Tongue base suspension using a repose bone screw system in the treatment of obstructive sleep apnea

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Objectives
The aim of this study was to evaluate the tongue base suspension suture technique using a repose bone screw system with respect to efficiency in relieving obstructive sleep apnea, safety, and postoperative morbidity.
Study design
This was a prospective study carried out on 10 patients with a complaint of moderate or severe obstructive sleep apnea because of retrolingual hypopharyngeal obstruction.
Methods
Demographic data were determined and preoperative investigations (flexible nasopharyngoscopy, polysomnography, and lateral cephalometry) were carried out; in addition, operative technique and postoperative assessment of patients' complaints and postoperative data of polysomnography and lateral cephalometry were carried out.
Results
Improvement in the main complaints of patients, a significant reduction in the mean apnea hypopnea index in postoperative polysomnography, and an increase in the mean posterior airway space at the level of the tongue base in postoperative lateral cephalometry were recorded.
Conclusion
The tongue base suspension technique using a repose bone screw system is an easy and efficient procedure for the treatment of retrolingual obstruction, with minimal postoperative morbidity.

Keywords:
bone screw system, tongue base, tongue base suspension

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Introduction

Obstructive sleep apnea (OSA) affects 24% of middle-aged adults. Snoring and OSA result from narrowing or complete occlusion of the pharynx [1].

The initial surgical treatment for OSA is often palatal surgery. However, only 25% of patients have strictly palatal obstruction. Airway collapse in patients with OSA may occur at multiple sites, including the palate or the upper pharynx and the tongue or the lower pharynx [2].

Untreated tongue base obstruction is a cause of uvulopalatopharyngoplasty (UPPP) failure [3]. In patients with type IIb/III airway collapse (retrolingual), the success rate of UPPP alone was as low as 5–10% [4]. Therefore, surgical treatment of sleep-disordered breathing should be targeted at the suspected level of obstruction [5].

Using this concept, surgical techniques were developed to attempt treatment of this portion and to improve the success rate. This included the following: reduction of the size of the tongue by midline glossectomy, genioglossus advancement through mandibular osteotomy, hyoid suspension both to the mandible and to the thyroid cartilage, and maxillomandibular advancement surgery [6].

These aggressive techniques yield high success rates in the treatment of patients with severe OSA, but they may be poorly accepted by both patients and surgeons. Its complications include bleeding, severe pain, tongue edema, prolonged dysphasia, and postoperative dysphagia in addition to tracheostomy, which must be carried out before each surgery [7].

Tongue base obstruction is widely acknowledged to be the most difficult level of obstruction to treat in OSA. The tongue base suspension suture is introduced as a minimally invasive technique for tongue base stabilization. The suture not only provides a sling-like effect in the tongue base but also incorporates into the tongue musculature, conferring rigidity to the airway. This procedure can be performed alone or as part of a multilevel surgical algorithm in the treatment of OSA [8].

The aim of this study was to evaluate the tongue base suspension suture technique using a repose bone screw system with respect to efficiency in relieving OSA, safety, and postoperative morbidity.

Patients and methods

This study was carried out on 10 patients diagnosed with moderate or severe OSA (by polysomnography) with tongue base obstruction [type IIb or III (according to Fujita [9]) (Table 1)] diagnosed by flexible nasopharyngoscopy using

Table 1 Fujita [9] classification of upper airway anatomy of obstructive sleep apnea patients

Type I	Oropharyngeal narrowing with normal palatal arch
Type II	Low palatal arch and large tongue
Type IIa	Predominantly oropharynx with normal hypopharynx
Type IIb	Predominantly oropharynx with narrow hypopharynx
Type III	Normal oropharynx with compromised hypopharynx with large or posterior tongue, lateral wall bulge, hypertrophic lingual tonsils, and atonic supraglottis

Muller's maneuver. All patients were recruited from the ENT department of Faculty of Medicine of Beni-Suef University Hospital from May 2008 to October 2011.

Preoperatively, all patients are subjected to the following: history taking (partner must be present), complete general examination, and complete otorhinolaryngological examination. They were also examined to define the site and degree of obstruction or collapse by flexible nasopharyngoscopy using Muller's maneuver, polysomnography, and lateral cephalometry to measure the posterior airway space (PAS) (the distance between the tongue base and the posterior wall of the pharynx at the level of the line connecting the supramental point and angle of the mandible). The procedure was explained to the patients and operative consent was taken.

Operative technique

Preoperative medications such as sedative drugs should be avoided to prevent more respiratory depression or distress. The operation was performed under general anesthesia administered through nasotracheal intubation with the patient in the supine position.

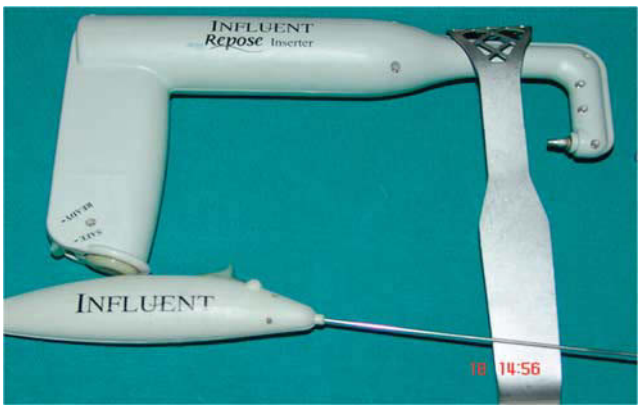
The mouth was opened by a jaw retractor and the operation was performed using the repose bone screw system (Fig. 1), which consists of a bone screw, which is a sharp-tipped small-diameter titanium screw with two prolene monofilament number 1 sutures crimped into its base and is self-tapping, a battery-operated bone screw inserter used to drive the screw into the inner table of the mandible, and a suture passer, which is a retractable needle that facilitates the passage of the suture through the tongue base.

The floor of the mouth at the frenulum was anesthetized locally using a vasoconstrictor. An incision of about 1.5 cm was made in the midline of the frenulum, between the two Wharton ducts, taking care not to injure the ductal orifices. The inner periosteum was then lifted by a curved hemostat that was passed through the incision into the floor of the mouth.

The tip of the screw inserter was passed through the incision posterior to Wharton ducts and the screw was pressed against the middle line of the mandible below the tooth roots in the area of the genioglossus muscle insertion. Thereafter, the inserter was activated to drive the screw to penetrate the inner table of the mandible (Fig. 2a).

At this point, the two prolene sutures protruded through the incision. One of the two prolene sutures passed through the incision in the floor of the mouth to an exit point at the tongue base at the circumvallate papillae, about 1.5 cm lateral to the midline on the right side by the suture passer, and was folded to create a loop protruding into the pharyngeal space (Fig. 2b).

Figure 1



Repose bone screw system (Repose; InfluENT Medical LLC, Concord, New Hampshire, USA).

By the same suture passer, the second prolene suture was then passed through the incision to another exit point at the opposite side of the tongue base, also about 1.5 cm lateral to the midline (Fig. 2c). Then, this second prolene suture was threaded onto an empty Mayo needle. This Mayo needle was passed back into the exit point of the suture and then passed submucosally past the midline to the exit point of the previously placed suture loop (Fig. 2d).

The prolene suture was then threaded onto the empty suture loop and pulled back to the anterior intraoral space (Fig. 2e), thereby creating a triangular-shaped suture pass, the base of which was in the posterior tongue (Fig. 2f). The two suture ends were tied and secured into the floor of the mouth and buried deeply. A small dimple should be felt at the base of the tongue during this tying process to ensure adequate tongue base support. The mucosal incision was sutured with an absorbable material avoiding the Wharton ducts.

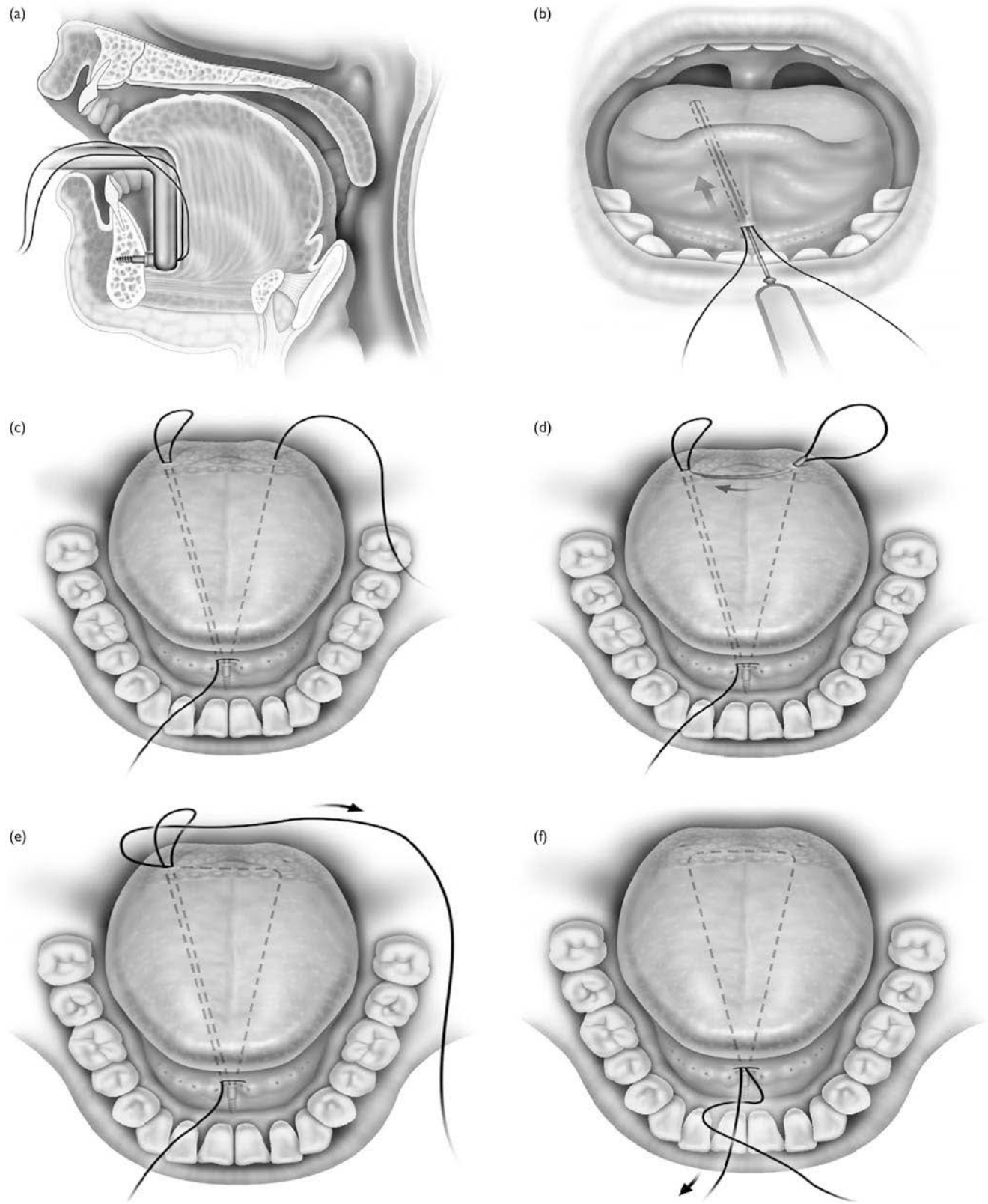
Follow-up visits were regularly carried out for 6 months postoperatively, weekly for the first month and then monthly until the end of the sixth month.

All patients were assessed postoperatively by history taking, flexible fiber-optic nasopharyngoscopy with Muller's maneuver (both in every postoperative visit), polysomnography, and lateral cephalometry (both were performed at the end of the sixth postoperative month).

Results

Ten patients (seven men and three women) with moderate or severe OSA because of retrolingual obstruction were included in this study. Their ages ranged from 38 to 59 years (mean 44 years). All patients were operated

Figure 2



Operative technique for the tongue base suspension procedure using a repose bone screw system [8]. (a) Inserter is activated to drive the screw to the inner table of mandible. (b) One of the 2 prolene sutures is passed to the tongue base about 1.5 cm lateral to the midline on the right side by the suture passer. (c) Second prolene suture is passed to the opposite side of the tongue base. (d) The Mayo needle is passed submucosally to the opposite side. (e) Prolene suture is now threaded onto the empty suture loop. (f) a triangular-shaped suture pass with its base in the posterior tongue.

upon by a tongue base suspension using the repose bone screw system.

None of the patients had a nasal obstruction. One patient had a history of previous treatment by nasal surgery (septal surgery and turbinectomy) and another four had a history of palatal surgery.

The main complaints of the patients before surgery were loud, daily snoring in seven patients (70%), which affected their bed partner. Two patients (20%) had excessive daytime sleepiness and one (10%) had nocturnal arousal (Table 2).

Postoperative improvement of main complaint was recorded by patients themselves and their bed-partners as complete elimination (>75%), reduction (50%–75%) or no improvement (<50%) of the main complaint at each postoperative follow up visit till the end of 6th month postoperatively.

Seventy percent of patients showed complete elimination of their main complaints, 20% developed a 50–75% reduction of their main complaints, and only 10% complained of no improvement (Table 3).

There was a statistically significant improvement with respect to the mean AHI, which was 31.4 preoperatively and decreased to 11.8 postoperatively ($P<0.05$) (Table 4).

The mean PAS in lateral cephalometry in the upright position preoperatively was 10.2. This was significantly improved to 12.4 postoperatively ($P<0.05$) (Table 4). Moreover, postoperative flexible nasopharyngoscopy with Muller's maneuver indicated widening of the retrolingual space and elimination or cessation in the degree of tongue base collapse.

Postoperative complications such as pain, numbness of lower incisors, swallowing, and speech problems are usually mild to moderate and are resolved progressively.

Table 2 Main complaints of the patients preoperatively

Main complaint	Total number of patients=10 [*n* (%)]
Loud snoring	7 (70%)
Excessive daytime sleepiness	2 (20%)
Nocturnal arousal	1 (10%)

Table 3 Postoperative improvement in symptoms at the end of the postoperative follow-up period

Degree of improvement	Total number of patients=10 [*n* (%)]
Complete elimination>75%	7 (70%)
Reduction 50–75%	2 (20%)
No improvement<50%	1 (10%)

Table 4 Preoperative and postoperative polysomnographic and lateral cephalometric data of patients

Parameters	Preoperative	Postoperative	*P* value
Mean AHI	31.4	11.8	0.00 S
Mean PAS	10.2	12.4	0.005 S

AHI, apnea hypopnea index; PAS, posterior airway space; S, statistically significant ($P<0.05$).

No long-term speech or swallowing problems have been reported. No patients reported infection at the floor of the mouth because of the use of perioperative antibiotics, and tracheostomy was not needed in any patient.

Discussion

OSA syndrome results from a complex scenario initiated by a structurally small upper airway, followed by airway collapse and obstruction [10]. OSA is not an uncommon disease, with a prevalence rate of 24% among middle-aged adults [11].

Snoring is primarily a palatal disorder, whereas OSA may result from multiple collapsing airway segments, which need further surgery rather than palatal shortening or stiffening as in UPPP and laser-assisted uvulopalatoplasty [12].

Continuous positive airway pressure is reasonably successful in the treatment of the OSA, but its tolerance is often poor because of the fact that the machine itself makes continuous noise and the application of the face-mask increases its refusal by the patients. Many patients experienced dry mouth, rhinorrhea, conjunctivitis, headache, and inflammatory facial reactions after its use. Nevertheless, this is probably an option that should be discussed with the patient at the time of counseling before surgery [13].

The tongue plays a crucial role in the structural integrity of the upper airway not only because of its central location in the oral cavity and oropharynx but also because of its bony attachment. The muscle fibers of the tongue converge and are primarily attached to the posterior surface of the mandible (genial tubercle) in the midline. When the mandible is displaced posteriorly (e.g. retrognathia), airway collapse may occur at the base of the tongue during sleep [8].

Many excisional surgical techniques that manage tongue base collapse, including midline glossectomy or lingualplasty, genioglossus advancement, and hyoid suspension procedures, lead to considerable postoperative morbidity such as swallowing difficulties, speech abnormalities, and breathing and bleeding problems.

To avoid the difficulties and morbidities of excisional procedures, a minimally invasive procedure for tongue base suspension using a repose bone screw system has been introduced by DeRowe *et al.* [14]. In the present study, we treated 10 patients with moderate or severe OSA because of retrolingual obstruction to assess this technique.

Tongue base surgeries have shown various rates of success depending on the proper selection of patients and the parameters chosen for evaluation. In this study, the mean AHI was 31.4 preoperatively, which decreased significantly to 11.8 at the end of 6 months postoperatively ($P<0.05$), with complete elimination of the main complaints in 70% of patients and a reduction in the main complaints by 50–75% in 20% of patients, with only 10% recording no improvement.

Similar success rates have been recorded using the repose screw system for tongue base suspension by Woodson

[15], who reported a mean decrease in the AHI from 35.4 to 24.5 ($P<0.05$) in 28 patients with OSA. Omur and coworkers [16] who reported the most promising success rate in 22 patients with severe OSA, the mean AHI reduced from 47.5 to 17.3 after a 12-month follow-up after performing combined tongue base suspension using repose bone screw system in addition to UPPP which explains their results.

In this study, lateral cephalometry was used to detect the degree of widening in the retrolingual space by measuring the PAS that showed a significant increase in the mean PAS from 10.2 to 12.4 ($P<0.05$). Moreover, Kühnel *et al.* [17] recorded an increase in PAS in 60% of patients with OSA treated using tongue base suspension by the repose bone screw system.

Postoperative medications such as antibiotics, anti-inflammatory drugs, and analgesics were used to prevent and control any suspected complications after surgery such as pain, numbness of lower incisors, infection, swallowing, and speech difficulties. These were usually mild to moderate and self-limited.

Conclusion

The tongue base suspension technique using a repose bone screw system is a minimally invasive procedure for the treatment of OSA in selected patients with tongue base collapse. The procedure is efficient, safe, easy, and has minimal postoperative morbidity.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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