ISSN: 1110-435X
ONLINE ISSN: 281-5258

Egyptian
Orthodontic Journal

Assessment of skeletal changes in Class II malocclusion correction using miniscrew supported advanced molar distalization appliance (AMDA ®)

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abstract

objective: *Is to assess skeletal changes in Class II malocclusion correction using miniscrew supported advanced molar distalization appliance (AMDA).*

Material and methods: *A prospective case series study with twelve participants fulfilling the eligibility criteria were enrolled in the study. All patients included were growing patients with mixed dentition or early permanent before the full eruption of maxillary second molar. The patients were collected from the outpatient clinic of the Orthodontic Department, Ain Shams University. Two mini-screw implant (1.6 x 8 mm) aided AMDA appliance was used for bilateral distalization of maxillary first molars. Lateral cephalometric radiograph was obtained before and after molar distalization; when Class I molar relation was achieved, for all participants. The skeletal changes were assessed using SNA, SNB, ANB, PP/SN, MP/SN, facial height.*

Results: *There was insignificant change in all measurements with P value > 0.05. In SNA: there was insignificant increase by 0.31 ± 1.52. For SNB, there was an insignificant increase by 0.91 ± 2.79. ANB showed insignificant decrease by -0.61 ± 3.00. Regarding PP/SN, there was insignificant increase by 0.42 ± 3.51. The PFH/AFH Ratio showed insignificant decrease by -0.06 ± 2.86, and LAFH/AFH Ratio increased insignificantly by 0.06 ± 1.82.*

Conclusions: *AMDA ® is effective for bilateral maxillary molars distalization and Class II correction. AMDA ® distalizer has not skeletal effects, so cannot replace the orthopedic appliance.*

Introduction

Class II malocclusion is the most common problem in the orthodontic field (1). It represents 21% of Egyptian population with comparable incidence in both genders (2). Thirty percent of Class II patients in the Egyptian population have only mild skeletal disproportions, 13% have no skeletal disproportions but only dental, and 30% of the Class II patients have normal vertical proportions (3).

In the Class II malocclusion the conventional orthodontic treatment involves the use of orthopedic, functional, and\or fixed appliances in conjunction with inter-maxillary elastics (4).On the other hand, the application of these modalities is highly dependent on patient's cooperation, and his/her growing potential. To overcome this drawback, noncompliance appliances evolved to distalize

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maxillary molars or to advance the mandible in a more forward position (5). Thereby, fixed maxillary molar distalizers was advocated instead of headgear. However, anchorage loss, expressed as mesial movement of anterior and premolar teeth were observed in conventional noncompliance appliances which represents a major drawback(6).

Further, distal movement of the molars is almost always accompanied by distal tipping and/or distal-in rotation, and occasionally extrusion (7). Nevertheless, after molar distalization, maxillary molars encounters anchorage loss in terms of mesial movement because these teeth were used as anchor units for the subsequent anterior teeth retraction (8). Previous attempts to combine noncompliance distalization appliances with miniscrew implants (9) were reported in the orthodontic literature in order to control or even avoid the anchorage loss. Previous miniscrew supported molar distalizers depended upon acrylic button, sophisticated laboratory fabrication procedures or inter-radicular miniscrews.

Therefore, “Advanced Molar Distalization Appliance” (AMDA ®) was selected in this study because it does not depend upon palatal acrylic buttons nor inter-radicular miniscrews. Since the AMDA ® is a palatal distalizer, it is invisible. Moreover, can be used with full-fixed appliances for the subsequent retraction of the anterior teeth without the necessity of its removal. To test whether the AMDA ® had a headgear- like skeletal effect in growing adolescents, the aim of this study was to assess antero-posterior and vertical skeletal changes in class II malocclusion corrected using the mini-screw supported advanced molar distalization appliance (AMDA ®).

Material and Methods

This study was a prospective case series study, No financial conflicts of interest were declared. The study was self-funded by the principle investigator.

Study procedure

Orthodontic patients were evaluated according toinclusion and exclusion criteria.

1. Inclusion criteria

a. Class II division 1 or class II division 2.
b. Growing patients.
c. Mixed dentition or early permanent (before the full eruption of maxillary second molar).

2. Exclusion criteria

a. Obvious periodontal disease and gingival recession.
b. Medically free from any diseases that can affect tooth movement.
c. Severe crowding requiring extraction.
d. Syndromic patients.
e. Patients with vertical growth pattern.

Participants who met the eligibility criteria were invited to participate inthis study.

Patients were collected from the outpatient clinic of the Orthodontic Department, Ain Shams University. Before treatment was carried out a detailed written Arabic consent was signed by all the subjects of both groups after a full explanation of the procedures and the aim of the study.

- **Sample size calculation**

A sample of 5 participants was required to assess the effect of mini-screw supported AMDA ® on the correction of class II malocclusion considering the mean upper molar cusp before intervention was 29.74 mm vs. 27.33 mm after and the standard deviation for the difference (distal tooth movement for cusp) was 1.27 mm. Applying an estimated effect size (Cohen's d for paired sample, 1982) of 1.9 at 5% level of significance to achieve 80% power of the study. While considering the mean upper molar root before intervention was 28.51 mm vs. 27.17 mm after and the standard deviation for the difference (distal tooth movement for root) was 0.95 mm, the sample size required was 7 participants applying an estimated effect size of 1.4 at 5% level of significance to achieve 80% power of the study. The upper molar measures and the assumed distal tooth movement among class II malocclusion cases applied in the above calculations had been reported by Yamada et al., 2009 (10) Calculated using "pwr" package in R software version 4.2.2 "Innocent and Trusting". Sample size was increased to 10 to compensate for any non-compliant participants and dropouts.

- Participants who agreed to participate were given a full detailed explanation of the study before any procedure.
- An informed consent was signed by the participants before their enrollment in the study in which the aim of the study and the methodology were clearly described

A panoramic radiograph was taken to detect stage of eruption & position of second molars (Fig. 1). Intraoral and extraoral photos (Fig. 2) and lateral cephalometric radiographs (Fig. 3) were obtained before the treatment.

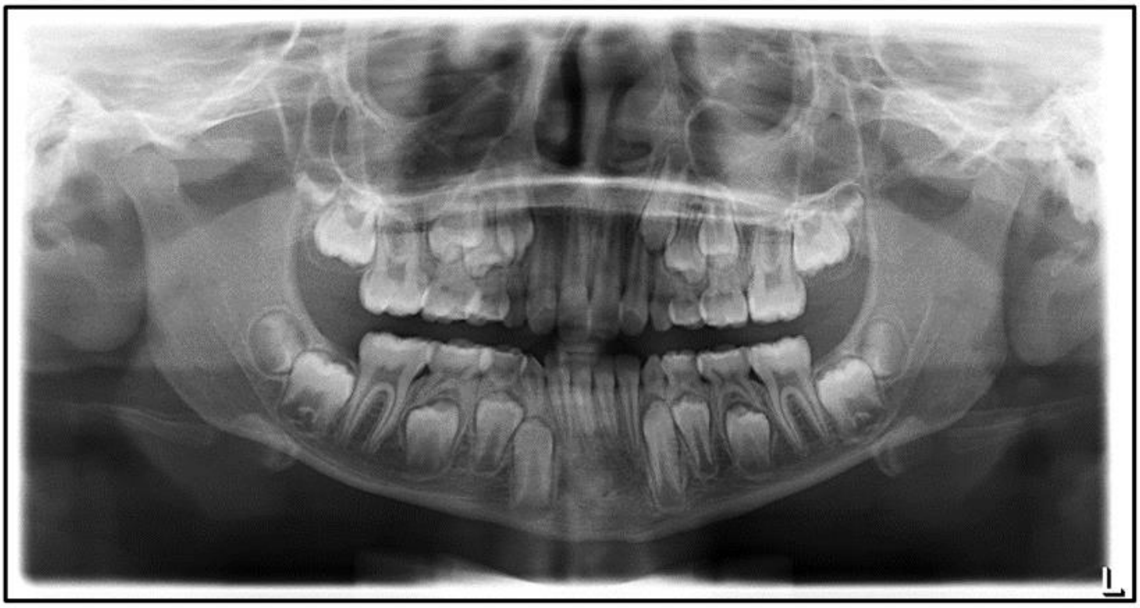

Figure 1: panoramic radiograph.

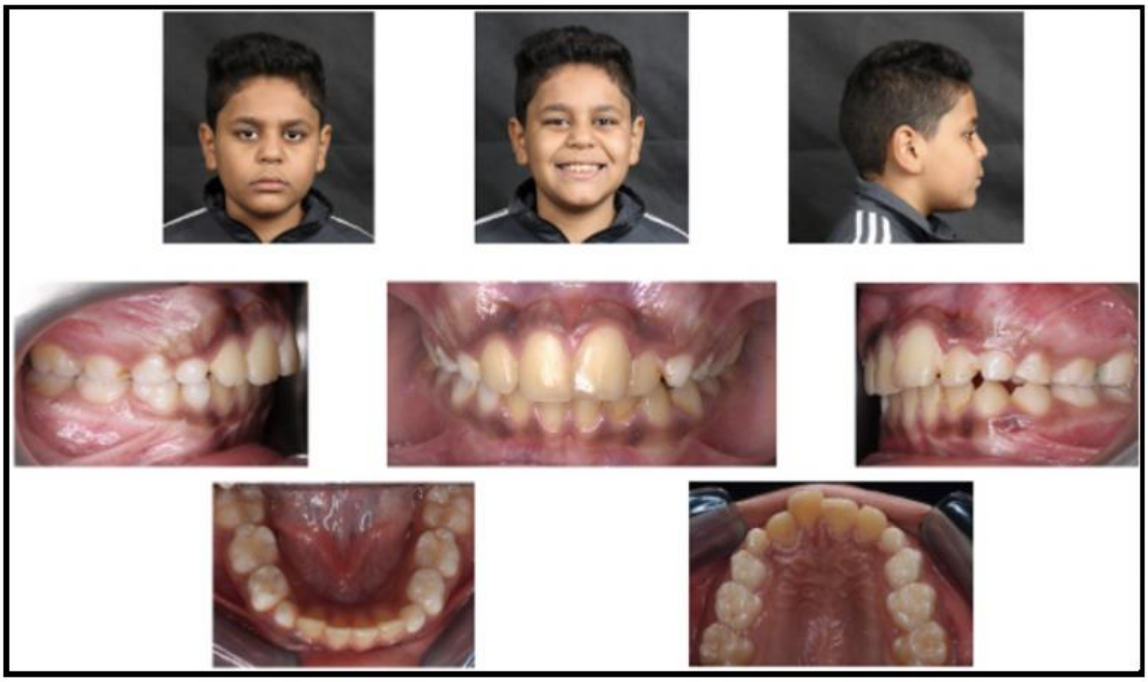

Figure 2: Intraoral and Extraoral photos.

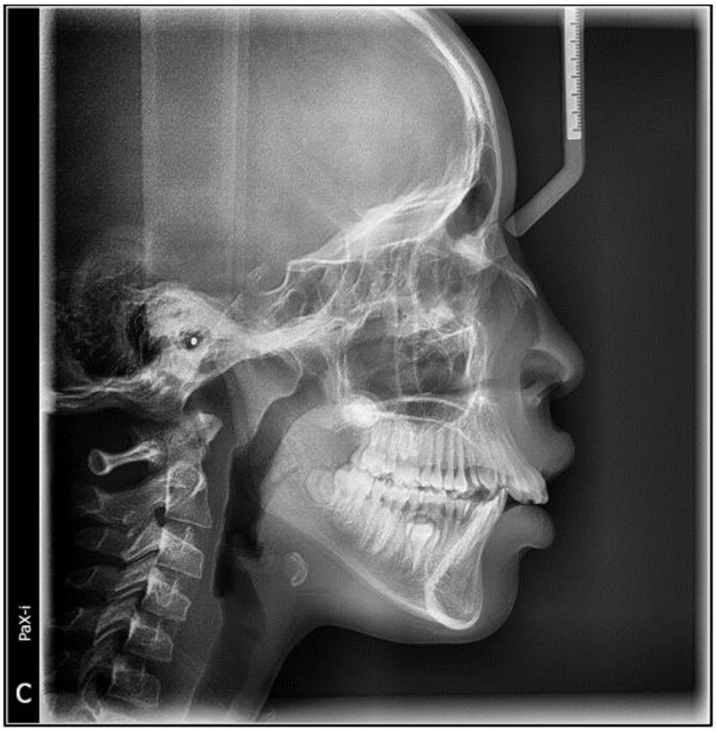

Figure 3: lateral cephalometric radiograph.

1. Mini-screw implant aided AMDA ® appliance, using two tomas[1] miniscrews, 1.6 in diameter and 8 mm length, were used for bilateral distalization of maxillary first molars.

2. Each AMDA ® appliance was fabricated and activated as previously described by Papadopoulos (12).

3. The patients were instructed to rinse with a 0.02% chlorohexidine solution to reduce bacterial count in the mouth thereby reducing risk of infection.

4. After molar distalization was achieved, the same records were taken (fig. 4).

[1] DENTAURUM, GmbH & Co. KG, Turnstarbe 31, 75228 Ispringen, Germany.

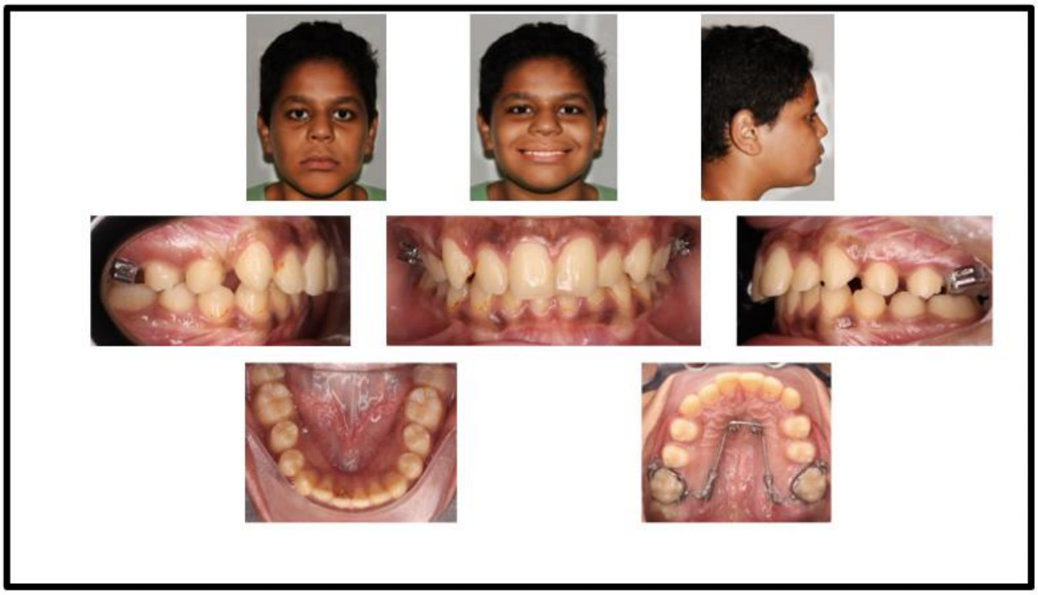

Figure 4: Intraoral and Extraoral photos.

Results

Statistical analysis was performed with SPSS 20®[2], Graph Pad Prism®[3] and Microsoft Excel 2016 [4] . All quantitative data were presented as minimum, maximum, means and standard deviation (SD) values.

Interobserver and Intraobserver reliability (Inter Class Coefficient) was used to evaluate the agreement between 2 observers and revealed excellent agreement (α = >0.9) in all measurements. Digital lateral cephalometric radiographs were taken before pre-treatment (T1) and after the achievement of Class I relationship (T2). Skeletal analysis was done using Dolphin version 11.5 [5] software. all participants were assessed regarding the following measurements; SNA, SNB, ANB, PP/SN, MP/SN, facial height.

Comparison between pre and post angular and linear skeletal measurements were performed by using Paired t test. There was insignificant change in all measurements with P value > 0.05, In SNA: there was insignificant increase by 0.31 ± 1.52, In SNB: there was insignificant increase by 0.91 ± 2.79, In ANB: there was insignificant decrease by -0.61 ± 3.00, In PP/SN: there was insignificant increase by 0.42 ± 3.51. For MP/SN: there was insignificant increase by 0.67± 3.94. (Table 1) Furthermore, the PFH/AFH ratio was insignificantly decreased by -0.06 ± 2.86, while LAFH/AFH ratio was insignificantly increased by 0.06 ± 1.82. (Table 2)

[2] *Statistical Package for Social Science, IBM, USA.*

[3] Graph Pad Technologies, USA

[4] *Microsoft Co-operation, USA*

[5] Dolphin Imaging and Management Solutions, Chatsworth, Calif. USA.

Table (1): Comparison between pre and post angular skeletal using Paired t test.

Angular Skeletal measurements		Minimum	Maximum	Mean	Standard Deviation	Paired Differences					
						Mean difference	Standard deviation	Std. Error Mean	95% Confidence Interval of the Difference		P value
									Lower	Upper	
SNA	Pre	77.10	87.60	82.28	3.48	0.31	1.52	0.44	-0.66	1.27	0.50
	Post	76.10	89.30	82.58	4.03						
SNB	Pre	72.00	80.20	75.23	2.62	0.91	2.79	0.81	-0.87	2.68	0.28
	Post	67.70	82.80	76.14	4.66						
ANB	Pre	4.60	9.90	7.03	1.99	-0.61	3.00	0.87	-2.52	1.30	0.50
	Post	1.30	10.40	6.42	2.92						
PP/SN	Pre	.60	13.10	8.03	3.76	0.42	3.51	1.01	-1.82	2.65	0.69
	Post	-4.80	17.50	8.45	6.27						
MP/SN	Pre	32.00	49.00	38.25	4.52	0.67	3.94	1.14	-1.84	3.17	0.57
	Post	29.00	51.00	38.92	7.09						

Significant difference as $P<0.05$

Table (2): Comparison between pre and post linear skeletal using Paired t test.

Linear Skeletal measurements		Minimum	Maximum	Mean	Standard Deviation	Paired Differences					
						Mean difference	Standard deviation	Std. Error Mean	95% Confidence Interval of the Difference		P value
									Lower	Upper	
PFH/AFH Ratio	Pre	52.80	65.90	62.23	4.03	-0.06	2.86	0.83	-1.88	1.76	0.94
	Post	53.70	70.60	62.18	4.92						
LAFH/AFH Ratio	Pre	54.50	61.00	57.28	1.88	0.06	1.82	0.52	-1.10	1.21	0.91
	Post	53.30	63.30	57.34	2.57						

Significant difference as $P<0.05$

Discussion

Class II malocclusion is frequently observed in patients who seek orthodontic treatment (2). Treatment modalities of patients with mild to moderate class II malocclusion is controversial. Molar distalization is one of the most common non-extraction treatment modalities in patients with class II malocclusion. The ideal treatment of Class II malocclusions demands correction of molar relation into Class I molar relation which can be achieved by distalization of maxillary teeth. Patient cooperation with Headgears might compromise treatment efficiency. That's why we used AMDA® in this study as a non-compliance intraoral distalization appliances developed by Papdopoulos (13).

This study investigates the skeletal effects of AMDA ® for Class II growing patients. All patients included were Class II growing patient in the mixed and early permanent dentition with half unit class II molar relation requiring bilateral maxillary molar distalization. Patient with severe skeletal discrepancy indicated for surgical treatment or patient with severe crowding indicated for extraction treatment were not included in this study. Since most distalization appliances cause molar extrusion, therefore patients were selected having normal or low mandibular plane angle. Vertical growing patients were not included to avoid further downward and backward mandible rotation as well as patients with shallow overbite to avoid adversely affecting the overbite by distalization (14).

Cephalometric radiographs were used to evaluate the skeletal, changes using Dolphin software which is a reliable and valid software providing accurate measurements (15). For the sake of integrity, all study procedures were carried out by the same trained orthodontist and all appliances were fabricated by the same orthodontic laboratory.

The appliance design provided a wide range of distalizing force with maximum 350 gm with full compression of coil spring. Also, force application with Ni-Ti closed coil springs provided continuous force level in-between visits. Additionally, the coil spring was built in inside housing so it was more hygienic preventing food accumulation and breakage. The appliance also can be used either unilateral or bilateral (13).

Bands were fitted and welded with special lingual sheaths, specially designed for AMDA ®. Palatal placement of miniscrews was the preferred choice of insertion in this study due to adequate bone density and reducing the risk of damage to anatomic structures such as dental roots, nerves, and blood vessels. Therefore, two palatal paramedian Tomas miniscrews[6] (1.6 x 8 mm) were inserted at third rugae area that is widely preferred than inter-radicular sites to avoid root injury (16).

Regarding the skeletal changes, AMDA ® showed insignificant changes in all following measurements SNA, SNB, ANB, PP/SN, MP/SN, and facial height. Our results agreed with **Park et al**, who reported that buccal miniscrew assisted distalization resulted insignificant changes in PP/SN and facial height but maxilla showed significant forward growth as the mean age of the patient was 17.9 ± 5.7 so some of patient were growers (17). Additionally, **Gelgor et al** reported that there were no significant changes regarding the maxillary and mandibular arch (14).

The study introduced by **Khaled et al**, the results agreed with ours regarding SNA, SNB, and ANB. However, their results showed significant increase in mandibular plane angle. (18) The study introduced by **Yamada et al**, showed there were insignificant changes in SNA and mandibular plane rotation (10). **Kinzinger et al** reported that distalization by skeletonized distal jet resulted insignificant changes in the mandibular plane angle (19).

Sar et al reported that implant supported distalizers resulted statistically

[6] Dentaurum GmbH & Co. KG; Turnstabe 31, 75228 Ispringen, Germany

insignificant changes in SNA, SNB, and mandibular plane angle (20). On the other hand, **Kircali et al** reported that pendulum miniscrews assisted distalization resulted statistically significant increase in SNA and SNB angles with significant reduction in mandibular plane angle (21). The patients were growers so the changes most properly returned to the growth potential. **Kinzinger et al** reported that distalization by skeletonized pendulum K resulted insignificant changes in maxillary arch, mandibular arch, facial height and mandibular plane angle (22).

Our results provided that AMDA ® cannot be used for skeletal class II malocclusion correction so cannot be replace the orthopedic appliance such headgear, only correct the dental relationship by maxillary molar distalization. In addition, mandibular plane rotation and the facial height were not increased by molar distalization in contrast to many other distalizers as molar distal drifting cause mandibular plane rotation increasing the anterior facial height with bite opening “molar acts as a fulcrum”. This might be due to the age of the sample as the patients were growers so the ramal compensation might be happen preserving the facial ratio and the bite.

Conclusions

1- AMDA ® distalizer has not skeletal effects, so cannot replace the orthopedic appliance.

Recommendations

- Future studies are recommended for TMJ assessment with CBCT post distalization
- Follow up the patients for long-term is required is required to evaluate the stability of the cases treated via molar distalization

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