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Genioglossus muscle advancement techniques for obstructive sleep apnea

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Genioglossus muscle advancement is a viable adjunctive procedure in the reconstruction of the upper airway. The author has not experienced the complications of osseous segment necrosis, and with appropriate drain placement with the anterior mandibular osteotomy and trephine osteotomy techniques, the risk of infection is low. Neurosensory changes and dental-pulp necrosis may occur, therefore, patients must be informed accordingly.

The role of the genioglossus muscle in posterior airway occlusion has been investigated at length [1–3]. A study of 10 obstructive sleep apnea (OSA) patients and 4 symptom-free controls found that during subsequent tidal breathing, the timing of the genioglossus onset progressively decreased after the onset of inspiration until the next OSA occurred [4]. This finding suggests that the timing relationship between genioglossus inspiratory activity and inspiratory effort is physiologically important in the pathogenesis of OSA. The rationale for advancement of the genioglossus muscle is as follows: the hypopharyngeal airway is stabilized by the forward movement of the genial tubercle and genioglossus muscle, which places tension on the base of tongue thereby decreasing the probability it will prolapse into the posterior airway space during sleep [5,6].

The functional genioplasty for surgical reconstruction of the upper airway (UA)was first described by Riley et al [6] as the inferior sagittal osteotomy (ISO). The hyoid was also suspended and fixed to the inferior border of the mandible as an adjunct to the genioglossus advancement. This technique was referred to as genioglossus advancement-hyoid myotomy. In a later study, the hyoid suspension was modified by suturing the hyoid to the thyroid cartilage [7]. The ISO was modified by Powell and Riley [5] because of an increased number of midline mandibular fractures; however, this osteotomy and all future modifications of the technique maintained the same objective: advancement of the genial tubercle and genioglossus muscle. The ISO was then modified and described by Riley et al [5] to retain continuity of the inferior border of the mandible by limiting the osteotomy to a rectangular window, including the genial tubercle. This osteotomy is called an anterior mandibular osteotomy (AMO). Further modification of this procedure was described by Lee and Woodson [8] as a circular osteotomy of the genial tubercle. All procedures have the same objective of ultimate stabilization of the hypopharyngeal airway by advancing the genioglossus muscle. Johnson and Chinn [1] reported a positive response rate of 77.8% in nine patients treated with a combination of UA procedures and genioglossus muscle advancement. Lee et al [2] reported a positive response rate of 69% in 35 patients treated with UA procedures and genioglossus muscle advancement.

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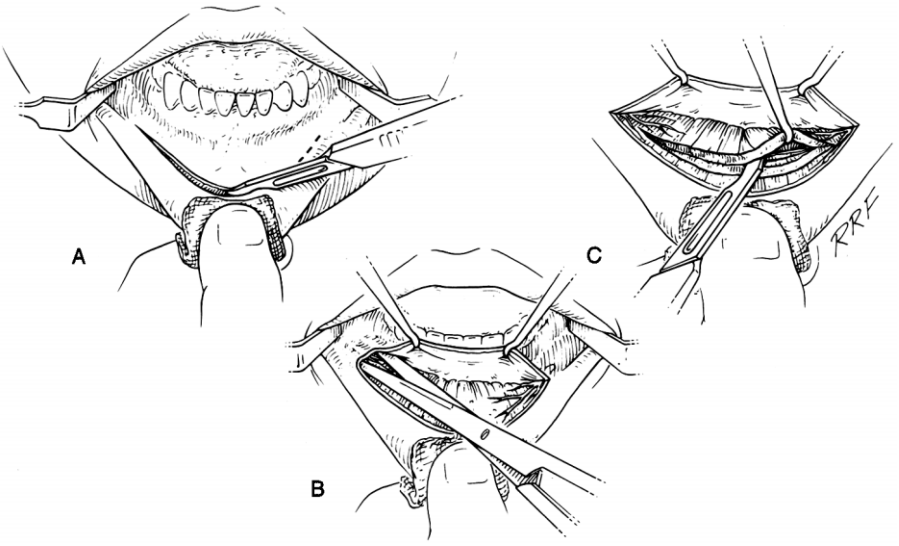

Fig. 1. (A) The mucusal incision. (B) The dissection of the mental nerves. (C) The full-thickness periosteal incision. (*From* Lee NR. Genioplasty techniques. Oral Maxillofacial Surg Clin N Am 2000;12:755–63; with permission.)

Therefore, when combined with other UA procedures, the genioglossus muscle advancement is a viable surgical treatment for OSA.

Inferior sagittal osteotomy

ISO is a technique reserved for the OSA patient with significant anteroposterior deficiencies in the horizontal menton position (microgenia). The inferior border of the mandible is disrupted and advanced with only the dentoalveolar process intact; therefore, a lingual splint is constructed and placed with interdental stainless steel 24-gauge wire. This splint aids in stress-shielding the forces of mastication and is removed in 6 weeks. All patients who undergo this procedure are requested to restrict their diets to nonchewable foods for 6 weeks following the procedure.

The soft tissue approach is the same as for the cosmetic intraoral genioplasty (Fig.1). The osseous midline is scored on the anterior surface of the symphysis. The genial tubercle pedicle is outlined with an oscillating saw in the anterior surface, with emphasis on completion of a full-thickness osseous pedicle that contains the entire genioglossus muscle attachment. The inferior portion of the osteotomy is the same as the

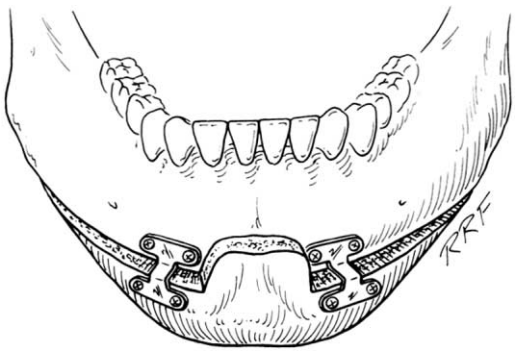

Fig. 2. Inferior sagittal osteotomy to advance the genioglossus musculature for obstructive sleep apnea. (*From* Lee NR. Genioplasty techniques. Oral Maxillofacial Surg Clin N Am 2000;12:755–63; with permission.)

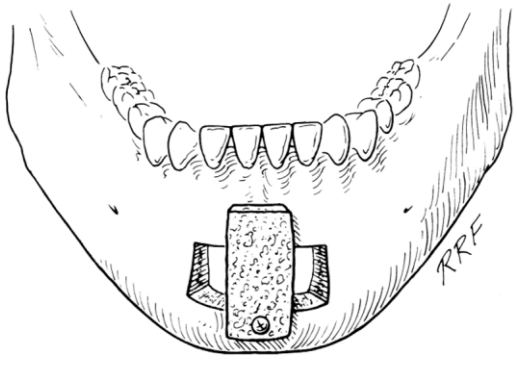

Fig. 3. An anterior mandibular osteotomy showing the advanced and rotated segment, which includes the genial tubercle and genioglossus musculature. (*From* Lee NR. Genioplasty techniques. Oral Maxillofacial Surg Clin N Am 2000;12:755–63; with permission.)

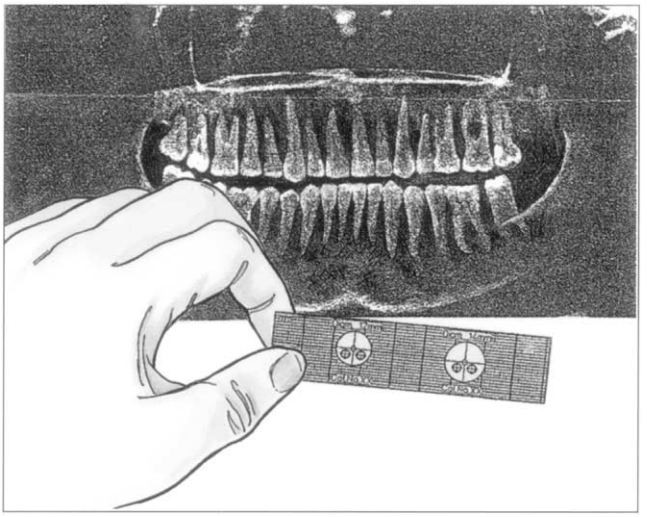

Fig. 4. System sizing. Select the appropriate trephine system (12 or 14 mm) using the radiograph template and panorex X ray. (*From* Stryker-Leibinger; with permission.)

horizontal augmentation genioplasty, extending bilaterally and posteriorly toward the gonial notch region. The osseous pedicle is mobilized and advanced anteriorly full thickness. The lingual cortex superior to the genial tubercle is brought to rest on the lateral plate of the dentoalveolar process with attention to coordination of the midline. Stabilization can be achieved by application of two precontoured chin plates at either side of the midline symphysis tubercle process. Soft tissue closure is accomplished in two layers, mentalis muscle and mucosa (Fig. 2).

Anterior mandibular osteotomy

The AMO technique is reserved for the OSA patient with a normal, horizontal, soft tissue menton position. The objective is the same as for the ISO—to advance the genial tubercle and genioglossus muscle without disruption of the inferior border of the mandible to improve stability of the hypopharyngeal airway.

The soft tissue approach is the same as described for the intraoral genioplasty, except that osseous

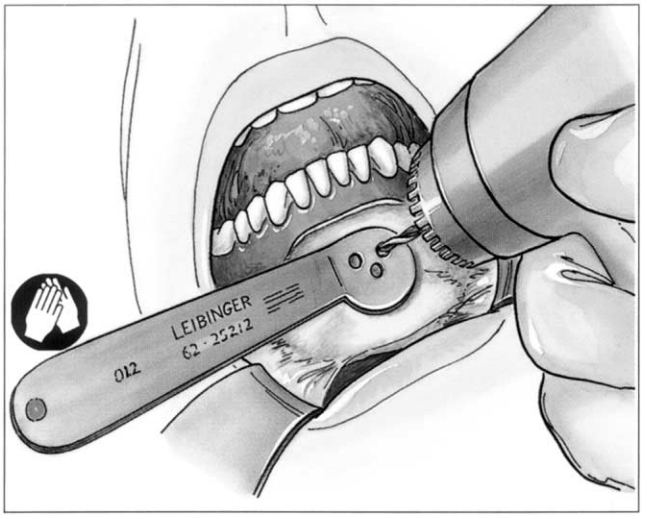

Fig. 5. Drilling pilot hole. Drill two superior 1.5-mm holes for guide-plate placement. (*From* Stryker-Leibinger; with permission.)

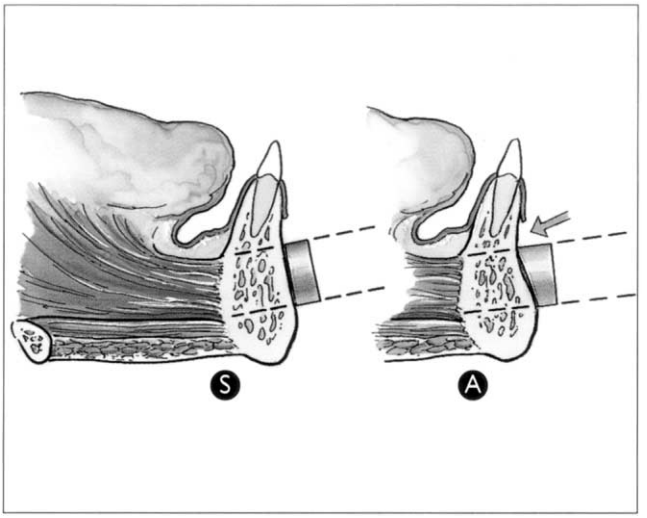

Fig. 6. Guide-plate selection. Choose appropriate guide plate (S, straight; A, angled) depending on tooth root location and genioglossus muscle position. (*From* Stryker-Leibinger; with permission.)

exposure is significantly reduced posteriorly. Periosteal dissection is accomplished posterior to and just distal to the cuspids bilaterally. The mental nerves do not require exposure and neurosensory deficit is minimal. The patient may experience dental-pulp necrosis of the mandibular anterior dentition, and amputation of the cuspid root tips may occur. This complication is treated by endodontic therapy when the tooth is diagnosed as nonvital. The genioglossus muscle attachment is located by lingual palpation. The muscle bundle cannot be palpated through the mylohyoid muscle; however, accurate interpretation of the position of the tubercle can be achieved with the anatomic knowledge that the genial tubercle is approximately 5 to 8 mm inferior to the apices of the mandibular incisors.

A bicortical 2-mm bone screw is placed at the midpoint of the genial tubercle location. A microsagittal oscillating saw is used to complete a rectangular osteotomy, with the screw serving as a

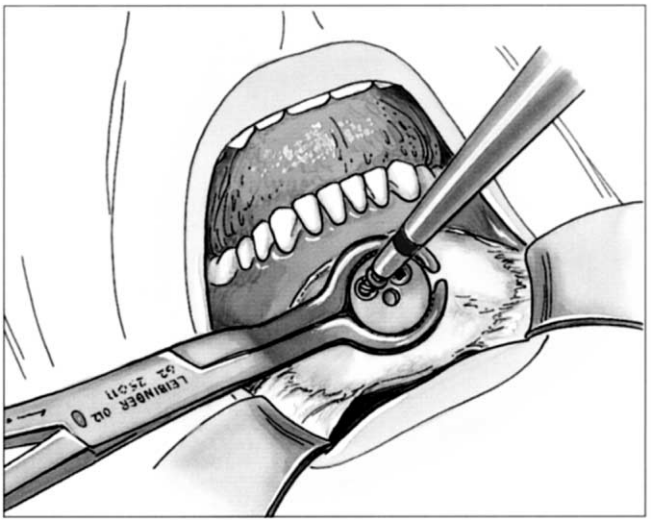

Fig. 7. Guide-plate fixation. Fixate guide plate to mandible using 2.0-mm-diameter bone screws with sufficient length to accommodate guide-plate profile. Alternate placement of the screws to ensure level guide-plate placement. (*From* Stryker-Leibinger; with permission.)

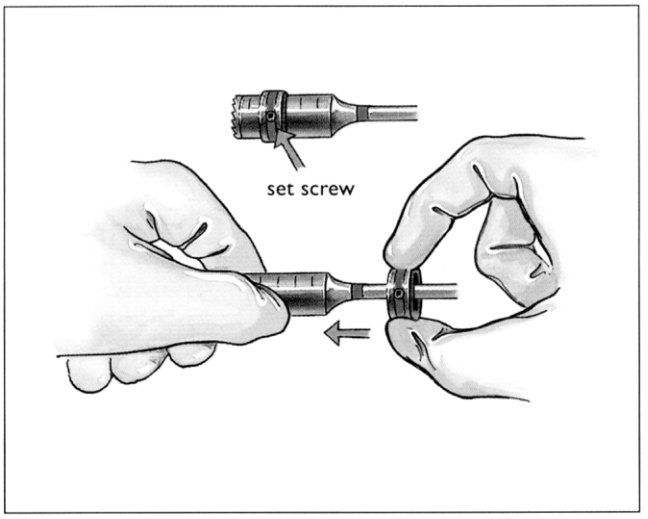

Fig. 8. Trephine stop assembly. Place trephine stop at a depth sufficient to osteotomize inferior border completely. Secure trephine stop by tightening the Square-fit set screw. (*From* Stryker-Leibinger; with permission.)

central guide for a symmetrical segment that contains the genioglossus muscle. Care must be taken not to shorten the lingual plate by excessive angulation of the saw during the osteotomy, with emphasis directed toward parallel walls of the symphysis osteotomy. The bicortical bone screw ensures mobilization of both cortical plates. If the segment does not mobilize, the lingual osteotomy may not be complete and, with force, the lateral cortical plate could fracture with the medullary bone, leaving the lingual plate intact. A bicortical bone screw placement will help prevent this complication. After mobilization, the segment is transpositioned full thickness anteriorly. The lingual cortical plate is then positioned anterior to the lateral cortical plate and rotated 90°. The medullary bone and lateral cortical plate are osteotomized, which leaves the lingual cortical plate and genioglossus muscle attachment. The segment is then stabilized with one unicortical 2-mm bone screw placed in an inferior position. The soft tissue closure is accomplished in two layers, and a 0.25-inch Penrose drain is placed transmucosally and removed in 24 hours. This

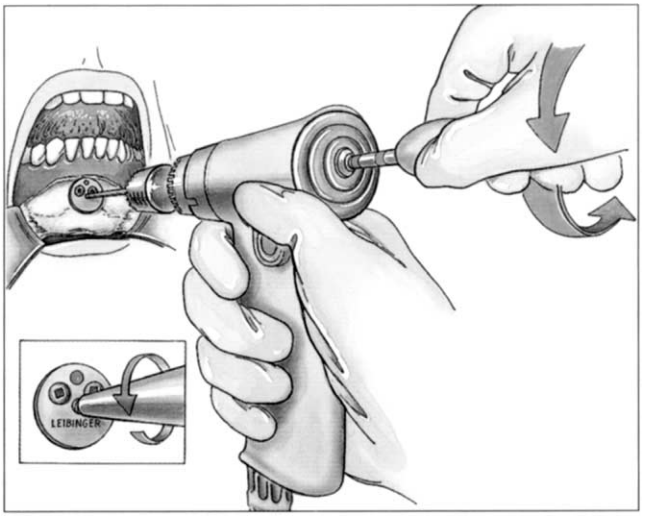

Fig. 9. Guide-rod assembly. Insert guide rod through the back of the minidriver and trephine. Thread guide rod counterclockwise into guide plate. (*From* Stryker-Leibinger; with permission.)

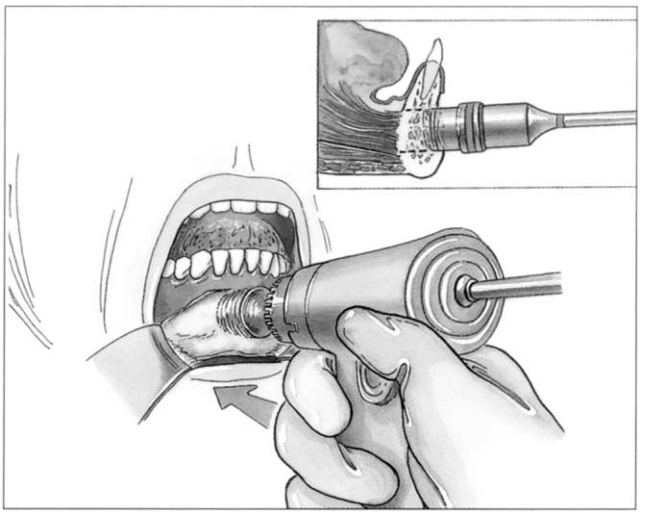

Fig. 10. Beginning the osteotomy. Slide the trephine into place over the guide plate onto the bone and start the minidriver. Never release your grip on the guide-rod handle or operate the minidriver in reverse. Complete the osteotomy with short pumping strokes and copious irrigation. (*From* Stryker-Leibinger; with permission.)

drainage reduces seroma formation. A pressure dressing is then placed on the closure for 48 hours (Fig. 3).

Trephine osteotomy approach

The trephine osteotomy (TOA) technique was designed to reduce the risk of amputation of the cuspid root apex and to simplify the osteotomy design for advancing the genioglossus muscle. The soft tissue dissection is the same as for the AMO technique. The appropriate size template is selected and placed over the lateral aspect of the symphysis at the location for the genial tubercle (Figs.4 and 5) A bicortical hole is drilled and the depth is measured (Fig. 6); the appropriate guide plate is placed and secured with a bicortical screw (Fig. 7). The remaining bicortical screw is then placed to secure the guide plate. The appropriate size trephine is placed with the trephine drill stop placed at the indexed depth of mandible

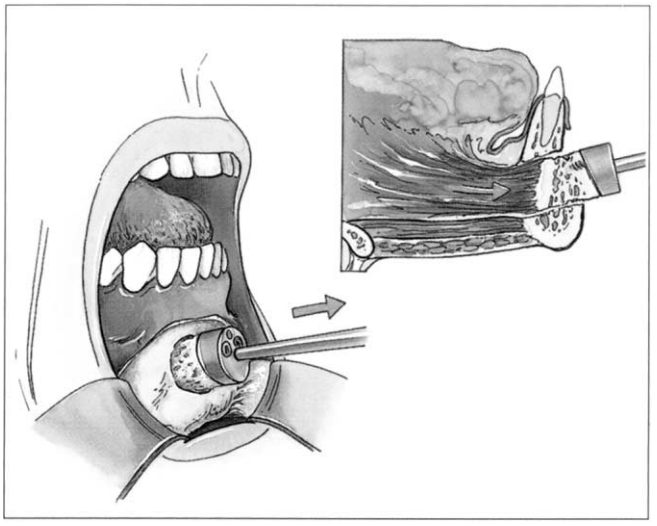

Fig. 11. Segment mobilization. After completion of the osteotomy, transposition the segment anteriorly by pulling out on the guide-rod handle. (*From* Stryker-Leibinger; with permission.)

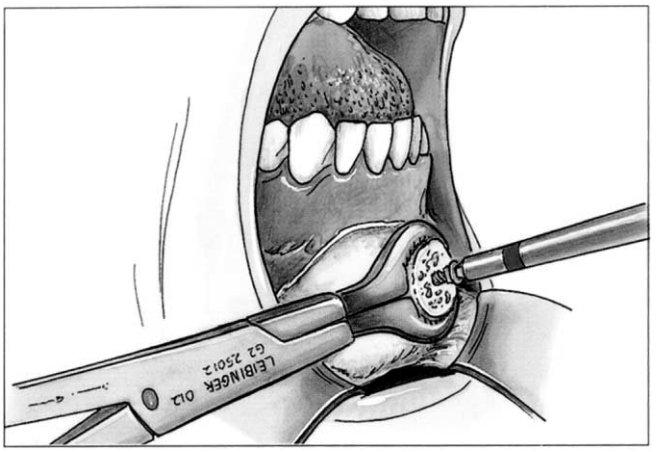

Fig. 12. Screw placement. Place a 2.0-mm-diameter screw in the center hole. Allow sufficient space below the screw head for screw-holding forceps and fixation-plate placement. (*From* Stryker-Leibinger; with permission.)

thickness (Fig. 8). The guide rod is inserted through the minidriver and threaded counterclockwise into the guide plate (Fig. 9). Attention is directed to completing the trephine osteotomy. It is important not to operate the minidriver in reverse and not to release the guide-rod handle, either of which can allow the genioglossus muscle to be avulsed (Fig. 10).

After completion of the osteotomy, the segment is grasped with bone-holding forceps and the guide rod is removed to free the minidriver. The guide rod is rethreaded and the segment is transpositioned anteriorly full thickness (Fig. 11). The segment-holding forceps are then applied to the lingual cortex, and the bicortical screws and guide plate are removed. The medullary bone and lateral plate are osteotomized with an oscillating saw. The template is used to drill and then place a central bone screw (Fig. 12). The screw-holding forceps are placed, and the segment is stabilized with the lingual plate resting in a superior position and overlapping the lateral plate of the symphysis (Fig. 13). An elevator placed in an inferior position may be helpful to maintain segment stability and full-thickness augmentation. The rigid fixation plate is placed, engaging the bone screw into the central groove of the plate. The feet of the plate are secured to the symphysis with bicortical screws, and a lateral screw is placed into the face of the plate to secure the segment. The

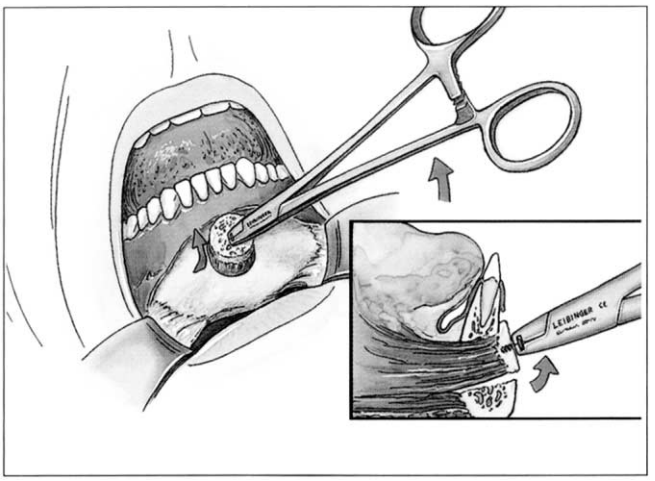

Fig. 13. Positioning bone segment. Transposition the segment anteriorly by sliding the lingual cortex up to rest on the labial cortex. (*From* Stryker-Leibinger; with permission.)

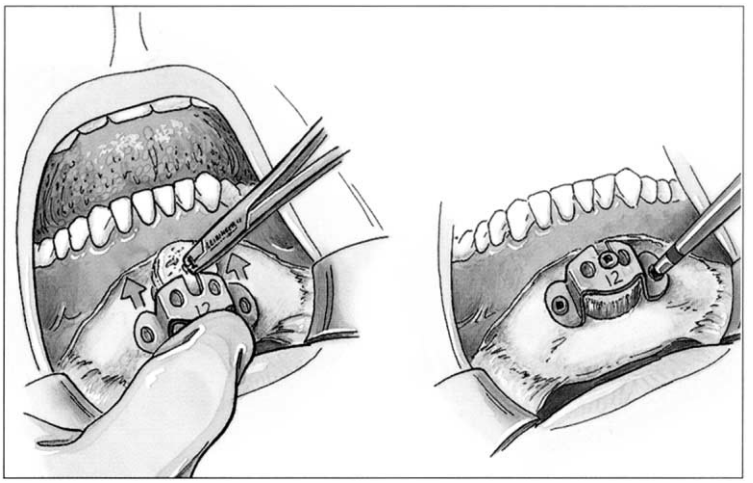

Fig. 14. Plate placement. The gap between the screw-holding forceps and the bone should be sufficient to allow the fixation plate to slide into position. (A) Plate position. Slide the fixation plate up into position so the center screw engages the plate slot. (B) Plate fixation. Place 2.0-mm-diameter fixation screws once bilateral foot-plate holes have been drilled. (Secure bone segment with one lateral segment screw prior to tightening center screw. Do not overtighten center screw.) (*From* Stryker-Leibinger; with permission.)

central screw is then secured to complete the segment stabilization (Fig. 14). The soft tissue closure is the same as that for the AMO closure, with placement of a transmucosal 0.25-inch Penrose drain. The drain is removed after 24 hours.

Summary

Genioglossus muscle advancement has been reported on extensively and remains a viable adjunctive procedure in the reconstruction of the UA. The author has not experienced the complications of osseous segment necrosis, and with appropriate drain placement using the AMO and TOA techniques, the risk of infection is low. Neurosensory changes and dental-pulp necrosis may occur, however, and patients must be informed accordingly.

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