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COMPARISON OF TREATMENT EFFECTS BETWEEN FORSUS WITH MINISCREWS AND CARRIERE MOTION APPLIANCE IN CLASS II MALOCCLUSION

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ABSTRACT

Objective: to study the effects of treatment of Forsus device supported with miniscrew and evaluate them against those of the Carriere Motion 3D™ Appliance (CMA).

Materials and Methods: Treatment records of 38 patients diagnosed with Class II malocclusion who underwent treatment with the miniscrew anchored Forsus device or Carriere Motion 3D™ Appliance were collected. Group I (12.78±1.7 years): A total of 19 patients, consisting of 11 girls and 8 boys, had treatment with a miniscrew-anchored Forsus. Group II (13.01±1.5 years): A total of 10 girls and 9 boys had treatment using a Carriere Motion 3D™ Appliance. Lateral cephalograms were measured linearly and angularly both before (T1) and after (T2) appliance installation and removal, respectively. independent t-tests were used to analyze differences between groups, while paired t-tests were employed to evaluate changes within groups.

Results: Both groups showed significant reductions in SNA and ANB angles, while SNB remained unchanged. LFH increased significantly in both groups. Group I showed significant retraction of maxillary incisors, whereas Group II demonstrated significantly more protraction of mandibular incisors. Both groups demonstrated significant reduction in overjet and overbite. Additionally, Group II showed significantly more distalization of the maxillary first molar compared to Group I.

Conclusion: Both miniscrew-anchored Forsus and CMA are effective and efficient approaches for correcting Class II malocclusion. CMA showed less retraction of maxillary incisors than miniscrew anchored Forsus. Significant protraction of the mandibular incisors in CMA could lead to an early correction of the overjet, which could subsequently restrict skeletal correction.

KEY WORDS: Forsus, Carriere Motion Appliance, Distalizer, Miniscrew, Class II malocclusion

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INTRODUCTION

Class II malocclusion is a prevalent issue frequently encountered by orthodontists in their routine practice. It is estimated to impact more than 30% of the population.[1] Various treatment modalities have been developed to address Class II malocclusion, including full fixed appliances with intermaxillary elastics, molar distalization devices, functional appliances, extractions, and orthognathic surgery. The selection of an appropriate treatment method depends on the severity of the malocclusion, the patient's esthetic preferences, the practitioner's experience, and patient compliance.[2,3]

The main cause of Class II malocclusion is retrusion of the mandible more than protrusion of the maxilla.[4] Various appliances could be utilized for treating Class II problems that are characterized by mandibular retrognathism. Fixed functional devices such as Forsus appliance do not rely on patient compliance and can be installed concurrently with brackets. Recently, several research studies have concentrated on minimizing these unwanted dentoalveolar effects by utilizing miniscrew as a means of skeletal anchorage. [5-9]

Carriere Motion Appliance (CMA) has gained popularity as a widely used device for correcting Class II malocclusion. It consists of a stainless-steel rod which extends from the upper canine to the first molar. It has a molar pad with a ball-and-socket joint that allows the molar to be tipped and rotated, and a canine pad with a hook that allows Class II elastics to be attached to the mandibular first molar, achieving a Class I molar relationship with high patient compliance early in treatment..[10] Compared to other appliances utilized for Class II correction, the Carriere Motion Appliance (CMA) demonstrated superior comfort, a more favorable experience, and fewer deleterious side effects.[11,12]

There is paucity of literature evaluating and comparing the skeletal, dentoalveolar and soft tissue effects following treatment with Forsus device supported with miniscrews and CMA. Therefore, the objective of this study is to evaluate the treatment effects of miniscrew-anchored Forsus and compare them with those of the CMA. The null hypothesis is that there is no significant difference between miniscrew-anchored Forsus device and CMA.

MATERIALS AND METHODS

The research study received approval from the committee of research ethics of Tanta University, Egypt (REC approval ID: R-ORTH-6-24-3125). Treatment records of 38 patients who underwent treatment, by the same experienced orthodontist, using either the miniscrew anchored Forsus appliance or Carriere Motion Appliance were gathered from the orthodontic clinic at Tanta University, Egypt, and a private orthodontic practice. Informed consent was collected from all candidates and their guardians. The criteria of inclusion for this research included patients between the ages of 10 and 15 years old who were in the permanent dentition stage, no previous orthodontic treatment, complete treatment records including lateral cephalometric Xray films, dental Class II division 1 malocclusion (end-to-end or more), a non-extraction treatment plan, and achievement of a Class I molar and canine relationship post-treatment. A total of nineteen participants, consisting of eleven females and eight males, were included in Group I with a mean age of 12.78±1.7 years. These patients received treatment using a miniscrew-anchored Forsus. Group II, consisting of ten girls and nine males with a mean age of 13.01 ± 1.5 years, had treatment using a Carriere Motion Appliance. Sample size determination was done using a significance level of 0.05 and a statistical power of 80%. Calculation of sample size was done using G* Power software (Universität Düsseldorf, Germany),[13] resulting in a sample size of 38 patients in both treatment groups.

Group I: Miniscrew anchored Forsus FRD

Patients received full fixed orthodontic appliances (3M™ Unitek™ Miniature Twin V-Slot Metal Brackets Kit). The manufacturer's instructions were followed when choosing and inserting Forsus appliance. In the region between the mandibular canine and the first premolar, miniscrews measuring 1.6 × 10mm were inserted bilaterally at the mucogingival junction level (MCT Tech of South Korea). Indirect anchorage was accomplished by shaping a piece of stainless steel wire and inserting it into the space between the miniscrew neck hole and the vertical slot of the lower canine bracket. Once a Class I molar connection was obtained, the Forsus and miniscrews were removed. (Figure 1)

Group II: Carriere® Motion 3D™

The Carriere Motion 3D™ Appliance (CMA) was bonded according to the manufacturer's instructions.[10] The size was determined by measuring the distance from the buccal groove of the maxillary first molar to the mesiodistal center of the maxillary canine crown. After etching and priming the canine and first molar teeth, a 3M™ Transbond™ XT Light Cure Adhesive was applied to the bonding pads of the Carriere rod. Two buccal tubes were bonded to mandibular first molars and a vacuum formed Essix retainer was inserted (Figure 2). Elastic (¼ "6 oz followed by 3/16" 8 oz) were used until the end of CMA treatment, then CMA was removed when Class I molar relationship had been achieved. Subsequently, full fixed appliances with 3M™ Unitek™ Miniature Twin V-Slot Metal Brackets were bonded.

Cephalometric Analysis:

Lateral cephalometric Xray films were acquired by the same machine before insertion and after removal of the Forsus (Group I) Or Carriere (Group II) to compare treatment outcomes. Tracings were created using CEPHX™ Cephalometric Analysis Software (version 4.02), and all measurements were documented for the purpose of comparing treatment results.

Statistical analysis:

SPSS Version 29.0 (SPSS Inc, Chicago, IL) was used to perform all statistical analysis. The cephalometric variables of the Forsus and Carriere groups were compared using independent t-tests. Paired t-tests were conducted to identify any alterations within each group. The interpretation of all statistical tests was conducted at a significance level of 5%.

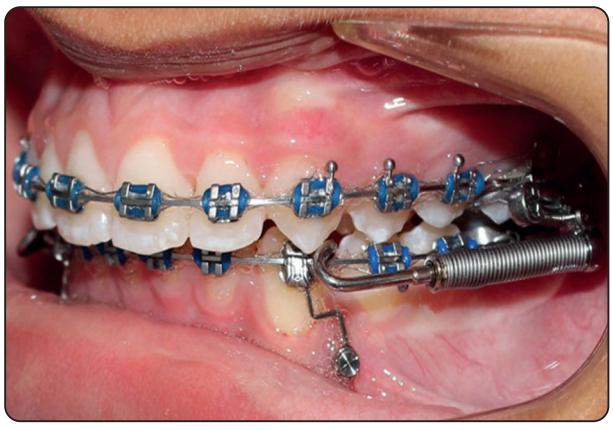

Fig. (1) Forsus FRD used with miniscrew between mandibular canine and first premolar.

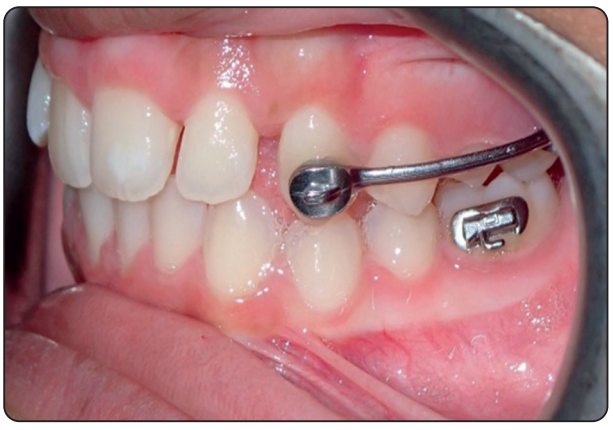

Fig. (2) Carriere Motion Appliance (CMA)

RESULTS

As shown in table 1, there was no significant difference in age between both treatment groups which indicated that the samples were matched in age. The mean treatment duration was 6.33 ± 1.9 months for the miniscrew-anchored Forsus group and 5.9 ± 2.1 months for Carriere Motion Appliance group. Additionally, no statistically significant differences were found between either group at T1 for all cephalometric variables except for overjet (Table 2). Table 3 compares the treatment effects cephalometric variables between the miniscrew anchored Forsus and the Carriere Motion Appliance groups.

TABLE (1) Baseline characterisitcs of patients in both groups

Characteristics		Group I	Group II	P value
Age		12.78±1.7	13.01±1.5	0.12
Gender	Male	8	9	
	Female	11	10	
Treatment duration		6.33±1.9	5.9±2.1	0.175

In evaluating skeletal changes, both Group I (miniscrew anchored Forsus) and Group II (Carriere motion appliance) showed significant reductions in SNA (-0.74° ± 1.52 and -0.67° ± 1.33, respectively) with no significant difference between the groups (P = 0.884). For SNB, neither group demonstrated significant changes (0.22° ± 0.58 and 0.28° ± 1.14, respectively; P = 0.831). Group I showed a significant increase in the MP-SN angle (2.09°±4.17) compared to Group II (0.84°±1.27), although the difference between groups was not significant (P = 0.219). Increases in LFH (ANS-Me) were significant in both groups (1.38 mm ± 1.54 for Group I and 0.94 mm ± 1.41 for Group II), with no significant intergroup difference (P = 0.367).

Regarding dentoalveolar changes, Group I exhibited significant retrusion and retroclination of the maxillary incisors, with U1-NA (mm) changing by -3.27 mm ± 1.37 and U1-NA (º) by -8.66° ± 5.22. Group II showed less retrusion and retroclination in both measurements (-1.55 mm ± 2.31 and -4.78° ± 3.89, respectively), with significant differences between the groups (P = 0.008 and P = 0.013, respectively). For mandibular incisors, Group II demonstrated significantly more protrusion and proclination, with L1-NB (mm) increasing by 2.29 mm ± 1.19 and L1-NB (º) by 5.99° ± 4.20, compared to Group I, which showed statistically significant changes (0.82 mm ± 2.06 and 1.97° ± 4.81). The differences between the groups were significant (P = 0.010 and P = 0.009, respectively). Additionally, Group II showed significantly more distalization of the maxillary first molar (U6 - PT Vertical) compared to Group I (-3.50 mm ± 2.06 versus -1.91 mm ± 1.69), with a significant difference favoring Group II (P = 0.013).

For soft tissue changes, both groups showed significant retraction of the Upper Lip to E-Plane (-1.88 mm ± 1.39 for Group I and -1.31 mm ± 1.47 for Group II), with no significant difference between the groups (P = 0.225). The nasolabial angle increased significantly in both groups (9.31° ± 8.44 for Group I and 4.70° ± 7.78 for Group II), but the difference between the groups was not significant (P = 0.088).

TABLE (2) Comparison between cephalometric variables of the miniscrew anchored Forsus FRD and the Carriere Motion Appliance at pretreatment

Measurements	Group I		Group II		p value
	Mean	SD	Mean	SD	
SNA (º)	82.96	2.88	81.43	3.44	0.156
SNB (º)	75.37	4.52	74.49	2.81	0.488
ANB (º)	7.59	2.25	6.92	2.51	0.406
MP - SN (º)	35.95	4.57	36.44	4.69	0.756
LFH (ANS-Me) (mm)	63.33	4.11	63.61	4.38	0.845
Co-A (mm)	83.47	3.23	83.78	4.25	0.803
Co-Gn (mm)	106.76	5.3078	108.24	4.58	0.375
Wits Appraisal (mm)	6.61	1.34	6.42	2.13	0.758
Interincisal Angle (º)	121	5.5206	119.66	7.81	0.557
U1 - NA (mm)	3.75	1.89	4.20	2.44	0.538
U1 - NA (º)	21.94	6.04	21.74	6.21	0.925
L1 - NB (mm)	6.23	1.88	7.77	2.87	0.064
L1 - NB (º)	30.71	3.71	31.39	4.74	0.635
Overjet (mm)	7.51	1.11	6.65	1.23	0.036
Overbite (mm)	4.33	1.75	3.65	1.72	0.247
U6 - PT Vertical (mm)	16.73	3.44	16.98	2.93	0.81
Lower Lip to E-Plane (mm)	2.80	2.82	*3.46*	2.32	0.449
Upper Lip to E-Plane (mm)	1.15	2.20	0.57	2.23	0.442
Nasolabial Angle (º)	112.85	10.63	109.98	11.34	0.439

TABLE (3) Comparison of the treatment effects between cephalometric variables of the miniscrew anchored Forsus FRD and the Carriere Motion Appliance groups

Measurements (T2-T1)	Group I			Group II			P value
	Mean	SD	P value	Mean	SD	P value	
SNA (º)	-0.74	1.52	0.048	-0.67	1.33	0.041	0.884
SNB (º)	0.22	0.58	0.112	0.28	1.14	0.293	0.831
ANB (º)	-0.96	1.73	0.026	-0.52	0.98	0.033	0.339
MP - SN (º)	2.09	4.17	0.042	0.84	1.27	0.01	0.219
LFH (ANS-Me) (mm)	1.38	1.54	0.001	0.94	1.41	0.009	0.367
Co-A (mm)	0.14	0.88	0.506	-0.43	1.22	0.142	0.109
Co-Gn (mm)	1.39	2.12	0.01	0.25	2.12	0.617	0.105
Wits Appraisal (mm)	-4.39	1.22	<.001	-4.19	2.14	<.001	0.719
Interincisal Angle (º)	2.82	6.63	0.08	-0.72	7.01	0.662	0.119
U1 - NA (mm)	-3.27	1.37	<.001	-1.55	2.31	0.009	0.008
U1 - NA (º)	-8.66	5.22	<.001	-4.78	3.89	<.001	0.013
L1 - NB (mm)	0.82	2.06	0.102	2.29	1.19	<.001	0.01
L1 - NB (º)	1.97	4.81	0.091	5.99	4.20	<.001	0.009
Overjet (mm)	-4.96	1.02	<.001	-4.17	1.47	<.001	0.063
Overbite (mm)	-2.83	1.90	<.001	-2.05	1.19	<.001	0.139
U6 - PT Vertical (mm)	-1.91	1.69	<.001	-3.50	2.06	<.001	0.013
Lower Lip to E-Plane (mm)	-0.15	1.90	0.739	-0.27	1.59	0.463	0.826
Upper Lip to E-Plane (mm)	-1.88	1.39	<.001	-1.31	1.47	0.001	0.225
Nasolabial Angle (º)	9.31	8.44	<.001	4.70	7.78	0.017	0.088

DISCUSSION

The findings of this study indicate that both miniscrew-anchored Forsus and CMA are effective and efficient approaches for correcting Class II malocclusion within 6 months of treatment. Popowich[14] examined predictors for the duration of Class II treatment in non-extraction Class II malocclusion, reporting an average duration of 10.0 (±6) months for wearing Class II elastics.

Forsus and CMA appliances exhibited a significant reduction in the SNA angle, possibly due to the distally applied forces on the maxillary arch that could impede forward growth of the maxilla (headgear effect). This outcome is consistent with prior research that has documented comparable results.[15,16,17] On the contrary, other research findings indicated that Forsus did not have a substantial impact on the growth of the upper jaw.. Oztoprak et al.[18] and Aslan et al.[19] attributed this debate to variations in the age at which treatment is administered, differences in treatment methods, or variations in treatment length.

During Forsus or CMA treatment, the mandible could be brought forward by spring or elastics, together with changes that would occur during

normal growth. Thus, an expected increase in mandibular length and SNB might happen following treatment. However, there was not clinically or statistically significant increase in mandibular length or SNB. This could be explained by the increase in vertical skeletal measurements (LFH and MP-SN) that occurred in both groups indicating that neither miniscrew anchored Forsus or CMA could stimulate forward growth of the mandible. This outcome was consistent with the results of earlier research that indicated minimal or no impact on the growth of the mandible.[7,11,16,18,19]

On the other hand, several studies found that Forsus appliance can increase mandibular growth.[16,20-22] One possible explanation for this variation is that the six months of treatment in the current study are insufficient time for mandibular development to occur.[7,16,17,23] Because SNA was lower in both treatment groups, ANB was also significantly lower in those groups. The reduction in ANB could be caused more by a restriction in maxillary growth than by stimulation of mandibular growth. [3] A decrease in ANB was found to be similar in a number of previous studies, which showed similar findings.[9,18,24,25]

Mandibular plane angle exhibited a significant increase in both groups, which was correlated with a concurrent increase in lower anterior facial height. Oztoprak et al.[18], in contrast to the present study, did not observe any significant change in facial height. They attributed this to the fact that the sample they used in their study was in the post-peak development period. In the same vein, other researchers did not observe any considerable changes in facial height.[26,27]

Compared to miniscrew-anchored Forsus, Carriere group showed less retroclination and retrusion of the maxillary incisors. The increased maxillary incisors retrusion in Forsus group may have resulted from the distal-directed force of the Forsus appliance , which was transmitted to the maxillary incisors through the continuous heavy archwire.[21] The result is consistent with the findings of prior Forsus investigations.[8,21,28,29] The backward displacement of A point would occur as a result of upper anterior tooth retrusion, which would lead to a reduction in SNA°.[30]

Forsus group showed statistically significant mandibular incisor protrusion and proclination. However, in skeletal or dentoalveolar cephalometric measures, there is a clear distinction between statistical significance and clinical significance. In previous clinical studies, a change of ≥2.0 mm or 2.0° in any cephalometric variable has been considered clinically significant, as recommended by O'Brien and coworkers.[31] Therefore, Forsus device supported with miniscrew as means of skeletal anchorage could restrict the protrusion of mandibular incisors, whereas CMA showed both statistical and clinical significant protrusion and proclination of the mandibular incisors; hence, the use of CMA could result in early overjet correction and possibly limit the skeletal correction which is still one of the major disadvantages of CMA.

The correction of overbite and overjet in both treatment groups was statistically significant. This finding was associated with the lingual tipping of the maxillary incisors and the labial tipping of the mandibular incisors, respectively, and suggests that both appliances had entire dentoalveolar effects. This finding agrees with other studies.[7,8,15,22, 29] CMA showed significantly more distalization of the maxillary first molar compared to miniscrew anchored Forsus which can be explained by the distally applied force of the appliance.

Both groups exhibited a significant upper lip retraction which could be attributed to the significant distal forces that act on the upper arch, which in turn causes the maxillary incisors to retract.[24] This was in agreement with previous studies [18,21] which reported similar conclusion. In both treatment groups, there was a considerable increase in the nasolabial angle secondary to the upper lip posterior movement following maxillary incisors retrusion.[32] These treatment outcomes validate the findings of previous research [15,33] that have also observed comparable soft tissue alterations.

CONCLUSION

1. Both miniscrew-anchored Forsus and CMA are effective and efficient approaches for correcting Class II malocclusion within 6 months of treatment.
2. CMA showed less retrusion and retroclination of maxillary incisors than miniscrew anchored Forsus.
3. Forsus device supported with miniscrews could minimize protrusion of mandibular incisor, whereas CMA showed both statistical and clinically significant protrusion and proclination of the mandibular incisors; hence, the use of CMA could result in early reduction of the overjet and minimize skeletal correction.

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