faculty of Dentistry Ain Shams University had reviewed the study protocol and approved the study design (FDASU-Rec M011806).

Material

Full orthodontic records were taken for the patients who met the inclusion criteria. These records were: Extraoral and intra-oral photographs, orthodontic study casts, panoramic and cephalometric radiographs.

Modified MIA-TPA is consisted of two orthodontic bands on the maxillary first molar maxillary first molars and 1mm stainless steel wire running palatal and gingival to the maxillary dentition 5-6 mm away from the gingival margin, with two hooks soldered distal to lateral incisors area (figure 1). After appliance cementation, 2 miniscrews (8*1.6 mm) size were inserted in the palatal inter radicular area between the first molar and the second premolar 5-6 mm away from the gingiva as close as possible to molar root furcation area vertically to direct the line of force through the center of resistance.

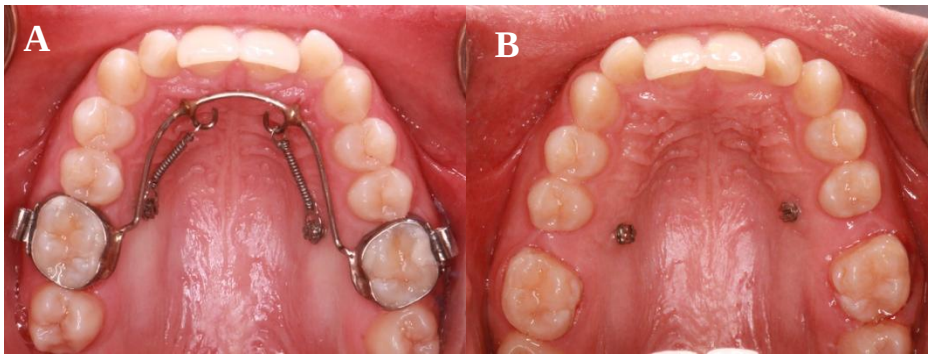

Figure (1): (A) Appliance cementation and mini-screws insertion, (B) after distalization.

Appliance was activated using Ni-ti closed coil springs calibrated to deliver 250 gm of force. Patients were followed up every 4 weeks for appliance re-activation till the end of distalization and correction of molar relation to class I.

MEASURMENT

All subjects were imaged using Vatech cone beam computed tomography(CBCT) machine*. The CBCT machine parameters were set to 90 kV at 12 mA and a voxel size of 400 microns. CBCT images were acquired for each patient, the first image (T0) was taken before distalization. The second image (T1) was taken after distalization was completed and a customized CBCT analysis was developed for this research to measure angular and linear changes in the maxillary molars during distalization (figure 2).

Statistical Analysis

Numerical data were explored for normality by checking the data distribution and using Shapiro-Wilk tests. T-test was used to compare between the two groups. Intra –and inter-observer reliability were assessed using Cronbach alpha reliability coefficient and Intra-Class Correlation Coefficient) ICC. The significance level was set at $P \geq 0.05$. Statistical analysis was performed with IBM SPSS Statistics for Windows, Version .22.0 Armonk, NY: IBM Corp.

Method Error

Intra-operator and inter-operator error of measurement were done to assess the reliability of measurements. Eight subjects were randomly selected for assessment of the reliability of measurements. For intra-operator error, the measurements were repeated by the same operator after at least two weeks of the first measurement. For inter-operator error, another trained orthodontic operator analyzed the measurements on the same eight subjects.

Results:

Numerical data were explored for normality by checking the data distribution and using Shapiro-Wilk tests. All data showed normal parametric distribution.

The CBCT analysis of the linear dental measurements for the maxillary first molar revealed highly statistically significant change for all variables as there is statistically significant decrease in the anteroposterior (distalization) and vertical position of the first molar (intrusion) and a statistically insignificant changes in the transverse position of the first molar as shown in table (1)

Table (1): Changes in the maxillary molar linear Measurements before and after distalization

						Paired Differences			P value
		N	Mean	SD	SEM	Mean	SD	SEM	
UR6-UL6	Pre	10	45.07	2.71	0.96	0.51	0.96	0.34	0.20246
	Post	10	45.58	2.99	1.06				
UR6-SV	Pre	10	42.53	5.27	1.86	-3.05	1.62	0.57	0.00109**
	Post	10	39.48	4.31	1.53				
UL6-SV	Pre	10	41.06	5.10	1.80	-3.28	1.56	0.55	0.00056**
	Post	10	37.78	4.14	1,47				
MBR6-FHP	Pre	10	43.95	2.26	0.80	-1.62	0.59	0.21	0.00011**
	Post	10	42.32	2.72	0.96				
MBL6-FHP	Pre	10	43.27	2.54	0.90	-1.54	0.50	0.18	0.00005**
	Post	10	41.73	2.89	1.02				

P ≤ 0.05 significant*, p ≤ 0.01 highly significant**, p > 0.05 insignificant

The CBCT analysis of the angular dental measurements and rotation measurements for the maxillary first molar revealed statistically insignificant difference for all variables as shown in table (2).

Table (2): Changes in the maxillary molar angular Measurements before and after distalization in the study group.

						Paired Differences			P value
		N	Mean	SD	SEM	Mean	SD	SEM	
UR6-SN	Pre	10	75.54	3.80	1.34	-1.93	6.52	2.31	0.43028
	Post	10	73.61	5.07	1.79				
UR6-FHP	Pre	10	84.17	3.49	1.23	-1.99	5.64	1.99	0.35178
	Post	10	82.18	4.48	1.58				
UL6-SN	Pre	10	75.74	3.90	1.38	0.67	4.91	1.74	0.71036
	Post	10	76.41	6.37	2.25				
UL6-FHP	Pre	10	82.76	3.61	1.28	-1.26	3.85	1.36	0.38485
	Post	10	81.50	4.78	1.69				
UR6-MB/ DP-MSP	Pre	10	24.03	6.29	2.22	-1.37	3.64	1.29	0.32315
	Post	10	22.67	3.68	1.30				
UL6-MB/ DP-MSP	Pre	10	30.94	5.37	1.90	-1.28	4.04	1.43	0.40083
	Post	10	29.67	4.19	1.48				

P ≤ 0.05 significant*, p ≤ 0.01 highly significant**, p > 0.05 insignificant

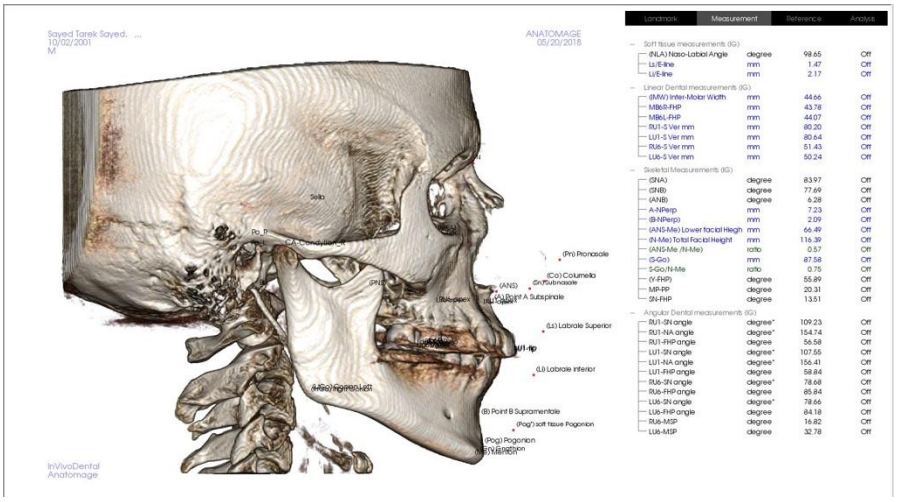

Figure (2) : Showing skeletal and dental measurements on CBCT.

Discussion:

Class II malocclusion can be successfully treated by maxillary molar distalization without permanent teeth extraction and/or surgical intervention.

All patients included in this study were adults with age ranging from 20 to 30 years. This eliminates the effect of any remnant growth which might affect the study results skeletally or dentally. Also, Age can play a significant role in the rate of orthodontic tooth movements through its direct influence on bone density and/or rate of osteoclast recruitment.[7,8]

High mandibular angle patients were not included in this study since distal molar movement causes wedging effect due to molar extrusion, thus patients were selected having normal mandibular plane angle.[9] Also, patients with shallow over bite were not included in this study to avoid the adverse effect that can occur during distalization on the overbite.[9]

The choice of third molar extraction before distalization aimed to decrease the resistance for first and second molar distalization, create the space for the distal movement, and facilitates bodily tooth movement reducing distal crown tipping and preventing future third molar impaction possibility.[10,11]

The MIA-TPA distalizer used here was fabricated with 1mm thick stainless-steel wire compared to 0.8 mm used in previous studies utilizing the same appliance.[12] This modification aimed at gaining more wire rigidity in order to preserve intermolar width and control molar rotation during distalization. The vertical component of force can be controlled through the miniscrew implants positioning.[12]

Distalization force delivered by ni-ti coil springs was calibrated to be 250 gm. This distalization force level was recommended to adults by Carano et al[13,14] and Hilger et al[15].

This was higher than the force range used by Sajedi et al[12] as they applied 150-200gm during distalization on younger individuals.

Customized CBCT analysis was used to evaluate the treatment effects in all three planes. According to Hatcher et al[16] CBCT scans have advantages of getting images with a true 1:1 representation of the structure being imaged so we can avoid the inherent magnification of the conventional lateral cephalometric image. Furthermore, we can avoid superimposition of adjacent structures, errors in head position, and we could manually adjust the threshold for optimal visualization of soft and hard tissues.

In our study, the dental measurement showed that the total amount of maxillary first molar distalization was highly statistically significant as the mean distal crown movement was 3.05 $\pm$1.62 mm for the right side and 3.28 $\pm$1.56 mm for the left side. This is in agreement with Sajedi et al[12] who also showed comparable distalization with MIA-TPA appliance using 150 -250 gm of force .

The CBCT analysis of the angular dental measurements for the maxillary first molar revealed statistically insignificant changes in the long axis of maxillary right first molar. According to these dental linear and angular measurements, the maxillary first molar showed bodily distal movement. This could be explained by the approximation of the distal traction forces to the molar center of resistance through the palatal mini-implants. These results were in agreement with previous studies that showed that the MIA-TPA can adjust the force vector to approximate the molar center of resistance.[9,12,17] However, distal tipping was reported by Cozzani et al[18], Gelgor et al[9] and Alikhani et al[19] . This may be due to the fact that they used indirect skeletal anchorage and buccal force application. This directs the force vector away from molar center of resistance and can cause significant molar tipping during distalization.

Vertically, the maxillary first molar showed statistically significant intrusion. The intrusion was 1.62 $\pm$ 0.59 mm on the right side and 1.54 $\pm$ 0.50 mm on the left side. These results showed that the maxillary molar intrusion was clinically and statically significant, however this did not affect the vertical skeletal measurements as they showed statistically insignificant changes for all variables. This is explained by the fact that the appliance is only connected to the molars with vertical control of the direction of force. These results are comparable to previous studies.[9,12,18,20] Molar intrusion in combination with maxillary molar distalization can be beneficial in hyperdivergent patients or patients with shallow overbite requiring non-extraction class II molar correction[15].

In the transverse dimension, there were statistically insignificant changes in the inter-molar width. Cörekçi et al[21] reported a decrease in the intermolar width using a different appliance in conjunction with piezocision. The stability of intermolar distance could be related to the use of arch wire with larger diameter than that used with Miresmaeili et al[12] who showed an increase in

the intermolar with a smaller base wire diameter.

Maxillary molar showed statistically insignificant rotation for both the right and left sides in both study and control groups. This result was similar to the findings of Cörekçi et al[21]. Miresmaeili et al[12] reported slight insignificant mesial molar rotation after distalization. The insignificant changes in maxillary first molar rotation measurements in our study could be related to rigidity of transpalatal wire.

Conclusions:

From the results of this study, we could conclude that:

1- MIA-TPA is efficient for bodily maxillary molar distalization movement.

2- Distalization using MIA-TPA produced significant molar intrusion but no vertical skeletal changes occurred.

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