AJDS ALAZHAR Al-Azhar Journal of Dental Science
Vol. 27- No. 3- 407:416- July 2024
Print ISSN 1110-6751 | online ISSN 2682 - 3314
https://ajdsm.journals.ekb.eg
Orthodontic & Pediatric Dentistry Issue (Orthodontics and Pediatric Dentistry)

EFFECT OF UPPER THIRD MOLAR EXTRACTION ON DISTALIZATION USING CARRIERE MOTION APPLIANCE: A PROSPECTIVE CLINICAL STUDY

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ABSTRACT

Objectives: This study evaluated the impact of the upper third molar on the distalization using a carriere motion appliance. **Subjects and methods:** The study was conducted on 12 class II malocclusion orthodontic patients (three males and nine females) with class II malocclusion; they were divided into two groups; the first group with the presence of upper third molar consisted of 6 patients (two males and four females) with mean age 16.5±2.25, the second group with the absence of upper third molar consists of 6 patients (1males and 5female) with mean age16.5±2.42. Cast superimposition for the upper and lower jaw and lateral cephalometric was taken before (T1) and after the first phase treatment with CMA (T2). **Results**: The inter-group difference was non-significant; there is some difference in significant value within each group which increased within group B than group A, especially in upper first molar sagittal movement. **Conclusions:** (1) CMA provides an effective tool for treating mild to moderate class II malocclusion. (2) Extraction of the upper third molar increases the amount of upper buccal segment distalization. (3) Extraction of the upper third molar decreases the anchorage loss in the lower jaw by decreasing the amount of mesialization of lower teeth.

KEYWORDS: distalization, carriere motion appliance, third molar, cast superimposition.

INTRODUCTION

Angle's Class II malocclusion consider the most challenging problem opposing the orthodontic profession [(1)]. The treatment modalities for no-growing skeletal ClassII patients include camouflage treatment and surgical correction[(2)]. In camouflage treatment, we can extract or distalize to correct classII of patient.

In recent years, the number of orthodontic patients treated with the extraction approach has decreased significantly. However, experiences have shown that premolar extraction does not necessarily promise stability of teeth alignment, but uncritical teeth extraction in the so-called borderline cases resulted in dishing in the profile with premature aging appearance [(1,3)]. Now, dentists have recognized that the general public often selects fullness and prominent lips over the orthodontic standards of earlier days. With careful case analysis and treatment planning, it is now possible to treat some of these patients with the non-extraction method, which was thought of extraction cases previously. This has led to a "Neo-Angle" school of treatment planning with modified techniques to facilitate non-extraction treatment.

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DOI: *10.21608/AJDSM.2022.174768.1384*

Distalization of the maxillary molars is an important treatment option for the treatment of classII. But several concerns have been raised about the eruption of the second and third molars during or after distalization[4,5]. The success of molar distalization has been reported to depend on two main factors: (1) the type of movement and (2) the timing of treatment. It has been argued that when the second molar has not yet erupted, distalization of the first molar occurs by tipping rather than by bodily movement. Several other authors agreed that the eruption stage of the second and third molars affected the distalization of the first molar. Duration of treatment has also been shown to increase if second molars have erupted, and therefore distalization is often recommended before the eruption of the total permanent dentition [6].

The effect of distalization on the maxillary third molars and the maxillary third molars' impact on distalization were determined to be particularly variable by Ghosh and Nanda [7] in 1996. In their study, no patients had more than half of root formation on the third molar teeth. In addition, none of these teeth had a significant amount of horizontal or vertical change in position after distalization.

Kinzinger et al. have another opinion about these results. Regarding their "fulcrum theory" of molar tipping, they found that if germectomy of the wisdom teeth had previously been done, almost totally bodily distalization of both molars was possible, even when the second molar was not banded. They consider a tooth bud acts as a fulcrum on the mesial neighboring tooth [5]. On the other side, another study by Kang J M in 2016 concluded that the presence or Absence of a third molar tooth follicle showed no significant effect on first molar movement regardless of the appliance[4]. This, agreed with a systemic review in 2013 by Flores-Mir C, indicates that there is minimal effect of maxillary second and third molar eruption stage on molar distalization, both horizontal and angular distalization[8]

FIG (1 A,B,E) showing pre and post treatment intra-oral photo. (A) Pre-treatment intra-oral photograph. (B) During treatment intra-oral photo. (C) CMA and his ball and socket design. (D) Post-treatment intra-oral photo with CMA

Luis Carriere, in 2004 [9] developed The Carriere Motion 3D appliance as a fixed appliance. As a result, the Class II Carriere Motion appliance (CMA) introduction has raised several orthodontics questions about its treatment effects. The appliance was designed to be an intermaxillary non-extraction Class II corrector by moving the class II buccal segment as a block unit into a class I relation. It consists of Mold-injected, nickel-free stainless steel runs from the maxillary canine to the first molar. It has a ball-and-socket design on the molar pad to allow tipping and rotation of the molar and a hook on the canine place for elastic wear to the mandibular first or second molar (figure 1). The CMA is efficient and effective in practically resolving ClassII malocclusion. Class II correction usually was done within 5–6 months of treatment[9-13].

SUBJECTS AND METHODS

***Study design*:** A prospective clinical study.

Study setting and population:

The current study was conducted on sixteen orthodontic patients. All patients received treatment at the outpatient clinic at Orthodontic Department, Faculty of Dental Medicine (Boys - The study protocol was reviewed and approved by the Institutional Review Board and the Ethical Research Committee of Al-Azhar University, Cairo, Egypt. ethically accepted with code 627/1151 and registered on ClinicalTrials.gov (ID: NCT05166928). Cairo), Al-Azhar University, Egypt.

Sample size calculation:

Sample size calculation was based on the mean difference between experimental & control groups retrieved from previous research (Kinzinger et a., 2004) [5].Using G power to calculate the difference between 2 means using t-test with effect size =1.21, 2 tailed, With α error =0.05 and power = 80.0%, significance level (alpha) =0.05 .The total sample size will be 16(8 in the intervention arm and 8 in the control arm).

Inclusion criteria:

1. Bilateral Angle's Class II canine relationship, at least half-unit. (2). Skeletal Class I or mild Class II relationship. (3). Upper second molars were fully erupted before starting distalization. (4). Normal or horizontal growth pattern. (5). Good oral hygiene. (6). Absence of any systemic diseases.

Exclusion criteria

1. Previous orthodontic treatment. (2). Patients who required surgery to correct skeletal discrepancies (severe skeletal class11). (3). Patients with hyperdontia, hypodontia, or syndromic diseases. (4). Extraction or badly destructed teeth in both arches.

Patient division:

The patients will be divided into two groups:

1. Control group: will be treated using a carriere motion appliance for distalization of the upper buccal segment in the presence of the upper third molar.
2. Test group: will be treated using a carriere motion appliance for distalization of the upper buccal segment with upper third molar extraction or have congenital missing upper third molar.

All patients were treated with CMA during phase I. The fit of the CMA was determined using the manufacturer's instructions. In the mandible, buccal tubes with elastic hooks were bonded to the mandibular second or first molars. A clear invisible retainer made from a 1-mm thick Essix plastic retainer was placed (Figure 1).

Elastic wear consisted of Force 1e elastics (1/4-inch 6.5 oz) and Force 2e elastics (3/16-inch 6.5 oz) worn until the end of treatment with CMA[10]. Later, full fixed appliances (FFA) with preadjusted 0.022-inch edgewise brackets were placed.

Cast superimposition for STL file for cast pre and post was done by Materials Mimics software.

Twenty measurements were taken for the upper arch and also 20 measures for the lower arch. In addition, the pre-and post-treatment scans of the dental models were superimposed on three points in the incisive papilla area (the most anterior point, the most prominent point, and the most posterior point of the incisive papilla) [(14)].

A frontal line will be constructed perpendicular to the midsagittal plane and pass through the most prominent point of the incisive papilla. Next, lines will be drawn from the teeth perpendicular to this plane, and the differences between measurements taken before and after molar distalization (figure 2) will be calculated to determine the amount of distalization, molar rotation, and the amount of expansion of the canines, premolars, and molars on a three-dimensional digital model[14].

For difficulty in making superimposition in the lower arch until now, a report has yet to be published estimating the stability of anatomical landmarks in the mandible for superimposing 3D mandibular digital models. Björk and Skieller [(15)] reported that stable structures in the mandible are the inner contour of the cortical plate at the lower border of the symphysis, the trabecular structure in the symphysis, the shape of the mandibular canal, and the lower contour of a mineralized molar germ before the root begins to develop [(15)]. However, these structures are, of course, not visible on dental casts, and teeth cannot serve as reference items as they are themselves subject to orthodontic movement.

So decided to take the frontal plane constructed in the upper as a reference plane for lower jaw superimposition. When the upper and lower arch is in occlusion, project the plane to the lower jaw, and take the exact measurement as in the upper. Measurements of molar mesilization, molar rotation, and the amount of expansion of the canines, premolars, and molars plus B point (figure 3).

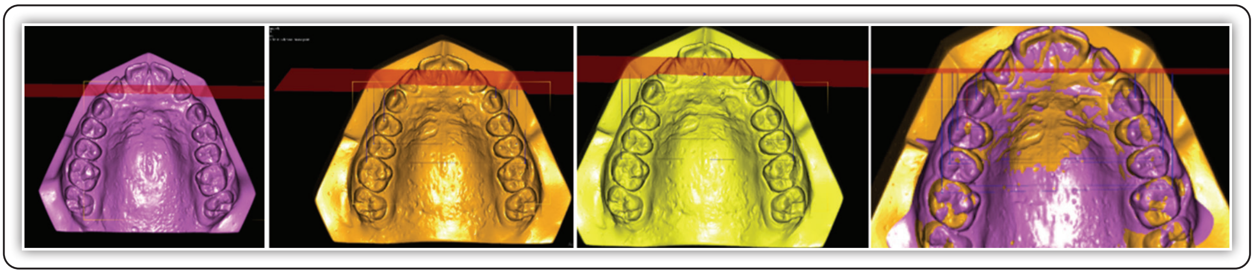

FIG (2) Shows frontal plane construction and method of measurement

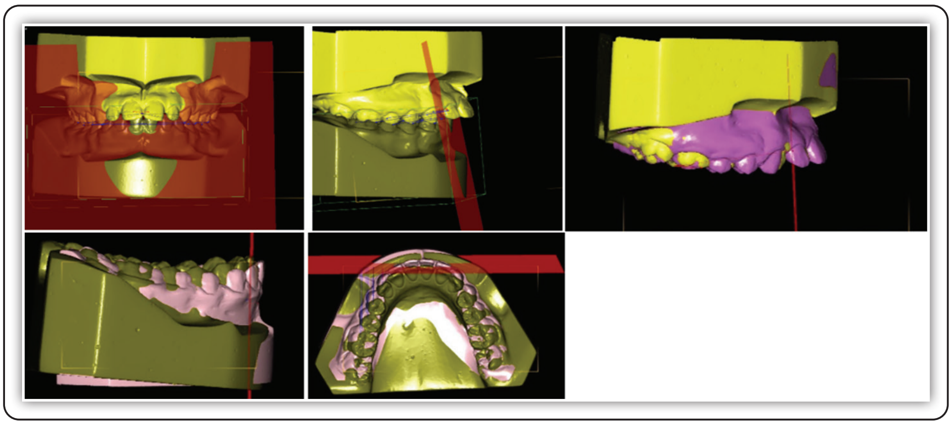

FIG (3) Shows frontal plane projection from upper to lower cast

RESULT

Reliability and error analysis:

Kolmogorov- Smirnov and Shapiro-Wilk tests were used to verify the normality of data distribution which showed normal distribution of all data. Parametric tests were used for statistical evaluation. Paired t-test was used for the normally distributed quantitative variables to compare the two periods (T1 and T2). Quantitative data were presented as mean and standard deviation with estimated upper and lower limits of the confidence intervals (CI) at a 95% confidence level. The significance of the obtained results was judged at the 5% level (P-value was considered significant at $P \leq 0.05$).

Statistical and descriptive analysis:

Table (1) shows Descriptive statistics and comparison of maxillary cast measurements before (T1) and after (T2) distalization in group A using paired t-test.

Table (2) shows Descriptive statistics and comparison of maxillary cast measurements before (T1) and after (T2) distalization in group B using paired t-test.

Table (3): Descriptive statistics and comparison of maxillary cast measurements before (T1) and after (T2) distalization in between groups A &B using independent t-test

Table (4): Descriptive statistics and comparison of mandibular cast measurements before (T1) and after (T2) distalization in between groups A &B using independent t-test

TABLE (1) Descriptive statistics and comparison of maxillary cast measurements before (T1) and after (T2) distalization in group A using paired t-test.

Outcomes	Descriptive values				Paired Differences (T2-T1)				t	P-value	Sig.
	T1		T2		Mean	S.D.	95% Confidence Interval of the Difference				
	Mean	S.D.	Mean	S.D.			Lower	Upper			
Transverse measurements											
Inter canine	34.57	2.50	35.86	1.77	1.29	2.00	-.80	3.39	1.584	.174	NS
Inter first premolar	41.41	2.17	43.69	1.41	2.28	1.67	.52	4.04	3.330	.021	S
Inter second premolar	45.35	3.25	47.18	2.06	1.83	2.38	-.67	4.33	1.880	.119	NS
Inter molar	48.92	2.82	49.55	2.32	.63	2.05	-1.53	2.79	.750	.487	N.S.
Sagittal measurements;											
Canine sagittal movement	2.81	2.32	4.54	2.52	1.73	1.37	.28	3.17	3.084	.027	S
1st premolar sagittal movement	10.80	2.24	12.13	2.48	1.33	1.45	-.19	2.85	2.236	.076	S
2nd premolar sagittal movement	17.39	2.55	18.96	2.62	1.56	1.23	.27	2.85	3.117	.026	S
1st molar sagittal movement	23.91	2.93	25.67	2.97	1.75	.92	.79	2.72	4.674	.005	S
Measurements of rotations											
Canine rotation	57.15	24.78	57.90	27.28	.75	3.18	-2.58	4.09	.581	.586	N.S.
Molar rotation	61.77	4.84	64.75	4.76	2.98	3.52	-.72	6.68	2.070	.093	N.S.

SD= Standard deviation, P- value= Probability value, s = Significance, NS =Non significant (P≥0.05), T1= before distalization, T2=after distalization.

TABLE (2) Descriptive statistics and comparison of maxillary cast measurements before (T1) and after (T2) distalization in group B using paired t-test.

Outcomes	Descriptive values				Paired Differences (T2-T1)				t	P-value	Sig
	T1		T2		Mean	S.D.	95% Confidence Interval of the Difference				
	Mean	S.D.	Mean	S.D.			Lower	Upper			
Transverse measurements; combined											
Inter canine	33.32	1.38	35.15	2.61	1.82	1.47	.27	3.3	3.028	.029	S
Inter first premolar	40.70	1.435	43.59	2.60	2.88	1.55	1.25	4.52	4.537	.006	S
Inter second premolar	45.28	1.55	47.87	2.51	2.58	1.11	1.42	3.75	5.703	.002	S
Inter molar	49.86	2.15	50.22	3.17	.36	1.96	-1.69	2.43	.459	.666	N.S.
Sagittal measurements; average											
Canine sagittal movement	1.98	.90	4.84	1.18	2.85	1.39	1.39	4.32	5.017	.004	S
1st premolar sagittal movement	8.73	2.14	11.13	2.02	2.39	1.10	1.23	3.55	5.308	.003	S
2nd premolar sagittal movement	15.96	2.36	18.45	1.93	2.48	1.11	1.31	3.66	5.467	.003	S
1st molar sagittal movement	21.79	2.95	24.39	2.35	2.60	1.28	1.25	3.95	4.972	.004	S
Measurements of rotations; average											
Canine rotation	47.22	10.97	43.83	6.86	-3.38	9.25	-13.10	6.32	-.896	.411	N.S.
Molar rotation	60.15	3.71	62.66	6.44	2.50	2.96	-.60	5.61	2.073	.093	N.S.

SD= Standard deviation, P- value= Probability value, s = Significance, NS =Non significant (P≥0.05), T1= before distalization, T2=after distalization

TABLE (3) Descriptive statistics and comparison of maxillary cast measurements before (T1) and after (T2) distalization in between groups A &B using independent t-test.

Outcomes	Descriptive values (T2-T1)				Intergroup difference (Group B-Group A)					
	Group A		Group B		t-value	Sig. (2-tailed)	Mean	S.E.	95% Confidence Interval of the Difference	
	Mean	S.D.	Mean	S.D.					Lower	Upper
Transverse measurements; combined										
Inter canine	1.29	2.00	1.82	1.47	.525	.611	.53	1.01	-1.72	2.79
Inter first premolar	2.28	1.67	2.88	1.55	.648	.532	.60	.93	-1.47	2.69
Inter second premolar	1.83	2.38	2.58	1.11	.703	.498	.75	1.07	-1.63	3.14
Inter molar	.63	2.05	.36	1.96	-.226	.826	-.26	1.16	-2.85	2.32
Sagittal measurements; average										
Canine sagittal movement	1.73	1.37	2.85	1.39	-1.406	.190	-1.12	.80	-2.90	.65
1st premolar sagittal movement	1.33	1.45	2.39	1.10	-1.426	.184	-1.064	.74	-2.72	.59
2nd premolar sagittal movement	1.56	1.23	2.48	1.11	-1.361	.203	-.923	.67	-2.43	.58
1st molar sagittal movement	1.75	.92	2.60	1.28	-1.316	.217	-.84	.64	-2.28	.58
Measurements of rotations; average										
Canine rotation	.75	3.18	-3.38	9.25	1.037	.324	4.14	3.99	-4.76	13.0
Molar rotation	2.98	3.52	2.50	2.96	.253	.805	.47	1.88	-3.71	4.66

SD= Standard deviation, P- value= Probability value, sig. = Significance, NS =Non significant (P≥0.05), T1= before distalization, T2=after distalization.

There was a significant change (P≤0.05) in the sagittal movement of canine, first premolar, second premolar, and upper first molar within group A and group B. With an increase in sagittal movement in the group B than group A by (1.4±0.19), (1.3±0.2) in the distal movement of canine and upper first molar respectively but not significant.

A significant change (P≤0.05) in Inter first premolar within group A, while there was a significant change (P≤0.05) in the inter-canine, inter the first premolar, and inter-second premolar width within group B. inter first and second premolar width decrease by (2.28±1.67) and (1.83±2.9) respectively in group A, and by (2.82±1.5) (2.38±1.11) respectively in group B. There was no significant change between the two groups in the transverse, sagittal movement and in the degree of rotation of the canine and upper first molar.

There was a significant increase in the lower incisor mesilization and lower first molar mesilzation in group A by (-0.7±0.3) (-1.6±1.2), respectively. But the inter groups result was non-significant.

TABLE (4) Descriptive statistics and comparison of mandibular cast measurements before (T1) and after (T2) distalization in between groups A &B using independent t-test.

Outcomes	Descriptive values (T2-T1)				t-test for Equality of Means (Group B-Group A)					
	Group A		Group B		t	Sig. (2-tailed)	Mean	S.E.	95% Confidence Interval of the Difference	
	Mean	S.D.	Mean	S.D.					Lower	Upper
Transverse measurements; combined										
Inter canine	.003	1.10	-.41	1.20	-.619	.550	-.41333	.66749	-1.90059	1.07392
Inter first premolar	.17	.96	-.66	1.58	-1.108	.294	-.84167	.75933	-2.53355	.85022
Inter second premolar	.59	1.76	-1.24	1.50	-1.945	.080	-1.8400	.94611	-3.94807	.26807
Inter molar	-.48	1.70	-2.30	2.67	-1.403	.191	-1.8171	1.29477	-4.70210	1.06777
Sagittal measurements; average										
L1 sagittal changes	-.74	.301	-.39	.86	.945	.367	.35	.37	-.48	1.19
Canine sagittal movement	-1.56	1.57	-2.37	3.65	.498	.629	.81	1.62	-2.812	4.43
1st premolar sagittal movement	-1.23	1.75	-.19	1.68	-1.053	.317	-1.04	.99	-3.25	1.16
2nd premolar sagittal movement	-1.43	1.36	.28	1.92	-1.784	.105	-1.71	.96	-3.86	.427
1st molar sagittal movement	-1.58	1.17	.17	1.63	-2.140	.058	-1.75	.82	-3.58	.071
Canine rotation	-1.83	5.72	1.96	4.65	-1.262	.236	-3.79	3.01	-10.50	2.90
Molar rotation	-2.75	6.82	-2.29	7.21	-.111	.913	-.45	4.05	-9.484	8.58
B-point change										
Point B changes	.051	1.59	.65	.51	.882	.398	.60	.68	-.92	2.134

SD= Standard deviation, P-value= Probability value, sig. = Significance, NS = Non significant (P≥0.05), T1= before distalization, T2=after distalization

DISCUSSION

The upper first molar sagittal movement:

There was a significant difference within each group between T.I. and T2. The upper first molar also shows more distal movement in group B than in group A by 1.3 mm. In group A the upper first molar movement was 1.74±0.92 and 2.6±1.2m in group B., but the non-significant result may be due to the sample size in the two groups. This agrees with Tunçer, Arman-Özçırpıcı[16] who found a more distal movement of the upper first molar by about 1mm in his group with extracted upper third molar. CBCT studies by Areepong et al [10]. Show molar distalization by 1.76mm. Hashem A[12] found the amount of distalization in the unerupted upper second molar group 3.9±0.8 more than in erupted second molar group, which was 3±0.6 this is the most significant amount of distalization may be related to the age of his group 11.6±1.4. Years.

Also, CAREYBETH[18] found that the upper first molar moves more distally by 0.7mm in the unerupted second molar cases. Wilson Brian et al [17], Show 2.14±1.34 mm distalization to the upper first molar. Fouda Ahmed et al [19]. also, in their CBCT study, found the amount of maxillary molar distalization of 1.5mm in his group treated with Essix as anchorage in the lower jaw, which is nearly equal to our result of group A (1.74±0.92) and The result of group B equal to his result in his group treated with miniscrew as anchorage which was 2.6mm in his study which similar to our result in group B which was2.6±1.2mm.

Upper canine sagittal movement:

There is a significant increase in the distal movement of the upper canine within each group, as the upper canine anterior-posterior relation to the constructed frontal plane increase by 1.7±1.4 in group A and by 2.8±1.3 in group B. We found an increase in the amount of distalization in group B by 1.3mm than group B in the upper first molar distal movement; also, we found almost the same amount in the canine distalization by means different 1,4 mm increasing in group B. But when compared between the two groups, the result was non-significant. These might be different if we used a large sample size. This agrees with the outcome of Areepong et al [10], which found statistically significant distalization of upper canine within the skeletal class II as he found 2.2 mm distalization. Also, Wilson Brian et al [17], found statistically significant distalization of the upper canine but with a slight increase in his amount of distalization, which was 3, 6 mm distal canine movement. This may be due to his large sample size (fifty patients) and wide range of age (10-17 years).

The result of group B was equal to the result of Fouda Ahmed et al [19], in his group treated with miniscrew as an anchorage, which was 2.7 mm in his study, and the result of group A equal to the result of his group treated with Essix as anchorage in the lower jaw which was 1.5mm, this similarity we found it also in upper molar movement.

So we may be saying that if we want to get the maximum effect of CMA in distalization, we should reinforce the anchorage in the lower jaw by miniscrew to increase the resistance to the vertical force of elastic this lead to an increase in horizontal force that effect on the upper buccal segment, or decrease the resistance to horizontal that effect on the upper buccal segment by Extraction of the upper third molar.

Transverse measurement:

About the transverse measurement, there is no significant difference between groups as the transverse measurement decrease in T2 than in T1, and the arch becomes narrower in T2, especially in the premolar region; this may be because the line of action of force pass buccal to the center of resistance and the premolar are free to move as there is no appliance placed on them as the rigid CMA bonded in canine then pass premolars then connected to the first molar.

In group B, we found a significant decrease in inter-canine width (1.82±1.4), inter the first premolar (2.8±1.5), inter-second premolar (2.5±1.1), and a non-significant reduction of intermolar width (0.36±1.9).

In group A the significant decrease only in inter-first premolar width by (2.2±1.6) and non-significant in inter-canine and intermolar width by about (1.29±2), (0.63±2).

The transverse measurements show a slight decrease in group B than in group A may be because there is an indirect proportion with sagittal measurement, as when sagittal movement increase, the transverse measurement decrees. Therefore, I can't entirely agree with Tunçer, Arman-Özçırpıcı who found a significant increase in inter premolar width [16].

The effect of CMA on the width of the upper canine, premolar, and molar are short-term effect that was no need for expansion later on. Still, this effect resolved spontaneously within the fixed appliance phase as the upper intermolar width decreased by a low degree of 0.6mm, 0.36mm, not by a high value as premolar, which reaches a decrease to 2.8 mm. Hence, the upper first molar maintains the transverse width of the upper arch.

Lowe incisor and lower first molar sagittal movement:

An anterior-posterior line from the lower incisal edge and another line from the mesial cusp tip of the lower first molar to a projection of frontal plane, we found a significant difference within group A in lower incisor and lower first molar mesialization the difference between T2 and T1 was (-0.74±0.39),(-1.58±1.2) respectively. Non-significant differences between inter groups difference as lower incisor protruded by 0.7mm in group A and by 0.39 in group B. There is a slight difference between the groups. This linear measurement indicates mesialization of lower teeth and anchorage loss. Fouda Ahmed et al [19], don't agree with us as they found in the group of Essix retainers as anchorage a significant increase in lower incisor movement by 2.2 mm, but in the group of the mini screw as an anchorage, the result agree with our result which was non-significant 0.06±1.5 mm.

CONCLUSION

The following conclusions could be drawn:

1. CMA provides an effective tool for treating mild to moderate class II malocclusion.
2. Extraction of the upper third molar increases the amount of upper buccal segment distalization.
3. Extraction of the upper third molar decreases the amount of anchorage loss in the lower jaw by reducing the amount of mesialization of lower teeth.

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