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Anatomic Analysis of the Genial Bone Advancement Trephine System's Effectiveness at Capturing the Genial Tubercle and its Muscular Attachments

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OBJECTIVE: The Genial Bone Advancement Trephine (GBAT) System (Stryker Leibinger Inc, Kalamazoo, MI) is a 1-step system that advances the genial tubercle for treatment of retrolingual obstruction in obstructive sleep apnea. The purpose of this project was to anatomically analyze the effectiveness of the GBAT System to capture the genial tubercle and its muscular attachments in the circular trephine.

METHODS: Eight cadaveric heads (ages 54-89 years; 3 female and 5 male) were examined, and Panorex radiographs (Stryker Leibinger Inc, Kalamazoo, MI) were obtained. Seven specimens were selected on the basis of mandibular height and dentition to undergo the procedure. The procedure was performed using the GBAT system with the 14-mm trephine according to the stepwise instructions. The mandibles were dissected, and analysis of the location of the osteotomy with respect to the genial tubercle, genioglossus muscles, geniohyoid muscles, and mandibular dentition was performed.

RESULTS: All 7 of the specimens had complete capture of the genial tubercle. The mean percentage of the genioglossus muscle captured in the circular trephine was 85% (50%-100%). All specimens had preservation of the posterior muscle fibers. The mean percentage of the geniohyoid muscle captured was 78% (15%-100%). No tooth roots were transected or contained in the bone plug.

CONCLUSIONS: The GBAT System is an effective 1-step system for capturing and advancing the genial tubercle and its muscular attachments in the treatment of OSA.

Obstructive sleep apnea (OSA) is a result of complete upper airway obstruction. Multiple levels of the upper airway including retropalatal, retrolingual, and hypopharyngeal can obstruct and produce OSA. In the surgical treatment of OSA, multiple sites of obstruction should be addressed to effectively treat the syndrome. The base of tongue or retrolingual region has long been identified as one of the critical sites that can contribute to OSA. The genioglossus muscle attaches to the genial tubercle on the lingual aspect of the mandible and splays out along the length of the tongue with a significant number of fibers extending to the base of tongue.[1] With advancement of the genioglossus muscle, the base of tongue is also advanced anteriorly, thus enlarging the retrolingual airway and restricting base of tongue collapse during sleep.[2-6] Through the years, multiple types of osteotomies have been designed to advance the anterior mandible and the attached genioglossus muscle. The various types of osteotomies that have been designed include the standard genioplasty, mortised genioplasty, "box" (inferior sagital) osteotomy, rectangular osteotomy, and the circular osteotomy. All of these techniques have been proven to capture and advance the genioglossus muscle to varying degrees.[7-13]

The Genial Bone Advancement Trephine (GBAT) system (Stryker Leibinger Inc, Kalamazoo, MI) has been developed by Leibinger and now is in use for genioglossus muscle advancement for the treatment of obstructive sleep apnea (Fig 1). The system uses a circular saw bit to create a 12-mm-diameter or 14-mm-diameter circular osteotomy.

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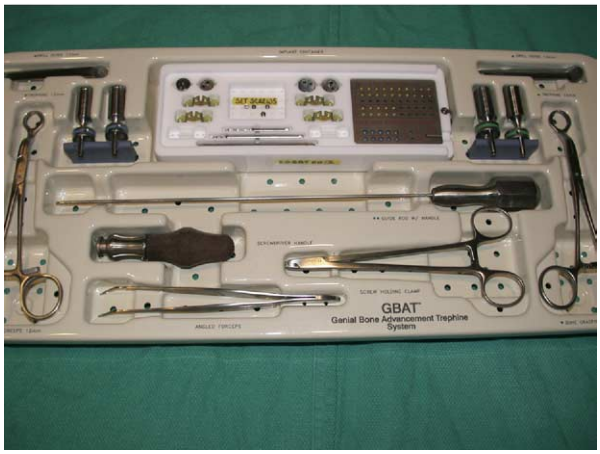

Figure 1 The Stryker Leibinger GBAT System, a self-contained kit to perform genioglossus advancement.

The bone plug is then advanced and plated with a prebent custom plate and screws. The system is designed to incorporate the genioglossus muscle and tubercle with the bone plug and advance them anteriorly. The system is marketed as a complete kit that is both simple and effective at advancing the genioglossus muscle. To date, no study has been published that analyzes the effectiveness of the GBAT system in isolating the muscle and its attachments. The purpose of this study was to assess the effectiveness of the GBAT system to incorporate the genioglossus muscle and its attachments in the circular bone plug.

MATERIAL AND METHODS

Eight (5 male and 3 female) randomly selected adult cadaver heads were obtained, ages 54-89 years. A Panorex radiograph was performed on the specimens to evaluate the dental status and mandibular height. We estimated an approximately 25% increase in size of the mandible on the Panorex when assessing the genial tubercle and tooth roots. Edentulous patients with significant loss of mandibular height were excluded from the study. An anterior gingivobuccal incision was performed and all soft tissue was dissected from the anterior aspect of the mandible. With a caliper, the mandibular height (alveolar ridge between central incisors to inferior aspect of central mandible) was measured and rounded to the nearest fourth of a millimeter. The GBAT radiograph template was placed over the Panorex to plan the location of the osteotomy. As described in work elsewhere, the identification of the genial tubercle and placement of the osteotomy is done through utilization of the Panorex radiograph and intraoperative palpation of the genioglossus muscle.[14] Although the GBAT system contains both 12-mm and 14-mm trephines, the 14-mm system was used on all cadavers. The 14-mm circular drill guide plate then was fixed with 2 monocortical screws at the desired osteotomy site (Fig 2A). The 14-mm circular trephine was then used to create the circular osteotomy (Fig 2B). The 14-mm osteotomy was selected to optimize the capture of the genial tubercle. The GBAT set also comes with a 12-mm osteotomy that may be selected for smaller mandibles or if the Panorex suggests crowding of the central incisor teeth roots. The anterior digastric and mylohyoid muscles were dissected free from the inferior aspect of the mandible, exposing the geniohyoid and genioglossus muscles (Fig 2C). With a handsaw, the mandibles were sectioned bilaterally lateral to the canines. The anterior mandible was removed, leaving the circular bone segment with its muscular attachments. The anterior mandible was inspected and distance from the inferior mandibular border to the inferior aspect of the trephine and the central incisor tooth roots to the superior aspect of the trephine were measured. Next, the bone segment, geniohyoid, and genioglossus muscles were then examined. A percentage of the geniohyoid and genioglossus muscles contained in the bony segment were estimated on the basis of visual inspection. The thickness of the mandible was measured at the inferior and superior aspects of the bone segment and then averaged to give a single value. The genioglossus width and height were then measured. These measurements were arbitrarily taken 2 mm posterior to their mandibular attachments for consistency. The distances from the inferior border of the mandible to the superior and inferior aspects of the genioglossus muscle and the superior mandibular border to the superior and inferior genioglossus muscle were measured. The muscular attachments were then transected, freeing the circular bone plug. The height and width of the genial tubercle were measured (Fig 2D). All measurements were taken with calipers and rounded to the nearest fourth of a millimeter.

RESULTS

Seven cadaveric heads with adequate mandibular height underwent the GBAT procedure with dissection and anatomic analysis. All specimens had complete capture of the genial tubercle. The mean percentage of the genioglossus muscles captured in the circular osteotomy was 85% (50% to 100%). When $<100\%$ of the genioglossus muscles were captured, it was due to transection of anterior muscle fibers. All of the specimens had intact posterior genioglossus muscle fibers. The mean percentage of the geniohyoid muscles captured was 78% (15% to 100%). No tooth roots were transected or contained within the bone plug. The distance from the tooth roots to the osteotomy was greater than 5 mm in all cases. The average distance ($\pm$SD) from the inferior mandibular border to the inferior aspect of the genioglossus muscle was 12.50 mm $\pm$ 1.44 mm. The average width of the genial tubercle was 6.86 mm $\pm$ 1.03 mm. The average height of the genial tubercle was 11.64 mm $\pm$ 1.84 mm (Table 1).