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DENTOSKELETAL CHANGES DURING MAXILLARY MOLAR DISTALIZATION USING A SKELETALLY ANCHORED APPLIANCE

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ABSTRACT

Objectives: The objective of the current trial was to assess the dentoskeletal changes during maxillary molar distalization using a skeletally anchored distal jet (SADJ). **Subjects and methods:** A prospective clinical trial was carried out to contrast the predistalization and postdistalization cephalograms of 10 patients (4 males, 6 females) (The average age at the beginning of therapy was 15.61±1.03 years) requiring bilateral molar distalization with SADJ and randomly selected from the orthodontic department's outpatient clinic at Al-Azhar University (Boys), Cairo, Egypt's Faculty of Dental Medicine. **Results:** The trial verified that the device is appropriate for translatory molar distalization (2.9 ± 0.53 mm). The anchoring unit, which consists of two anchorage teeth and two mini-screws, absorbed the majority of the forces operating reciprocally on the anchorage setup. Considerable anchoring loss shown as 0.94± 0.78 mm of first premolar mesialization and central incisors protrusion of 0.83± 0.32 mm were found. **Conclusion:** Upper molar distalization using a skeletally anchored device, such as the distal jet and palatal miniscrews, is a practical and effective method of treating the Class II malocclusion. The skeletally anchored device distal jet can produce a sufficient amount of molar distalization, with minimal effects on the anterior teeth.

KEYWORDS: Mini-screw supported distalizer, Upper molar distalization, molar rotation

INTRODUCTION

Class II malocclusion is the most common type of malocclusion, affecting roughly 15% to 25% of the population. [1]. It is characterized by an excessive overjet and a distal relationship of the mandibular teeth to the upper teeth, which can cause functional, aesthetic, and psychosocial problems [2]. The management of malocclusion in Class II depends on the etiology and severity of the condition, as well as the patient's age, growth potential, and preference. Some of the treatment options include orthodontic camouflage, orthopedic correction, orthognathic surgery, and maxillary molar distalization [3].

Maxillary molar distalization is a non-extraction treatment modality that aims to move the maxillary molars distally in the arch in order to restore the Class II molar relationship [4]. This can create clearance so that the anterior teeth can align, reduce the overjet, and improve the occlusion and facial profile [5]. However, conventional methods of molar distalization, such as headgear or intraoral appliances, often require patient adherence and

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may cause unwanted adverse reactions, including anchorage loss, incisors protrusion, and soft tissue changes [6]. To overcome these limitations, skeletally anchored appliances have been developed, which use temporary anchorage devices (TADs) to provide stable and direct anchorage for molar distalization.

One of the most popular skeletally anchored appliances is the distal jet, which consists of a palatal acrylic plate with two distal extension arms that are attached to 2 mini-screws that were placed within the palatal alveolar bone [7]. The distal jet can produce a continuous distal force on the maxillary molars without relying on patient cooperation or affecting the anterior teeth. Several research has assessed the dentoskeletal alterations induced through upper molar distalization using the distal jet and palatal mini-screws, and reported favorable results in terms of molar movement, anchorage preservation, and occlusal improvement [8-11].

The present trial aims to review the effects of palatal mini-screws and distal jet, two skeletally attached devices that are used to manage Class II malocclusion, on the skeleton and teeth. The essay will also discuss the advantages and disadvantages of this appliance, as well as the clinical implications and recommendations for its use.

SUBJECTS AND METHODS

Study design:

The present clinical prospective study was carried out on 10 patients. They were chosen from a large pool of patients attending the orthodontic department's outpatient clinic at Al-Azhar University (Boys), Cairo, Egypt's Faculty of Dental Medicine.

Sample size calculation:

Considering the earlier clinical trial [12] and using statistical software, a sample size computation was performed depending on the predetermined variables: 80% power, unpaired t-test, and significance level (alpha) ≤ 0.05 (two-tailed). The anticipated least number of samples of 8 patients was sufficient with the power of 80% and use a significance threshold of 5% to find a clinically meaningful variance. In order to account for potential participant dropouts during the study period, it was decided to raise the sample size to 10 patients.

Eligibility criteria:

Inclusion criteria:

The subsequent parameters were used in the choice of patients: 14-17 years old. Every permanent tooth is present (excluding the wisdom molar). Bilateral dental Class II malocclusion. Skeletal Class I or mild Class II relationship. Typical or lowered vertical face length. Absence of gaps or crowding in the posterior. Lack of underlying illnesses or ailments that may impede orthodontic tooth movement. No prior orthodontic therapy. Maintaining dental health.

Exclusion criteria:

The participants were not included in the study if they have: Skeletal discrepancies which require orthognathic surgery. Congenital abnormalities of the dentoskeleton. Missed or badly decayed teeth in the upper arch.

Ethical considerations:

An informed permission statement was authorized by every participant and/or their parents before starting therapy. Ethics Committee, Faculty of Dental Medicine (Boys), Al-Azhar University, Cairo, Egypt approved the treatment (ethically accepted with code 647/1760).

Periodontal prophylaxis and patient's instructions:

Scaling and gingival therapy were among the extensive prophylactic treatments that every trial participant had in an effort to as closely match every participant's prior treatment periodontal state as feasible. Every participant also received a document with instructions for at-home care and all of them were given a month to evaluate the patient's desire and outlook regarding home care processes by enrolling them in a home care programme prior to beginning therapy.

Interventions:

Skeletally anchored Distal Jet molar distalizing appliance (SADJ):

Appliance Fabrication:

Four solder connections were made at the first premolar and first molar bands on the one-unit appliance that was constructed. 1 mm away distally to the third section of the rugae, 3 mm away laterally to the midpalatal raphe an 3mm beyond the palatal mucosa, microimplant insertion slots were performed. The insertion slot was wire fabricated in helix form 2 mm diameter. Ultimately, the device was cleaned, polished, and finished and became ready for delivery.

Appliance insertion:

The elastomeric separators were removed using a sharp explorer. The teeth were polished, rinsed and dried. Then, the device was tested and checked-in for any technical problem, soft tissue impingement or occlusal interference. The appliance was removed, washed and dried. Teeth were dried and kept dry using cotton rolls placed within the mucobuccal folds and against the openings of salivary gland ducts for isolation. After that, glass ionomer cement (Medicem, Germany) was used to facilitate dry field cementation of the device. Following the initial setting, extra cement was scraped off with a sharp dental scailer. Local anaeshtia (Artinibsa, 40mg/0.01mg/ml., Spain): Palatal infiltration near the placement site. Betadine antiseptic topical application, spitting without rinsing. Two micro-implants (OAS-T1511, Biomaterials Korea Inc. Company) (Each implant is 1.8mm in diameter and 11mm in length) installed into the (2mm diameter) insertion slot to be oriented away from the nearby teeth's roots and perpendicular to the palate figure (1- a and b).

Active molar distalization:

A total of 240 gms of force was obtained at both sides when the 240 gms NiTi springs were completely encased [12]. The experimentation began at that point (T0).

Participants were presented in each 4 weeks to have the springs reactivated. The identical activation procedure was used on both sides to guarantee an identical force.

Study measurements and data collection:

The subsequent characteristics were evaluated to find alterations in the cephalograms obtained at T1 (predistalization) and T2 (post distalization).

1. SNA: the angle formed by the maxilla's ventral concavity's lowest level and the anterior cranial base.
2. SNB: the angle formed by the mandible's ventral concavity's lowest position and anterior cranial base.
3. MP(cGoMe)-PP: the angle formed by the mandibular plane and the palatal plane.
4. Bjork's summation angle: the sum of the saddle angle (N-S-Ar), the articular angle (S-Ar-Go), and the gonial angle (Ar-Go-Me).
5. PFH/AFH%: The proportion of facial heights, measured from posterior to anterior.
6. U1-CEJ/PTV: the distance between the upper central incisor to the pterygoid vertical.
7. U4-CEJ/PTV: the distance between the upper first premolar to the pterygoid vertical.
8. U5-CEJ/PTV, the distance between the upper second premolar to the pterygoid vertical.
9. U6-CEJ/PTV: the distance between the upper first molar to the pterygoid vertical.
10. U1/SN: the angle formed by the upper central incisor and the anterior cranial base.

11. U4/SN: the angle formed by the upper first premolar and the anterior cranial base.
12. U5/SN: the angle formed by the upper second premolar and the anterior cranial base.
13. U6/SN: the angle formed by the upper first molar and the anterior cranial base.
14. U1-CEJ/ANS-PNS: the distance between the upper central incisor to the palatal plane.
15. U4-CEJ/ANS-PNS, the distance between the upper first premolar to the palatal plane.
16. U5-CEJ/ANS-PNS: the distance between the upper second premolar to the palatal plane.
17. U6-CEJ/ANS-PNS: the distance between the upper first molar to the palatal plane.

To confirm any skeletal alterations, measurements or computations of SNA, SNB, MP(cGoMe)-PP, Bjork's summation angle, and the face proportion of height were made.

The relative second premolar and first molar distal movement in respect to the pterygoid vertical (U1-CEJ/PTV, U4-CEJ/PTV, U5-CEJ/PTV, and U6-CEJ/PTV) and the relative incisor and first premolar mesial movement, which resulted in the anchoring loss, were measured in the sagittal plane. On the longitudinal plane of the teeth, the cemento-enamel junction (CEJ) served as the appropriate point of reference for the assessments. Alteration brought about by growth (an increase of 1 mm for a year) were considered.

The angles formed by the longitudinal tooth axis and the anterior cranial base (U1/SN, U4/SN, U5/SN, U6/SN) were used to calculate the quantities of labial tipping of the incisors and first premolars and distal tipping of the second premolars and first molars. In the palatal plane, possible dental intrusions and extrusions were confirmed (U1-CEJ/ANS-PNS, U4-CEJ/ ANS-PNS, U5-CEJ/ANS-PNS, and U6-CEJ/ANSPNS).

Statistical analysis

Data management and statistical analysis were carried out utilizing the Statistical Package for Social Sciences (SPSS) edition 20. The mean, standard deviation, median, and range were used for summarizing the numerical information. Every p-value has two sides. P-values ≤0.05 were regarded as significant.

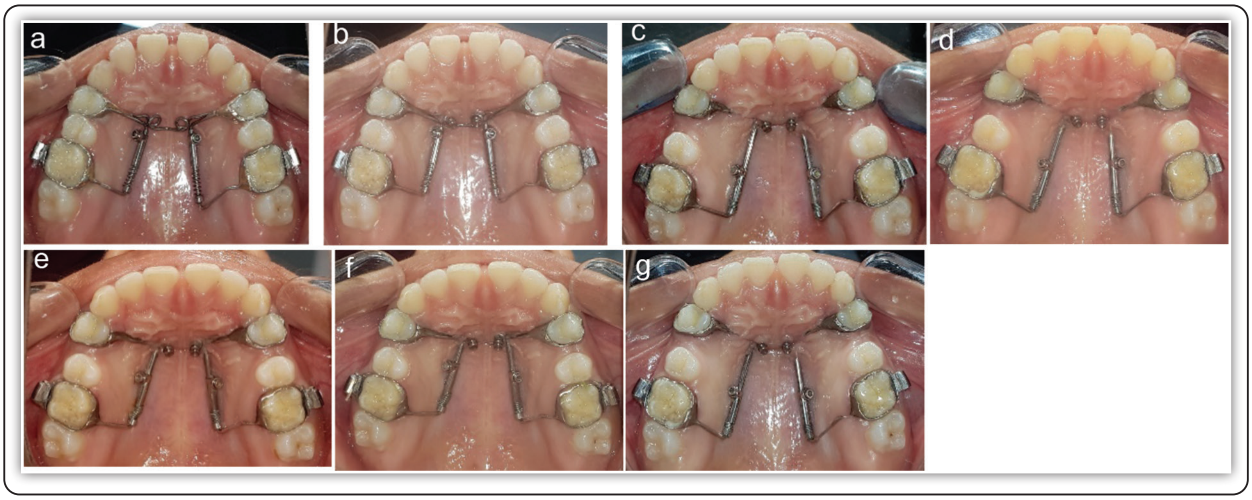

FIG (1) a-Distal jet without miniscrew, b- Distal jet with miniscrew, c-After 4 weeks distalization, d-After 8 weeks distalization, e-After 12 weeks distalization, f-After 16 weeks distalization, g-After 20 weeks distalization.

RESULTS

The cranial base remained steady, according to skeletal examinations, despite just median 0.08^0 and median 0.49^0 variations in the SNA and SNB angles, respectively. There was almost little alteration in the palatal plane's location in reference to the mandibular plane. During molar distalization, Bjork's summation angle altered by just 0.28^0 and the facial proportion of height by 0.55%. During therapy, no discernible alterations in the skeleton were seen (Table I).

The first molars were distalized by 2.9± 0.53 mm and intruded by 0.1 ± 0.26 mm in the CEJ region. Meanwhile, they also suffered 0.8± 0.51^0 distal tilting with respect to the anterior cranial base. Not included in the anchoring arrangement, the second premolars moved 1.61± 0.74 mm distally following the molars, intruded 0.39± 0.41 mm, and mesially tipped in reference to the anterior cranial base by 0.39± 0.69^0. Integrated in the anchoring arrangement, the first premolars mesially tipped 1.36± 1.98^0 in reference to the anterior cranial base, intruded by 1± 0.14 mm, and mesialized by 0.94± 0.78 mm. The central incisors had a modest labial tilting of 0.64± 0.79 in reference to the anterior cranial base, protruding by 0.83± 0.32 mm and extruding by 0.93± 0.29 mm. Every tooth movement that was linear with respect to the pterygoid vertical was significant, the intrusion of the first molars and second premolars were non-significant, the intrusion of the first premolars was significant, the extrusion of the incisors was non-significant, and the angular teeth position alterations of the first and second premolars, first molars and incisors were non-significant (Table II).

TABLE (I) Linear and angular skeletons evaluations:

Cephalometric analysis	n	Predistalization		Post distalization		T-value	P-value	Sig.
		mean	SD	mean	SD			
Skeletal angular								
SNA (˚)	10	81.17	2.59	81.25	2.25	0.54	0.78	NS
SNB (˚)	10	74.55	2.16	75.04	2.63	0.59	0.33	NS
MP(cGoMe)-PP(˚)	10	24.25	4.70	24.11	4.93	1.51	0.82	NS
Bjork Sum (cGo) (˚)	10	395.18	3.46	394.90	3.60	0.71	0.18	NS
Skeletal linear								
PFH/AFH%	10	62.18	2.60	61.63	2.35	1.56	0.25	NS

TABLE (II) Linear and angular dental evaluations:

Cephalometric analysis	n	Predistalization		Post distalization		T-value	P-value	Sig.
		mean	SD	mean	SD			
Dental angular								
U6/SN(˚)	10	77.30	6.84	76.50	5.48	7.05	0.78	NS
U5/SN(˚)	10	79.68	4.82	80.07	5.36	3.99	0.84	NS
U4/SN(˚)	10	85.75	4.53	87.11	4.78	6.24	0.70	NS
U1/SN(˚)	10	101.86	5.28	102.50	5.45	2.60	0.30	NS
Dental linear								
U6-CEJ/PTV mm	10	17.94	2.71	15.04	2.27	1.75	0.03	S
U5-CEJ/PTV mm	10	27.62	3.25	26.01	2.06	2.59	0.04	S
U4-CEJ/PTV mm	10	34.05	3.16	34.99	3.43	0.18	0.05	S
U1-CEJ/PTV mm	10	46.42	4.19	47.25	3.95	1.42	0.04	S
U6-CEJ/ANS-PNS mm	10	14.50	2.02	14.40	2.20	1.47	0.10	NS
U5-CEJ/ANS-PNS mm	10	17.70	2.27	17.31	1.66	1.82	0.55	NS
U4-CEJ/ANS-PNS mm	10	18.58	2.27	17.58	1.92	2.66	0.05	S
U1-CEJ/ANS-PNS mm	10	18.66	2.71	19.59	2.66	0.87	0.27	NS

DISCUSSION

Maxillary molar distalization is a common management choice for Class II malocclusion, which is characterized by an excessive overjet and a distal connection between the lower and upper teeth. However, conventional methods of molar distalization, such as headgear or intraoral appliances, often require patient adherence and may cause unwanted adverse reactions, including anchorage loss, incisors protrusion, and soft tissue changes. To overcome these limitations, skeletally anchored appliances have been developed, which use temporary anchorage devices (TADs) to provide stable and direct anchorage for molar distalization. One of the most popular skeletally anchored appliances is the distal jet, which consists of a palatal acrylic plate with two distal extension arms that are attached to 2 mini-screws that were placed within the palatal alveolar bone. The distal jet can produce a continuous distal force on the maxillary molars without relying on patient cooperation or affecting the anterior teeth [13-15].

Several research has assessed the dentoskeletal alterations induced through upper molar distalization using the distal jet and palatal miniscrews. A systematic review by Anraki et al. [16] displayed that the distal jet can achieve a mean of 3.5 mm of molar distalization, with a distal tipping of 9.5° and an intrusion of 1.5 mm. The authors also reported that the distal jet had minimal effects on the maxillary incisors, premolars, and soft tissues, compared to other intraoral distalizers. However, they noted that the distal jet may cause some adverse effects on the maxillary transverse dimension, such as a decrease in the intermolar width and an increase in the palatal vault height.

Another study by Villanova et al. (17) used three-dimensional imaging to assess the changes after maxillary molar distalization using the distal jet and palatal miniscrews. The authors found that the distal jet generated a notable distal movement of the upper first premolar and first and second molars, with a progressive increase from the anterior to the posterior teeth. They also observed a small intrusion and distal rotation of the first molar, and an increase in the intermolar distance at the mesiobuccal cusps. The authors concluded that the distal jet was effective for maxillary molar distalization and suggested that the appliance design could be modified to reduce the distal rotation and increase the bodily movement of the molars.

A recent study by Grec et al. (9) compared the consequences of molar distalization on the skeleton and teeth utilizing a modified distal jet and a modified pendulum appliance, both supported by palatal miniscrews. The authors found that both appliances achieved similar amounts of molar distalization, with an average of 4.3 mm and 4.2 mm, correspondingly. However, the modified distal jet showed less distal tipping and more intrusion of the molars than the modified pendulum. The authors also reported that both appliances had no significant effects on the connections between the sagittal and vertical skeletons, the upper incisors, or the soft tissues.

CONCLUSION

In conclusion, upper molar distalization with a skeletally anchored device, such as the distal jet and palatal miniscrews, is a practical and effective method of treating the Class II malocclusion. The distal jet can produce a sufficient amount of molar distalization, with minimal effects on the anterior teeth. However, the appliance may also cause some unwanted changes in the maxillary molar angulation, which may require further adjustments or corrections. Therefore, careful diagnosis, planning, and monitoring are essential for achieving optimal results with this appliance.

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