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THE EFFICIENCY OF MINISCREW-SUPPORTED CANTILEVER APPLIANCE IN MOLAR DISTALIZATION

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ABSTRACT

Various appliances have been routinely used for distalization, some of which require patient's compliance, others have undesirable side effects. Temporary skeletal anchorage devices (TSADs) are the alternatives used nowadays to eliminate these side effects. The aim of this study was to evaluate the skeletal, dental and soft tissue effects of molar distalization using a cantilever arm and miniscrew appliance. A sample of 20 patients who needed upper first molar distalization were recruited. The miniscrew supported cantilever appliance was inserted and open coil springs were used for distalization applying 150 gms on buccal and palatal sides. Pre- (T1) and post-distalization (T2) lateral cephalograms were taken and measured. The results showed significant amount of distalization (4.0 mm) of upper first molar with distal tipping and intrusion. The upper centrals were retracted and intruded. There was an increase in the Frankfort-Mandibularr plane ange (FMA) with no significant soft tissue change. The miniscrew- supported cantilever distalizer is an efficient appliance for the distalization of upper first molars.

INTRODUCTION

Premolar extraction has long been used as a treatment approach to resolve crowding. The rapid increase in technology and the invention of new orthodontic materials enhanced the use of non-extraction approach to achieve the orthodontic goals. Class II malocclusion cases are the most benefiting the non extraction treatment modality specially if there are esthetic concerns on the extraction approach. To gain the desired space, expansion, stripping or molar distalization can be performed rather than extraction. Crowding cases with moderately protrusive profiles that cannot withstand expansion benefit the most from distalization.[1]

Various appliances have been routinely used for distalization [2-5], some of which require patient's compliance. Extra oral traction, removable appliances with springs, and Class II intermaxillary elastics are used. Traditionally, headgear has been accepted as an appliance of choice for this mission. However, there are esthetic and compliance drawbacks for the use of headgears.[6]

Trying to resolve the compliance issue, noncompliance intraoral appliances have been developed. [7-10] However, a serious disadvantage of these appliances is the anchorage loss of anterior teeth due to the reactive forces of distalization.

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This leads to proclination of the anterior teeth. This drawback is the result of the tooth support nature of these appliances. In addition molar extrusion, distal tipping and distal rotation occur. [11-12]

Temporary skeletal anchorage devices (TSADs) are the alternatives used nowadays to eliminate the undesirable effects of the intraoral molar distalizing appliances. TSADs are used with different appliance design to provide bony rather than dental anchorage to the appliance. [13-18]

In 2008, Lim and Hong [19] described a cantilever and mini-screw system for distal movement of maxillary molars. To achieve bodily movement, the position of the mini-screw and the length of the cantilever arm can be adjusted to result in a line of action is passing through the center of resistance of maxillary molars. In a pilot study, a modified version of the appliance was evaluated for its efficiency in molar distalization and showed good results. [20]

The aim of this study was to evaluate the skeletal, dental and soft tissue effects of molar distalization using a cantilever arm and miniscrew appliance.

MATERIAL AND METHODS

A sample of 20 patients who needed upper first molar distalization were recruited from the Department of Orthodontics, Faculty of Dentistry, Ain Shams University. The inclusion criteria were: 1) Age more than 18 years, 2) Skeletal Class I relationship 3) Class II molar relationship 4) Moderate maxillary arch crowding or maxillary protrusion. The exclusion criteria were 1) Hyperdivergent facial type, 2) Bad oral hygiene, 3) Any systemic disease that can affect bone quality and miniscrew placement. 4) Vulnerable groups.

The patients average age was 20 years; 4 males, 16 females. Sample size calculation showed that at least 15 cases should be recruited to identify an effect size of 1 unit. For each patient, pre- (T1) and post-distalization (T2) lateral cephalograms were taken. Informed consents were obtained for each participant according to the Declaration of Helsinki.

Construction and insertion of the appliance:

The cantilever appliance consisted of buccal and palatal 0.9 mm stainless steel cantilever arms ending with anteriorly bent hooks. The arms were soldered to the bands on the maxillary first molars (Figure 1). The cantilever arm was so constructed to be parallel to the occlusal plane, vertically extended so that the force vector passes through the center of resistance of the first molar. Two miniscrews of 1.4 mm diameter (Hubit, Co, Ltd) were placed between the upper first molar and second premolar buccaly and palataly. Their lengths were 6 and 8 mm, respectively. Distalization started immediately after placement using nickel-titanium coil springs. The coil springs were attached between the hooks of the cantilever arms and the miniscrews, applying approximately 150 g of force per side. An indicator wire was soldered to the bands to avoid the confusion caused by superimposition in locating the upper first molar root.

Cephalometric Measurements:

Lateral cephalograms were taken by I-cat next Generation, (Imaging Sciences International) and digitized using Onyx Ceph® version 2.6.24 (142)

Fig. (1) The miniscrew-supported cantilever appliance inserted in place and coil springs placed between the arms and the miniscrews.

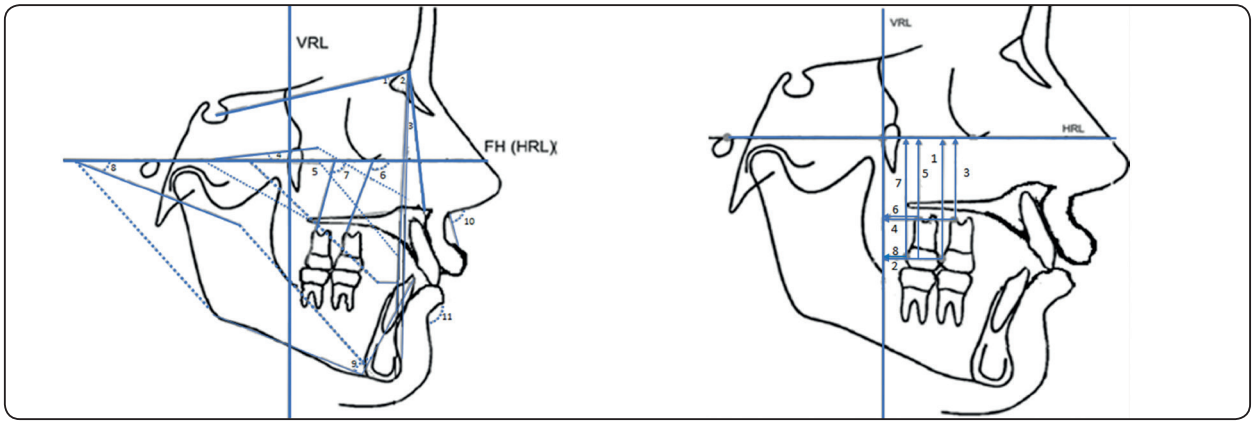

Fig. (2) Linear and angular measurements made on lateral cephalometric radiograph.

software program. The horizontal reference line (HRL) was the FH plane and the vertical reference line (VRL) was perpendicular to the FH plane, passing through the pterygoid point. Twenty-six linear and angular measurements were made by one examiner as shown in figure 2. Differences between T1 and T2 were calculated (T1– T2).

To evaluate measurement reliability, 10 random cases were selected and re-digitized 2 weeks apart by the same examiner. Intra-examiner reliability was evaluated using the intra-class correlation coefficient (ICC), and showed an ICC > 0.90.

STATISTICAL ANALYSIS:

All measurements were presented into an excel spreadsheet and analyzed using a statistical software package (SPSS version 17.0, Chicago, III) for windows. Normal distribution of the data was confirmed using Shapiro-Wilk test. Paired t-test was used to evaluate the skeletal, dental, and soft tissue changes that occurred from T1 to T2 for variables following the normal distribution. The variables that were significantly different from the normal distribution were compared between T1 and T2 using Wilcoxon rank-sum test.

The significance level was set at $P \leq 0.05$. Statistical analysis was performed using IBM SPSS Statistics Version 20 for Windows

RESULTS

Table I shows the dental, skeletal and soft tissue changes after upper first molar distalization using the cantilever miniscrew- supported distalizer. The comparison between pre- and post-treatment variables revealed that the first molar had significant amount of distalization (4.0 mm). There was less root distal movement than crown distal movement which led to significant distal tipping (6.2°) ($P < 0.001$)). The upper first molar showed significant intrusion (1.1 mm). The second molar showed significant distalization of 3.2 mm with distal tipping of 12.0° ($P < 0.001$). The upper central showed 2.3 mm of retraction and 1.8 mm intrusion .

Among the skeletal variables, only the FMA had a significant increase of 1.9° ($P < 0.001$). There was no statistically significant change in the anteroposterior position of maxilla or mandible. There was no significant changes in the soft-tissue variables except for 0.56 retraction of lower lip.

TABLE (I) Comparisons of predistalization and postdistalization positions of the dental, skeletal and soft tissue structures.

	Pre-Tx		Post-Tx		Diff-Tx		paired t-test (pre vs post)
	Mean	SD	Mean	SD	Mean	SD	p-value
DENTAL							
U6RoottoVRL	22.64	3.80	23.20	3.80	0.56	2.30	0.244
U6CusptoVRL	16.95	3.93	12.98	3.50	-3.97	1.70	<0.001
U1RoottoVRL	48.40	4.90	46.96	4.94	-1.40	3.00	0.029
U1CusptoVRL	58.40	5.00	56.00	5.00	-2.30	3.40	0.003
U6roottoFH	32.50	4.50	31.80	4.50	-0.70	1.00	0.006
U6CusptoFH	43.00	5.00	42.00	5.00	-1.00	1.00	<0.001
U1RoottoFH	32.00	3.00	31.60	3.50	-0.70	2.00	0.131
U1cusptoFH	53.00	4.00	51.50	4.00	-1.80	2.90	0.007
U6FHangle	72.00	7.65	66.00	5.50	-6.00	3.00	<0.001
U1FHangle	113.75	7.00	112.70	6.70	-1.00	2.00	0.029
Overjet	4.50	1.60	4.00	1.00	-0.30	0.95	0.106
Overbite	3.50	1.70	3.50	1.50	0.09	0.80	0.579
U7cusptoVRL	11.00	3.50	7.80	4.00	-3.00	2.00	<0.001
U7FHangle	59.70	5.00	47.70	6.60	-12.00	6.00	<0.001
U7cusptoFH	37.60	3.00	36.50	3.00	-1.00	1.50	0.002
U7roottoFH	25.00	2.60	24.60	2.00	-0.40	1.00	0.086
OcclusalPlaneAngle	5.00	5.00	6.00	5.60	0.70	3.00	0.233
SKELETAL							
SNA	82.00	4.00	81.80	3.00	-0.20	1.60	0.458
ANB	5.00	2.80	5.00	2.80	0.09	1.00	0.656
Facialangle	87.60	3.40	87.00	3.60	-0.20	1.20	0.393
IMPA	101.00	8.70	101.00	8.00	0.09	3.00	0.885
FMA	26.00	4.00	28.00	4.00	2.00	1.30	<0.001
SOFT TISSUE							
UlipTVL	2.66	1.00	2.50	1.00	-0.20	1.00	0.444
LlipTVL	2.00	1.50	2.80	1.50	0.56	1.00	0.049
NasolabialAngle	100.00	7.00	99.80	8.90	-0.30	7.00	0.842

DISCUSSION

Molar distalization is a convenient solution to avoid tooth extraction in Class II cases. The target is to achieve maximum amount of distalization with least amount of side effects. TADs are used to support distalizers in order to overcome the disadvantages of traditional appliances; including the required patient compliance, anchorage loss, distal tipping and extrusion of first molars.

This study evaluated the efficiency of the cantilever miniscrew- supported distalizer by assessing the amount and type of tooth movement in the three planes of space.

Noncompliance appliances for molar distalization produced about 71% molar distalization and 29% reciprocal anchorage loss. [7] However, TAD-anchored molar distalizing appliances showed 3.3–6.4 mm of distalization of the maxillary first molars without flaring of anterior teeth. [21] Sar et al [22] demonstrated 2.81 mm of first molar distalization using skeletal anchorage. In agreement, the amount of distalization of the cantilever in our study was 4.0 mm, with 2.3 mm mm of incisor retraction. This was also in accordance with Escobar [22], Moschos [23], Lim [19], Oberti [24] , Nalcaci [25] and Hyo-Sang Park [26].

The upper first molar showed significant distal tipping. This could be attributed to the design of the appliance where there is no 3D control of the molar movement. The use of rectangular wire or engaging the whole posterior segment might be a solution to the tipping side effect. In addition, there was 1.1 mm intrusion of upper first molar confirming the findings of Oh [27] and Lim[19].

The upper second molar showed significant distal tipping (12 degrees). As the upper second molar was not engaged in the appliance, the distal pressure exerted by the first molar led to the severe distal tipping of the second molar.

The upper central showed 2.3 mm of retraction. These findings were in conformity with that of Moschos [23], Oberti [24] and Hyo-Sang Park[26] but not in agreement with Gelgor [28] who used open-coil springs between the first premolar and the molar. The premolars showed mesial tipping which lead to anchorage loss observed in proclination of anterior teeth. Contrary to the findings of Moschos [23], Oberti [24], Escobar [22] who showed no vertical change in the position of upper incisors, our study showed 1.8 mm intrusion of upper incisors.

Skeletally, there was no significant change in the anteroposterior position of the maxilla or mandible. This finding agrees with Gelgor [28], Moschos [23] and Nalcaci [25]. However, there was an increase in the FMA (1.9 degrees) with the appliance despite the recorded molar intrusion. The increase in mandibular plane angle could be attributed to the wedging effect of molar distalization which was not compensated by enough amount of molar intrusion. This finding is in agreement with that of Lim [19] and Escobar [22], .

In accordance to the results of Nalcaci [25] and Oh[27] , there was no significant soft tissue change post-distalization. This is expected as the distalization was for the first molar only and there is still there was a second phase of anterior segment retraction which might affect the soft tissue thereafter.

Further studies are needed to compare the cantilever appliance with other distalizers to come to a conclusive evidence regarding the efficiency of the appliance.

CONCLUSIONS

1- The cantilever miniscrew- supported distalizer is an efficient appliance for the distalization of upper first molars.

2- Distalization with this appliance is accompanied with molar tipping and intrusion.

3- The upper incisors showed significant retraction and intrusion.

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