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A Miniplate System for Improved Stability of Skeletal Anchorage

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Despite their growing popularity, orthodontic miniscrews reportedly have failure rates as high as 10-30%.[1-4] Miniscrew loosening or tipping can result from any of the following factors:

- Insufficient bone quantity or quality at the insertion site.[5-7]
- Use of a screw of inadequate diameter or length.[3,8-10]
- Inappropriate intraosseous design.[10-12]
- Root contact during insertion.[13]
- Manipulation by the patient's fingers or tongue.[8]
- Poor oral hygiene.
- Application of excessive forces or moments.[9,14]
- Too long a lever arm, if the miniscrew is inserted in a region where the gingiva or mucosa is too thick.[9,14,15]
- Peri-implantitis from insertion in the mucosal region.[2,8]
- Insufficient primary stability.[15-17]
- Bone damage on insertion from stress or overheating.[2,18,19]

In an attempt to improve stability and prevent tipping, we tried coupling two miniscrews in the line of force. Initially, we tied the miniscrews together with an .017" × .025" stainless steel sectional wire or a premolar band surrounding the screw heads, covering the assembly with Transbond LR* resin. Application and removal of these components were time-consuming, however, and in some cases the attachments failed because of resin fracture.

As an alternative, we developed the Benefit** miniscrew system,[20] with four different types of stainless steel abutments that can be attached to the top of the implant with integrated miniature fixing screws (Fig. 1). The Benefit system can provide stable skeletal anchorage, especially when two coupled miniscrews are used (Fig. 2). The two abutments have to be connected by welding or soldering, however, which requires an impression

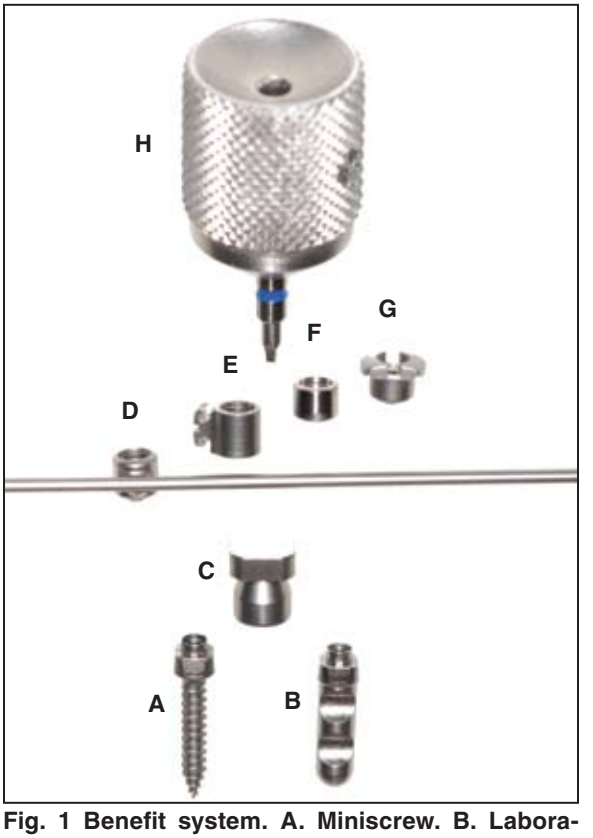

Fig. 1 Benefit system. A. Miniscrew. B. Laboratory analog. C. Impression cap. D. Wire abutment with wire in place. E. Bracket abutment. F. Standard abutment. G. Slot abutment. H. Screwdriver for abutment fixation.

*3M Unitek, 2724 S. Peck Road, Monrovia, CA 91016; www.3Munitek.com. Transbond is a trademark.

**Mondeal North America, Inc., P.O. Box 500521, San Diego, CA 92150; www.mondeal.us.

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and laboratory work.

To streamline the procedure, we developed the Beneplate,** a 1.2mm-thick stainless steel plate available in two lengths (12mm and 18mm, Fig. 3). The Beneplate can be connected to the orthodontic appliance with an .045" stainless steel wire for a Beneslider,** Mesial Slider,** or Mesial-Distal Slider** (Fig. 3F); an .032" TMA*** wire (Fig. 3E) or a palatal screw (Fig. 3B) for a Pendulum B**; or a stainless steel bracket for other applications (Fig. 3A). The Beneplate can easily be adapted to Benefit miniscrews by bending the plate and the attached wire (Fig. 4).

**Mondeal North America, Inc., P.O. Box 500521, San Diego, CA 92150; www.mondeal.us. The Mesial Slider, Mesial-Distal Slider, and Pendulum B are all fabricated from components available from Mondeal.

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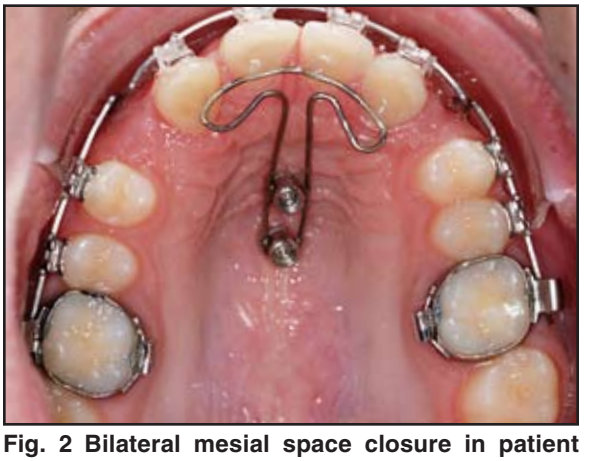

Fig. 2 Bilateral mesial space closure in patient with missing maxillary anterior teeth. Stainless steel wire is bonded to lingual surfaces of maxillary central incisors and welded to Benefit abutment for indirect anchorage.

Placement Procedure

We prefer the anterior palate as an insertion site because of its good bone quality and quantity.[21]

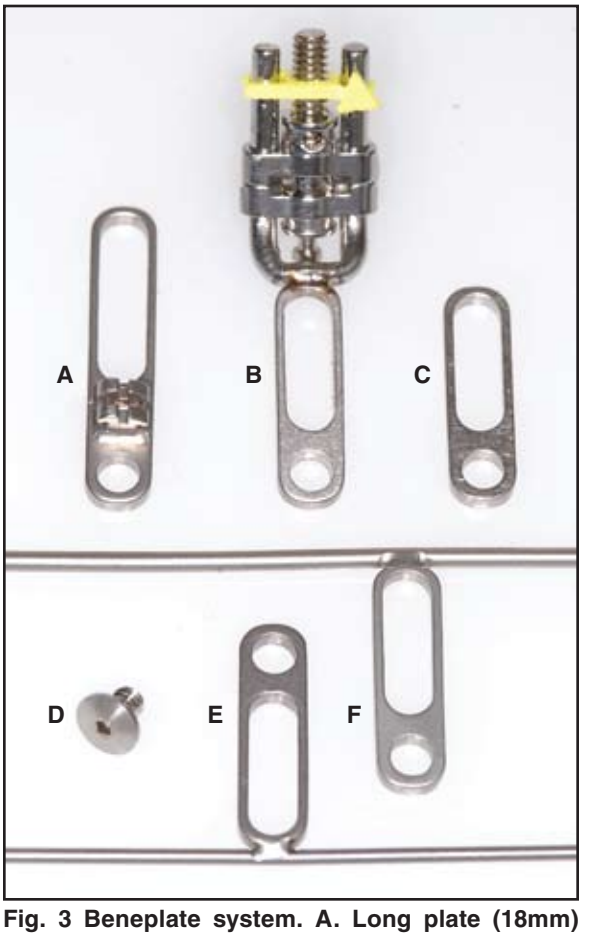

Fig. 3 Beneplate system. A. Long plate (18mm) with metal bracket. B. Short plate (12mm) with palatal screw. C. Short plate. D. Fixing screw. E. Short plate with .032" TMA wire. F. Short plate with .045" stainless steel wire.

Fig. 4 Beneplate with wire bent for indirect anchorage of central incisors.

The greatest stability is achieved by using two 2mm-diameter miniscrews with lengths of 11mm (anterior, near the second palatal ruga) and 9mm (posterior, near the third palatal ruga).[5,10,22,23] The soft tissue should be measured with a dental probe and an endodontal rubber stop to identify appropriate insertion sites with thin soft tissue. If the patient is apprehensive about the use of a syringe, the miniscrews can be placed under a topical anesthetic. In younger patients (10-12 years old) with relatively little bone mineralization, pilot drilling is usually not necessary. In adolescents and especially adults, pilot drilling is recommended to avoid excessive insertion moments.

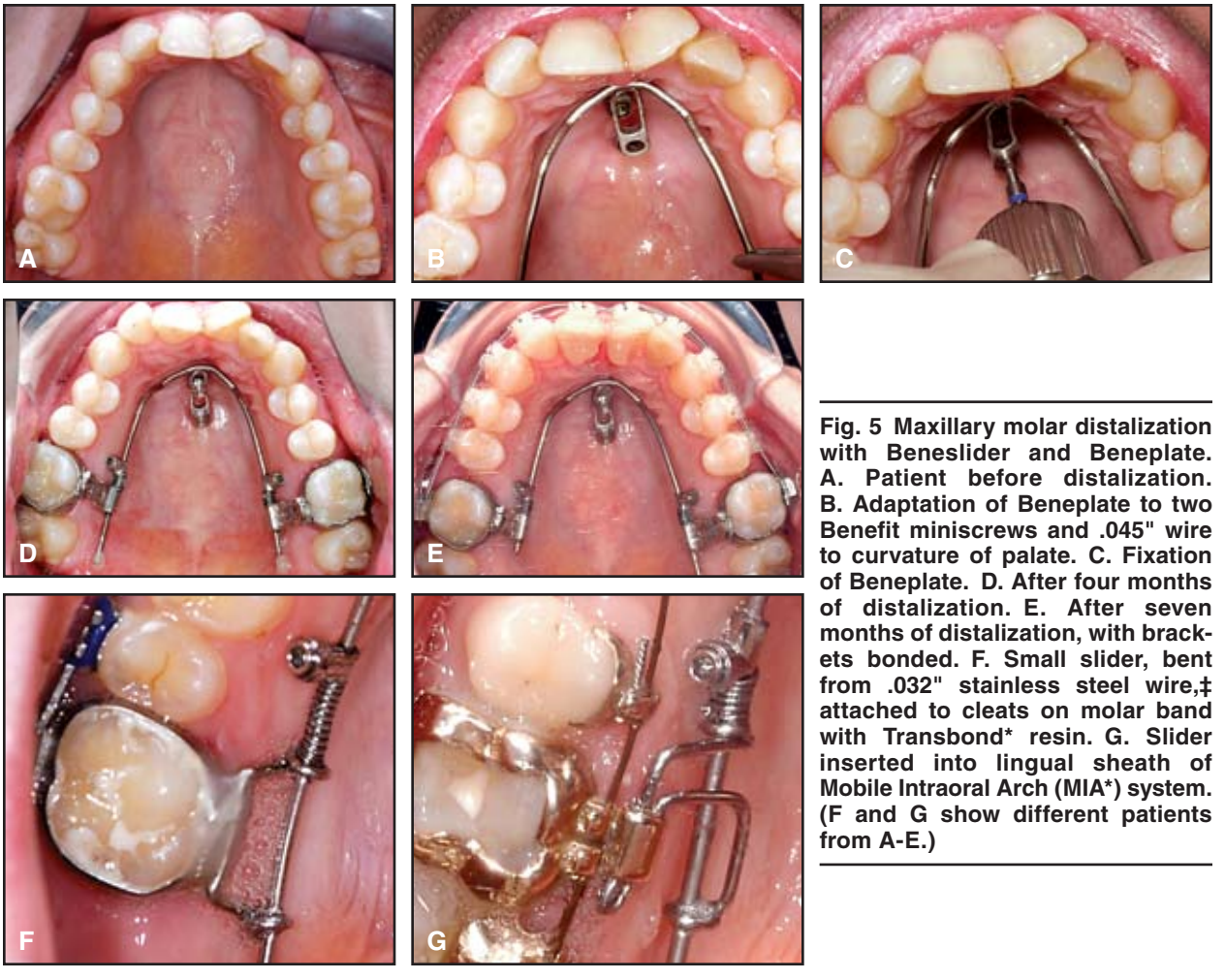

Fig. 5 Maxillary molar distalization with Beneslider and Beneplate. A. Patient before distalization. B. Adaptation of Beneplate to two Benefit miniscrews and .045" wire to curvature of palate. C. Fixation of Beneplate. D. After four months of distalization. E. After seven months of distalization, with brackets bonded. F. Small slider, bent from .032" stainless steel wire,‡ attached to cleats on molar band with Transbond* resin. G. Slider inserted into lingual sheath of Mobile Intraoral Arch (MIA*) system. (F and G show different patients from A-E.)

In many cases the Beneplate can be adapted intraorally, using dental floss to hold it in place. This does require some chairtime, however. The alternative is to adapt the miniplate in the laboratory by taking an impression and transferring the intraoral setup to a plaster cast, using the impression cap and the laboratory analog from the Benefit system[20] (Fig. 1B). An alginate impression is generally precise enough for this purpose.

Clinical Applications

Maxillary Molar Distalization

Although indirect anchorage can be used to support the premolars during maxillary molar distalization, miniscrew tipping and wire deformation may result in anchorage loss and premolar mesial migration. Moreover, after molar distalization, the appliance must be reconstructed to distalize the premolars and anterior teeth.

Therefore, we prefer to use direct anchorage with the Beneslider molar-distalization appliance,[20,24] which combines elements of the Distal Jet†[25,26] and the Keles Slider[27] (headgear tubes‡). After two Benefit miniscrews are inserted, the Beneplate with the .045" stainless steel wire (Fig. 3F) is adapted (Fig. 5B). The Beneplate is then secured (Fig. 5C) by tightening its miniature fixing screws (Fig. 3D) sufficiently with the Benefit screwdriver (Fig. 1H) to prevent loosening. Molar bands with headgear tubes are slid onto the .045" wire from the distal, and active force is applied with two 240g nickel titanium springs.† Because the premolars and canines will drift distally due to the pull of the transseptal fibers, small spaces will open (Fig. 5D,E). As an alternative to headgear tubes, we bend small sliders from .032" stainless steel wire‡ and connect them to the cleats of the molar bands with Transbond resin (Fig. 5F), or insert them into the lingual sheaths of the Mobile Intraoral Arch (MIA*) system (Fig. 5G).

Although the Beneslider produces distal movement with excellent bodily guidance of the molars, friction will result in a relatively long treatment time of eight to 10 months for 4-5mm of distalization.[24] For low-friction mechanics, we use Pendulum-type mechanics or a horseshoe arch in combination with the Beneplate (Fig. 6).

Maxillary Space Closure

In patients with missing maxillary lateral incisors involving bilateral space closure, the Beneplate stainless steel wire can be bonded to the lingual surfaces of the maxillary central incisors for indirect anchorage (Fig. 4). The main goal is to preserve appropriate overjet during space closure.

When unilateral mesialization is needed to

†American Orthodontics, Inc., 1714 Cambridge Ave., Sheboygan, WI 53081; www.americanortho.com.

‡Dentaurum USA, 10 Pheasant Run, Newtown, PA 18940; www.dentaurum.com.

*3M Unitek, 2724 S. Peck Road, Monrovia, CA 91016; www.3Munitek.com. Transbond is a trademark.

Fig. 6 Low-friction distalization mechanics. A. Beneplate with .032" TMA wire (Fig. 3E) inserted into lingual sheaths of MIA system for use with Pendulum B. B. Beneplate with palatal screw (Fig. 3B) connected to two .032" TMA wires with acrylic resin for use with Pendulum B; appliance can be reactivated by turning screw. C. Beneplate with wire oriented distally and connected to horseshoe arch with elastic chains, producing distal forces at molars.

correct a midline shift, direct anchorage should be used. Friction allows the midline shift to be corrected as the spaces are closed (Fig. 7). Alternatively, the Mesial Slider[20] is a direct-anchorage device that can be used to close space in the upper arch from the distal, as needed, for example, in cases of agenesis of the maxillary second premolars (Fig. 8) or lateral incisors. We use 200g nickel titanium springs† as the active elements. The slider's bodily molar guidance eliminates the need to band the other teeth.

†American Orthodontics, Inc., 1714 Cambridge Ave., Sheboygan, WI 53081; www.americanortho.com.

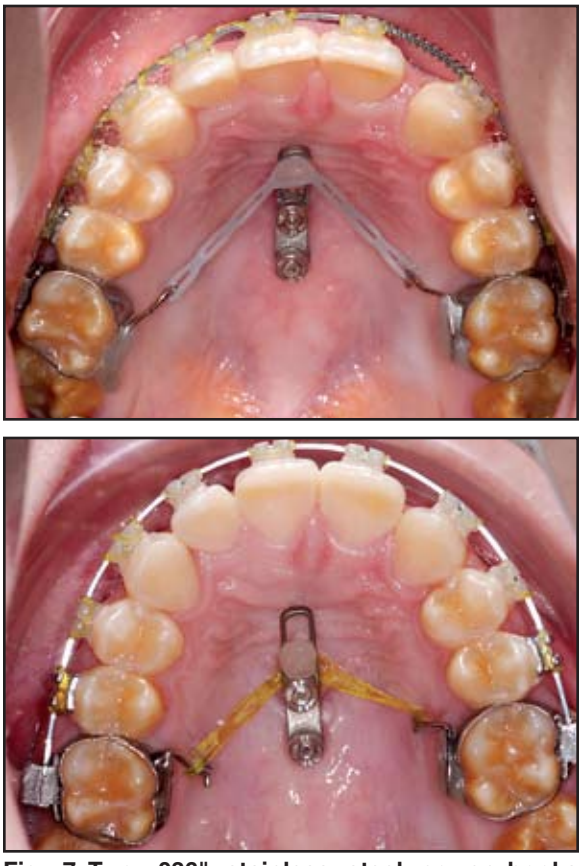

Fig. 7 Two .036" stainless steel power hooks bonded palatally to molar bands with Transbond; elastic chains with varying forces attached to Beneplate. Friction results in correction of midline shift as spaces close.

Asymmetrical Molar Distalization and Space Closure

Many patients with unilaterally missing teeth have deviated midlines. The Mesial-Distal Slider can be used to correct a midline shift, close the space on one side, and distalize the contralateral segment (Fig. 9).

Other Applications

The Beneplate with metal bracket (Fig. 3A) can be used to provide stable anchorage in the anterior palate for other tooth movements. For molar intrusion, an .016" × .022" stainless steel sectional wire is ligated to the bracket, and an

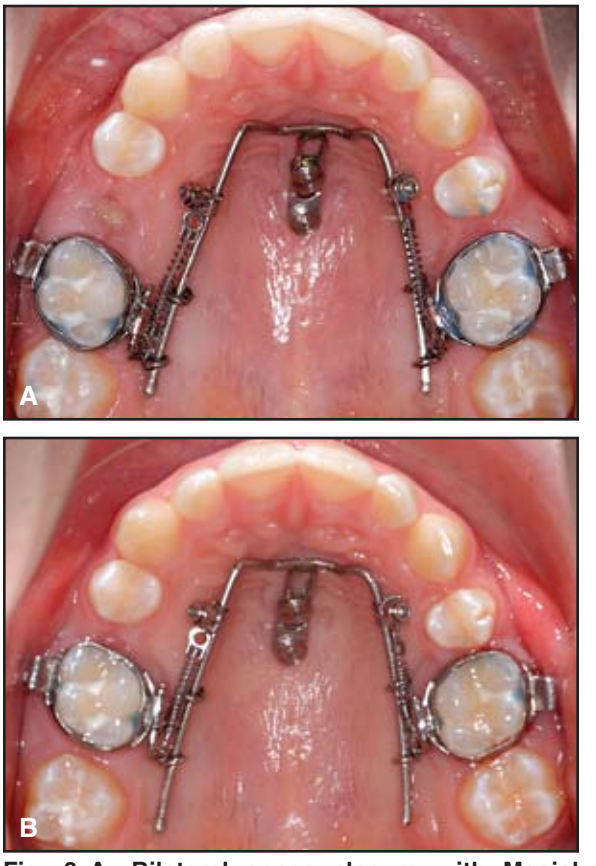

Fig. 8 A. Bilateral space closure with Mesial Slider[20] in patient with agenesis of maxillary second premolars; active force applied with 200g nickel titanium springs.† B. After two months of treatment.

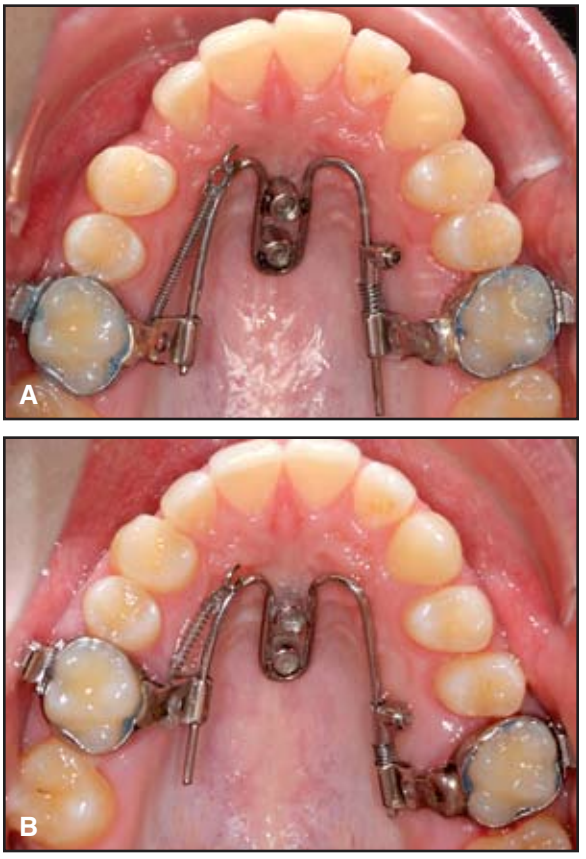

Fig. 9 A. Asymmetrical molar distalization (left side) and space closure (right side) using Mesial-Distal Slider in patient with missing maxillary right canine and midline shift. B. After seven months of treatment.

Fig. 10 Beneplate with metal bracket (Fig. 3A) used to provide stable anchorage for intrusion of overerupted maxillary right first molar; .016" × .022" stainless steel sectional wire is ligated to Beneplate bracket, and intrusive force is applied palatally to maxillary right first molar. Goshgarian palatal bar prevents molar tipping.

intrusive force is applied palatal to the extruded molar (Fig. 10). A Goshgarian transpalatal bar will prevent molar tipping.

The Beneplate can also be used for maxillary molar anchorage. The mechanics are similar to those of the Beneslider, but with no active elements (Fig. 11).

Another use is for skeletal retention after expansion with the tooth- and bone-borne hybrid Hyrax‡ (Fig. 12).[20] Anterior dental anchorage is often inadequate for rapid maxillary expansion because of missing deciduous teeth or premolars with underdeveloped roots. In addition, if the premolars have just erupted, heavy forces may result in root damage or curvature. In these cases, we use the hybrid Hyrax. Anterior skeletal anchorage for the expansion is provided by two 2mm × 7mm Benefit miniscrews, placed about 5mm apart. The skeletal anchorage seems to minimize mesial migration of maxillary teeth, especially when simultaneous maxillary protraction with a face-

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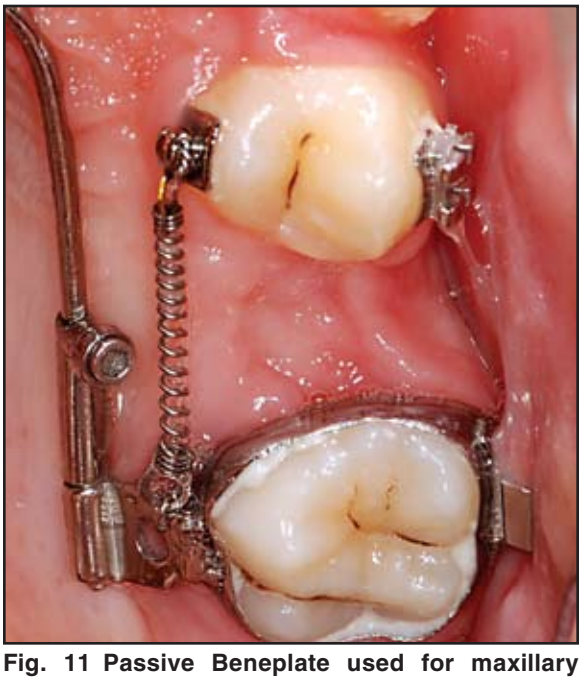

Fig. 11 Passive Beneplate used for maxillary molar anchorage.

Fig. 12 A. Patient before rapid maxillary expansion with hybrid Hyrax‡ anchored by two 2mm × 7mm Benefit miniscrews. B. After 14 days of expansion. C. Skeletal retention using anterior anchorage provided by Beneplate.

mask is planned.

A Benefit miniscrew in the anterior palate provides sufficient anchorage to align an impacted anterior tooth.[20] Two coupled miniscrews in the anterior palate are recommended to compensate for the larger tipping moments generated by the alignment of posterior teeth (Fig. 13).

Discussion

Coupling two miniscrews in the line of force has allowed us to dramatically minimize our miniscrew failure rate, from 17.8% (41 of 230) to 6.2% (18 of 288, including all insertion sites). This coupling could be accomplished using miniscrews with abutments, as in the Benefit system, but the Beneplate eliminates the need for indirect transfer and laboratory work.

Although the miniscrews were inserted in the midpalatal suture area in the patients shown here, including the adolescents, our failure rate in these cases has been notably low. We have measured maximum insertion moments of 8-25Ncm for miniscrews placed in the anterior and medial suture regions, which can be considered adequate to achieve sufficient primary stability.

The question of whether miniscrews in the midpalatal suture may affect the growth of the maxilla was investigated by Asscherickx and colleagues, who observed an inhibition of transverse maxillary growth after the insertion of two Orthosystem‡‡ implants into the sutures of dogs.[28] In this study, however, only one control animal was available, and only one parameter was found to be different between the control and study samples.[29] Moreover, because Orthosystem implants have a larger diameter than miniscrews and a rough surface, the relevance of these results to miniscrew anchorage is questionable. We have not seen any signs of inhibited transverse maxillary growth in our practice, but further studies are needed to investigate this issue in more detail. If desired, the miniscrews can be inserted as far as 3mm lateral to the suture, as long as the bone quantity is sufficient.[30]

In a patient with reduced bone height in the anterior palate, miniscrews as long as 11mm may penetrate the nasal cavity. Complications are unlikely and have not occurred in any of our patients, although some patients have reported itching of the nose at the time of insertion.

Conclusion

The Beneplate system expands skeletal-anchorage options in orthodontic treatment and significantly improves miniscrew stability. The anterior palate is our preferred insertion region because of its superior bone quality and relatively low incidence of failure or loosening, as well as its elimination of the risk of tooth or root damage. Insertion and removal are minimally invasive: orthodontists can place the screws themselves and load them immediately. The screws can usually be removed without anesthesia.

‡‡Registered trademark of Straumann USA, LLC, 60 Minuteman Road, Andover, MA 01810; www.straumannusa.com.

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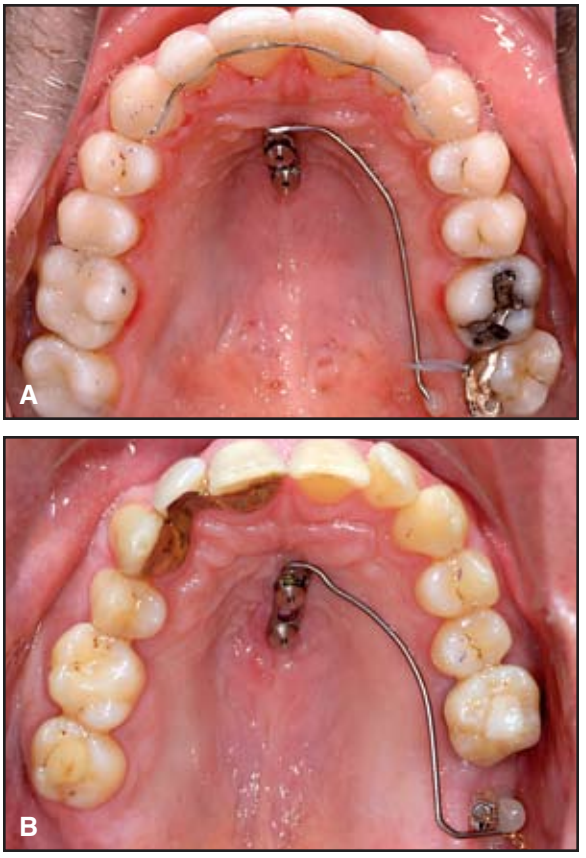

Fig. 13 Alignment of posterior teeth with Beneplate, using only half of attached .032" TMA wire. A. Intrusion and palatal movement of maxillary left third molar after mesialization. B. Extrusion of impacted maxillary left third molar.

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