Genioglossus Muscle Advancement with the Genioglossus Bone Advancement Technique for Base of Tongue Obstruction

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Abstract

Objective: To report our early experience evaluating the efficacy of genioglossus muscle advancement using the genioglossus bone advancement technique (GBAT) for symptomatic base of tongue obstruction and sleep-disordered breathing.

Study Design: Retrospective, nonrandomized study.

Methods: Patient data were obtained from the hospital records of 13 patients undergoing genioglossus muscle advancement with the GBAT system.

Results: Thirteen patients underwent genioglossus muscle advancement with the GBAT system. All patients demonstrated greater than 75% obstruction at the base of the tongue as determined by preoperative Müller's manoeuvre. Nine patients demonstrated obstructive sleep apnea syndrome and four demonstrated severe upper airway resistance syndrome on nocturnal polysomnography. Postoperatively, all patients reported improvement of snoring and hypersomnolence and greater than 90% improvement of collapse at the base of the tongue. Minor complications (3/13) included haematoma and transient tooth paresthesia. There was one case of infection requiring plate removal and one case of airway obstruction secondary to angioedema.

Conclusions: Genioglossus muscle advancement using the GBAT system is a safe, simple, and rapid method for improving symptomatic base of tongue obstruction in sleep-disordered breathing.

Sommaire

Objectif: Rapporter notre expérience précoce et évaluer l'efficacité de l'avancement du génioglosse par son attache osseuse (AGAO) pour l'obstruction symptomatique de la base de la langue et les troubles du sommeil.

Devis: Etude prospective sans allocation aléatoire.

Méthode: Données obtenues des dossiers de 13 patients opérés par cette technique.

Résultats: Tous les patients ont montré une amélioration de plus de 90% de l'obstruction par la base de la langue telle que démontrée par la manoeuvre de Müller. Chez neuf patients on notait un syndrome d'apnée obstructive du sommeil et chez quatre un syndrome sévère de résistance des voies respiratoires supérieures. Tous ces patients ont démontré une amélioration du ronflement et de l'hypersomnolence diurne. Trois patients ont présenté une complication mineure (hématome et paresthésie dentaire temporaire). On note aussi un cas d'infection nécessitant l'exérèse de la plaque et un cas d'obstruction respiratoire secondaire à un angioédème.

Conclusion: La technique de l'avancement du génioglosse est une technique simple, sécuritaire, et rapide pour améliorer l'obstruction symptomatique de la base de la langue des troubles respiratoires du sommeil.

Key words: advancement, genioglossus, genioglossus bone advancement technique (GBAT), tongue

Since the identification of obstructive sleep apnea syndrome (OSAS) and the recognition of its social and cardiovascular sequelae, the treatment for OSAS has evolved. Initially, severe cases were treated with tracheotomy, thereby bypassing often multiple sites of obstruction. In the last two decades, continuous positive airway pressure (CPAP), which stents the airway, has become the treatment of choice. However, there is a subset of patients who do not tolerate CPAP for a variety of reasons. Site-specific airway surgery was a natural evolution not only to address noncompliance with CPAP but also as a treatment alternative. The initial enthusiasm for uvulopharyngopalatoplasty, as treatment alone, has waned secondary to mixed results. Failure, in part, was attributable to persistent or unrec-

Received 27/07/01. Accepted for publication 30/01/03.

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ognized retroglossal collapse. Subsequently, genioglossus advancement, hyoid suspension, advancement genioplasty, tongue base suspension, volume reduction of the tongue, and maxillomandibular advancement were developed to target hypopharyngeal obstruction. The multitude of treatments proposed to address base of tongue obstruction lend credence to the fact that the ideal method has not been determined. In this report, we describe our early experience using the genioglossus bone advancement technique (GBAT) system for symptomatic base of tongue obstruction.

Methods and Materials

Thirteen consecutive patients who underwent genioglossus advancement using the GBAT system were reviewed. Candidates for the procedure had previously undergone nocturnal polysomnography. Initially, only those patients with severe OSAS unresponsive to traditional procedures were offered advancement. However, as our positive experience grew, patients who did not tolerate CPAP and those with upper airway resistance syndrome characterized by crescendo snoring, disrupted sleep, and hypersomnolence with clinically relevant base of tongue collapse were included in the study.

Patients were selected based on an upper airway examination including fibre-optic Müller's manoeuvre. All candidates demonstrated greater than 75% collapse at the level of the base of the tongue in relation to the posterior pharyngeal wall. All patients underwent preoperative panorex evaluation of the mandibular height and position of the dental apices.

Most patients underwent combined procedures (Table 1), including uvulopalatopharyngoplasty, tonsillectomy, nasal-septal reconstruction, and turbinate reduction. All were observed for a minimum of 24 hours postoperatively. Patients were then evaluated at 1- and 3-month intervals. Specifically, improvement of hypopharyngeal collapse as it relates to base of tongue obstruction, symptomatic improvement, and CPAP tolerance were reviewed. A panorex was also obtained for comparison.

Surgical Technique

Typically, patients underwent genioglossus advancement last if combined with additional procedures. The Leibinger GBAT system (Stryker-Leibinger, Kalamazoo, MI) was used in all cases. An intraoral incision is made in the midportion of the lower gingivobuccal sulcus

Table 1 Patient Demographics

				Sleep Study				*Müller Base of Tongue*		
Age	*BMI*	*Comorbid Diseases*	*Additional Procedures*	*AI*	*HI*	*RDI*	*LSAT (%)*	*Pre (%)*	*Post (%)*	*Complications*
28	35.0	None	UP3, tonsillectomy	6.3	0.7	7.0	50	95	0	None
36	29.3	None	UP3, NSR, tonsillectomy	25.7	3.3	29	67	90	0	None
49	28.4	HTN	None	16.2	2.6	18.8	64	90	0	Dehiscence
68	43.3	HTN, macroglossia	UP3, turbinate reduction, septoplasty, tonsillectomy	11.8	8.7	20.5	90	90	< 10	Angioedema requiring reintubation; dehiscence
46	50.9	HTN, CHF, COPD	UP3, NSR, tonsillectomy, turbinate reduction	0	31.9	31.9	75	75	0	None
33	38.5	NIDDM	UP3, tonsillectomy	2.7	4.8	7.5	53	90	0	None
42	47.8	Down syndrome	UP3, tonsillectomy, turbinate reduction	14	16.9	30.9	72	90	0	None
69	38.2	IDDM, HTN	UP3, NSR, tonsillectomy	12.6	31.8	44.3	82	90	10	None
70	36.4	NIDDM	None	1.2	7.0	8.2	84	90	0	None
63	39.4	COPD, CHF hypercholesterolemia	UP3, tonsillectomy, turbinate reduction	0.9	4.8	5.6	82	90	0	None
30	44.0	None	UP3, tonsillectomy, turbinate reduction	55.2	4.4	59.6	45	80	0	Transient teeth numbness
45	46.4	HTN	UP3, turbinate reduction	38.8	43.5	82.3	58	90	0	Transient teeth numbness
42	71.0	HTN, asthma, seizure disorder, hypercholesterolemia	UP3, tonsillectomy, turbinate reduction	0	6.2	6.2	85			Hematoma, infection

AI = apnea index; CHF= congestive heart failure; COPD = chronic obstructive pulmonary disease; HI = hypopnea index; HTN = hypertension; IDDM = insulin-dependent diabetes mellitus; LSAT = lowest oxygen saturation; NIDDM= non–insulin-dependent diabetes mellitus; NSR = nasal-septal reconstruction; RDI = respiratory disturbance index; UP3 = uvulopalatopharyngoplasty.

between the second premolars bilaterally. The mucosal and submucosal layers are then elevated separately to facilitate closure. The mentalis muscles are sectioned in their midportion to increase exposure. At this point, the periosteum is elevated to the inferior border of the mandible, taking care to avoid traction injury to the mental nerve. The appropriate trephine system (12 vs. 14 mm or angled vs. flat) is selected based on the mandibular height and the relationship of the genial tubercle to the roots of the anterior dentition (Figure 1). The drill guide is placed overlying the genial tubercle, and a 1.5 mm hole is drilled for guide plate placement. The guide plate is secured with 2.0 mm bicortical screws (Figure 2). The guide rod is inserted through a minidriver and trephine and is secured to the guide plate in a counterclockwise direction. The osteotomy is then completed with the minidriver by advancing the trephine over the guide plate. After completion of the osteotomy, the osteotomized mandibular segment, centred over the genial tubercle, is advanced anteriorly with traction exerted on the guide rod. The lingual cortex is grasped with the circular bone-holding clamp (Figure 3). Using a marking pen, the 12 o'clock position is marked and maintained, and the guide rod and plate are removed. An oscillating saw is now used to osteotomize the labial cortex. Again, the 12 o'clock position is maintained to prevent inadvertent torque of the genioglossus muscle. The drill guide is placed over the remaining bone segment, and a 2.0 mm diameter screw is placed in the center hole. At this point, the screw-holding clamp is used to grasp the mobilized segment, and the circular bone clamp is removed. The segment is then transposed anteriorly so that the posterior border of the lingual cortex is flush with and slightly overlaps the labial cortex. The segment is secured with a prefashioned titanium fixation plate (Figure 4). The floor of mouth musculature is palpated for adequate tension on the genioglossus muscle. The wound is irrigated and a three-layer closure is achieved, taking care to reapproximate the mentalis muscle over the plate.

Figure 2 With the guide rod inserted into the guide plate, the osteotomized segment is advanced anteriorly.

Results

During a 3-month period, 13 individuals underwent genioglossus advancement. The average age was 42 years old, with a 47% female to 53% male distribution. Most patients were morbidly obese, with an average body mass index of 42.1. Over 75% had comorbid conditions. Eighty-four percent of the cohort underwent concomitant procedures, including uvulopharyngopalatoplasty, tonsillectomy, septorhinoplasty, and turbinate reduction.

All patients reported subjective improvement of snoring and hypersomnolence. The overriding indication for surgery was intolerance to nasal CPAP, and postoperatively, all patients who required CPAP based on sleep study criteria were able to use CPAP on a reg-

Figure 1 Drill guide positioned on the anterior aspect of the mandible overlying the genial tubercle.

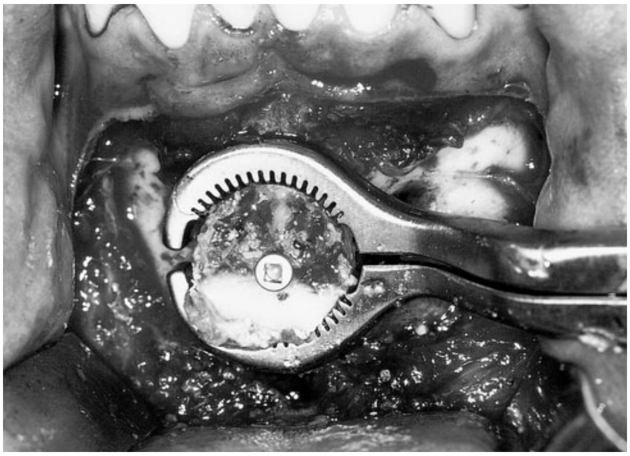

Figure 3 Bone-holding clamp maintaining advancement and facilitating removal of the labial cortex.

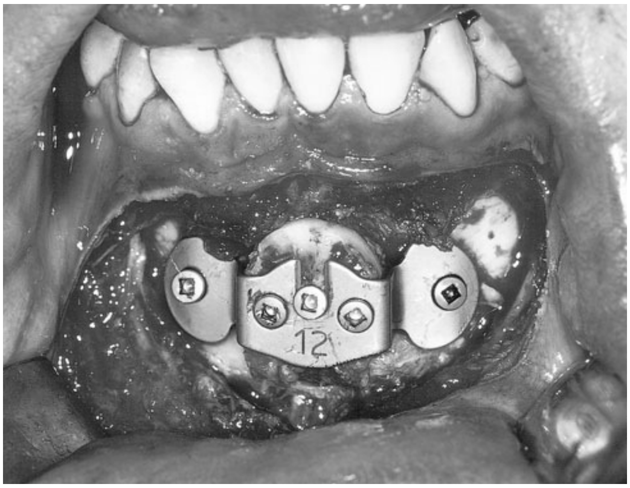

Figure 4 Titanium step plate holding the osteotomized genial tubercle in the anterior position.

ular basis. A subset of our population (n = 4) had severe upper airway resistance syndrome and did not require CPAP. Müller's manoeuvre performed at the first postoperative visit demonstrated greater than 75% improvement of obstruction at the level of the base of the tongue. Minor complications (3/13; 23%) occurred, including transient lower dentition paresthesia and minor hematoma. One patient developed a local delayed wound infection following evacuation of a hematoma. Subsequently, she required hospitalization with intravenous antibiotics, and the plate was removed. Interestingly, there continued to be maintenance of the genioglossus advancement in this patient despite plate removal 8 weeks postoperatively. The mobilized segment incorporating the genial tubercle had actually fibrosed in a favourable position, as evidenced on clinical examination. Only one patient developed airway compromise postoperatively. The patient's tongue and upper lip became edematous; therefore, she was reintubated for 24 hours. This was felt to be related to her history of angiotensin-converting enzyme inhibitor–induced angioedema. She was readmitted 3 weeks later with similar symptoms. Following a change in her antihypertension regimen, she has had no further episodes. No patient in this series developed dysphagia or significant aesthetic blunting of the mentolabial groove.

Discussion

OSAS, secondary to upper airway collapse, is associated with daytime hypersomnolence, nocturnal apnea and hypopneas, and states of relative hypoxia. The long-term cardiovascular sequelae include systemic and pulmonary hypertension, myocardial infarction, and cardiac arrhythmias, which may lead to a significant mortality risk.[1] The cardiopulmonary risks have been noted in the untreated OSAS population as well as being documented from studies in which the only surgical treatment was tracheotomy and the medical treatment of choice was weight loss. Over the past two decades, both medical and surgical treatments have been developed to avoid tracheotomy while at the same time attempting to reduce the morbidity and mortality of OSAS.

CPAP has become the most widely used nonsurgical treatment for OSAS. Its efficacy has been well documented; however, many patients are unable to tolerate high pressures, and suboptimal compliance becomes a problem, particularly when the settings exceed 7.5 cm H_2O.[2,3] The two most common reasons for noncompliance are obstruction within the nose and pharynx and lack of subjective improvement with treatment.[4] Although not specifically addressed in the literature, anecdotally, many patients benefit from various airway surgical procedures by improving tolerance to CPAP.

In OSAS, there are two main sites for dynamic collapse: the retropalatal and retroglossal areas. Fujita and colleagues first described the uvulopalatopharyngoplasty to excise redundant palatal tissue.[5] However, this procedure alone in unselected patients improves symptoms in only 50% of patients postoperatively and cures OSAS uncommonly.[6,7] Riley and colleagues extensively reviewed their uvulopalatopharyngoplasty patients and found that persistent obstruction at the base of the tongue was the leading cause of failure.[8]

Several procedures have attempted to surgically target the base of the tongue to improve retroglossal collapse. Genioglossus advancement with or without hyoid suspension is the most common technique. Outcome based on a respiratory disturbance index (RDI) < 20, 50% reduction in respiratory events, and improvement of oxygenation above 90% has demonstrated an efficacy of 42 to 78%.[9–11] These studies used the rectangular osteotomy with a 90-degree rotation of the osteotomized segment. Mintz and colleagues further modified this technique with the creation of a circular bone incision in an attempt to decrease the risk of loss of the mandibular incisors.[12] Tongue base suspension using the soft tissue-to-bone anchor has also been reported, with variable results.[13,14] Although termed minimally invasive, it can be technically challenging. Other procedures address the tongue base by altering or reducing tongue size. Midline glossectomy with laser or sharp dissection has been used with variable success, with responders ranging from 25 to 80%; however, a tracheotomy is required, and long-term difficulty with persistent dysphagia is commonly seen.[15–17] Recently, radiofrequency volume reduction of the tongue base had demonstrated promising early results as a minimally invasive procedure.[18] Maxillomandibular advancement is the most aggressive alternative for refractory base of tongue collapse, with success approaching 90% in selected patients.[19] However, there is a significant alteration in the aesthetic appearance of the lower two-thirds of the face in most of these patients as well as significant potential surgical morbidity associated with the procedure.

Because there are no universally accepted predictors for surgical success, we used preoperative and postoperative Müller's manoeuvre as the main outcome measure. Although the predictive value of preoperative Müller's manoeuvre is less than 50%, most studies used the technique for selection criteria for uvulopalatopharyngoplasty.[20–22] Furthermore, fibre-optic Müller's manoeuvre provides a simple and inexpensive means to assess airway collapse in an awake patient without the aid of radiographic analysis. In our series, all patients demonstrated greater than 90% opening in the hypopharynx.

The trephine mandibular advancement using the GBAT system provides a clear advantage over other alternatives. Unlike the rectangular osteotomy with 90-degree rotation around the vertical axis, there is no change in the orientation of the genioglossus muscle; therefore, the advancement is more physiologic and should lessen any muscle dehiscence. Furthermore, there is no blunting of the mentolabial fold, and monocortical screw placement during plating will generally avoid damage to the dental apices. Although not specifically addressed in this article, using the GBAT system, the surgeon is more efficient with reduced operative time. Lee and Woodson reported a reduced operative time of 20 minutes using this technique when compared with the traditional anterior mandibular osteotomy.[23]

There are obvious limitations to this study. The series is small, and the follow-up needs to continue. Postoperative nocturnal polysomnography is needed to determine the efficacy of treatment; however, because many patients undergo concomitant procedures, analysis would be difficult. Nevertheless, this technique has proven safe and effective in improving symptomatic base of tongue collapse and CPAP tolerance.

Conclusion

Genioglossus advancement has been refined and improved over the years. The circular trephine osteotomy using the GBAT system provides a more physiologic advancement compared with its predecessors. This technique isolates the genial tubercle in a predictable and symmetric fashion. Genioglossus advancement using the GBAT system for base of tongue obstruction is a useful alternative to previously described techniques. It provides a safe, simple, and rapid method to reduce symptomatic base of tongue collapse. Based on the postoperative Müller's manoeuvre, symptomatic improvement, and CPAP tolerance, the results are promising. Further studies based on comparative controls and postoperative polysomnography are indicated.

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