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Evaluation Treatment Outcomes of Anterior Open Bite Treated with Maxillary Intrusive Force by Temporary Anchorage Devices

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ORIGINAL STUDY

Evaluation Treatment Outcomes of Anterior Open Bite Treated With Maxillary Intrusive Force by Temporary Anchorage Devices

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Abstract

Purpose: This study was conducted to assess anterior open bite correction in orthodontic patients by intrusive force on upper posterior teeth using temporary anchorage devices. **Patients and methods:** The present study was carried-out on 10 orthodontic patients (females) with two dropped out, they aged from 15 to 18 years with mild to moderate anterior open bite and indicated for maxillary posterior dentoalveolar intrusion, each patient received six temporary anchorage devices (three each side) connected to upper segmented fixed appliance and 200 g intrusive force was applied, The following parameters were measured from cone-beam tomography: volumetric root length, amount of intrusion and amount of open bite closure reading. **Results:** The results showed a highly statistically significant posterior teeth intrusion with decrease on amount of open bite, and all examined roots showed decrease volumetric root length. **Conclusions:** In the present study, intrusion by temporary anchorage device is an effective solution concerning open bite correction.

Keywords: Anterior open-bite, Cone beam computed tomography, Intrusion, Temporary anchorage devices

1. Introduction

Without correct diagnosis, identification, as well as removal of etiologic variables, treatment stability of anterior open bite (AOB) would have a poor prognosis, making it one of the most challenging malocclusions to manage orthodontically. Treatment for AOB might range from monitoring or easy control to a major surgical operation, therefore these factors should be taken into account while planning treatment [1,2].

The expression 'open bite' was first used in 1842 to describe a specific type of malocclusion; it has since been described in several ways. Open bite, or a tendency towards open bite, has been characterized by some authors as the absence of incisal contact among the anterior teeth in centric relation. While it is possible to treat AOB in children and adults by obstructing the eruption of the back teeth utilizing orthopedic functional appliances, treating AOB in adults is much more difficult and may include molar intrusion, incisor extrusion, or both, as well as surgery in severe cases [3,4].

Treatment options for AOB include intrusion of the posterior teeth. The methods used with adults and adolescents are different. Aside from intruding the molars, the primary function of the vertical forces exerted against them in developing patients is to regulate the rate of their vertical eruption [5–7].

The real intrusion of molar teeth is required to allow the mandible to auto-rotate and eventually seal the open bite anteriorly among adults or nongrowing patients without vertical compensation of ramus development. Jaw geometry indicates that an open bite of about 2 mm in the anterior region is the result of an intrusion of 1 mm in the posterior region [5].

As this is one of the difficult cases of malocclusion to be treated. In such situations, maxillary posterior segment intrusion getting support by miniscrews has been shown to be a successful beneficial option,

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with outcomes on par with those of traditional surgery. However, root resorption along with the other negative consequences of intrusion of the posterior teeth were not thoroughly studied [8,9].

So, the purpose of this study was to assess treatment outcome of AOB with intrusive maxillary force by TADs.

2. Patients and methods

2.1. Participants

The study got ethical approval (REC-OR-23-04) from the research ethical committee at Al-Azhar University, Cairo, Egypt. The study was registered in the Clinical Trials Registry of Egypt (NCT06147739). A minimum total sample size of 10 ± 2 participants was sufficient to detect the effect size of 0.9 (according to de Brito Vasconcelos, Juliana *et al.*), a power (1-β = 0.80) of 80% at a significance probability level of *P* less than 0.05. The sample size was calculated according to G*Power software version 3.1.9.3 [9]. It was carried-out primarily on who were recruited from the outpatient clinic of Orthodontic Department, Faculty of Dental Medicine, girls, Al-Azhar University, Cairo, Egypt. Prior to starting the study's activity, all patients who met the following criteria were told about the procedures and provided their written informed consent to participate. Patients between the ages of 15 and 18 who present with AOB have all of their permanent teeth erupted (except the third molars), have anterior open-bite because of part to posterior dento-alveolar excess without transverse disorders, have no craniofacial abnormalities, and are in good oral and general health. No prior orthodontic treatment, and no important medical history that could affect therapy.

If a patient had any of the following conditions, he was not included in the study: severe cases of AOB, particularly those that originate in the skeleton. Patients who are very uncooperative affect their ability to achieve treatment goals, two patients were dropped out of the present study. Thus, the remaining eight patients were used to assess whether or not the study goals had been met.

2.2. Preoperative

Each patient had an in-depth case history along with extraoral and intraoral examinations performed as part of a full diagnostic report (Fig. 1). In besides ensuring they fulfilled the inclusion criteria, we also took a detailed medical history from every patient to rule out any systemic disease which could impede orthodontic and possibly surgical operations. Then, regular four extraoral as well as five intraoral pictures, a panoramic radiograph, a standard lateral cephalometric radiography, as well as an orthodontic study model are all part of a patient's orthodontic documentation.

2.3. Research related records

To achieve the aim of the present study, for each patient, two cone beam computed tomography (CBCT) scans were conducted; one pre-intrusion (T1) as well as additional instantly following completion of intrusion (T2). The Planmeca ProMax 3d scanner was used to collect the CBCT pictures.

2.4. Operative procedures

2.4.1. Fixed orthodontic appliance

Each patient had a segmented, fixed appliance placed on the bilateral maxillary posterior segments (Fig. 2), which included the first and second premolars as well as molars (Direct bonding metal) orthometric roth with 0.22 sloth brackets were bonded by (3 M Unitek Transbond XT Light Cure Orthodontic Adhesive agent) to the first and second maxillary premolars only, and in the upper first[t] and second molar metal buccal tube bonded. Levelling and alignment was done until it reached 0.017 × 0.025-inch stainless-steel archwires. In palatal 0.017 × 0.025 inch stainless-steel arch wires attached to the palatal surfaces of the first and

Fig. 1. Intraoral photographs before treatment.

Fig. 2. TADs connected with segmented fixed appliance in AOB patient.

second maxillary molar and premolars by round eyelet orthodontic accessory, and connected to palatal miniscrews by a memory power chine [10,11].

Patients in this study were selected because they had normal incisor show during rest and when smiling, therefore a continuous arch would cause the incisor teeth to protrude. Instead, a segmented fixed appliance was utilized. It took some time for incisors to bond after the intrusion phase ended [12].

Then, six self drill mini-screws (TADs) (1.6 mm in diameter and 8 mm in length) manufactured from biocompatible pure titanium (Hubit made in Korea), were implanted for all patients bilaterally, for each side two buccally placed at the alveolar process of maxilla between maxillary first and second premolar and maxillary first and second permanent molar. Two palatal miniscrews inserted paramedially at the mesiopalatal angle apical to the first molar in the palatal side utilizing the suitable screwdriver. The palatal screws were placed perpendicular to the palatal shelf and 8–10 mm away from the gingival border [10,12].

Immediately load on was done after stability of mini-screws was examined [13], then intrusion was started using a memory power chine [14]. The overall intrusion force magnitude done on each side by the memory power chin was 200 g [12]. To ensure accurate force delivered, memory power chine changed every 2 weeks [11].

2.4.2. Cone beam computed tomography (CBCT) analysis

A CBCT scan was taken immediately before each patient received intrusion (T1) and again after intrusion was complete and normal overbite had been obtained (T2) so that findings could be analyzed with the greatest possible precision. The pre-operative CBCT data was uploaded into InvivoDental Application v.5.3.1 (Anatomage.Inc., San Jose, CA), which was then used for radiographic evaluation by registering the preintrusion CBCT plan onto the post-treatment CBCT findings. Frankfort Horizontal Plane, Vertical Planes is a new representation of each of the three orthogonal axes (Axial, Coronal, as well as Sagittal).

Additionally, the Sagittal Plane is also important. High-precision automatic volume-based registration is then used to perfectly superimpose pre- and postoperative images, with a reference point found for calculating roots resorption and intrusion depth (Fig. 3), after initial point-based registration has been performed, while lateral cephalometric image was extracted from CBCT to determine quantity change of open bite closure. Then the results were tabulated and statistically analyzed.

2.4.3. Finishing and retention

Once the posterior segment intrusion was finished and the study goals were achieved, full orthodontic

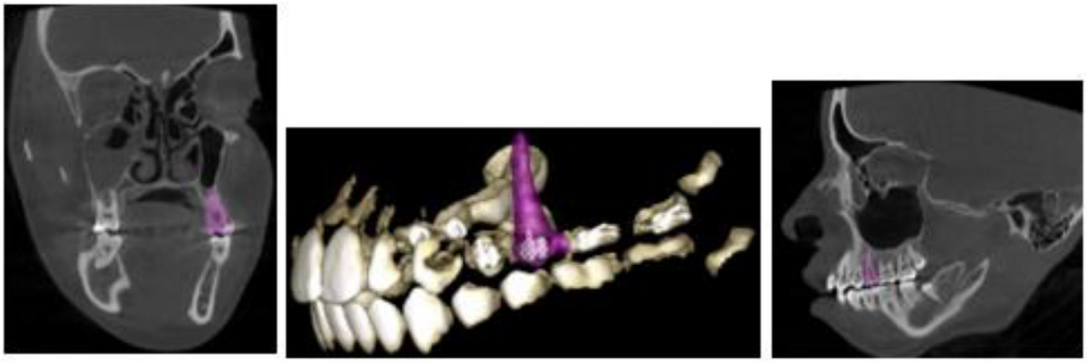

Fig. 3. Tooth length measurement to detect root resorption in the volumetric image.

treatment was carried out according to plan. A Hawley retainer containing a posterior bite plane was placed on the top arch, whereas bonded retainers were placed on the lower arch at the end of treatment.

3. Results

3.1. Volumetric root length (Table 1) (Fig. 3)

Paired *t*-test revealed that there was a highly statistically significantly lower mean value in post intrusion compared with preintrusion according to roots length in the right side and left side, with *P* value ($P < 0.05$). We used pre- and postintrusion CBCT scans to quantify root resorption as root lengths (from the top of the cusp to the base apex of every root of all posterior teeth on the two sides). To determine how much of the root had been resorbed throughout the intrusion phase, we used the value obtained after the intrusion and subtracted it from the previous value. After taking and recording the dimensions of each root, the data was combined for both the premolar and the molar roots, and then again for all intruded roots.

3.2. Amount of intrusion (Table 2) (Fig. 4)

The software was used to locate the molar trifurcation as well as the premolar center (the midpoint among the buccal top of the cusp along with the top of the premolar root), and then calculate the amount of maxillary teeth intrusion as a shift in perpendicular distance among the Frankfurt transverse plane as well as these two landmarks, as shown in (Table 2). There was a highly statistically significant lower mean value in postintrusion comparing to pre intrusion according to amount of intrusion of the right side and left side, with *P* value ($P < 0.001$).

3.3. Amount of anterior open bite closure (Fig. 5)

In AOB correction (Fig. 5) the result was 2.80 ± 0.26 mm SD decreased in the bite (Fig. 6), which is a highly statistically significant lower mean value in postintrusion compared with pre intrusion with P value ($P < 0.001$).

There was a highly statistically significant lower mean value in post intrusion comparing to pre intrusion according to roots resorption of the right side and left side, with *P* value ($P < 0.05$).

4. Discussion

Treatment and maintenance of AOB have historically been among the most difficult malocclusions. The treatment of anteroposterior discrepancies continues to generate more linkage than their vertical counterparts, even though it is indicated that vertical discrepancies need to be treated before anteroposterior ones. A combination of skeletal, dental, as well as soft-tissue abnormalities were considered to be the root cause of the AOB [15,16].

Table 1. Comparison among preintrusion as well as postintrusion change according to roots resorption.

Root desorption	Preintrusion	Postintrusion	Difference		*t*-test	*P* value
	Mean ± SD	Mean ± SD	MD ± SE	%		
Rt side						
Buccul root of upper right first premolar	20.38 ± 2.18	19.69 ± 2.40	−0.69 ± 0.17	−3.4	4.082	0.005*
Palatal root of upper right first premolar	20.23 ± 2.24	19.08 ± 2.73	−1.15 ± 0.24	−5.7	4.888	0.002*
Root of upper right second premolar	20.53 ± 2.31	19.70 ± 1.78	−0.82 ± 0.32	−4.0	2.547	0.038*
Mesio buccal root of upper right first molar	18.43 ± 1.02	17.74 ± 0.74	−0.69 ± 0.21	−3.7	3.329	0.013*
Disto buccul root of upper right first molar	18.70 ± 1.43	17.89 ± 1.21	−0.81 ± 0.15	−4.3	5.441	<0.001**
Palatal root of upper right first molar	19.60 ± 0.96	18.81 ± 0.98	−0.79 ± 0.20	−4.0	3.878	0.006*
Mesio-buccal root of upper right second molar	18.83 ± 0.54	18.11 ± 0.68	−0.71 ± 0.23	−3.8	3.105	0.017*
Disto-buccal root of upper right second molar	19.33 ± 1.19	17.93 ± 0.84	−1.40 ± 0.40	−7.2	3.516	0.010*
Palatal root of upper right second molar	19.50 ± 0.44	18.70 ± 0.79	−0.80 ± 0.21	−4.1	3.742	0.007*
LT side						
Buccul root of upper left first premolar	21.35 ± 2.44	20.26 ± 2.36	−1.09 ± 0.32	−5.1	3.382	0.012*
Palatal root of upper left first premolar	20.95 ± 2.78	19.63 ± 2.86	−1.33 ± 0.31	−6.3	4.309	0.004*
Root of upper left second premolar	20.80 ± 1.17	19.55 ± 1.47	−1.25 ± 0.15	−6.0	8.204	<0.001**
Mesio buccal root of upper left first molar	19.13 ± 1.32	17.88 ± 0.87	−1.25 ± 0.30	−6.5	4.209	0.004*
Disto buccal root of upper left first molar	17.86 ± 1.11	16.93 ± 1.03	−0.94 ± 0.16	−5.2	5.890	<0.001**
Palatal root of upper left first molar	19.23 ± 1.11	18.20 ± 1.48	−1.03 ± 0.17	−5.3	5.999	<0.001**
Mesio buccal root of upper left second molar	19.25 ± 0.59	18.63 ± 0.94	−0.63 ± 0.18	−3.2	3.491	0.010*
Disto buccal root of upper left second molar	19.21 ± 0.87	18.08 ± 0.63	−1.14 ± 0.26	−5.9	4.426	0.003*
Palatal root of upper left second molar	20.15 ± 0.97	19.05 ± 0.51	−1.10 ± 0.34	−5.5	3.234	0.014*

Data are expressed as mean ± SD; SE: standard error using: Paired sample *t*-test.
P value greater than 0.05 is insignificant; **P* value less than 0.05 is significant; ***P* value less than 0.001 is highly significant.

Table 2. Comparison among preintrusion as well as postintrusion change according to amount of intrusion.

Amount of intrusion	Preintrusion	Postintrusion	Difference	%	*t*-test	*P* value
	Mean ± SD	Mean ± SD	MD ± SE			
Rt side						
Upper right second molar	31.77 ± 2.76	30.49 ± 2.37	−1.28 ± 0.20	−4.0	6.414	<0.001**
Upper right first molar	35.09 ± 3.10	33.32 ± 2.50	−1.78 ± 0.28	−5.1	6.324	<0.001**
Upper right second premolar	36.43 ± 3.03	35.05 ± 2.86	−1.38 ± 0.22	−3.8	6.291	<0.001**
Upper right first premolar	37.55 ± 2.78	36.36 ± 2.47	−1.19 ± 0.29	−3.2	4.044	0.005*
Lt side						
Upper left second molar	30.91 ± 3.09	29.43 ± 2.95	−1.49 ± 0.14	−4.8	10.668	<0.001**
Upper left first molar	34.01 ± 3.67	32.43 ± 3.43	−1.58 ± 0.23	−4.6	6.913	<0.001**
Upper left second premolar	35.84 ± 3.70	34.05 ± 3.50	−1.79 ± 0.32	−5.0	5.658	<0.001**
Upper left first premolar	37.10 ± 3.61	35.05 ± 3.06	−2.05 ± 0.30	−5.5	6.740	<0.001**

Data are expressed as Mean ± SD; SE: standard error using: paired sample *t*-test.
P value greater than 0.05 is insignificant; **P* value less than 0.05 is significant; ***P* value less than 0.001 is highly significant.

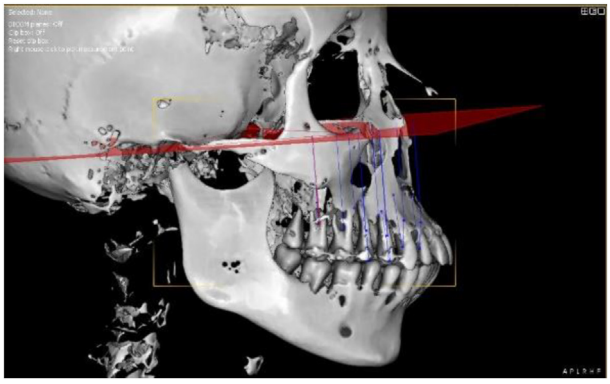

Fig. 4. Intrusion measurements on a cone beam computed tomography image: distance from the center of premolars or molar trifurcation to the Frankfurt horizontal plane.

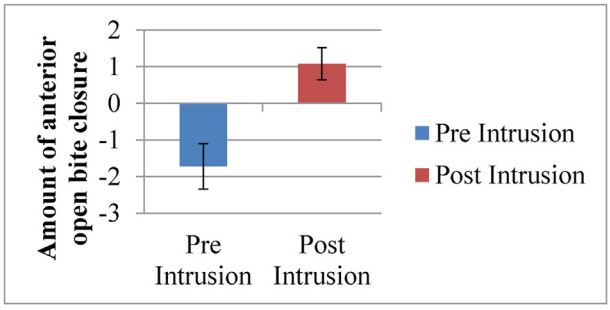

Fig. 5. Comparison among preintrusion as well as postintrusion change according to the amount of anterior open bite closure.

The AOB has been treated in a variety of ways. Among them was the posterior teeth intrusion. The long anterior facial height might be reduced through the autorotation of the mandible within a counter-clockwise direction, which is why molar intrusion was proposed as the optimal treatment [17–19].

The need for orthognathic surgery is not required, and alternative, less invasive treatments may be available. The patient's open bite would be closed by the new occlusal plane, mandibular plane, reduced anterior face height, as well as anterior dental overbite that would result from orthodontic intrusion of the patient's posterior teeth [9,20,21].

Furthermore, a variety of papers indicated that many of the treatment mechanisms aimed to address open bite were ineffective in rotating the mandible forward and causing additional condylar development and also had several disadvantages [22].

So, the present clinical study was conducted to evaluate the intrusion of the upper posterior segment by TADs in AOB treatment.

Among the most typical negative effects of orthodontics is root resorption. Many different types of tooth motion and dental tools have been linked to this phenomenon.

In the present study, according to this measurement value in Table 1, there was a highly statistically significant lower mean value in postintrusion compared with preintrusion of root length, this finding worth in agreement with Akel H *et al.* [10], who obtained a highly statistically significant *P* value when root subjected to 200 g of intrusion force, but did not agree with Crillo R *et al.* [23], and Daimaruya T *et al.* [24]. It showed that root resorption due to intrusion was very small at only around 0.1 mm utilizing force magnitudes of 50–200 g.

Also, the average amount of intrusion of maxillary permanent premolars and molars that was achieved according to results in Table 2, are in agreement with many studies [9,17]. However, most of these reports used only miniplates. Comparatively, Erverdi *et al.* [17] observed a mean maxillary molar intrusion of 2.6 mm in ten patients following a mean of 5.1 months, while Sherwood *et al.* [9] showed a mean upper molar intrusion of roughly 1.99 mm with intrusive pressures continuing for 5.5 months in four patients.

In the present CBCT study, a significant quantity of open bite correction of +2.8 ± 0.26 mm was

Fig. 6. Intraoral photographs after the anterior open bite has been closed.

detected. These findings agree with Akel H *et al.* [10] who obtained correction of AOB by 2.24 ± 1.18, but disagreed with Tamami Shino *et al.* [22], who used high-pull headgear and skeletal anchoring incursion to correct AOB by 4.6 and 5.5 mm, respectively, in growing participants.

4.1. Conclusion

Within the limitations and findings of the present study, it could be concluded that TADs are effective treatment choices of open bite correction. It is effective in producing proper skeletal and dental development of the upper posterior premolars and molars.

4.2. Recommendations

Further randomized clinical studies are needed with a larger sample size to evaluate any possible gender differences as well as the long-term stability of the present results.

Ethics information

The study got ethical approval (REC-OR-23-04) from the research ethical committee at Al-Azhar University, Cairo, Egypt.

Funding

No funding has been received.

Biographical information

This study was conducted at clinic of Orthodontic Department, Faculty of Dental Medicine for girls, Al-Azhar University, Cairo, Egypt.

Conflicts of interest

There are no conflicts of interest.

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