Zygoma-gear appliance for intraoral upper molar distalization

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The aim of this report is to present an intraoral upper molar distalization system supported with zygomatic anchor plates (Zygoma-gear Appliance, ZGA). This system was used for a 16-year-old female patient with a Class II molar relationship requiring molar distalization. The system consisted of bilateral zygomatic anchor plates, an inner-bow and heavy intraoral elastics. Distalization of the upper molars was achieved in 3 months and the treatment results were evaluated from lateral cephalometric radiographs. According to the results of the cephalometric analysis, the maxillary first molars showed a distalization of 4 mm, associated with a distal axial inclination of 4.5°. The results of this study show that an effective upper molar distalization without anchorage loss can be achieved in a short time using the ZGA. We suggest that this new system may be used in cases requiring molar distalization in place of extraoral appliances. (Korean J Orthod 2010;40(3):195-206)

Key words: Distalization, Zygomatic anchorage plate, Class II, Anchorage

INTRODUCTION

Several methods have been used for upper molar distalization including extraoral1 and intraoral2-10 appliances. The esthetic and social concerns of the use of headgear wear and the anchorage loss that occurs with the application of intraoral systems have stimulated many investigators to use skeletal anchorage. To overcome these anchorage problems, skeletal anchorage units applied to palatal regions, for example, osteointegrated implants, miniscrews, and Graz type implant were combined with these tooth and tissue supported intraoral appliances.11-18 Although anchorage loss has been eliminated in this way, different problems related with the proximity between the implant and the roots of teeth or the presence of a bulky acrylic Nance appliance behind the upper incisors may become a problem during the retraction of anterior teeth.

The zygomatic process of the maxilla is another appropriate region for skeletal anchorage.19 Recently, zygomatic anchorage systems have been used alternatively for upper molar distalization.20,21 We designed an intraoral upper molar distalization system supported by the zygomatic region named as the Zygoma-Gear Appliance (ZGA). The aim of this study is to present the use of ZGA for bilateral upper molar distalization in a 16-year-old female with a Class II molar relationship requiring molar distalization.

The system consists of two zygomatic anchor plates (Multi Purpose Anchor MPI 1000, Tasarim Med, Istanbul, Turkey), an inner-bow, and heavy intraoral elastics (Fig 1A). The effective distalizing force vector of the ZGA is illustrated in Fig 1B.

The zygomatic anchor is a titanium miniplate with three holes, which continues into a round bar. The anchor plates are placed at the zygomatic buttress of the maxillae under local anesthesia (Fig 2). The zygomatic
buttress is palpated in the labial sulcus, and a 1- to 2-cm-high vertical incision is made starting at the mucogingival junction while maintaining contact with the bone. The lower aspect of the zygomatic process of the maxilla is totally exposed by blunt dissection. The anchor plate is adjusted to fit the contour of the lower face of each zygomatic process and fixed by three bone screws (length, 7.0 mm). The body portions of them are positioned subperiosteally. The round bars are intraorally exposed and positioned outside the dentition, so that they never disturb the distalization of the maxillary molars. After fixation, the incision site is closed and sutured. The free intraoral parts of the miniplates are bent distally into hooks.

The inner-bow is made from stainless steel wire, 1.1 mm in diameter and designed like the inner part of a conventional facebow. Two hooks are soldered onto the inner-bow at the lateral teeth regions, and U bends are bent bilaterally in front of the upper first molars. The inner-bow is adjusted to the headgear tubes on the upper first molar bands. A distally directed force is applied to the upper molar teeth via the heavy intraoral elastics, which are placed between the zygomatic plate and the inner-bow hooks.

**DIAGNOSIS AND ETIOLOGY**

A 16-year and 8 month-old female was diagnosed with skeletal Class II, Division 1 malocclusion. She was referred to our department for consultation about her unerupted upper teeth. She had a well-balanced face and a mild convex profile (Fig 3). The dental midlines were concordant with each other and with her face, and no mandibular shift was detected on closure. Intraoral examination revealed that she had a bilateral Class II molar and canine relationship with a posterior
crossbite on the right side. The dental cast analysis showed 2 mm of space deficiency in the upper arch, 1.5 mm of space excess in the lower arch, 4 mm overjet, and 6 mm overbite (Fig 4). The maxillary lateral incisors were small, creating a tooth size discrepancy. Bolton’s tooth size analysis revealed a maxillary anterior deficiency of 2.1 mm.

Radiographic examination showed that all teeth, including the third molars, were present (Fig 5). Initial panoramic radiograph revealed that both maxillary canines had well developed roots, were impacted at the level of the roof of the palate, and were mesially angulated near the roots of the maxillary lateral incisors. Further detailed radiographic investigation disclosed no significant resorption of the roots of the maxillary lateral incisors. A horizontal tube shift technique with periapical radiographs and clinical palpation confirmed that both impacted maxillary canines were in the palatal position.

Cephalometric evaluation revealed a mild skeletal Class II pattern due to a mild mandibular retrognatia. The pre-treatment cephalometric parameters showed that the maxilla was normal (SNA 82°), and in centric occlusion the mandible was in a slightly retruded position according to the cranial base (SNB 76°). The maxillary incisors were slightly upright, while the mandibular incisors were normal. The mandibular plane was normal relative to the cranial base (SN-GoGn 34.5°).
TREATMENT OBJECTIVES

Treatment objectives, based on the clinical examination and cephalometric analysis, were to:
1. Align the palatally impacted maxillary canines.
2. Correct the unilateral posterior crossbite.
3. Obtain normal overjet and overbite.
4. Establish a well-intercusped bilateral Class I canine and molar occlusion.
5. Constitute a good aesthetic smile.

TREATMENT ALTERNATIVES

There were four treatment alternatives for this case: (1) align the palatally impacted maxillary canines and distalization of upper molars; (2) extraction of the impacted canines and closure of the extraction space orthodontically; (3) extraction of the impacted canines and prosthetic rehabilitation with implants or bridge-work; and (4) align the palatally impacted maxillary canines with the extraction of two upper first premolars.

Considering all aspects of the case in detail, during the treatment-planning interview, the patient was told...
that the impacted canines might not respond to orthodontic eruption; and if this were the case, they would need to be extracted, and prosthetic rehabilitation with implants or bridgework would be required. She chose orthodontic eruption of the impacted canines with the nonextraction approach, and informed consent was taken to this effect.

TREATMENT PROGRESS

Preadjusted fixed appliances (0.022 × 0.028-in, MBT system) were placed in both arches to achieve leveling and alignment. Intraoral cross elastics were used for the correction of crossbite at the right first molars. After the leveling phase, the retained primary canines were extracted and then both palatally impacted maxillary canines were surgically exposed with the help of an envelope flap. Bondable cleats were bonded to them, and stainless steel ligature wires were braided from these cleats. After soft tissue healing, an auxiliary continuous 0.016-in Australian wire including vertical loops with terminal eyelets was applied with a 0.016-in stainless steel main archwire (Fig 6A). In the passive state, the eyelets faced down occlusally. Torsion was built up in the round wire, which was secured at its distal ends as the vertical loops were bent through 90° to tie them to the braided ligatures from the canines. This was done to generate eruptive forces for the bi-

Fig 6. Intraoral occlusal views of the mechanics for erupting of the impacted canines (A), and of the erupted canines (B).

Fig 7. Application of the ZGA (Zygoma-Gear Appliance) at the beginning of distalization (A), and the views of the patient immediately after the distalization (B).
laterally impacted teeth. After 2.5 months of traction, it was observed that the maxillary canines were erupted sufficiently in crossbite. An elastic chain was applied to move the canines labially (Fig 6B). Bite-raisers (Guray Bite Raiser, GAC International Inc, Bohemia, NY) were adjusted on the upper first molar bands for bite-opening to avoid possible interferences between the upper canines and lower teeth during the labial movement of the upper canines.

When the maxillary canines had moved into the arch, canine brackets were then bonded and a continuous 0.016-in superelastic nickel-titanium (NiTi) wire was placed. After leveling, we decided to accomplish the upper molar distalization with an extraoral appliance. However, usage of an extraoral appliance was rejected by the patient and her parents because the patient was concerned about her facial appearance. Therefore, the ZGA was designed and applied for distalization of the upper molars (Fig 7A).

Three weeks after the zygomatic plate implantation surgery, a distalization force of 400 g per side was applied to the upper molars. The patient was instructed to wear her appliance for at least 20 hours a day and to change intraoral elastics every 12 hours. After 3 months of distalization, super Class I molar relationships were achieved on both sides (Figs 7B and 8). The teeth located at the anterior of the upper molars were also distalized together with the molar teeth, spontaneously. Then fixed appliance treatment was progressed for other alignment problems. The maxillary premolars and canines were completely distalized by using power chains. After the Class I canine relationship was obtained, the retraction of incisors was accomplished by using closed coils, which were placed between the zygomatic anchor and 0.019 × 0.025-in stainless steel posted archwire (Fig 9).

At the end of active treatment, finishing procedures were used for the final alignment of the teeth and detailing of the occlusion. The orthodontic appliances were removed after active treatment was completed (Figs 10 - 12). After debonding procedures, peg shaped maxillary lateral incisors were restored with composite resin (Fig 13) and a maxillary removable Hawley retainer and a 3-3 mandibular fixed lingual retainer were constructed for the patient and placed.

**RESULTS**

After 21 months of treatment with the ZGA and full fixed orthodontic appliances, the impacted canines were successfully aligned and Class I molar and canine relationships were established with satisfactory inter-

![Fig 8](image). Lateral cephalometric radiograph of the case taken immediately after the distalization.

![Fig 9](image). The system for retraction of the incisors.
digitation of the posterior teeth. Acceptable overjet and overbite were also achieved and the tooth size discrepancy caused by the upper lateral incisors was managed successfully.

Table 1 shows the cephalometric changes in all stages of the treatment. A comparison of the pre- and post-distalization cephalometric analysis revealed that the maxillary first molars showed a distalization of 4 mm, associated with a distal axial inclination of 4.5°. Non-significant changes were observed in vertical angles (SN/GoGn, FMA, and ANS-PNS/GoGn) (Fig 14A). According to the analysis of the posttreatment lateral cephalometric radiograph, SNA, ANB, Wits appraisal, interincisal angle, overjet, and overbite were decreased (Fig 14B).

After the completion of active treatment, the centric relation coincided with the centric occlusion, and the patient reported no temporomandibular joint problems. The final panoramic radiograph showed that minimal root resorption had occurred during treatment and that root parallelism was satisfactory. The patient has been in retention for more than 12 months, and the occlusion has been maintained very well during this time.

**DISCUSSION**

Nonextraction treatment of Class II malocclusion often requires distal movement of the upper molar teeth
into a Class I relationship. Conventional extraoral appliances such as headgear are frequently used for this purpose.\(^1\) Despite their efficacy in tooth movement; these appliances have the major disadvantage of a
heavy dependence on patient cooperation. Additionally, many patients reject headgear wear because of social and esthetic concerns.

The difficulty in the use of headgear wear has stimulated many investigators to develop intraoral devices and techniques for the distal movement of molars.\(^2\)\(^-\)\(^10\) Intraoral maxillary molar distalization appliances, such as Wilson arches,\(^2\) repelling magnets,\(^3\) Hilgers pendulum appliances,\(^4\)\(^-\)\(^6\) the sectional jig assembly,\(^7\) the distal jet,\(^8\) the Keles slider,\(^9\) and the first class appliance\(^10\) do not require extensive cooperation from patients. However, they have several disadvantages such as mesialization of the maxillary premolars, protrusion of the maxillary incisors, an increase in overjet, and relapse of molars. Relapse of molar distalization is commonly seen as the molars are used as anchorage during distalization and retraction of the premolars and incisors.

To remedy these anchorage problems of noncompliant appliances, intraoral distalizing mechanics combined with palatal implants have attracted attention,\(^11\)\(^-\)\(^16\) because it has become possible to distalize the maxillary molars without anchorage loss by using absolute anchorage more efficiently than ever. Although anchorage loss has been eliminated in this way, an important problem still occurs during the retraction of anterior teeth. Because of the proximity of palatal implant to the roots of anterior teeth or the presence of a bulky acrylic Nance appliance behind the upper incisors, the retraction of the anterior teeth is limited. At this stage,
the palatal implants must be removed and the distalized molars are used as part of the anchorage during retraction of the anterior teeth. Therefore, the reinforcement of molar anchorage or the use of another anchorage area is required to prevent the relapse of molars. The zygomatic process of the maxilla can be used for this purpose because zygomatic anchors can be positioned at the zygomatic buttress, at a safe distance from the roots of the maxillary molars and allow a full unit buccal segment distalization. Sugawara et al. and Kaya et al. described their distalization systems supported with the zygomatic anchor plates. They reported that the en-masse distalization of maxillary buccal segments was successfully accomplished by their systems.

In the current study, we used the ZGA for upper molar distalization in a 16-year-old girl. The upper molars were efficiently distalized to Class I relationships without anchorage loss in a short time. The ZGA system has more advantages than other intraoral distalization appliances and combines the advantages of extraoral and intraoral appliances.

The upper molar distalization with the ZGA system is completely different from previous intraoral molar distalization methods. The difference in the appliance design enables the first and second premolars to drift distally freely with the help of the transeptal fibers. The distalized molars are never required as part of the anchorage during the retraction of the premolars and the anterior teeth, because the orthodontic force can be directly provided from the zygomatic anchor plates. Additionally, this system is more esthetic than extraoral appliances and is well tolerated by the patient.

The other advantages of this system are the simple and hygienic design, easy application, short chair time, minimal laboratory procedures, controllable force magnitude, and easy repair. The force magnitude can be adjusted according to need to achieve treatment objectives. A different amount of distalization can be achieved on each side. When needed, all parts of the appliance (molar bands, elastics, and inner-bow) can be easily repaired or changed except the zygomatic anchor plates. This new system also allows the use of fixed orthodontic appliances during the molar distalization, simultaneously. On the other hand, the minor surgical operation to place the anchorage plates on the zygomatic buttress was the main disadvantage of this appliance. The necessity of a second operation for the removal of these plates and additional cost appears to be another disadvantage.

From a clinical point of view, the choice of force system and the optimum force magnitude are the decisive factors for obtaining the desired tooth movement. Achieving the bodily movement of molars is also an important strategy in modern orthodontics during distalization. For this purpose, an effective force vector
must be passed through the center of the resistance (CR) of teeth. In our case, the vector for an effective distalizing force was located occlusally close to the CR of the upper first molars. The force vector of ZGA could be adjusted to obtain bodily molar movements by changing the level of the zygomatic anchor hooks and the height of the inner bow hooks. Additionally, we used heavy intra oral elastics to gain orthodontic force. As is known, this type of force is intermittent in character. A continuous force is desirable for providing more efficient tooth movement. Thus, the force characteristic of the ZGA could be converted to a continuous form with the usage of NiTi closed coils instead of elastics. The appliance can be modified according to the treatment objectives. In further studies, the effects of the ZGA on dentofacial structures could be assessed with large samples.

**CONCLUSION**

In conclusion, the results demonstrated that for this case the ZGA was an effective system to distalize upper molars without anchorage loss. Absolute anchorage control was provided by using zygomatic anchorage plates during the distalization of molars and the retraction of incisors. The main disadvantage of this system was the minor surgical operations to place and remove the plates. We suggest that this new system can be used in nonextraction Class II treatment in place of extraoral and intraoral distalization appliances.

- **REFERENCES**

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