

# Multilevel Surgery in Moderate to Severe Obstructive Sleep Apnea Patients

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## ABSTRACT

**Objective:** The aim of this study was to investigate the objective and subjective effectiveness of multilevel surgery, i.e. combined lingualplasty with new technique of partial posterior glossectomy (PPG) and uvulopalatopharyngoplasty in moderate to severe obstructive sleep apnea (OSA) patients.

**Study design and setting:** Retrospective study of 60 OSA patients undergoing multilevel surgery for the treatment of moderate to severe OSA.

**Results:** Preoperative mean apnea hypopnea index (AHI) was 57.5 events/h and preoperative mean lowest SpO<sub>2</sub> was 79.1%. After multilevel surgery, postoperative mean AHI significantly decreased to 29.7 events/h ( $p < 0.001$ ) and postoperative mean lowest SpO<sub>2</sub> increased to 84.4% ( $p < 0.001$ ). Patients had postoperative follow-up assessments for 1 to 3 years. Results of surgery was classified as curative in 35/60 (58.3%) of patients, and as effective, i.e. postoperative AHI less than preoperative AHI in 52/60 patients (86.7 %). Surgery was ineffective in 8/60 (13.3%) patients. Early postoperative complications comprised early velopharyngeal insufficiency (VPI) 20% (12/60), dysarthria 20% (12/60) and wound dehiscence 3.33% (2/60) but without serious complications after 1 year.

**Conclusion:** Combined lingualplasty (with new PPG) and uvulopalatopharyngoplasty (UPPP) as multilevel surgery can be an effective treatment of choice for patients with moderate to severe OSA. No medium-term serious complication was found.

**Keywords:** Apnea hypopnea index, Glossectomy, Lateral pharyngoplasty, Multilevel surgery in obstructive sleep apnea, Obstructive sleep apnea, Uvulopalatoplasty.

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## INTRODUCTION

Obstructive sleep apnea (OSA) is a relatively common and potentially fatal disorder affecting 2 to 4% of

middle-aged adults.<sup>1</sup> Generally, patients have narrow and collapsible airways.<sup>2,3</sup> The Sleep Heart Health Study and the Wisconsin Sleep Cohort<sup>4,5</sup> have demonstrated that the consequences of the collapse of the upper airway are hypertension, cardiovascular disease and cerebral vascular accident due to sleep fragmentation, nocturnal hypoxemia and increased sympathetic tone.<sup>6,7</sup> Nasal continuous positive airway pressure (CPAP) is considered as the gold standard and the primary treatment for OSA but is limited by poor long-term compliance.<sup>8,9</sup> Upper airway surgery is an important treatment option for patients with OSA, particularly for those who have failed CPAP therapy.

Main aim of surgery was to reduce anatomical upper airway obstruction. Since the report by Fujita et al<sup>10</sup> in 1981, uvulopalatopharyngoplasty (UPPP), with the aim of enlarging the potential airspace in the oropharynx, has become a common surgical procedure for the OSA.

Reported success rates of UPPP for OSA range between 16 and 83%, depending on the definition of a positive outcome and selection of patients; according to international journals, criteria for surgical success or cure of OSA after UPPP are: (i) a postoperative 50% reduction in apnea hypopnea index (AHI) and (ii) a residual (postoperative) AHI  $\leq 20$  events/hour.<sup>11-16</sup>

However, one should consider multiple sites of obstruction in severe cases OSA. Furthermore, Riley et al<sup>17-19</sup> were the first to advocate the simultaneous performance of a multilevel surgery for these patients and their invasive technique included maxillary and mandibular advancement. Despite as high a success rate of 95% being reported,<sup>18,20</sup> more publications are needed since many Asian patients may not accept such an extensive surgery. Nevertheless, in selected patients extensive surgery may have a role in treatment of OSA.<sup>21</sup>

Regarding lingual operations, although some authors have described midline glossectomy (and/or lingualplasty) for 'failed UPPP' patients, there has been no previous report on partial posterior glossectomy (PPG) with suturing as part of lingualplasty like ours.

The aim of study was to investigate the objective and subjective effectiveness of the multilevel surgery: partial midline glossectomy (PMG) and PPG as party of lingualplasty together with UPPP as combined multilevel surgery in moderate to severe OSA patients with multilevel airway obstructions.

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## MATERIALS AND METHODS

A retrospective analysis was conducted on 60 consecutive patients who underwent multilevel surgery, i.e. combined lingualplasty (with new PPG) and UPPP for moderate to severe OSA, from January 2004 to 2012. All these patients had attended the snoring clinic in Ramathibodi Hospital (a tertiary center receiving patients from all parts of Thailand).

Inclusion criteria were: patients aged 20 to 70 years, significant symptoms of habitual snoring and/or excessive daytime somnolence, no previous upper airway surgical treatment for OSA, failure or refusal of conservative treatments, e.g. oral appliances or CPAP, retropalatal and retrolingual obstructions as identified by the Müller maneuver, absence of significant maxillofacial abnormalities and AHI  $\geq$  15 events/hour.

Exclusion criteria were: pregnancy, significant heart disease (Canadian class 3-4), coagulopathy, psychiatric disease, significant maxillofacial abnormalities, e.g. sella-nasion-B (SNB) angle  $<$  76° and sella-nasion-A (SNA) angle  $<$  78°, and/or history of previous upper airway surgical treatment for OSA.

Comprehensive preoperative assessments were carried out and included thorough history and physical examination. Patients also completed the Epworth's sleepiness scale (ESS) snore scale (SS) and some questionnaires. Height, weight, neck circumference, BMI (body mass index—calculated as weight in kilograms divided by height in meters squared), and vital signs were also documented. Examination included the documentation of soft palatal redundancy, uvula size and thickness, Mallampati grades, and adenoid and tonsillar sizes. Nasal cavity and laryngeal examination with a flexible fiberoptic endoscopy was also performed; and, Müller maneuver was performed on each patient. Investigations included radiographic cephalometry, thyroid function

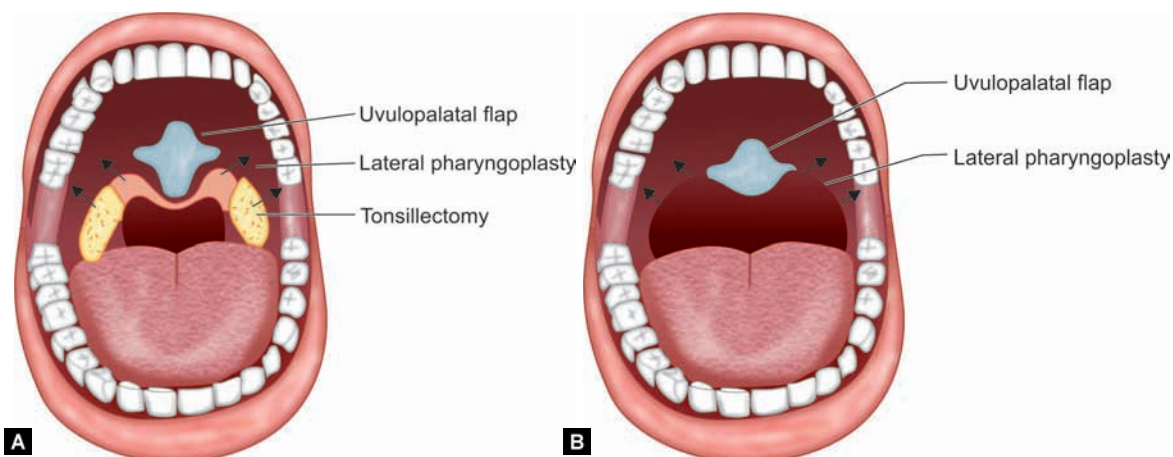
test, electrocardiogram (EKG) and polysomnography (PSG). All patients underwent lingualplasty (including new PPG). Three months after multilevel surgery, PSG tests were repeated to compare preoperative and postoperative values. Surgical success in this study was defined as postoperative AHI reduction of at least 50% or postoperative (residual) AHI  $<$  20 events/hour.

## OPERATIVE PROCEDURES

Initially, tonsillectomy was performed by incision of soft palate—1 cm lateral to uvula by an angle 45° to the vertical. Then, suturing anterior pharyngeal pillar to posterior pharyngeal pillar was made by three 'vicryl 3-0' stitches (Figs 1A and B). Uvulopalatal flap was done by retraction of the uvula superiorly toward the hard-soft palate junction after limited removal of the uvula (leaving 1 cm of uvula remnant) and was completed by lateral pharyngoplasty (LP). Such modified UPPP and LP (Figs 1A and B) will be regarded as 'UPPP' in this study.

Lingualplasty was performed by the following procedures: (i) PMG (resecting spindle-shaped tongue lateral from midline 0.5 to 1 cm, 4.5 cm long, 1 cm thick posterior about circumvalate papillae), (ii) PPG (resecting spindle-shaped base of tongue lateral from midline 1.5 cm, 1 to 1.5 cm posterior, 1 cm thick (Figs 2 and 3), and (iii) suturing (using J-shaped needle with 'vicryl 2-0' to suture the midline for 3 stitches and to suture base of tongue 3 stitches) for lingualplasty (Fig. 4). Overall surgery took approximately 60 to 90 minutes and all surgical procedures were performed by two experienced surgeons.

All patients remained on endotracheal tube for 3 days and were hospitalized for at least 4 nights (risk management for possible tongue edema). In addition, an antibiotic was given for 3 days (amoxycyclavulonic acid 1.2 gm intravenous every 8 hours) and normal saline was used to irrigate oral cavities.



Figs 1A and B: The modified uvulopalatopharyngoplasty (tonsillectomy, lateral pharyngoplasty and uvulopalatal flap)

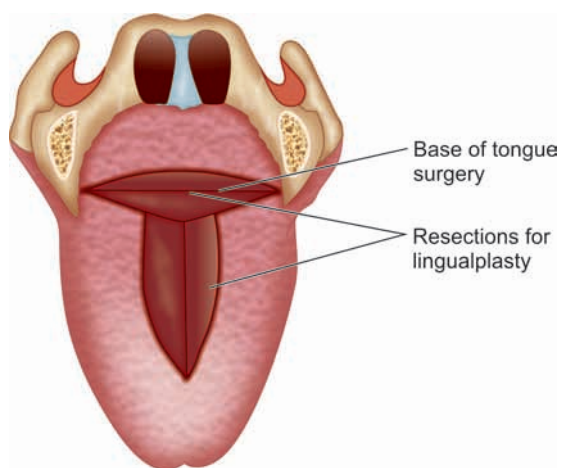


Fig. 2: Technique for lingualplasty

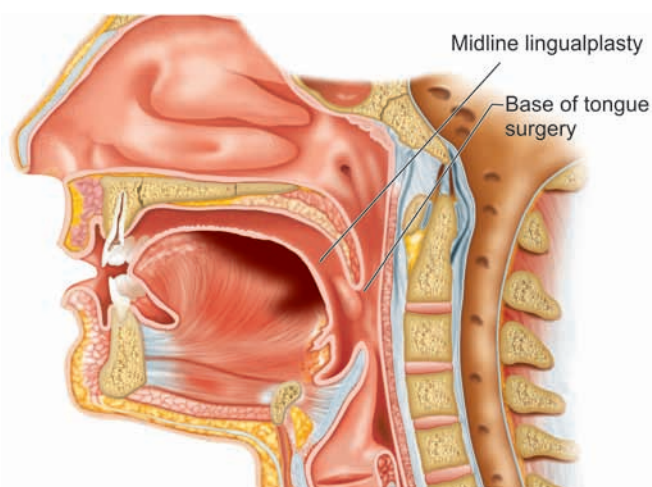


Fig. 3: Technique for lingualplasty (lateral view)

**STATISTICAL ANALYSIS**

Subject demographic and treatment outcomes were summarized as mean SD for continuous variables. The distributions of mean lowest SpO<sub>2</sub> between time points and AHI were compared using the paired t-test. A paired t-test was also done to assess statistically significant differences between preoperative and postoperative parameters. Results were accepted to be significant for a p-value of < 0.05. Statistical analyses were performed using statistical software (SPSS 11.9).

**RESULTS**

In this study, there were 60 multilevel surgical patients whose characteristics and parameters are shown (Table 1).

Mean preoperative AHI decreased significantly from 57.5 events/hour (SD 24.38 events/hour) to mean postoperative AHI of 29.7 events/hour (SD 25.44 events/hour) (p < 0.001); and, the mean preoperative lowest SpO<sub>2</sub> increased significantly from 79.1% (SD 11.07%) to 84.4% (SD 7.84%) (p < 0.001) (Table 2).

If 'curative' surgical success for OSA is considered (criteria: either a postoperative AHI decrease > 50% or a

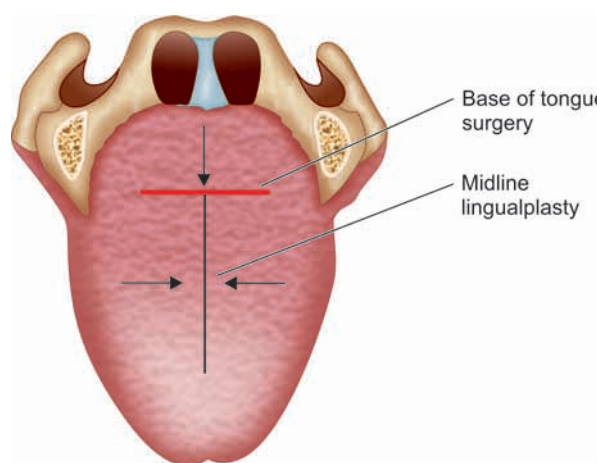


Fig. 4: Sutured line after lingualplasty

residual postoperative AHI < 20 events/hour), this was achieved in 58.3% (35/60 patients) (Table 3).

If 'effective' surgical success for OSA is considered (criterion: postoperative AHI < preoperative AHI), this was achieved in 86.7% (52/60 patients) while the 'ineffective' rate was 13.3% (8/60 patients) (Table 4).

Early postoperative complications comprised velopharyngeal insufficiency (VPI) 20% (12/60), dysarthria 20% (12/60), and wound dehiscence 3.33% (2/60) but VPI

**Table 1:** Characteristics and parameters of multilevel surgical patients

Variables	N	Percent	Mean	SD	SE	Min.	Max.
Age	60		48.4	49.0	8.84	26.0	69.0
Gender	60	100.0					
Male	50	83.3					
Female	10	16.6					
BMI	60	100.0	27.4	26.4	4.39	19.7	41.3
Preoperative mean SpO <sub>2</sub>	60		94.3	94.8	2.54	84.2	98.0
Postoperative mean SpO <sub>2</sub>	60		95.2	95.7	2.50	84.1	98.4
Preoperative lowest SpO <sub>2</sub>	60		79.1	11.07	1.43	52.1	96.1
Postoperative lowest SpO <sub>2</sub>	60		84.4	7.84	1.00	53.2	97.0
Preoperative AHI	60		57.5	24.38	3.14	15.0	109.5
Postoperative AHI	60		29.7	25.44	3.28	0.4	95.7

AHI: Apnea-hypopnea index; pre-op: preoperative; post-op: postoperative; SpO<sub>2</sub>: peripheral oxygen saturation by pulse oximetry



**Table 2:** Differences of mean lowest oxygen saturations (O<sub>2</sub> Sat, SpO<sub>2</sub>) and apnea-hypopnea indexes (AHIs) before and after surgery

		Paired samples statistics					
		N	Mean	SD	SE	t-test	p-value
Pair 1	Preoperative lowest O <sub>2</sub> sat (SpO <sub>2</sub> )	60	79.1	11.07	1.43	-4.175	< 0.001
	Postoperative lowest O <sub>2</sub> sat (SpO <sub>2</sub> )	60	84.4	7.84	1.00		
Pair 2	Preoperative AHI	60	57.5	24.38	3.14	9.280	< 0.001
	Postoperative AHI	60	29.7	25.44	3.28		

**Table 3:** Postoperative changes of apnea-hypopnea indexes

Postoperative changes in AHI values	N	Percent
AHI decrease > 50% or AHI < 20 events/hour	35	58.3
No AHI decrease > 50% or AHI ≥ 20 events/hour	25	41.7
Total	60	100.0

**Table 4:** Comparison of preoperative and postoperative apnea-hypopnea indexes (AHIs)

AHIs	N	Percent
Postoperative AHIs < preoperative AHIs (effective)	52	86.7
Postoperative AHIs > preoperative AHIs (ineffective)	8	13.3
Total	60	100.0

cases improved within 90 days. Longer medium-term follow-ups (1–3 years) did not reveal any VPI, abnormal nasality, dysphagia, dysarthria or hypoglossal nerve palsy.

## DISCUSSION

Multilevel surgery, i.e. combined lingualplasty with the new PG and UPPP in moderate to severe OSA patients was successful as assessed by cure rate and effective rate. Such surgery probably expanded pharyngeal air space. It is possible that the new transverse resection of PPG plus anterior-posterior suturing had a role in this expansion.

After this surgery, mean AHI improved significantly (mean AHI decreased significantly— $p < 0.001$ ) while mean lowest saturation (SpO<sub>2</sub>) increased significantly (from comparison of preoperative SpO<sub>2</sub> and postoperative SpO<sub>2</sub> among PSG results,  $p < 0.001$ ).

On successful results (criteria: postoperative AHI decrease > 50% or residual or postoperative AHI < 20 events/hour), the successful cure rate was achieved in 58.3% (35/60 patients) (Table 3); and, on effective results (postoperative AHI less than preoperative AHI), the successful effective rate was 86.7% (52/60 patients) (Table 4).

On ineffective results, the 'ineffective' rate was 13.3% (8/60 patients) (Table 4). Both the positive surgical cure

rate and the high surgical effective rate emphasize the relevant role of multilevel surgery in the treatment of moderate to severe OSA. It should be mentioned that the multilevel surgery in this study is less extensive than the maxillomandibular advancement surgery;<sup>17-20</sup> however, more extensive surgery may have a role in treatment of selected patients with OSA.<sup>21</sup>

Although this research has some limitations, such as retrospective design, small number of patients and absence of a control group, there are some positive promising surgical results and future studies are recommended.

## CONCLUSION

In this study, multilevel surgery, i.e. combined lingualplasty (including new PPG) and 'UPPP' represents a minimally invasive technique with aim to improve tongue base collapse and narrowing of oropharynx in patients with multilevel airway obstructions; and, success rates (from AHI results) have emphasized the relevant role of multilevel surgery in moderate to severe OSA patients. Such surgery can be easily performed and should be considered as an alternative choice to CPAP therapy especially in cases with CPAP-intolerance or CPAP-failures. Being relatively inexpensive and less extensive than maxillo-mandibular advancement surgery, this combined lingualplasty and 'UPPP' have sufficiently successful rates to be justified as a treatment for moderate to severe OSA patients.

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