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# The Zygoma Anchorage System

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**F**ixed appliance treatment of Class II malocclusions often requires intrusion and retraction of the anterior segment, which, in turn, usually necessitate mechanical reinforcement of posterior anchorage.<sup>1</sup> Intraoral devices such as transpalatal bars or Nance appliances<sup>2</sup> can reduce the need to wear Class II elastics, but can cause mesial movement of the lower first molars and protrusion of the incisors. Additional extraoral anchorage in the form of headgear<sup>3,4</sup> is often rejected by adult patients for social and professional reasons. Even when headgear is worn 14 hours a day, some anchorage loss and mesial movement of the upper molars are usually observed.

Osseointegrated titanium implants have recently been used to enhance orthodontic anchorage without the need for special patient compliance.<sup>5</sup> After orthodontic treatment, these implants can be used to replace one or more missing teeth.<sup>6</sup> Removable implants have also been placed distal to the molars to close first molar extraction spaces<sup>7</sup> and prevent tipping of the second and third molars. These implants are unpredictable, however, because their relationship to the adjacent teeth and the occlusion changes considerably during treatment.

The thickness of the anterior midpalatal bone allows a more stable implant to be placed

there,<sup>8,9</sup> and a rigid appliance can be connected from the central implant to the first premolars or molars.<sup>10</sup> Because the transpalatal arch must be as rigid as possible, however, the amount of anchorage cannot be adjusted during treatment. The reaction forces generated during intrusion of the anterior teeth are first applied to the upper molars and then transmitted to the implant by the transpalatal arch, making the implant system an indirect anchorage unit. Because of osseointegration and the large diameter of the implant, a hollow explantation drill must be used to remove the implant at the end of treatment, leaving a bone cavity with a diameter of about 5mm. Some authors advise leaving the subgingival part of the implant in the bone permanently.

Miniscrews are small enough to be placed between the roots of the teeth in the alveolar bone.<sup>11-14</sup> By connecting two or more miniscrews, the orthodontic reaction forces can be neutralized. The surgical procedure is uncomplicated because the screws are placed directly through the gingiva, without a mucoperiosteal flap, and can be loaded immediately after insertion. Miniscrews can be used in the anterior or posterior region and attached with elastics or coil springs to the fixed appliance for direct anchorage. Anchorage can be adapted to changing treatment needs in different parts of the dental arches.

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The main disadvantage of these screws is their proximity to the roots, which may be damaged during placement of the screws or when the adjacent teeth are displaced.

We have developed a Zygoma Anchorage System (ZAS) in which the miniscrews are placed at a safe distance from the roots of the upper molars. Because of its location and its solid bone structure, the inferior border of the zygomaticomaxillary buttress, between the first and second molars, was chosen as the implant site. Combining three miniscrews with a titanium miniplate<sup>14-17</sup> can bring the point of force application near the center of resistance of the first permanent molar.

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## Appliance Design and Placement

The upper part of the Zygoma Anchor\* is a titanium miniplate with three holes, slightly curved to fit against the inferior edge of the zygomaticomaxillary buttress (Fig. 1). A round bar, 1.5mm in diameter, connects the miniplate and the fixation unit. A cylinder at the end of the bar has a vertical slot, where an auxiliary wire with a maximum size of .032" × .032" can be fixed with a locking screw.

The plate is attached above the molar roots by three self-tapping titanium miniscrews, each with a diameter of 2.3mm and a length of 5mm or 7mm. The miniscrews do not need to be sand-blasted, etched, or coated. Square holes in the center of the screw heads accommodate a screw-

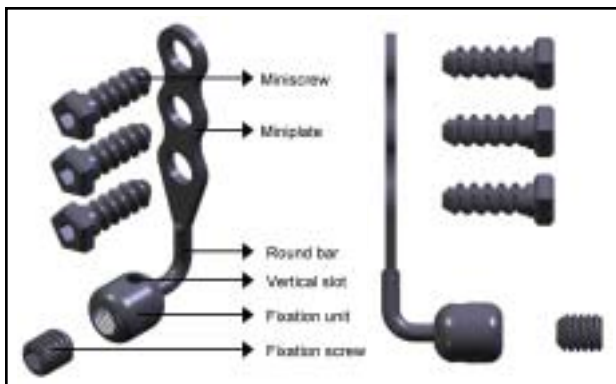


Fig. 1 Zygoma Anchor.



Fig. 2 Radiographic views of Zygoma Anchor.

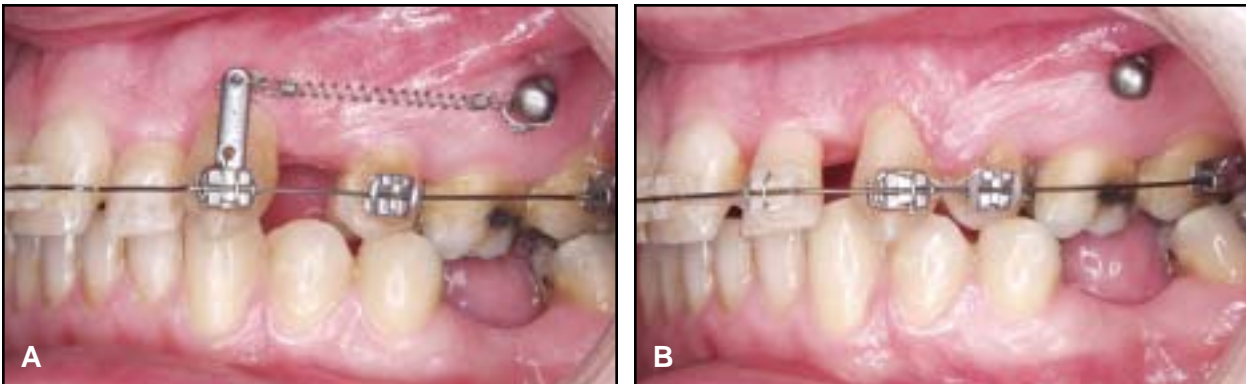


Fig. 3 A. Zygoma Anchorage System with rigid power arm attached to canine. B. After canine distalization.



Fig. 4 Elastic attached between sliding jig and Zygoma Anchor for first molar distalization.

driver for initial placement, while pentagonal outer holes are used to remove the screws at the end of treatment.

To place the anchor, an L-shaped incision, consisting of a vertical incision mesial to the inferior crest of the zygomaticomaxillary buttress and a small horizontal incision at the border between the mobile and attached gingiva, is made under local anesthesia. The mucoperiosteum is elevated, and the upper part of the anchor is adapted to the curvature of the bone crest (Fig. 2). Three holes with a diameter of 1.6mm each are drilled, and the Zygoma Anchor is affixed with the three miniscrews. The cylinder should penetrate the attached gingiva in front of the furcation of the first molar roots at a 90° angle to the alveolar bone surface.

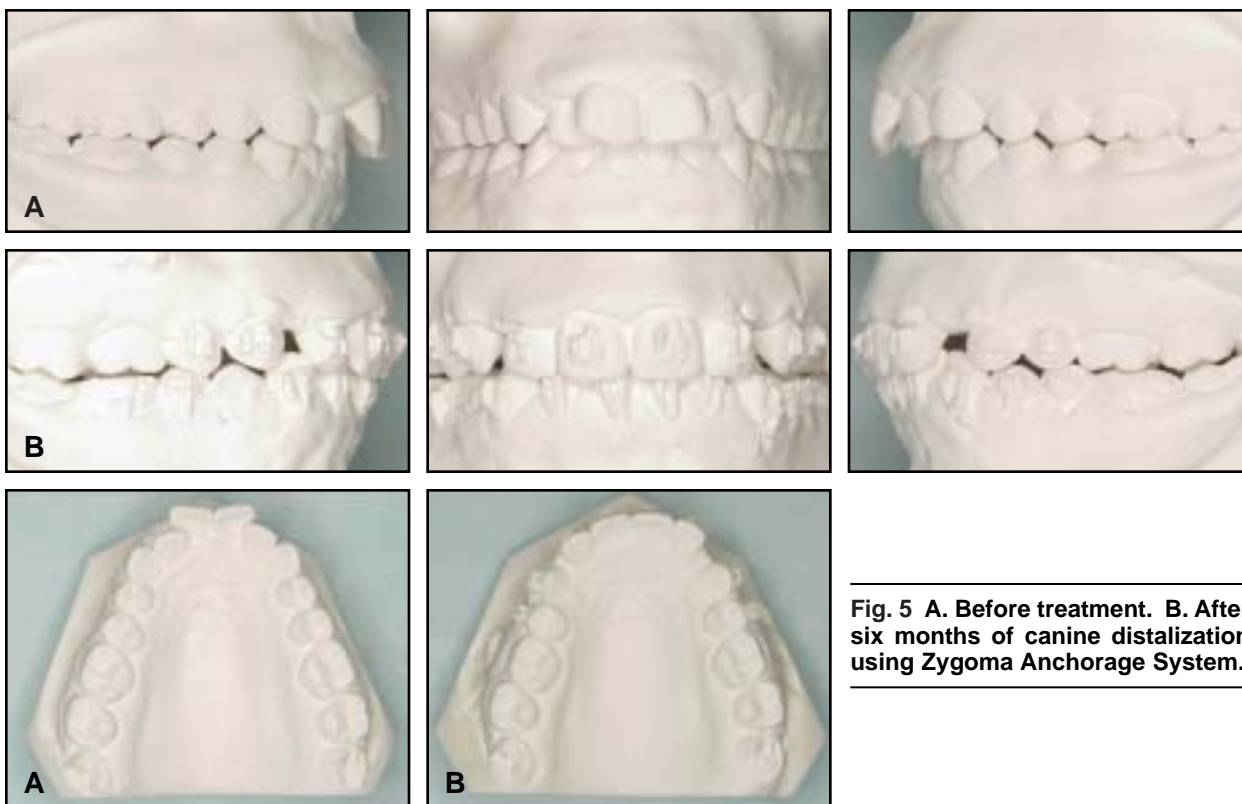
The miniplate is covered by the mucoperiosteum and sutured with resorbable stitches.

When indicated, premolars are extracted at the same appointment.

### Clinical Application

Orthodontic forces can be applied to the anchor immediately after implantation. To connect the Zygoma Anchor with the anterior teeth, a rigid power arm\* was designed to fit in the large vertical slot of a canine bracket (Fig. 3). The hook at the end of the power arm is situated at the level of the canine's center of resistance. A nickel titanium closed-coil spring with a force of 50-100g is attached between the power arm on the canine and the Zygoma Anchor, so that the direction of force is parallel to the main archwire.

The first molars can be distalized with a sliding jig (Fig. 4) before force is applied to the upper canines. The ZAS can also be used with



**Fig. 5 A. Before treatment. B. After six months of canine distalization using Zygoma Anchorage System.**

open-coil springs to neutralize the reaction forces generated by distal movement of the upper molars. During retraction and intrusion of the anterior segment with T-loop arches, the ZAS is used as an indirect anchorage unit.

We have placed the ZAS in 27 patients (11 bilaterally and 16 unilaterally) for retraction of the upper canines. Unilateral skeletal anchorage is indicated when maximum anchorage is needed on one side and anchorage loss on the other. The surgical procedure has been well tolerated by the patients, although some edema has occurred in the first few days after surgery. Using sliding mechanics, the canines have been moved distally at an average rate of 1.14mm per month (Fig. 5).

Some inflammation has been observed around the implants, especially when they are placed too high in the vestibule. In most cases, however, the cylinder at the end of the Zygoma Anchor promotes better oral hygiene than a pen-

etrating miniplate does (Fig. 6). No other complications have occurred during treatment. To date, no implant has been lost.

After orthodontic treatment, the miniscrews are removed under local anesthesia through a small vertical incision in the gingiva covering the miniplate. A special screwdriver that fits into the pentagonal outer holes of the screw heads is used. After the screws are removed, only three 1.6mm-diameter holes remain, minimizing bone loss (Fig. 7).

### Conclusion

The ZAS uses three miniscrews, increasing total anchorage over other types of implants. Because the miniscrews and miniplate have excellent mechanical retention, immediate loading is possible. The point of application of the orthodontic forces is brought down to the level of the furcation of the upper first molar roots. The



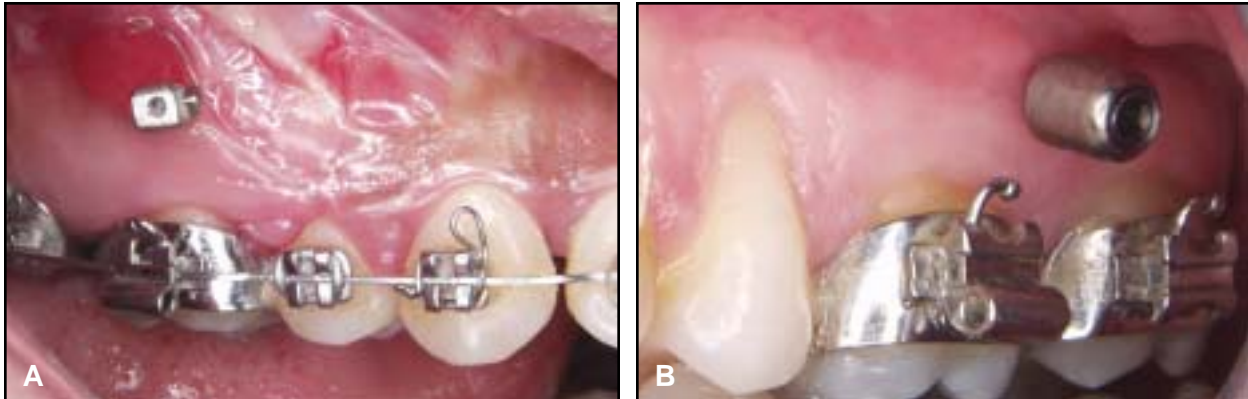


Fig. 6 A. Gingival condition around penetrating miniplate. B. Gingival condition around penetrating cylinder.



Fig. 7 Bone surface after explantation: Three small bone defects and some bone apposition at border of miniplate.

vertical slot with the locking screw makes it possible to attach an auxiliary wire, which can move the point of force application some distance from the anchor. The connection between the anchor and the conventional fixed appliance can easily be adapted to changing anchorage needs throughout treatment. Therefore, the ZAS seems to be an effective alternative to conventional extraoral anchorage.

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