Transsubmental tongue-base suspension in treating patients with severe obstructive sleep apnoea after failed uvulopalatopharyngoplasty: Our Experience

Huang, T.-W.,*[†] Su, H.-W.,[‡] Wang, C.-T.* & Cheng, P.-W.*[†]

*Department of Otolaryngology, Far Eastern Memorial Hospital, [†]Department of Health Care Administration, Oriental Institute of Technology, Taipei, and [‡]Department of Tourism and Leisure Management, Tung-Fang Design University, Kaohsiung, Taiwan Accepted for publication 22 January 2014

Dear Editor,

Snoring and obstructive sleep apnoea is largely owing to narrowed upper airway and abnormal collapsibility during sleep. More than 90% of apneic patients have single obstruction in the retropalatal level, whereas 40–50% of those have obstruction in multiple sites, including retropalatal space, retrolingual space and hypopharynx.¹ Successful surgical management of obstructive sleep apnoea requires various procedures to address these multiple levels of airway obstruction. Although uvulopalatopharyngoplasty is commonly performed in treating snoring or obstructive sleep apnoea patients, the success rate of uvulopalatopharyngoplasty is as low as 5–10% in severe obstructive sleep apnoea patients with retrolingual obstruction.²

Traditional tongue-base suspension with Repose System (Metronic Xomed, Jacksonville, FL, USA), first described by DeRowe et al.,³ is a minimally invasive surgery to prevent retrolingual collapse during sleep. However, the effectiveness of tongue-base suspension in treating severe obstructive sleep apnoea patients with failed uvulopalatopharyngoplasty remains unexplored. Additionally, traditional tongue-base suspension with the transoral approach causes significant postoperative morbidity, e.g., teeth numbness, sialoadenitis, sublingual hematoma and sublingual gland obstruction.³ The aim of this study is to investigate the role of newly designed transsubmental tongue-base suspension in treating severe obstructive sleep apnoea patients while uvulopalatopharyngoplasty has failed. Exactly how the sleep position affects the efficacy of transsubmental tongue-base suspension is also analysed.

Patients and methods

Inclusion criteria

A prospective study was conducted in patients who were still snoring and experienced sleepiness during the daytime after uvulopalatopharyngoplasty. These patients were referred to our clinic due to previous failed uvulopalatopharyngoplasty. Uvulopalatopharyngoplasty failure is defined as postoperative apnoea-hypopnoea index more than or an equivalent of 15 events hourly, as determined by polysomnography at more than 3 months after surgery.

Each patient had a complete workup, including a thorough medical history review, physical examination, overnight polysomnography, lateral cephalometry and fiberoptic nasopharyngolaryngoscopy with Müller manoeuvre. The study enroled patients with retrolingual obstruction and a Friedman palate position of grade 3 or 4. Each patient had more than or an equivalent of 30 events hourly on the apnoea-hypopnoea index, as determined by polysomnography and their inability to tolerate or refusal of continuous positive airway pressure. Patients with a body mass index (calculated as weight in kilograms divided by height in square metres) exceeding 35 were excluded. All patients did not have nasal obstruction or had undergone previous nasal surgery. This study was approved by an institutional review board.

Surgical procedures

The patients were placed in a supine position under general anaesthesia with nasotracheal intubation. A 2-cm horizontal submental incision was made. The AIRvance screw inserter (Medtronic Xomed) was placed, and the screw was inserted into the mandible (Fig. 1a). A temporary suture loop was first passed with a suture passer through the submental incision to the right side of the tongue base. A single arm of the screw-attached polypropylene sutures was then passed through the left side of the tongue base, \approx . 1–1.5 cm lateral

Correspondence: P.-W. Cheng and T.-W. Huang, Department of Otolaryngology, Far Eastern Memorial Hospital, 21, Section 2, Nan-Ya South Road, Pan Chiao 220, Taipei, Taiwan. Tel.: + 886 2 89667000 ext 1513; Fax: +886 2 29579505; e-mail: huangtw28@gmail.com and powenjapan@yahoo.com.tw



Fig. 1. Diagrams of transsubmental tongue base suspension. The screw is inserted into the mandible (a). Screw-attached sutures are passed through the tongue base (b).

to the midline. Next, the polypropylene suture was then passed across the tongue base with a free cutting needle to the temporary suture loop. The suture loop pulled the polypropylene suture back to the submental incision area. The polypropylene suture was tied with maximal force on the mandible screw (Fig. 1b). The submental skin incision was closed with a subcutaneous absorbable suture. Upon completion of the procedure, a dimple on the base of the tongue was created and could be observed with endoscopy (Fig. 2). The above procedure lasted \approx . 20 min. Patients were hospitalised at least one night for possible oedema of the tongue.

Subjective evaluation

Postoperative pain intensity was evaluated using a visual analogue scale (score range, 0-10). Subjective outcomes were evaluated using the snoring scale. The degree of snoring before surgery and 6 months after surgery was estimated based on a snoring scale ranging from 0 to 10. Bed partners of all the subjects were requested to participate in the study by

helping to establish this scale. A score of 0 represented no snoring at all. A score of 10 indicated when the bed partner had moved out of the bedroom owing to the snoring or avoided sleeping near the patient.

Objective evaluation

Overnight polysomnography was performed in each patient before surgery and at 6 months after surgery. Sleep study variables included the apnoea-hypopnoea index score, apnoea-hypopnoea index in supine and non-supine position, as well as minimal oxygen saturation. The apnoeahypopnoea index score refers to the total number of obstructive apnoea and hypopnoea episodes per hour of sleep. Apnoea refers to cessation of airflow for at least 10 s. Hypopnoea refers to a 50% or greater reduction in the baseline ventilatory value for more than 10 s associated with a more than 4% decrement in oxygen saturation. 'Surgical success' was defined as postoperative apnoea-hypopnoea index below 15 and reduction of more than 50%, compared with the preoperative value.



Fig. 2. Retrolingual space photographs before (a) and after transsubmental tongue-base suspension (b). The enlarged retrolingual space is observed (arrow). Scale bar = 10 mm.

Cephalometric evaluation

Lateral cephalometric radiography was performed before and at 6 months after surgery to examine the bony structures and evaluate the space between the tongue and posterior pharyngeal wall. The posterior pharyngeal space was determined by drawing a line connecting the supramental point and gonion with the posterior wall of the pharynx and measuring the distance between the tongue base and the posterior wall of the pharynx.

Statistical analysis

Statistical analysis was performed using spss software (SPSS Inc, Chicago, IL, USA). A comparative analysis of the results was performed by Student's *t* test and Wilcoxon signed rank test. Where P < 0.05 indicated a statistically significant difference. The effects of the variables of preoperative body mass index, apnoea-hypopnoea index and posterior pharyngeal space on surgical success have been detected by logistic regression analysis.

Results

Thirty patients (26 men, and four women; age range, 29–52 years old [mean age, 39.2 years old]) after failed uvulopalatopharyngoplasty were enroled in this study. All of them underwent transsubmental tongue base suspension. Figure 2 presents the enlarged retrolingual space after operation. The mean body mass index were 27.0 \pm 3.1 before surgery and 26.9 \pm 3.0 at 6 months after surgery, a statistically non-significant difference (P < 0.05). The mean visual analogue scale scores were 7.0 \pm 1.1 on the first postoperative day and 1.4 \pm 0.5 on the seventh postoperative day. The preoperative snoring scale was 8.2 \pm 1.0, which is in contrast to 4.9 \pm 1.4 at 6 months after surgery (P < 0.05).

Before surgery, the mean apnoea-hypopnoea index scores and minimal oxygen saturation were 46.7 ± 19.8 (/h) and $69.8 \pm 11.8(\%)$, respectively, and the corresponding values at 6 months after surgery were 23.7 \pm 20.0 and 78.2 \pm 10.2 (%), which were statistically significant differences (P < 0.01in both groups). The reduction of apnoea-hypopnoea index was $56.0 \pm 26.6(\%)$ compared with the preoperative apnoea-hypopnoea index. The surgical success rate was 57% (seventeen of thirty patients). Table 1 shows how sleep position influences apnoea-hypopnoea index scores. Notably, in non-responders, the median improvement rate of non-supine positional apnoea-hypopnoea index was 16.4%, compared with 34.5% in supine positional apnoea-hypopnoea index, which exhibited significant differences (P < 0.01, Wilcoxon signed rank test). Table 2 summarises the logistic regression analysis of the variables of the 'surgical success'. The surgical outcomes can be reliably predicted by preoperative apnoea-hypopnoea index severity. Lateral cephalometric radiography revealed that the preoperative mean posterior pharyngeal space was $8.6 \pm 1.4(mm)$, whereas that at 6 months following surgery was 9.4 \pm 1.5 (mm), exhibiting a significant difference (P < 0.05, 2Fig. 3).

The postoperative pain and dysphagia were observed for 2 days. Only one patient (3%) has mouth floor oedema and hematoma, which are resolved within 1 week postoperatively.

Table 2.	The	logistic	regression	analysis	of the	variables	of	the
surgical	succe	ess'						

			95% CI		
	Р	Odds	Lower	Upper	
Preoperative BMI (kg/m ²)	0.284	0.668	0.319	1.397	
Preoperative AHI (1/h) Preoperative PAS (mm)	$0.044 \\ 0.470$	1.316 1.653	1.008 0.422	1.718 6.466	

BMI, body mass index; AHI, apnoea-hypopnoea index; PAS, posterior pharyngeal space.

Table	1.	Change	of sleep	positional	AHI	after	transsubmental TBS
-------	----	--------	----------	------------	-----	-------	--------------------

	Preoperative AHI (1/h)	Postoperative AHI (1/h)	Improvement rate (%)	P value [*]	
Responders $(n = 17)$					
Overall	31.2 (30.0, 51.0, 3.1)	8.8 (1.7, 14.9, 5.7)	74.4 (55.2, 94.8, 15.4)	< 0.01	
Supine	38.0 (33.0, 60.1, 3.3)	10.5 (0.5, 20.0, 8.0)	72.1 (42.9, 98.8, 15.8)	< 0.01	
Non-supine	14.1 (7.8, 37.5, 9.6)	5.5 (1.2, 9.8, 4.6)	72.5 (30.0, 92.5, 35.2)	< 0.01	
Non-responders $(n = 13)$					
Overall	65.7 (35.0, 101.0, 14.7)	46.0 (18.2, 60.1, 14.5)	30.3 (1.6, 59.4, 10.9)	< 0.05	
Supine	76.4 (55.9, 105.0, 14.8)	50.4 (25.1, 70.0, 13.3)	34.5 [#] (9.8, 56.9, 8.4)	< 0.05	
Non-supine	50.2 (20.3, 66.3, 25.8)	42.9 (16.3, 51.1, 19.8)	$16.4^{\#}$ (1.0, 45.1, 10.7)	>0.05	

Data were expressed as median (minimum, maximum, interquartile range).

AHI, apnoea-hypopnoea index; TBS, tongue base suspension.

*Comparisons between preoperative and postoperative AHI, Wilcoxon signed rank test.

#P < 0.01, Wilcoxon signed rank test.



Fig. 3. Lateral cephalometric radiography before (a) and at 6 months after transsubmental tongue-base suspension (b). Enlarged posterior pharyngeal space is observed after surgery (left arrow: 7.2 mm, right arrow: 8.2 mm). Scale bar = 30 mm.

No one had sialadenitis, tooth numbness, tongue numbness, taste disturbance or postoperative airway obstruction. No suture was removed during 6-month follow-up.

Discussion

Uvulopalatopharyngoplasty failure may be owing to collapse and obstruction at retrolingual space, hypopharyngeal level and failure at the primary palatal site.⁴ Among them, tongue base is the most common site of obstruction after uvulopalatopharyngoplasty failure.⁵ Earlier studies evaluated the effectiveness of tongue-base suspension by either tonguebase suspension alone or tongue-base suspension combined with uvulopalatopharyngoplasty during a single operation.^{6,7} In this study, newly designed transsubmental tongue base suspension is performed independently in severe obstructive sleep apnoea patients who have earlier failed uvulopalatopharyngoplasty. Therefore, we can evaluate the role of tongue-base suspension in treating severe obstructive sleep apnoea patients without other confounding factors.

Comparisons with other studies

According to the literature, the surgical success rate of tonguebase suspension alone applied to the patients with obstructive sleep apnoea is 30-42%,^{3,8} whereas the success rate increases to 67-81% in patients who underwent concomitant uvulopalatopharyngoplasty and tongue-base suspension when the criteria of >50% reduction and <20 apnoea-hypopnoea index are applied.^{7,9} Our study enrols only patients with preoperative apnoea-hypopnoea index more than 30/h; in addition, the criteria for success are >50% reduction in apnoeahypopnoea index and <15 postoperative apnoea-hypopnoea index, which is more stringent than in previous studies.^{7,9} The success rate of transsubmental tongue-base suspension in severe obstructive sleep apnoea patients after failed uvulopalatopharyngoplasty is 57% (17/30), and the mean reduction in apnoea-hypopnoea index is 56%. This finding suggests that tongue-base suspension is an effective and considerable salvage surgery in patients who have poor outcome after uvulopalatopharyngoplasty treatment.

However, when tongue-base suspension is applied in combination with uvulopalatopharyngoplasty, the surgical success rate and apnoea-hypopnoea index reduction were higher than those in the present study.⁶ Concomitant uvulopalatopharyngoplasty and tongue-base suspension in patients with severe obstructive sleep apnoea also save the time, money and energy. Therefore, in obstructive sleep apnoea patients with retropalatal and retrolingual obstruction, concomitant uvulopalatopharyngoplasty and tongue-base suspension are indicated if they can accept this treatment modality.

Clinical applicability

In the non-responder group, sleep positional analysis reveals that the reduction of apnoea-hypopnoea index is greater in the supine position (36%) than that (15%) in the non-supine position. As the tongue may obstruct the upper airway, the lateral position can have a protective function by preventing the tongue from occluding the airway when the genioglossus muscle is hypotonic. Therefore, tongue-base obstruction may play a more significant role when patients sleep in a supine position than in a lateral position. Analytical results in this study indicate that tongue-base suspension is more effective in preventing the tongue from dropping back in a supine position than in a non-supine position during sleep. A more severe apnoea-hypopnoea index in the lateral position implies a lower efficacy of tongue-base suspension in treating obstructive sleep apnoea patients. Moreover, logistic regression analysis of the 'surgical success' variables reveals that the tongue-base suspension outcomes can also be more reliably predicted by preoperative apnoea-hypopnoea index severity than by an anatomy-based staging system,

which is an acceptable approach in predicting uvulopalatopharyngoplasty outcomes.¹⁰ The mean postoperative posterior pharyngeal space is increased for around 0.78 mm during wakefulness after operation. Rather than creating a large retrolingual space during wakefulness, tongue-base suspension focuses mainly on preventing tongue base collapse when patients sleep. The posterior pharyngeal space cannot be enlarged too much during wakefulness; otherwise, the tongue cannot close up against the posterior wall of the pharynx in bolus transport, causing swallowing problem.

Transsubmental tongue-base suspension is also characterised by its fewer complications than traditional tonguebase suspension with transoral approach. Neither of transsubmental tongue-base suspension in this study has tooth numbness or sialadenitis compared with 10–20% incidence rate in the literature.⁸ The mean visual analogue scale scores of postoperative pain in this study are lower than those in transoral tongue-base suspension reported in the literature on the first and seventh postoperative days.⁸ Additionally, the transsubmental approach also reduces the risk of infection by avoiding oral bacterial contamination.

Synopsis of key findings

To our knowledge, this is the first study to investigate the role of transsubmental tongue-base suspension in severe obstructive sleep apnoea patients after failed uvulopalatopharyngoplasty. Results of this prospective study show favourable subjective and objective outcomes in obstructive sleep apnoea patients undergoing tongue-base suspension after failed uvulopalatopharyngoplasty. Tongue-base suspension is more effective in treating obstructive sleep apnoea patients in a supine position than in a non-supine position during sleep. We believe that transsubmental tongue-base suspension is an effective and safe approach for severe obstructive sleep apnoea patients who underwent failed uvulopalatopharyngoplasty and cannot tolerate continuous positive airway pressure.

Acknowledgment

The authors would like to thank the Far Eastern Memorial Hospital for financially supporting this research under Contract No. FEMH-2013-C-016.

Conflict of interest

None to declare.

Keypoints

- To our knowledge, this is the first study to investigate the role of transsubmental tongue-base suspension in severe obstructive sleep apnoea patients undergoing failed uvulopalatopharyngoplasty.
- In severe obstructive sleep apnoea patients after failed uvulopalatopharyngoplasty, the surgical success rate of tongue-base suspension is 57% and the mean reduction in apnoea-hypopnoea index is 56%.
- Tongue-base suspension is more effective in treating obstructive sleep apnoea patients in a supine position than in a non-supine position during sleep.
- The surgical outcomes of tongue-base suspension can be reliably predicted by preoperative apnoea-hypopnoea index severity.
- Tongue-base suspension with the transsubmental approach reduces postoperative morbidity, e.g., teeth numbness, sialoadenitis, sublingual hematoma and sublingual gland obstruction.

References

- 1 Rama A.N., Tekwani S.H. & Kushida C.A. (2002) Sites of obstruction in obstructive sleep apnea. *Chest* **122**, 1139–1147
- 2 Sher A.E., Schechtman K.B. & Piccirillo J.F. (1996) The efficacy of surgical modifications of the upper airway in adults with obstructive sleep apnea syndrome. *Sleep* **19**, 156–177
- 3 DeRowe A., Gunther E., Fibbi A. *et al.* (2000) Tongue-base suspension with soft tissue-to-bone anchor for obstructive sleep apnea: preliminary clinical results of a new minimally invasive technique. *Otolaryngol. Head Neck Surg.* **122**, 100–103
- 4 Metes A., Hoffstein V., Mateika S. *et al.* (1991) Site of airway obstruction in patients with obstructive sleep apnea before and after uvulopalatopharyngoplasty. *Laryngoscope* **101**, 1102–1108
- 5 Aboussouan L., Golish J., Wood B. *et al.* (1995) Dynamic pharyngoscopy in predicting outcome of UPPP for moderate and severe obstructive sleep apnea. *Chest* **107**, 496–51
- 6 Sezen O.S., Aydin E., Eraslan G. *et al.* (2011) Modified tongue base suspension for multilevel or single level obstructions in sleep apnea: clinical and radiologic results. *Auris Nasus Larynx* **38**, 487–494
- 7 Omur M., Ozturan D., Elez F. et al. (2005) Tongue base suspension combined with UPPP in severe OSA patients. Otolaryngol. Head Neck Surg. 133, 218–223
- 8 Woodson B.T. (2001) A tongue suspension suture for obstructive sleep apnea and snorers. *Otolaryngol. Head Neck Surg.* **124**, 297–303
- 9 Terris D.J., Kunda L.D. & Gonella M.C. (2002) Minimally invasive tongue base surgery for obstructive sleep apnoea. J. Laryngol. Otol. 116, 716–721
- 10 Li H.Y., Wang P.C., Lee L.A. *et al.* (2006) Prediction of uvulopalatopharyngoplasty outcome: anatomy-based staging system versus severity-based staging system. *Sleep* **29**, 1537–1541