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Noncompliance Open-Bite Treatment with Zygomatic Anchorage

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ABSTRACT

Objective: To evaluate the dentoalveolar and skeletal effects of the new-generation open-bite appliance.

Subjects and Methods: The study group was composed of 11 subjects with a mean age of 19.5 years who underwent intrusion of the posterior dentoalveolar segment using an open-bite appliance supported by bilateral zygomatic implants. The study was carried out on lateral cephalograms of the subjects taken before treatment and after intrusion. The mean intrusion time was 9.6 months.

Results: The mean intrusion measured as the distance of the U6 to the palatal plane was 3.6 ± 1.4 mm ($P < .001$). This resulted in an average of 3.0° ± 1.5° of closure of the Go-Gn-SN angle ($P < .001$). The gain in the overbite was 5.1 ± 2.0 mm ($P < .001$), and the overjet was reduced by 1.4 ± 1.5 mm ($P < .01$). The change in the occlusal plane angle was an average of 2.4° ± 1.4° counterclockwise rotation ($P < .001$). The lower facial height was also decreased significantly by 2.9 ± 1.3 mm ($P < .001$). No significant changes were observed in the SNA angle and incisor positions ($P > .05$), except for the interincisal angle, which was increased by 3.5° ($P < .05$).

Conclusion: Zygomatic anchorage can be used effectively for open-bite correction through posterior dentoalveolar intrusion.

KEY WORDS: Open bite, Zygomatic anchorage, Posterior dentoalveolar intrusion.

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INTRODUCTION Return to TOC

There is no question that one of the most difficult malocclusions to treat and maintain in orthodontics is the anterior open bite. Morphologic traits of these cases usually include increased vertical dimensions due to the vertical overgrowth of the maxillary posterior dentoalveolar structures, which should be reduced to correct the skeletal open bite properly.[1–3] This is generally managed with the surgical impaction of the maxilla, which allows the reduction of the anterior facial height.[4] However, orthognathic surgery is complex, brings about risk and cost issues, and is not always easily accepted by the patients and/or the parents. Therefore, clinicians have been working on alternative clinical procedures to correct this skeletal discrepancy.

Early efforts for open-bite correction included the use of bite blocks in the late 1980s,[5–9] fixed appliance and vertical elastic combinations in 1990s,[10–12] and new face mask designs at the beginning of this millennium.[13] All of these proved to be effective in passive intrusion of the maxillary posterior segment.[5–7,9] However, the actual correction was achieved primarily through the extrusion of incisors or by preventing passive eruption of posterior teeth. These untoward effects led clinicians to use the osseointegrated implants or surgical miniplates and screws, which recently gained great interest as anchorage units for orthodontic purposes.[14–21] These devices have been used for the intrusion of lower[22,23] and upper[24–29] molars.

One interesting application is the use of titanium miniplates placed at the zygomatic buttress region for anchorage purposes.[25–29] Despite the fact that a few anecdotal case presentations and technical reports demonstrated successful results,[24–30] the effects of this treatment protocol on a larger sample of subjects are missing. Therefore, the aim of this study was to evaluate the dentoalveolar and skeletal effects of the new-generation open-bite appliance that uses zygomatic miniplates as anchorage units. For the purposes of the study, the null hypothesis assumed that zygomatic anchorage supported posterior dentoalveolar intrusion provided no statistically significant changes in the cephalometric measurements of the cases studied.

MATERIALS AND METHODS Return to TOC

The study group was composed of 11 subjects (5 male and 6 female) with an average age of 19.5 years. Inclusion criteria mandated that the subjects presented with an open-bite value of at least 4 mm measured between the upper and lower central incisors and increased vertical growth pattern indicated with a minimum SN-GoGn angle of 38° with increased lower facial height before the treatment (T1).

The study was carried out on lateral cephalograms of the subjects taken before treatment (T1) and at T2, which is defined as the time point at which the intrusion was completed. The mean application time was 9.6 months. All subjects underwent intrusion of the posterior dentoalveolar segment using an open-bite appliance, which is supported by bilateral zygomatic miniplates and basically exerts vertical intrusive force to this area.

Two l-shaped multipurpose zygomatic miniplates (Tasarim Med, Istanbul, Turkey) were placed on the lower contours of each zygomatic process and fixed by three bone screws under local infiltrative anesthesia. The straight arm of the miniplate is exposed into the oral cavity from the attached gingiva at the mucogingival junction to prevent inflammation. The tip of the exposed miniplate is used to attach coil springs for intrusion. After fixation, the incision site is closed and sutured. The patients were advised to use antiseptic mouthwash for 1 week and to administer proper oral hygiene during the healing period.

Appliance Design and Fabrication

The intrusion appliance, which has undergone several modifications since its first introduction, consisted of two shallow acrylic bite blocks. The bite blocks were connected to two heavy palatal arches (1.4-mm round stainless steel) and wire attachments on each buccal side, which were used for force application.[29] The palatal arches were bent on two layers of wax to avoid impingement to the palatal mucosa during intrusion. The bite blocks covered all the teeth that needed to be intruded (ie, generally all teeth present distal to the maxillary canines). The outer wire attachments were made from 0.9-mm stainless steel wire, and two 200-g NiTi open-coil springs were hooked before the ends of the wire, which are embedded into the acrylic resin. The offset of this wire was adjusted so that the vector-of-force application was parallel to the long axis of the first molars when the NiTi coils are activated.

Placement and Force Application

After allowing 7 to 10 days for wound healing and following removal of the sutures, the appliance was first tried in the mouth to check occlusal contact bilaterally. The cusp tips of the appliance segments were trimmed flat to control bite opening during expansion and the generation of eccentric and unilateral contact points. The bonding material was glass ionomer cement, which provided for adequate appliance retention.

Following suture removal on day 7, the appliance was cemented and force application initiated. Two 9-mm NiTi coil springs (Masel, Bristol, Pa) were placed bilaterally between the tip of the miniplate and the outer wire, which created an intrusive force of 400 g. The patients were seen in 4-week intervals, and progress was observed. No fixed appliances were placed until the completion of the posterior dentoalveolar intrusion. After completion of the impaction, records were collected and fixed appliance therapy was initiated. The impaction achieved was maintained with wire ligation between the miniplate and the molar tubes throughout the treatment.

Measurements

Lateral cephalograms were taken at the start and at the end of dentoalveolar intrusion. Final cephalograms were taken after 9.6 ± 1.9 months. Eight angular and seven linear cephalometric measurements were determined (Figure 1 ◑). The radiographs were traced and measured by one investigator. The cephalometric data were analyzed using paired-samples *t*-test.

To assess the error of the cephalometric method, the radiographs were retraced 2 weeks after the first measurements. A paired-samples *t*-test was applied to the first and second measurements. It was found that the difference between the first and second measurements of the radiographs was insignificant. Correlation analysis applied to the same measurements showed the highest *r* value of .989 for interincisal angle and the lowest *r* value of .914 for upper face height.

RESULTS

The data from skeletal and dental measurements of the pretreatment and postintrusion lateral cephalograms are summarized in Table 1 ◑. Statistically significant cephalometric changes given below were observed, and the null hypothesis was thus rejected.

The mean intrusion, measured as the distance of the U6 to the palatal plane, was 3.6 ± 1.4 mm ($P < .001$). This resulted in an average of 3.0° ± 1.5° of closure of the Go-Gn-SN angle ($P < .001$). The gain in the overbite was 5.1 ± 2.0 mm ($P < .001$), and the overjet was reduced by 1.4 ± 1.5 mm ($P < .01$). The change in the occlusal plane angle was an average of 2.4° ± 1.4° counterclockwise rotation ($P < .001$). The lower facial height was also decreased significantly by 2.9 ± 1.3 mm ($P < .001$).

No significant changes were observed in the SNA angle and incisor positions ($P > .05$), except for interincisal angle, which was increased by 3.5° ($P < .05$).

DISCUSSION

The present study evaluates the dentoalveolar effects of an open-bite appliance that is anchored to two miniplates placed in the zygomatic buttress in the treatment of subjects with an anterior open bite, high angle growth pattern, and excessive posterior growth. In such patients, molar intrusion should be the treatment goal to improve the esthetics and achieve stable treatment. Therefore, the inferior border of the zygomatic process of the maxilla, which has a solid bone structure and is located at a safe distance from the roots of the upper molars, was selected as the anchorage site. A miniplate, which is fixed with three or four miniscrews in this area, provides adequate retention for immediate loading. The bone anchorage in this area can be used indirectly to reinforce the molar anchorage or can be used directly as described in this article.

Skeletal anchorage also can be obtained by palatal implants[19,20,30,31] and microscrews[32–34] that are placed in the alveolar bone. Although palatal implants provide reliable absolute anchorage, they require a period of at least 3 months for osseointegration before orthodontic force application. Microscrews offer advantages such as simple placement surgery, less discomfort after implantation, immediate loading, and lower costs. However, their proximity to the roots can create problems during placement or when the adjacent teeth are moved. The success rate of microscrews with a 1- to 1.5-mm diameter has been reported to be lower in the maxilla than in the mandible because the buccal cortical bone of the maxilla is thinner than that of the mandible.[35] Considering the failure risk of microscrews in the maxilla because of relatively thin buccal cortical bone, it was considered that the zygomatic miniplate anchorage would be a safer choice compared with microscrew anchorage.[36]

Every aspect and detail of the open-bite appliance presented in this article was based on our experience with the problems encountered with previous designs used in the department. The heavy palatal bars are essential to avoid buccal tipping of the posterior segment, which is otherwise inevitable because of the location of the force vector in relation to the center of resistance of this segment. Tipping of the buccal segment not only impairs posterior occlusion but also impedes successful elimination of the open bite because of the interferences created between the upper and lower teeth. If expansion of the maxillary arch is also required, these bars can be replaced by a hyrax screw, and rapid maxillary expansion can be performed simultaneously. The offset of the buccal wire enables more appropriate force direction and minimizes soft tissue impingement. Besides the major intrusive effect of the NiTi coils, the effect of the appliance was probably accentuated by masticatory muscle forces transferred through the acrylic bite blocks and vertical forces exerted on the palatal bars by the body of the tongue. Thus, a triple intrusive effect was present.

The insertion technique for the implants to the zygomatic buttress required a short 1-cm flap opening to visualize the operation field. This noninvasive technique facilitates surgical procedures and reduces operation time. The surgical procedure lasted about 30 minutes, and drilling and screwing was done with hand instruments to cause minimal trauma and prevent overheating of the bone. There was only minor edema and pain postoperatively. The simple fixation techniques (limited incision, reduced flap area, drilling with a hand instrument) are well tolerated by the patient. Although not assessed systematically, patient acceptance of this treatment modality as an alternative to the conventional Le Fort I surgery was positive, and postoperative pain and discomfort were negligible.

Another benefit of this treatment as an alternative to conventional orthodontic appliances such as extraoral appliances[12,37] (headgear) and/or intraoral mechanics[9,10,38] (anterior box elastics) is the reduced demand for patient cooperation, which is not required for skeletal anchorage treatment. However, this should not be regarded as no special care required by the patient. It is mandatory that the patient maintain an optimum oral hygiene procedure to avoid inflammation of the implant exposure site during the entire treatment.[27]

One concern with this treatment method can be the effect of vertical forces on the roots of teeth involved and the nasal floor. Although Daimaruya et al[39] found some moderate root resorption in a dog model, Ari-Demirkaya et al[40] reported no significantly higher resorption with this method when compared to conventional fixed orthodontic mechanics.

A slight posterior open bite was observed when the intrusion appliance was first removed, which was caused by the acrylic bite block of the appliance. As the upper molars were tied to the zygomatic implant and were not free to extrude, this open bite was closed by the extrusion of the lower molars.

Despite the fact that most cases included in this study are still under fixed appliance therapy, a few 1-year follow-up cases demonstrated that the upper molars were extruded by about 1 mm after their ties to the zygomatic implants were removed. Despite this dental relapse, 2.5° of counterclockwise rotation is stable at 1-year follow-up (unpublished data). Vertical development of the posterior teeth,[11] initial open-bite severity,[41] and lack of adaptation of tongue posture[42] have been reported to be important factors in the relapse of open bite in the long term regardless of the treatment protocol applied. Therefore, longer follow-ups with a large number of patients are necessary to correctly interpret the stability of the impaction achieved with this method.

It was possible to acquire an open-bite correction of 5.1 mm in 9.6 months with this technique through 3° of mandibular autoclosure. However, further long-term clinical studies with large samples are required to prove the technique's effectiveness and stability of molar intrusion.

CONCLUSION Return to TOC

- Zygomatic anchorage can be used effectively for open-bite correction through posterior dentoalveolar intrusion.

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TABLES Return to TOC

Table 1.   Comparison of Initial and Final Skeletal Measurements

Measurement	T1	T2	Mean	SD	Test
Age, y			19.5	4.1	
Intrusion time, mo			9.6	1.8	
1. SNA, °	79.5	79.9	0.4	0.7	ns[a]
2. SNB, °	74.8	76.6	1.8	1.2	***
3. ANB, °	4.8	3.3	−1.5	0.9	***
4. Overjet, mm	6.2	4.8	−1.4	1.5	**
5. Overbite, mm	−4.0	1.2	5.1	2.0	***
6. Occlusal plane to SN, °	22.7	20.4	−2.4	1.4	***
7. U6 to palatal plane, mm	22.6	19.0	−3.6	1.4	***
8. SN to Go-Gn, °	42.5	39.5	−3.0	1.5	***
9. Interincisal angle, °	123.7	127.2	3.5	6.3	*
10. Upper 1 to nasion-A, mm	5.4	5.5	0.1	2.3	ns
11. Upper 1 to nasion-A, °	26.9	24.2	−2.7	6.2	ns
12. Lower 1 to nasion-B, mm	6.5	6.5	0.0	0.5	ns
13. Lower 1 to nasion-B, °	24.9	24.5	−0.5	2.0	ns
14. Lower face height, mm	76.5	73.6	−2.9	1.3	***
15. Upper face height, mm	55.6	55.6	0.0	0.0	ns

[a] ns = not significant.
* $P < .05$, ** $P < .01$, *** $P < .001$.

FIGURES Return to TOC

Click on thumbnail for full-sized image.

Figure 1. Measurements used in the cephalometric evaluation (see Table 1 for descriptions)

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