Three-dimensional evaluation of the soft tissue changes using two different types of molar distalizers

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Abstract: Aim: The purpose of this study was to evaluate the skeletal and dentoalveolar effects of maxillary molar distalization with K-loop appliance, and to compare these effects with that of pendulum group. The purpose of this study was to evaluate the skeletal and dentoalveolar effects of maxillary molar distalization with K-loop appliance, and to compare these effects with that of pendulum group. The purpose of this study was to evaluate the skeletal and dentoalveolar effects of maxillary molar distalization with K-loop appliance, and to compare these effects with that of pendulum group. The purpose of this study was to evaluate the skeletal and dentoalveolar effects of maxillary molar distalization with K-loop appliance, and to compare these effects with that of pendulum group. The purpose of this study was to evaluate the skeletal and dentoalveolar effects of maxillary molar distalization with K-loop appliance, and to compare these effects with that of pendulum group. The purpose of this study was to evaluate the soft tissue effects of Carriere distalizer, and to compare these effects with that of dual force distalizer.

Materials and methods: Thirty patients with dental Class II malocclusion were equally divided into two groups. In the first group (nine females and six males with a mean age of 16.4±2.6 years), patients were treated with Carriere distalizer with lower lingual holding arch for anchorage, while in Group 2 (four females and eleven males; mean age, 16.4 years), the patients were treated with dual force distalizer. Cone beam computerized tomographic images were taken at the beginning of treatment and at the end of molar distalization. Changes were statistically analyzed with paired t-test. **Results:** After maxillary molar distalization with Carriere distalizer, the results showed statistically significant differences in Li-esthetic, nasolabial angle and soft tissue convexity measurements ($P < 0.05$), and statistically insignificant differences in upper lip length and thickness ($P > 0.05$). In case of Dual Force Distalizer, there is insignificant differences in Li-esthetic, nasolabial angle and soft tissue convexity measurements ($P > 0.05$), and statistically significant differences in upper lip length and thickness ($P < 0.05$).

Conclusions: The changes in the soft tissue parameters differ with the design of the maxillary molar distalizing appliance.

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1. Introduction

Dental Class II malocclusions can be corrected by extractions in at least one dental arch[1,2], by using intermaxillary elastics without extractions[3,4], or by maxillary molar distalization[5]. Overjet reduction, which is the general treatment objective in these malocclusions can be obtained by any of these approaches. However, the orthodontist can select the proper approach according to certain specific treatment objectives[6].

The extraction of teeth for correction of dental Class II malocclusions in border line cases is controversial. Premolar extraction does not necessarily ensure teeth alignment stability. However, indiscriminate teeth extraction in the borderline cases may cause dishing in of the profile with early aging appearance[7]. Nowadays, it is well recognized that most patients prefer lip fullness than the orthodontic standards of earlier days. It is now possible to treat these patients with a non-extraction approach using proper case analysis and treatment planning[8].

Soft tissue profile was also affected by class II correction as the inclination of the anterior teeth which was affected by class II correction also affect the soft tissue parameters like nasolabial angel, lip length and thickness etc.

Several treatment modalities could be used for the distal movement of the maxillary molars. These could be either fixed or removable, and intra or extra oral appliances. These modalities include the headgear[9], the repelling magnets[10], the bimetric (Wilson) arch[11], the pendulum appliance[12], the distal jet[13], the Jones Jig appliance[14] and others.

Luis Carriere developed the Carriere distalizer (Ortho Organizers, USA) for nonextraction Class II correction by moving the Class II buccal segment as a block unit into a Class I occlusion. A Class I molar and canine relationship could be achieved, allowing the treatment to be finished with any technique preferred by the orthodontist[15].

Another type of distalizers is Dual Force Distalizer that based on mini-implants as an anchorage

and double traction to the molar (from buccal and palatal sides), and also have motion path to control the direction of distalization.

In this study, we will compare soft tissue profile changes between carrier distalizer and dual force distalizer in class II molar cases.

2. Materials and methods

This prospective study included thirty patients indicated for maxillary first molar distalization. The criteria of selection included bilateral Angle´s Class II molar relationship, at least half-cusp, skeletal Class I malocclusion and normal or horizontal growth pattern. Patient should not have the upper wisdoms, either missing or extracted. The exclusion criteria included the need for extraction in the lower arch and the presence of any craniofacial anomalies. All the patients and/or their parents were informed about the details of the treatment procedure. A written informed consent was signed by each patient and/or his/her parent.

Patients were randomly divided into two equal groups. In the first group (9 females and 6 males with a mean age of 16.4± 2.8 years), patients were treated with Carriere distalizer. In the second group (4 females and 11 males with a mean age of 16.4± 2.8 years), patient were treated with Dual force distalizer.

Carriere distalizer group:

All patients were fitted with a 0.036" soldered lower lingual holding arch cemented on the mandibular first molars with bands bearing hooks at their buccal sides. This provided the anchorage for molar distalization.

The distalizer is made of mold-injected, nickel-free stainless steel. It consists of a canine pad carrying a hook for the attachment of Class II elastics, a molar pad at which a ball articulates in a socket and a stiff arm connecting them (Figure 1):

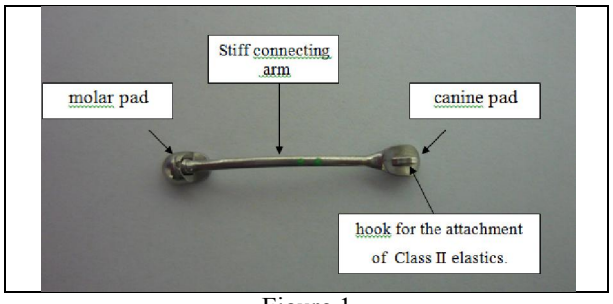

Figure 1

The distalizer length was selected (23mm, 25mm or 27mm) according to the distance from the midpoint on the facial surface of the upper first molar to the midpoint of the facial surface of the upper canine.

The distalizer was bonded with the protuberance of the molar pad placed into buccal groove on the gingival third of the molar and the cuspid pad pushed onto the middle third of the labial surface of the cuspid (Figure 2).

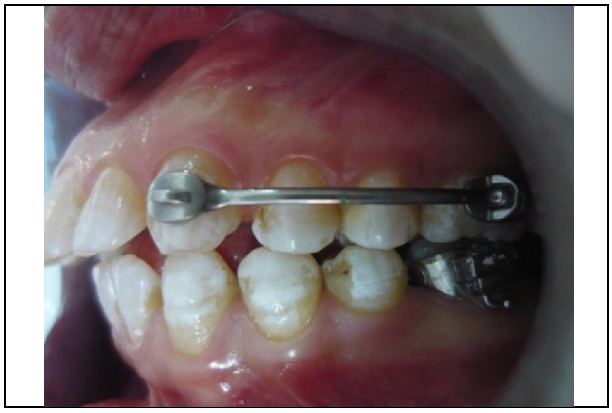

Figure 2: Bonded Carriere distalizer)

Patients were instructed to attach heavy Class II elastics (size 1/4) from the mandibular molar band hook to the hook on maxillary cuspid pad of the distalizer, wearing them 24 hours a day, except when eating or playing sports and replacing them every 48 hours.

Dual Force Distalizer group:

According to dual force distalizer, two micro-screws placed in the buccal and palatal sides in the inter-septal bone between the roots maxillary second premolar and mesio-buccal root of first molar.

Dual force distalizer consists of custom made bands on canine, second premolar and first molar. Horizontal segment of wire connecting two vertical rods originating from canine and second premolar bands from the buccal and the palatal side, vertical segment of wire originating from first molar band directed gingivally up to the area of molar trifurcation, then directed mesially up to the mesial third of the horizontal wire segment (Figure 3).

This part was present in buccal and palatal side, flying tube soldered in the wire segment attached to first molar and sliding along the horizontal wire segment that attached to canine and second premolar. Two closed coil spring (6mm in length) one buccal and one palatal connecting the screw head and wire soldered to 1st molar band (Figure 4).

Three dimensional cone beam computerized tomography imaging, landmark identification and measurements:

One cone beam computerized tomographic image (Scanora3D, Sorredex- Finland) was taken for each patient before distalization and another one after a bilateral Class I molar relationship was achieved in the same standardized technique. Exposure was

performed at 15 mA, 85 KV and at a field of view. The obtained CBCT images were converted to DICOM format with the i-CAT software. A fully reconstructed 3 dimensional volumetric image was generated by using the Materialize MIMICS image processing software. Landmarks identification was determined by using the generated multiplanar projections. The selected points were then assessed in the 3-dimensional image by double examiner technique. Tables 1 & 2 show the landmarks and measurements used.

Figure 4: Dual Force Distalizer)

Table (1): Three-dimensional cephalometric reference landmarks

Point	**Description**
Ns	Tip of the nose
Pog	Soft tissue pogonion
Li	Most inferior point on the red border of the lower lip
Ls	Most superior point on the red border of the upper lip
N	Soft tissue nasion
Sn	The intersection of the columella of the nose with the upper lip
Sto	The intersection of the closed upper and lower lip
1 lab	Most anterior point on the labial surface of the upper incisor

Table (2): Three-dimensional CBCT measurements

Measurement	**Description**
Li-esthetic	The distance between Li and a line extending from the Ns to Pog
Nasolabial angle	
Soft tissue convexity	The angle N-Sn-Pog
Upper lip length	The distance from Sn to Sto
Upper lip thickness	The distance from 1 lab to Ls

The collected data were statistically analyzed. This statistical analysis included descriptive statistics (mean, standard deviation and standard error) for all variables included in the study. Also, the paired sample T-testing was performed to compare the means of these different variables. All the measurements were re-taken by the same investigator after a period of two weeks and the mean values were taken.

3. Results

The mean distalization period was 135±27 days. Two patients had unilateral distalizer debonding for one time during the distalization period. The distalizers were re-bonded and the distalization treatment was completed. Spaces were created between the upper lateral incisors and the canines in group A, and between the upper first molar and second premolar in group B during the course of distalization. Tables 3 & 4 show the descriptive statistics and the paired t-test for the different measurements before and after distalization.

Table (3): Descriptive statistics and paired sample t-testing for the different measurements before and after distalization using Carierre distalizer

	Before distalization			After distalization			Significance
	Mean	Standard deviation	Standard error	Mean	Standard deviation	Standard error	
Li-esthetic	1.995	1.037	0.423	1.383	0.851	0.347	0.004
Nasolabial angle	140.81	2.257	0.921	141.94	2.052	0.837	0.005
Soft tissue convexity	157.343	3.292	1.344	159.62	3.405	1.39	0.000
Upper lip length	21.356	1.404	0.571	21.546	1.121	0.457	0.252
Upper lip thickness	10.791	1.258	0.513	10.408	1.311	0.535	0.122

Significant at $P \leq 0.05$ using paired t-test.

Table (4): Descriptive statistics and paired sample t-testing for the different measurements before and after distalization using dual force distalizer

	Before distalization			After distalization			Significance
	Mean	Standard deviation	Standard error	Mean	Standard deviation	Standard error	
Li-esthetic	4.156	4.191	1.711	4.183	3.356	1.37	0.952
Nasolabial angle	141.75	8.343	3.406	141.1	3.803	1.552	0.814
Soft tissue convexity	147.15	12.208	4.983	152.265	10.206	4.166	0.052
Upper lip length	29.008	2.785	1.136	27.715	3.245	1.324	0.045
Upper lip thickness	12.935	1.101	0.449	11.958	1.134	0.463	0.006

Significant at $P \leq 0.05$ using paired t-test.

Statistics for paired samples					
		Mean value	Number of specimens	Standard deviation	Standard failure
Pair 1	pre_Li-esthetic	3,0758	12	3,12257	,90141
	post_Li-esthetic	2,7833	12	2,75483	,79525
Pair 2	pre_Naso Labial angle	142,0683	12	5,81598	1,67893
	post_Naso Labial angle	140,9817	12	2,92847	,84538
Pair 3	pre_Skeletal convexity	160,7925	12	8,47075	2,44529
	post_Skeletal convexity	165,8083	12	4,79882	1,38530
Pair 4	pre_Soft tissue convexity	152,2467	12	10,05043	2,90131
	post_Soft tissue convexity	155,9425	12	8,20809	2,36947
Pair 5	pre_Upper lip length	25,0708	12	4,58518	1,32363
	post_Upper lip length	24,9600	12	3,68993	1,06519
Pair 6	pre_Upper lip thickness	11,8783	12	1,56675	,45228
	post_Upper lip thickness	11,1033	12	1,41825	,40941

Test with paired samples									
		Paired difference					T	df	Sig. (2-seitig)
		Mean	Standard deviation	Standard deviation	95% Konfidenzintervall der Differenz				
					Lower	Upper			
Pair 1	pre_Li-esthetic - post_Li-esthetic	,29250	,79924	,23072	-,21531	,80031	1,268	11	,231
Pair 2	pre_Naso Labial angle - post_Naso Labial angle	1,08667	4,40381	1,27127	-1,71138	3,88471	,855	11	,411
Pair 3	pre_Skeletal convexity - post_Skeletal convexity	-5,01583	4,34646	1,25472	-7,77744	-2,25422	-3,998	11	,002
Pair 4	pre_Soft tissue convexity - post_Soft tissue convexity	-3,69583	3,65980	1,05649	-6,02116	-1,37051	-3,498	11	,005
Pair 5	pre_Upper lip length - post_Upper lip length	,11083	1,50656	,43491	-,84639	1,06805	,255	11	,804
Pair 6	pre_Upper lip thickness - post_Upper lip thickness	,77500	,49937	,14416	,45771	1,09229	5,376	11	,000

Group statistics					
	distalizer	Number	Mean Value	Standard deviation	Standard failure
pre_Li-esthetic	dualforce	6	4,1567	4,19189	1,71133
	carriere	6	1,9950	1,03701	,42336
pre_Naso Labial angle	dualforce	6	141,7500	8,34380	3,40634
	carriere	6	142,3867	2,13404	,87122
pre_Skeletal convexity	dualforce	6	153,5967	5,32865	2,17541
	carriere	6	167,9883	2,27845	,93017
pre_Soft tissue convexity	dualforce	6	147,1500	12,20815	4,98396
	carriere	6	157,3433	3,29291	1,34432
pre_Upper lip length	dualforce	6	29,0083	2,78503	1,13699
	carriere	6	21,1333	1,13431	,46308
pre_Upper lip thickness	dualforce	6	12,9350	1,10116	,44955
	carriere	6	10,8217	1,22805	,50135
post_Li-esthetic	dualforce	6	4,1833	3,35651	1,37029
	carriere	6	1,3833	,85195	,34781
post_Naso Labial angle	dualforce	6	141,1000	3,80316	1,55263
	carriere	6	140,8633	2,09032	,85337
post_Skeletal convexity	dualforce	6	162,5683	4,70466	1,92067
	carriere	6	169,0483	1,82621	,74555
post_Soft tissue convexity	dualforce	6	152,2650	10,20614	4,16664
	carriere	6	159,6200	3,40545	1,39027
post_Upper lip length	dualforce	6	27,7150	3,24549	1,32496
	carriere	6	22,2050	1,09776	,44816
post_Upper lip thickness	dualforce	6	11,9583	1,13413	,46301
	carriere	6	10,2483	1,17663	,48036

4. Discussion:

Selection of an appropriate appliance for maxillary first molar distalization has always been a challenge in orthodontic practice. In this study, a comparison was made between a non-compliance distalizer versus a compliance one. Most studies were directed towards dental and skeletal effects of the distalizers with little discussion of the soft tissue effects.

Prediction of soft tissue changes is not an easy task, because of the different variables needed to be considered. Variations in the thickness and tension of soft tissues between individuals produce a complex variation in profiles as demonstrated by hard tissue changes[16].

Accurate orthodontic treatment planning depends on precise measurements of the craniofacial skeleton, position of teeth and soft tissue lateral profile. CBCT measurements have excellent advantages over traditional 2D lateral cephalograms. First, it is easier to precisely locate anatomical landmarks using CBCT due to absence of image overlapping[17]. Second, CBCT offers the distinct advantage of 1:1 geometry, on the contrary to lateral cephalograms, where structures on one side are magnified less than the other side because of proximity to the film[18].

Regarding the Carriere distalizer appliance, there was a significant decrease in the Li-esthetic line measurement. This was in accordance with two factors. First, the significant increase in SNB angle. Second, the use of mandibular first molar as anchorage for maxillary molar distalization with the resulting significant proclination of lower incisors[18]. Changes in the positions of the incisors have a direct impact on the supporting soft tissues[16].

Also, there was a significant increase in the nasolabial angle which can be attributed to the resulting significant decrease in SNA angle and retroclination of upper anterior teeth.

The significant increase in the soft tissue convexity angle could result from the combined significant effects on both SNA and SNB angles[19]. Non-significant changes in both upper lip length and thickness were also found.

Otherwise, in case of Dual Force distalizer, there was a non-significant increase in the Li-esthetic line and nasolabial angel. These were due to the fact that, the Dual force distalizer is mainly affect the posterior teeth only with very mild effect on anterior portion because of the total anchorage of the appliance was from the micro-implant only and the only effect of the anterior portion was from the force of elastomeric separators that were fitted at the area of canine and premolars.

Also the soft tissue convexity was not changed because the Dual Force distalizer has no components in lower arch. So, the mandibular teeth were not affected at all.

Conclusions

- The changes in the soft tissue parameters differ with the design of the maxillary molar distalizing appliance.

- Carriere Distalizer has more soft tissue effect than dual force distalizer.

- Any effects on anterior teeth from distalizing appliances induce change in patient profile and also the thickness of soft tissue covering it.

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