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Genioglossus Advancement: Technique Modification for Improved Chin Contour

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Summary: Genioglossus advancement plays an important role in the armamentarium of the obstructive sleep apnea surgeon and has gone through many iterations over several decades. A recently described technique involves creating a box osteotomy, which is carried through the inferior border of the mandible in order to increase recruitment of the suprahyoid musculature. Here we introduce a further modification of the technique that uses virtual planning to improve the safety and accuracy of genial tubercle capture. In addition, angulation of the lateral osteotomies enhances bone to bone contact. Before the osteotomy, the surgeon has the opportunity to drill the buccal plate to reduce the chin profile. This approach is particularly valuable in the patient who is prognathic at baseline or who becomes prognathic after simultaneous maxillomandibular advancement. Here we discuss this unique approach, demonstrating how the patient profile may be balanced even as the genial tubercle is advanced. *(Plast Reconstr Surg Glob Open 2023; 11:e4846; doi: 10.1097/GOX.0000000000004846; Published online 8 March 2023.)*

INTRODUCTION

Moderate to severe obstructive sleep apnea (OSA) is exceedingly common, affecting an estimated 425 million adults.[1] Although positive airway pressure is the first line treatment,[2] many cannot tolerate positive airway pressure and consider surgical intervention such as genioglossus muscle advancement (GA).[3,4] This procedure involves advancing the genioglossus muscle, increasing tension at the base of the tongue, and decreasing the risk of tongue prolapse into airway during sleep.[5–8] A recent meta-analysis of GA for treatment of OSA found that this surgery alone can reduce apnea-hypopnea index by a mean of 41.7%.[9]

A variety of GA techniques have been described, including the rectangular osteotomy,[10] trapezoid osteotomy,[11] elliptical window GA,[12] trephine osteotomy,[13] and the mortized genioplasty.[14] The variety of techniques attest to the challenge of predictably advancing the genial tubercle in a safe and reproducible manner. Demian et al described a rectangular osteotomy that extends to the inferior border of the mandible; following advancement of the bone flap, the osteotomy gap is filled with bone graft.[15]

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Here we describe a modified technique involving en bloc advancement of the mandibular symphysis and capture of the genial tubercle through virtual planning (Fig. 1). The genial tubercle is advanced without changing the chin profile. Alternatively, in patients who are prognathic, the chin profile is reduced, but the genial tubercle is simultaneously advanced.

TECHNIQUE

GA can be broken down into multiple steps:

1. Exposure
   - A lower lip vestibular incision is fashioned.
   - Subperiosteal dissection is performed to the inferior border of the mandible.
   - Dissection occurs between and inferior to the canine roots. The mental nerves do not require exposure.
2. Osteotomy
   - The osteotomy is marked with a virtually planned cutting guide 5 mm inferior to the tooth root apices and medial to the canine roots. The guide registers to the mandibular dentition and includes an inferior extension with a horizontal bar located at least 5 mm below the tooth roots while enabling capture of the genial tubercle. After making the horizontal osteotomy below the incisor roots, the osteotomy is then carried vertically to the caudal border of the mandible.

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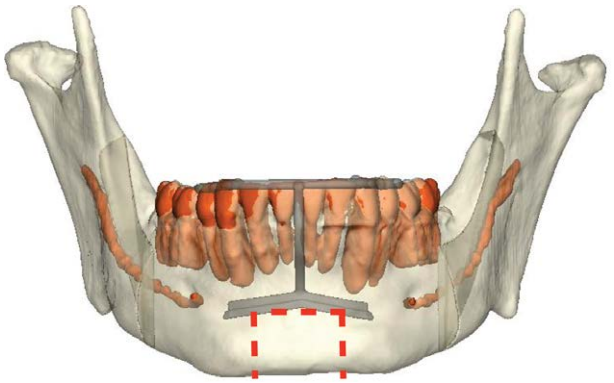

Fig. 1. Virtual surgical planning image of mandible, with red dotted lines showing location of osteotomies.

- A decision is made to preserve or reduce the chin profile with a rotary bur along the symphysis.
- A 2.0-mm locking titanium reconstruction plate is then prebent and secured to the intact mandible using bicortical screws. The plate is then removed.
- An intermaxillary fixation screw is placed in the bone flap for manipulation following osteotomy.
- A sagittal saw is used to perform the osteotomies. The lateral osteotomies are made with 10 to 20 degrees of angulation and then carried through the inferior border of the mandible. The saw is angulated laterally in order to capture a greater width of the lingual cortex than would be achieved if the saw were directed perpendicular to the mandible. This strategy enables the lingual cortex to have sufficient bone width to contact the adjacent buccal cortex as the segment is advanced.
- The bone segment is released. The genioglossus muscle insertion on the tubercle is confirmed (Fig. 2).

3. Advancement
   - A saw is then used to resect the buccal and medullary portion of the bone flap. This allows for preexisting chin osseous contours to be maintained (Fig. 3).

4. Closure
   - The GA is then stabilized with the prebent plate. Locking screws are placed on each side of the bone segment into the predrilled holes (Fig. 4).
   - The mentalis muscle and lip mucosa are repaired.

DISCUSSION

The technique described builds on the approach described by Demian et al to include complete and safe capture of the genial tubercle through virtual planning. Angulation of the lateral osteotomies allows for GA with good bone to bone contact, eliminating the need for placement of a bone graft. In addition, burring of the buccal segment, before plating, allows for advancement with simultaneous reduction of the chin profile when indicated.

This technique allows for advancement of floor of mouth musculature in addition to the genioglossus muscle. While the genioglossus muscle is considered a key target in the treatment of OSA, the inferior border

Takeaways

Question: How to perform a genioglossus advancement for improvement of obstructive sleep apnea in patients who are prognathic at baseline?

Findings: Using virtual planning, the genial tubercle can be safely captured and advanced using a box osteotomy that is carried through the inferior border of the mandible. The buccal plate can be burred down to reduce the chin profile before advancement.

Meaning: Safe genioglossus advancement in prognathic patients.

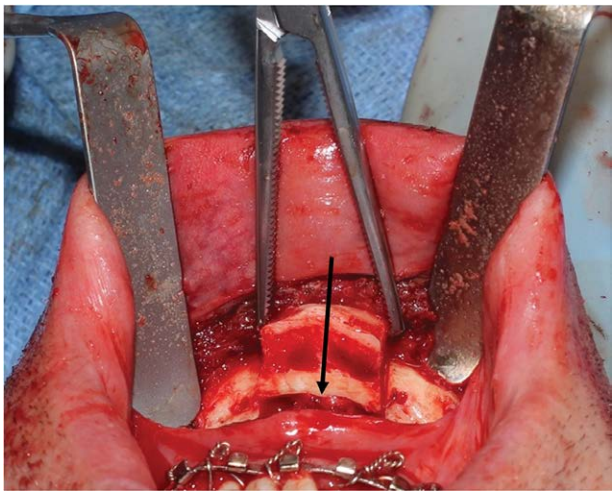

Fig. 2. Bone segment with attached genioglossus muscle (arrow).

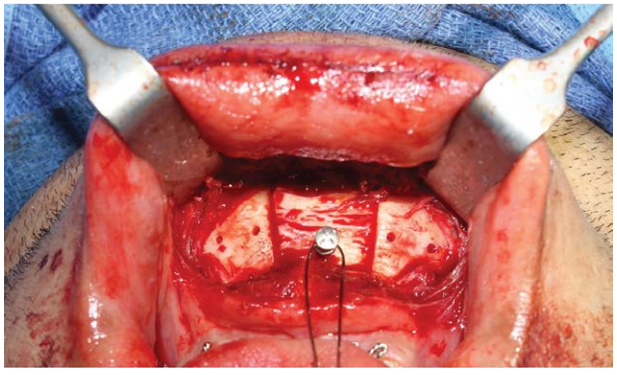

Fig. 3. Advancement of the lingual cortex and genial tubercle using an intermaxillary fixation screw and wire.

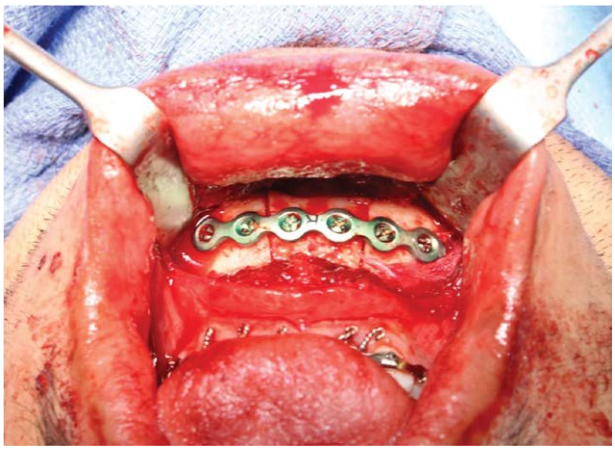

Fig. 4. Plate and screw fixation of the advanced lingual cortex and genial tubercle.

of the mandible serves as the attachment for additional suprahyoid muscles important to hyoid elevation and airway patency.[16] Virtual planning improves the safety of the osteotomy in capturing the genial tubercle and avoiding injury to tooth roots.[17] The use of virtual planning has grown in popularity and accessibility in the past decade. Historically, a box osteotomy was performed and rotated 90 degrees, which increased the risk of both causing muscle ischemia and shearing the genioglossus muscle from the genial tubercle. The risk of this is reduced by our technique, which involves an A-P advancement of the bone without rotating it; this reduces the ischemic and shear forces on the muscle.

The amount of advancement that can be achieved during GA depends on mandibular symphyseal thickness. Cadaveric studies and studies based on CT measurements have found a mean thickness of the mandibular symphysis of 13.2 to 14.5 mm.[18,19] This number can vary with age and ethnicity. The amount of advancement able to be achieved ranges from 9 to 14 mm.[14,20,21]

Although these studies describe significant improvement in patients' OSA, it is unknown how much advancement is required to achieve a therapeutic effect. Even with a reduction in 3 to 5 mm of the bone to improve chin contour, significant advancement can still be achieved considering the average 14.5-mm thickness of the symphyseal bone at baseline. With the addition of maxillomandibular advancement (MMA) to the GA procedure, the amount of total advancement at the level of the genial tubercle is easily over 20 mm.[22]

MMA is highly efficacious at treating OSA by expanding the airway at multiple levels.[2] The procedure involves a Le Fort I maxillary and bilateral sagittal split mandibular osteotomies, often with counterclockwise rotation. A meta-analysis found that the mean reduction for apnea-hypopnea index after MMA was 80.1%.[23]

Patient satisfaction is related to both the airway and aesthetic outcome. Over 95% of patients report changes in their facial appearance after MMA; 9% report feeling less attractive.[24] For this group of patients, many of whom may be prognathic at baseline or following MMA, the technique described in this article may be particularly useful for balancing the facial profile while maximizing the airway expansion.

Traditionally, the advantage of preserving the inferior border of the mandible is the ability to ensure stability of the jaw, decrease the risk of fracture, and preserve chin contour. The strategy of preplating the inferior border of the mandible as part of our modified technique helps decrease the risk of fracturing the mandible or creating an unfavorable contour, while preserving bone stability. The other risk involves creating a palpable step-off at the inferior border of the mandible between the reconstruction plate and the lingual cortex of the mandible, which has been advanced to move the genial tubercle forward. This subtle step-off is not palpable in most patients being treated for OSA because of the thick soft tissue envelope over the chin, although patients should be counseled about this possibility.

This article describes a novel modification of a GA technique previously described by Demian et al.[15] Limitations of the study include long-term assessment of outcomes, including patient attitudes toward chin aesthetics. Future investigations may focus on analyzing patient-reported outcomes, quantifying the amount of symphyseal bone reduction and simultaneous genial tubercle advancement, and assessing airway outcomes in a larger patient cohort.

CONCLUSIONS

In summary, GA is important in the armamentarium of surgical options for OSA. The modification described carries multiple advantages. The genial tubercle is reliably captured while decreasing the risk of tooth root injury, and there is no need for bone grafting. Additionally, the chin profile can be maintained or even reduced, even as the genial tubercle is advanced. This is particularly advantageous for the prognathic patient with severe OSA.

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