A Palatal Locking Plate Anchor for Orthodontic Tooth Movement

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A recently developed titanium locking plate for orthognathic surgery, designed to prevent screw movement and loosening,[1] can also be effective in orthodontic treatment (Fig. 1). The palatal locking plate anchor (PLPA) can be used as skeletal anchorage for a wide variety of tooth movements (Fig. 2), as described in this article.

Appliance Design and Placement

The PLPA, a three-hole locking plate* measuring 15mm long, 4.5mm wide, and 1mm deep, is attached with three self-tapping, self-drilling screws, each 2mm in diameter and 10mm long. The plate needs no adjustment in most cases, but can be adapted to conform to the patient's palatal surface if necessary.

The PLPA is placed under local anesthesia. Because the risk of penetrating the nasal or sinus floor is greater on the sides of the palate, we recommend insertion along the midpalatal suture in the anteroposterior direction. The first screw should be threaded through the middle hole of the locking plate before placement in the mouth. Using a surgical screwdriver to control both speed and torque, the screw is then inserted directly through the palatal mucosa between the maxillary first molars. The screw should be turned slowly into the palatal bone, with the plate revolving around it. Drilling is stopped when the plate lies 2-3mm away from the palatal mucosa; with a pitch of .75mm between screw threads, this distance is indicated by three or four threads showing above the plate. If there is inadequate clearance for the locking plate to spin freely, the plate can be held 2-3mm from the palatal surface using a forceps or plier while the screw is inserted. If the palatal bone at the insertion point is especially dense, a pilot hole can be created with a 1.5mm-diameter drill.

The second and third screws are inserted through the remaining holes of the palatal plate. Again, pilot holes can be drilled if necessary. To prevent bending of the locking plate toward the

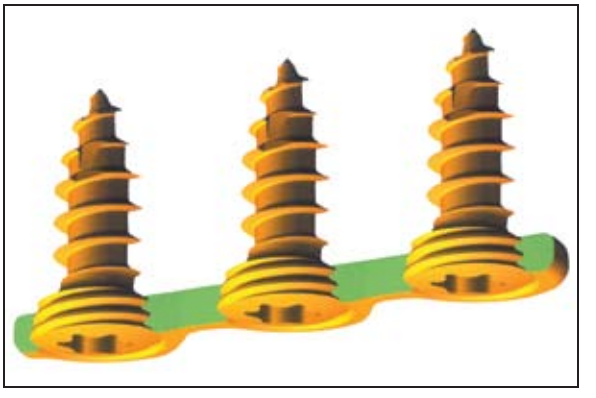

Fig. 1 Palatal locking plate anchor (PLPA) fixed over midpalatal mucosa, 2-3mm from palatal surface, with three double-threaded bone screws.

*Compact Lock 2.0, Synthes K.K., Ebisu Business Tower 4F, 1-19-19 Ebisu, Shibuya-ku, Tokyo 150-0013, Japan; www.synthes.com.

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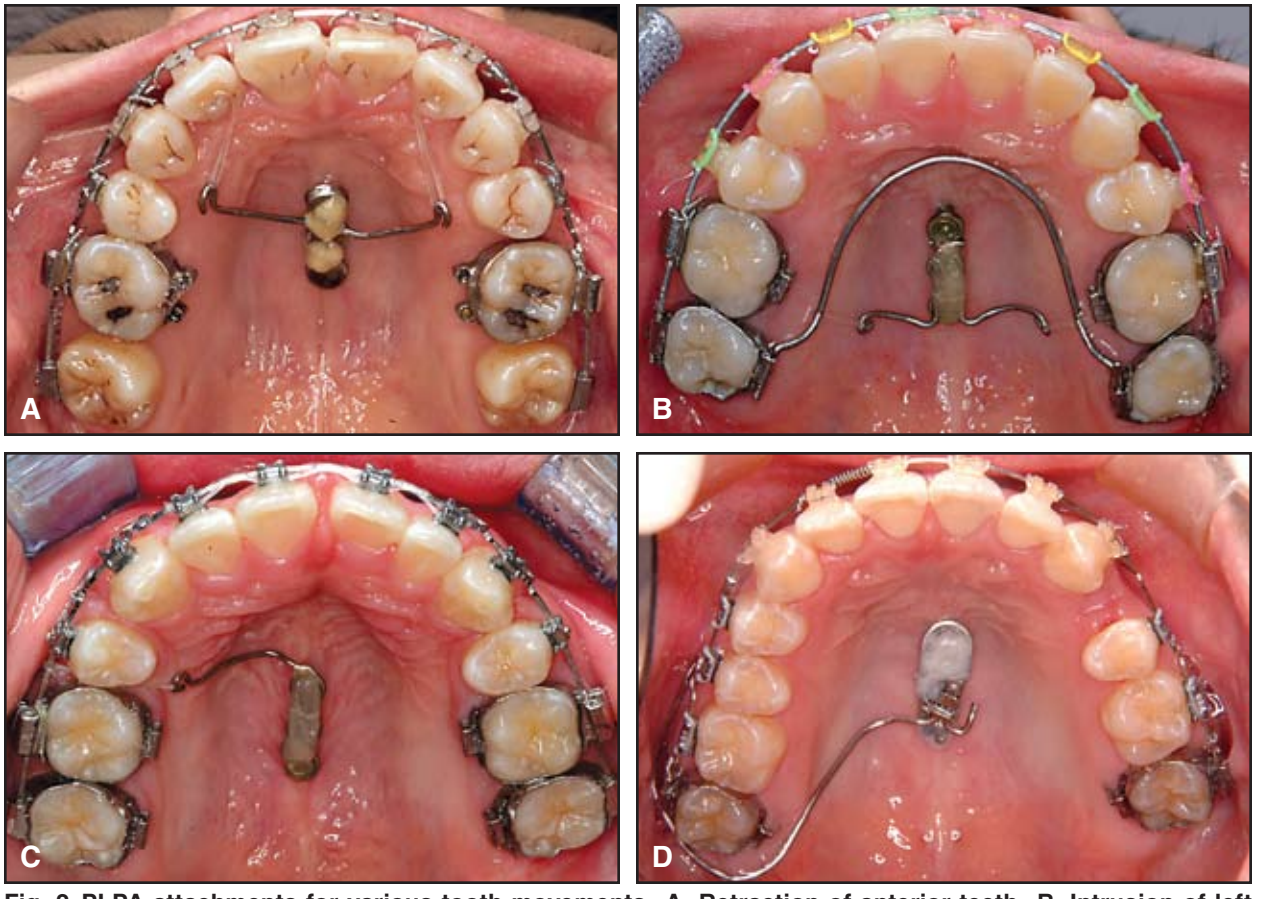

Fig. 2 PLPA attachments for various tooth movements. A. Retraction of anterior teeth. B. Intrusion of left and right molars. C. Lingual movement of right molars. D. Distalization of right maxillary arch.

palatal surface at both ends, the anterior and posterior portions of the locking plate can be bent slightly in the opposite direction in advance, using a scaler or plier.

This screw system achieves extremely rigid fixation of the PLPA to the palatal bone surface. Various types of attachments can then be applied between the PLPA and the orthodontic fixed appliance (Fig. 2). The attachments are usually made in the laboratory from stainless steel wire and affixed to the PLPA in the mouth with ligature wire. Acrylic resin should be added around the ligature wire and PLPA to prevent loosening and to avoid tongue irritation.

Fig. 3 Case 1. 18-year-old female patient with maxillary anterior protrusion before treatment.

Case 1

An 18-year-old female presented with maxillary anterior protrusion, a Class II molar relationship, 12.5mm of overjet, 2mm of overbite, and a bilateral buccal crossbite of the second molars (Fig. 3). The patient had a convex profile with a protrusive upper lip. Cephalometric analysis showed a skeletal Class II relationship (ANB = 5.1°), a mesofacial pattern (SN-MP = 36.0°, FMA = 27.8°), and protrusive upper incisors (U1-SN = 116.7°).

The treatment plan was to extract the maxillary first premolars and retract the maxillary anterior teeth. Because improvement of the interincisal angle and the upper lip protrusion required maximum retraction, the PLPA was chosen to provide skeletal anchorage for en masse tooth movement.

After six months of leveling with upper and lower fixed appliances, the PLPA was implanted (Fig. 4). To prevent mesial movement of the upper molars, the upper first molars were anchored to the PLPA with .036" copper chromium wire, which was secured with ligature wire to the anterior and posterior screws, and acrylic resin was added over the attachment points. The upper anterior teeth were sufficiently retracted without loss of anchorage.

After 28 months of treatment, the fixed appliances were removed, and bonded lingual retainers were placed. Good intercuspation was achieved with a Class II molar relationship, and the upper lip protrusion was substantially improved (Fig. 5).

Case 2

A 16-year-old female presented with a missing maxillary left second premolar and first molar due to periapical lesions (Fig. 6). Orthodontic distalization of the maxillary left second molar was required to produce the additional 3mm of space needed for placement of two dental implants

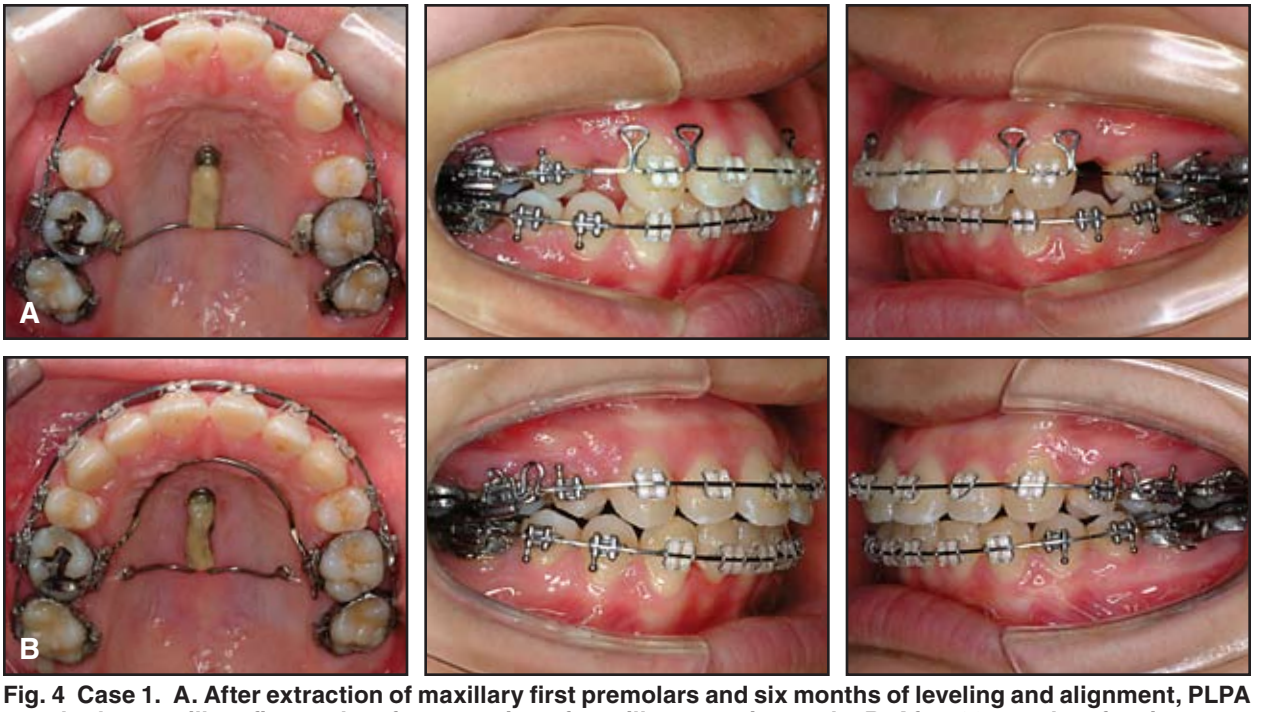

Fig. 4 Case 1. A. After extraction of maxillary first premolars and six months of leveling and alignment, PLPA attached to maxillary first molars for retraction of maxillary anterior teeth. B. After 23 months of active treatment, maxillary molars intruded with PLPA to achieve proper intercuspation.

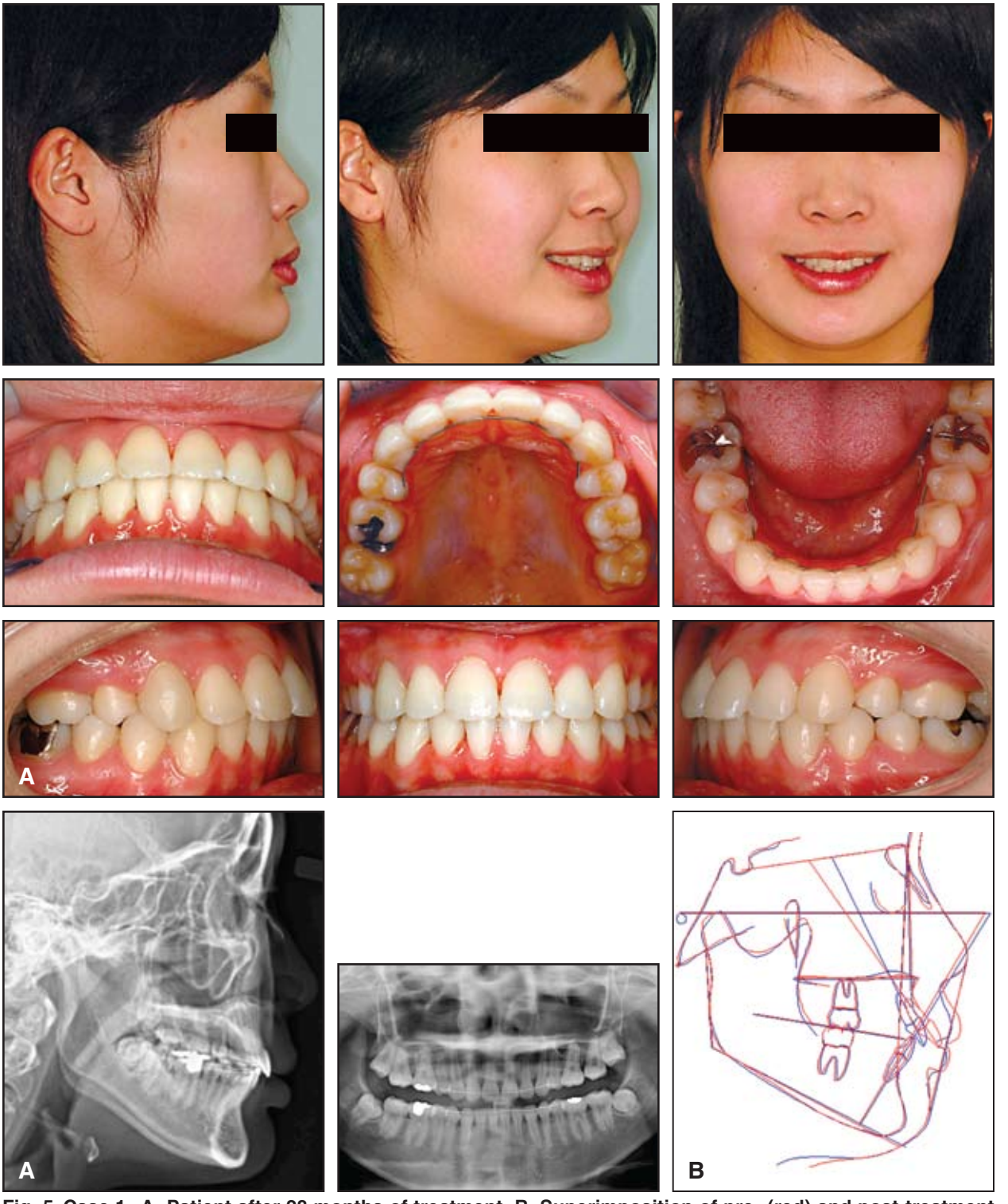

Fig. 5 Case 1. A. Patient after 28 months of treatment. B. Superimposition of pre- (red) and post-treatment (blue) cephalometric tracings, showing retraction of maxillary incisors with no mesial movement of molars; U1-SN angle was reduced from 116.7° to 107.7°.

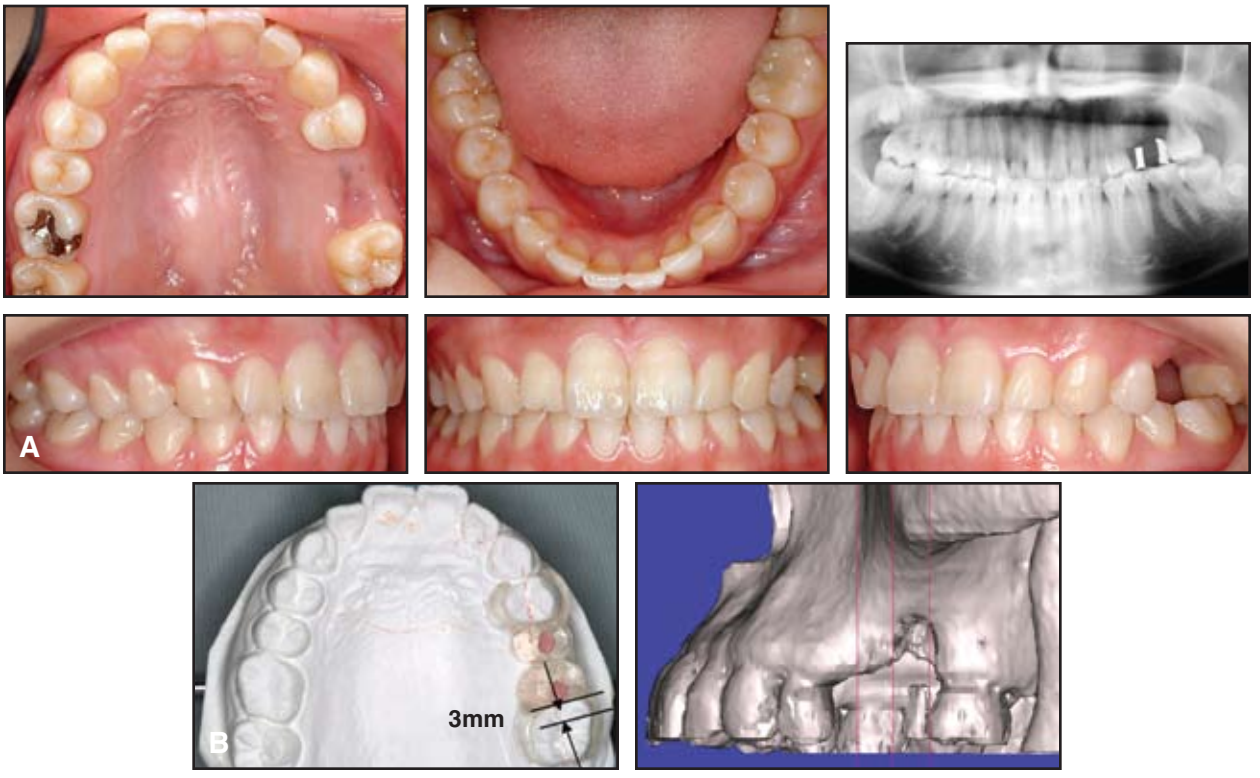

Fig. 6 Case 2. A. 16-year-old female patient with missing maxillary left second premolar and first molar before treatment. (Radiograph taken with surgical template incorporating two metal markers for dental implants.) B. Opening space for implants required 3mm of maxillary second molar distalization. Pink vertical lines on CT scan indicate planned positions of dental implants.

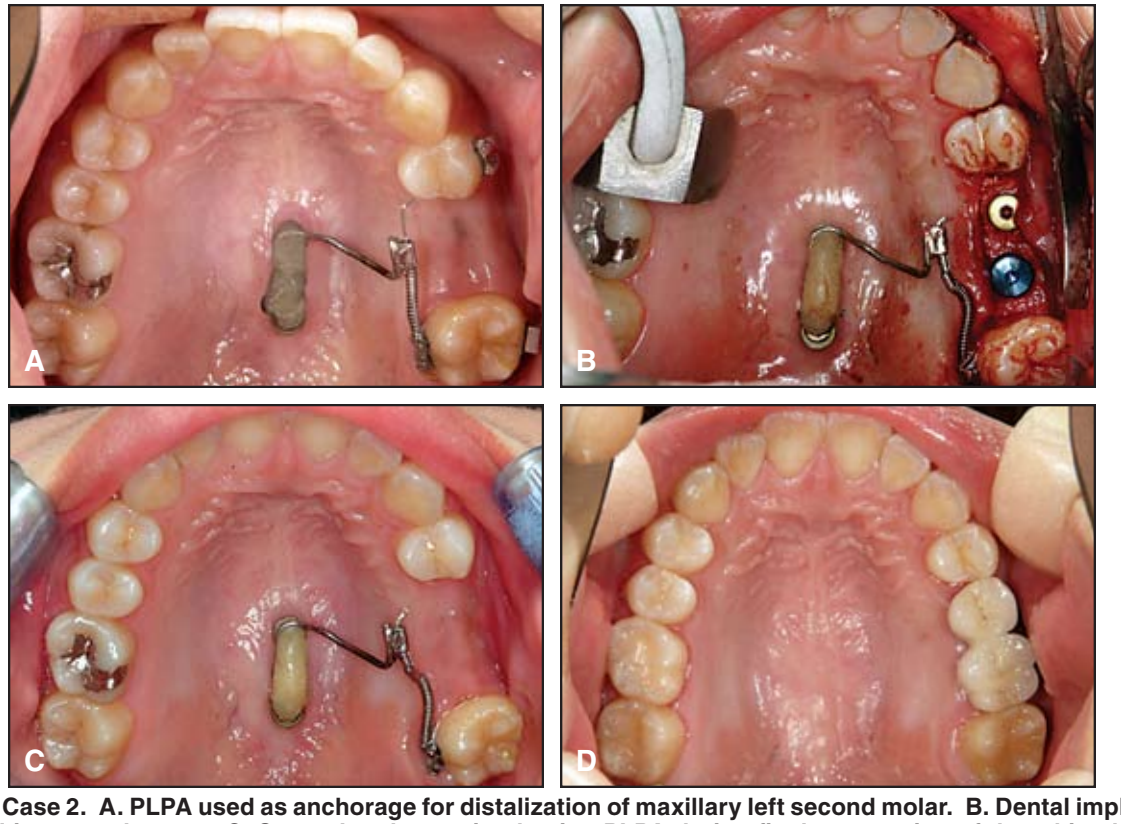

Fig. 7 Case 2. A. PLPA used as anchorage for distalization of maxillary left second molar. B. Dental implants placed in opened space. C. Second molar retained using PLPA during final preparation of dental implants. D. Final restoration of second premolar and first molar.

prior to prosthodontic restoration.

A PLPA was implanted into the midpalatal region and connected to an .047" copper chromium arm. At the other end of the wire, an .018" × .025" rectangular tube was soldered in the same orientation as the second molar tube (Fig. 7). After 3mm of space had been opened mesial to the maxillary second molar, two osseous dental implants were placed.

Discussion

We have used the PLPA in more than 130 cases over the past six years. Only three of these cases required removal of the device due to loosening—a success rate of more than 97%, which is remarkably high compared to previous studies of bone screws used for orthodontic anchorage.[2,3] Park and colleagues found that miniscrews had a greater success rate in the palatal area (100%) than in the retromolar area, in buccal alveolar bone, or in anterior alveolar bone.[3] The midpalate is especially suitable for temporary skeletal anchorage because of its relatively thin soft tissue and thick cortical bone.[4]

Studies have shown that inflammation around dental implants can damage the surrounding bone and cause implant failure,[5,6] and that such inflammation can be prevented by implanting the bone screws in keratinized mucosa.[7,8] Placement in the midpalatal area, where the thinner soft tissue is covered by keratinized mucosa, allows the self-drilling screws of the PLPA to be inserted directly without mucoperiosteal flap surgery, as required by previously described bone plates.

To ensure successful placement, the bone thickness in the midpalatal area should be assessed radiographically. It has been suggested that vertical bone support can be at least 2mm higher than it may appear on a cephalogram.[9] With the PLPA, considering a locking-plate thickness of 1mm, another 2-3mm of space beneath the appliance, and a mucosal thickness of 1-2mm, about 4-6mm of a 10mm screw will be inserted into the palatal bone. When radiographic assessment indicates insufficient bone thickness at the posterior aspect of the midpalatal area, an 8mm screw should be used. Even if slight bony perforation occurs, the thick nasal mucosa will prevent contact with the nasal cavity.[9] None of our patients has shown any sign of bleeding from the nasal cavity.

Conclusion

The advantages of the PLPA are:

- Rigid fixation through the thin mucosa and the thick, highly calcified cortical bone of the midpalatal area.
- Relatively simple surgical procedure, requiring less instrumentation than with other bone plates.
- Flexibility in the direction of application and magnitude of orthodontic force.
- Reduction of peri-implant inflammation compared to similar anchorage systems.
- Minimal risk of damage to nerves, vessels, and dental roots.
- Compatibility with fixed lingual appliances.
- Capability of being used as anchorage for mesiodistal movement of the entire arch, which is impossible with interradicular miniscrews.

The PLPA does have several disadvantages, including the need to fabricate an attachment between the device and the orthodontic fixed appliance, the complexity of the resulting force system, and the potential for tongue irritation. In addition, Asscherickx and colleagues noted the possibility of a restriction of normal maxillary anterior transverse expansion from skeletal-anchorage implants placed in the midpalatal suture.[10] In a study of young adults age 18-25, however, Knaup and colleagues reported a median midpalatal sutural width of 211.2 microns,[11] which may be narrow enough to allow safe engagement with a 2mm-diameter bone screw.

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