A New Bone Screw for Orthodontic Anchorage

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Although the efficacy of endosseous implants for orthodontic anchorage has been verified both clinically[1,2] and experimentally,[3-5] their clinical applications are generally confined to partially edentulous cases.[6,7] Their disadvantages include: cost; a limited number of indications and potential implant sites; complex design and relatively large size; the difficulty of surgical implantation and removal; and the long waiting period for osseointegration before orthodontic traction can be applied.

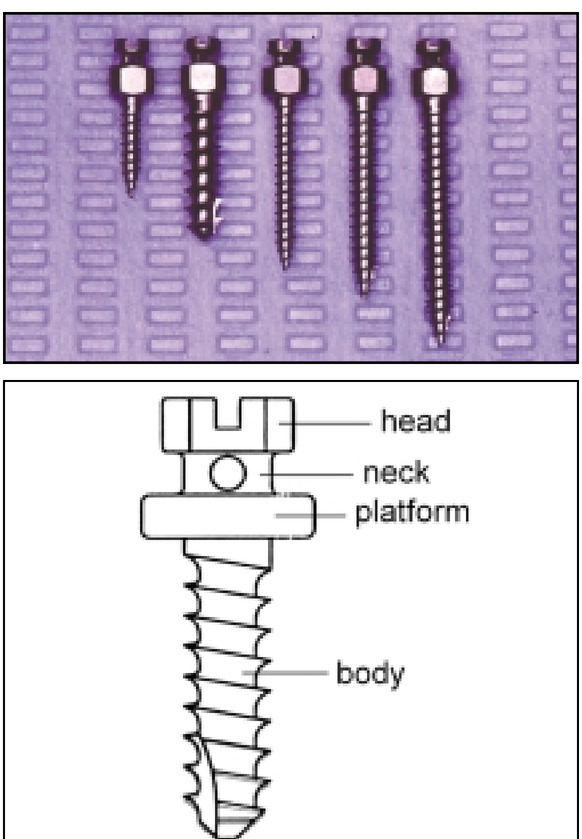

Fig. 1 OMAS bone screw in various diameters and lengths.

To circumvent these problems, several temporary osseous anchor systems have been introduced. These can be classified into four categories based on clinical applications and designs:
1. Subperiosteal palatal onplants.[8]
2. Temporary palatal endosseous implants.[9,10]
3. Bone plates.[11,12]
4. Bone screws.[13-16]

Among these, the bone screws offer several advantages over the others: smaller size; easier surgical procedures with less trauma; lower cost and risk; and a greater number of clinical indications and implant sites. Because they are unable to withstand heavy orthodontic loading, however, these screws tend to loosen and break.

We have developed a new bone screw called the Orthodontic Mini Anchor System* (OMAS) that can bear heavier orthodontic forces and thus has a lower rate of loosening and failure.[16]

Screw Design

The OMAS bone screw, made of pure titanium, is designed to be used transmucosally for osseous orthodontic anchorage. The screw comes in three diameters (1.5mm, 2.0mm, and 2.7mm) and five lengths (7mm, 10mm, 12mm, 14mm, and 17mm). It has four components (Fig. 1):
1. Head—an .022" × .028" slot for placement of an orthodontic archwire.
2. Neck—an isthmus between the head and platform for attachment of an elastic, nickel titanium coil spring, or other accessory. A .8mm round hole serves as an auxiliary tube for an archwire or ligature wire.
3. Platform—three different heights (1mm, 2mm, and 3mm) for accommodating different soft-tissue thicknesses at different implant sites. Its smooth surface improves peri-implant wound

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healing and prevents slippage and displacement of an elastic or coil spring, thus avoiding gingival irritation and keeping the screw head from becoming embedded in the soft tissue.

4. Body—parallel in shape and self-drilling, with a wider diameter and deeper thread pitches than previous designs. This provides better mechanical retention, less loosening and breakage, and stronger anchorage than other bone screw systems.

Implant Sites

Implant sites are selected according to the treatment plan, the mechanics, and the quality and quantity of bone. The following locations are only a few of the many available implant sites for the OMAS:

- Paramedian or midsagittal region of the hard palate.
- Zygomatic buttress of the maxilla (Fig. 2A).
- Maxillary tuberosities.
- Area below the anterior nasal spine.
- Mandibular buccal shelf at the oblique ridge (Fig. 2B).
- Mandibular retromolar area (Fig. 3).
- Mandibular symphysis or parasymphysis.
- Mandibular or maxillary interseptal bone be-

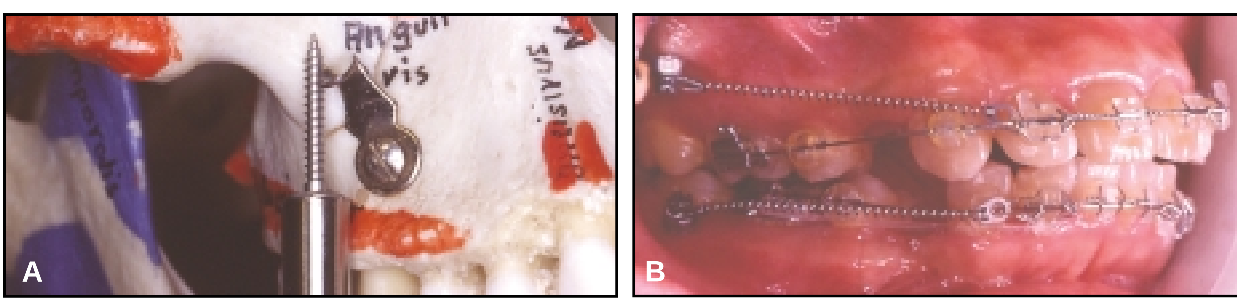

Fig. 2 A. OMAS bone screw inserted in zygomatic buttress (pillar of cortical bone running along zygomatic process of maxilla and upward into zygoma, usually located above maxillary first molar in older patient or between maxillary second premolar and first molar in younger patient). Angle of insertion should be as parallel as possible to long axis of maxillary first molar to prevent soft-tissue irritation. B. OMAS screws implanted in zygomatic buttress and in mandibular buccal shelf at oblique ridge to retract upper and lower anterior teeth simultaneously.

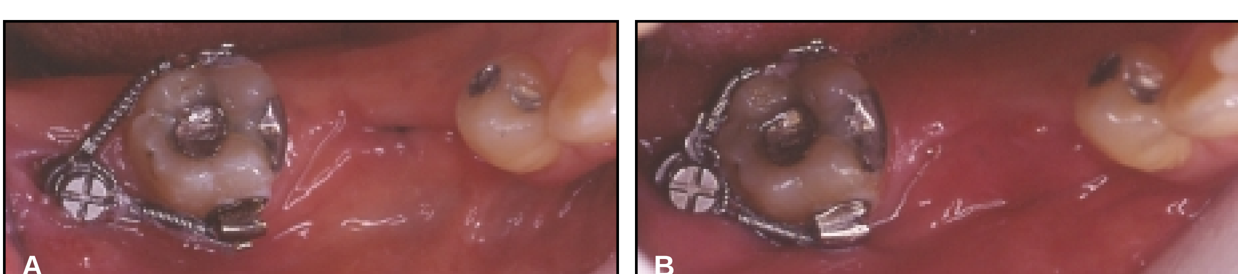

Fig. 3 A. OMAS screw inserted in mandibular retromolar area to distalize mesially tipped second molar. B. Correction after two months of treatment.

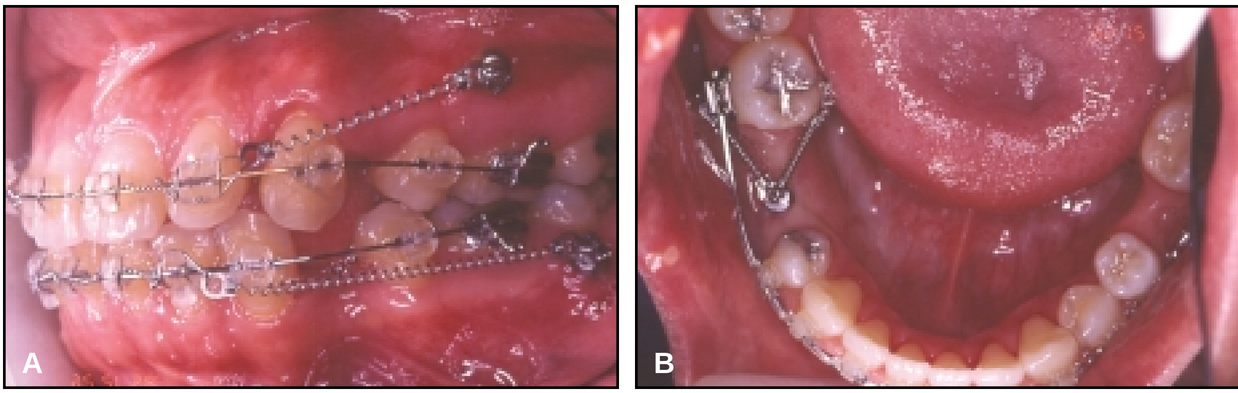

Fig. 4 A. OMAS screw inserted in maxillary interseptal bone between first molar and second premolar roots to retract and intrude upper anterior teeth. B. OMAS screw placed in mandibular edentulous alveolar ridge to protract second molar.

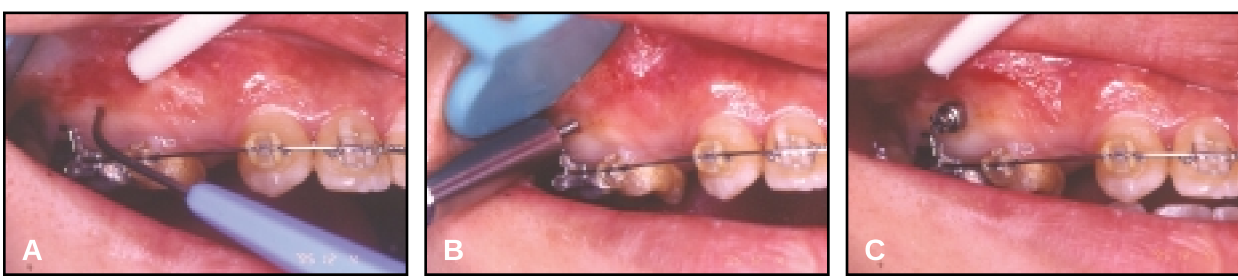

Fig. 5 Placement of OMAS screw in attached gingiva. A. After administration of local anesthesia, implant site is identified with explorer while referring to x-ray. B. After exposure of underlying bone, bone screw is inserted manually with special long screwdriver. C. No suturing is necessary; orthodontic forces can be loaded immediately after surgery.

tween two adjacent teeth (Fig. 4A).

• Mandibular or maxillary edentulous alveolar ridges (Fig. 4B).

Implant Procedure

1. Before surgery, evaluate the preferred implant site carefully for bone quality and quantity, using the lateral and anteroposterior cephalometric films, panoramic x-rays, or computed tomographic scans.

2. Depending on the implant site, perform one of the following two surgical procedures under local anesthesia:

a. Attached gingiva—use a high-speed diamond bur to expose the underlying bone; no flap elevation or sutures are needed (Fig. 5).

b. Alveolar mucosa—make a 3mm vertical or horizontal incision along the mucogingival junction with a No. 15 surgical blade, then elevate a mucoperiosteal flap to expose the underlying bone (Fig. 6).

3. Drill a pilot hole with a 1.0mm, 1.5mm, or 2.0mm spiral drill, depending on the screw diameter. Keep the drill speed to 500-800rpm under thorough irrigation with normal saline to avoid overheating and bone necrosis. Drill the pilot hole just inside the cortical bone to allow self-drilling of the bone screw and better mechanical retention.

4. Insert the OMAS bone screw using the special short or long screwdriver* (Fig. 7). Leave the head and platform of the bone screw outside the attached gingiva or alveolar mucosa.

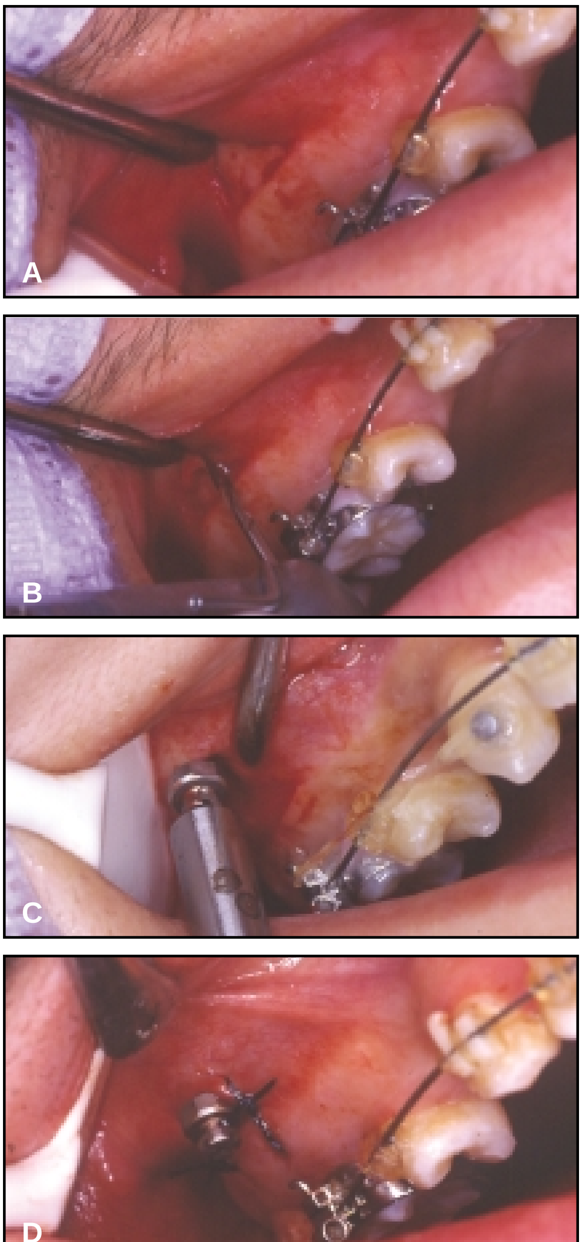

Fig. 6 Placement of OMAS screw in alveolar mucosa. A. After administration of local anesthesia, incision is made around mucogingival junction, and mucoperiosteal flap is elevated to expose underlying bone. B. Pilot hole is drilled to barely penetrate cortical bone layer. C. Screw is inserted with special screwdriver, leaving head and platform outside alveolar mucosa. D. After wound irrigation, flap is sutured.

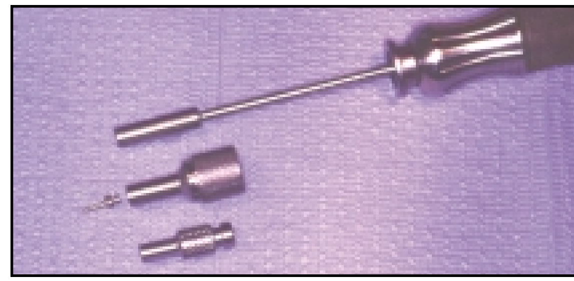

Fig. 7 Special short and long screwdrivers for OMAS insertion.

5. For sites in the alveolar mucosa, irrigate the wound thoroughly with normal saline before suturing.
6. Prescribe one week of antibiotics to prevent postoperative inflammation and of 2% chlorhexidine to maintain good oral hygiene.
7. If the implant site is in the alveolar mucosa, allow a healing period of two weeks before orthodontic loading to prevent any postoperative infection. If the implant site is in the attached gingiva, forces can be loaded immediately.

Screw Selection

The OMAS is designed for a wide variety of applications. The 1.5mm-diameter bone screw is intended for tooth-bearing areas, particularly the interseptal bone between teeth. Previous bone screws designed for this purpose have been only 1.2mm in diameter,[13,15] but the extra thickness of the OMAS screw provides better mechanical retention with its deeper thread pitches. This screw should be placed in the interseptal bone at the level of the root apex to avoid root damage during surgical placement or orthodontic tooth movement.

The 2.0- and 2.7mm-diameter OMAS bone screws are designed mainly for use in non-tooth-bearing areas such as the zygomatic buttress, the midsagittal region of the hard palate, or the mandibular buccal shelf. These screws can bear forces as high as 500-600g to achieve a headgear effect without loosening or failure. They can be

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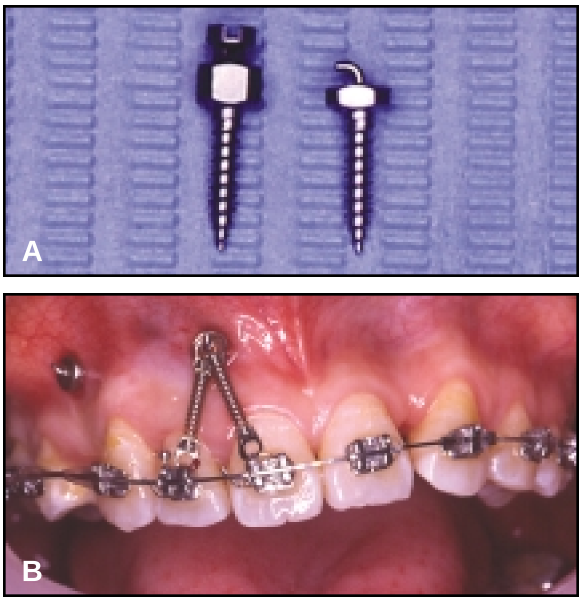

Fig. 8 A. New OMAS hook screw (right) compared to original OMAS bone screw. B. OMAS hook screws with and without coil springs attached.

used not only for canine retraction, but also for en masse anterior retraction or for molar distalization or protraction. In addition, the thicker screws can act as emergency anchors in locations where thinner screws would be unstable.

The 14mm and 17mm screw lengths are primarily designed for insertion in the zygomatic buttress. The 7mm, 10mm, and 12mm lengths can be selected based on the bone height at the implant site.

New OMAS Hook Screw

A new OMAS hook screw* is made from pure titanium alloy, which is stronger than commercial pure titanium.[17] This provides greater anchorage potential and reduces the risk of breakage in self-drilling. The hook head allows easier attachment of coil springs, without ligature wires, and better access for oral hygiene (Fig. 8). The lower profile of the head and platform (each 1mm in height) also improves patient comfort.

The tapered body and sharp tip of the new screw ensure a tighter initial fit and make insertion easier. We call the placement method the "Bone-Density-Guided Insertion Technique".[17] For example, the posterior part of the maxilla is made up mainly of porous cortical and fine trabecular bone (D3) or fine trabecular bone (D4). If we want to insert an OMAS hook screw into the interseptal bone between the upper first molar and second premolar, where the bone density is either D3 or D4, we no longer need to drill a pilot hole. After removal of the covering soft tissue to expose the underlying bone, the self-drilling screw is directly inserted with a screwdriver. In areas of dense cortical bone (D1) or porous cortical and coarse trabecular bone (D2), a surgical procedure is still required.

Conclusion

The OMAS offers many advantages over other bone screw systems:

- More sizes for different applications.
- Easier access for oral hygiene and placement of orthodontic accessories.
- Stronger body and deeper thread pitches for better mechanical retention and loading of heavier forces.

With its upgraded design, the OMAS can be applied with confidence to the most complex and difficult anchorage cases.

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