

# Snoring and obstructive sleep apnea

Chairat Neruntarat MD.\*

## **Abstract**

Snoring and obstructive sleep apnea (OSA) are ongoing disease processes. Snoring once thought to be only a social disease, may actually be a precursor to subsequent OSA. Treatment begins by eliminating or reducing causative or exacerbating factors. The traditional plan involves weight loss, alteration of sleeping position, and avoidance of sedatives, smoking, and alcohol. In the management of all patients with OSA, weight loss with continuous positive airway pressure or surgery may be considered. There are several innovations in the surgical techniques available for treatment of patients with sleep-disordered breathing. Outpatient techniques such as laser-assisted uvulopalatoplasty (LAUP) and additional procedures designed to address hypopharyngeal and base of tongue obstruction (genioglossus advancement, hyoid myotomy, and tongue base suspension) have been developed and proven successful. This study was conducted to evaluate the efficacy of the treatment options for snoring and OSA. There were 324 patients who enrolled for the treatment of snoring and OSA, 163 patients (50.3%) chose non surgical interventions. One hundred and sixty one patients (49.7%) were determined to be candidates for surgery. Seventy five simple snorers who underwent LAUP procedure, 85% of patients had greater than 70% improvement of their snoring. A successful surgical response in the postoperative respiratory disturbance index (RDI) compared with the preoperative value was achieved in 69.6% of uvulopalatopharyngoplasty (UPPP)-treated and 66.7% of LAUP-treated OSA patients. Twenty-two patients with more significant obstructive sleep apnea (mean RDI =  $56.6 \pm 18.8$ ) underwent pharyngeal surgery consisting of genioglossus advancement and hyoid myotomy combined with UPPP. The surgical success rate in this group of patients was 63.6%. Six patients underwent UPPP and tongue base suspension. There were 4 cases of surgical success. Hyoid myotomy with suspension could be performed under local anesthesia with mild oral or intravenous sedation. There were no serious complications in the treatment modalities in this study.

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\* Department of Otolaryngology, Faculty of Medicine, Srinakharinwirot University

\* ภาควิชาโสต นาสิก ลาริงซ์วิทยา คณะแพทยศาสตร์ มหาวิทยาลัยศรีนครินทรวิโรฒ

## บทคัดย่อ

## การนอนกรนและการหยุดหายใจขณะหลับจากการอุดกั้น

ชัยรัตน์ นิรันดร์ตัน พ.บ.\*

การนอนกรนและการหยุดหายใจขณะหลับจากการอุดกั้นมีความเกี่ยวข้องถึงกัน เดิมเข้าใจกันว่าการนอนกรนนั้นเพียงแต่ก่อให้เกิดความรำคาญกับผู้ที่อยู่ใกล้ชิดเท่านั้น แต่ในปัจจุบันพบว่าอาจก่อให้เกิดการหยุดหายใจขณะหลับร่วมได้เป็นปัจจัยให้เกิดโรคต่างๆ ตามมา การรักษาเริ่มด้วยวิธีขจัดหรือลดปัจจัยเสี่ยงต่างๆ รวมทั้งให้ผู้ป่วยลดน้ำหนัก ปรับท่านอน หลีกเลี่ยงการใช้ยาแก้ไอและยาแก้ปวด งดสูบบุหรี่ งดดื่มสุรา วิธีรักษาการหยุดหายใจขณะหลับ ให้ใช้เครื่องปรับความดันบวกร่วมกับวิธีลดน้ำหนักหรือพิจารณาให้การผ่าตัดรักษา ร่วมกัน มีการผ่าตัดหลากหลายวิธีที่จะรักษาผู้ป่วยเหล่านี้ การตกแต่งเพดานอ่อน และลิ้นไก่ด้วยเลเซอร์แบบผู้ป่วยนอก (laser-assisted uvulopalatoplasty : LAUP) หรือ การผ่าตัดเพิ่มเติมในรายที่มีอาการมากบริเวณ hypopharynx อันประกอบด้วยวิธี genioglossus advancement, hyoid myotomy และ tongue base suspension ล้วนพบว่าทำให้ผู้ป่วยดีขึ้น งานวิจัยนี้มีวัตถุประสงค์จะประเมินผลการรักษาผู้ป่วยนอนกรนและผู้ป่วยที่มีการหยุดหายใจขณะหลับด้วยวิธีการต่างๆ กัน ผู้ป่วยจำนวน 324 ราย ที่เข้ารับการรักษา พบว่าจำนวน 163 ราย (ร้อยละ 50.3) เลือกรับการรักษาดด้วยวิธีอนุรักษ ผู้ป่วยจำนวน 161 ราย (ร้อยละ 49.7) เข้ารับการผ่าตัดรักษา พบว่าผู้ป่วย 75 ราย ที่ทำการรักษาด้วยวิธี LAUP จำนวนร้อยละ 85 มีอาการนอนกรนดีขึ้นอย่างน้อยร้อยละ 70 เมื่อเปรียบเทียบกับก่อนผ่าตัด ส่วนผู้ป่วยที่มีการหยุดหายใจขณะหลับที่ได้รับการรักษา ด้วยวิธีการตกแต่งเพดานอ่อนและลิ้นไก่ (uvulopalatopharyngoplasty : UPPP) ผล respiratory disturbance index ลดลงร้อยละ 69.6 และผู้ป่วยที่ได้รับการผ่าตัดวิธี LAUP ได้ผลร้อยละ 66.7 ในผู้ป่วยจำนวน 22 ราย ซึ่งมีการหยุดหายใจขณะหลับในขั้นรุนแรง (ค่า RDI =  $56.6 \pm 18.8$ ) ได้รับการผ่าตัดบริเวณ hypopharynx วิธี genioglossus advancement และ hyoid myotomy ร่วมกับการผ่าตัดวิธี UPPP พบผลดีในการรักษา ร้อยละ 63.6 และผู้ป่วยจำนวน 6 ราย ได้รับการผ่าตัดวิธี UPPP ร่วมกับ tongue base suspension ได้ผลดีในผู้ป่วยจำนวน 4 ราย การผ่าตัดวิธี hyoid myotomy with suspension สามารถทำภายใต้ยาชาเฉพาะที่ร่วมกับให้ยาแก้ไอและยาแก้ปวดชนิดรับประทานหรือฉีด ไม่พบภาวะแทรกซ้อนที่เป็นอันตรายจากการให้การรักษาผู้ป่วยในงานวิจัยนี้

## Introduction

Habitual snoring in adults is a distressing social problem which may also predispose them to develop obstructive sleep apnea, ischemic heart disease, and cerebrovascular disease. It is usually associated with obstructive sleep apnea (OSA).<sup>1</sup> Chronic snorers often report restless sleep,

morning headaches, or fatigue. They may demonstrate daytime listlessness and hypersomnolence. Other symptoms associated with OSA include memory difficulties, attention or concentration deficits, behavioral and affective changes, impotence, loss of alertness, toxemia, and even sudden death due to cardiovascular complications.<sup>2</sup> The management of snoring and OSA is complex and challenging.

The most effective method used in the medical management is continuous positive airway pressure (CPAP). In addition, weight loss, body position training for sleep, and avoidance of alcohol and sedative medications must be behaviorally addressed. However, because medical and behavioral management requires ongoing, prolonged follow-up and adherence to the therapy regimens, not all patients are able to comply with these recommended treatment modalities.<sup>3</sup>

Surgical intervention becomes a more viable option for such patients. Surgical management appears more desirable, particularly to younger or middle-aged individuals who visit to overturn the harsh sentencing of nightly attachment to a CPAP machine for a long time, may be for life. Precise identification of each anatomic region of constriction is essential for accurate planning and sequencing of surgical intervention. The surgical management continues to be a challenge, beginning with selecting which surgical procedure to perform. Until 1981 when uvulopalatopharyngoplasty (UPPP) was introduced,<sup>4</sup> the only operations available were either tonsillectomy/adenoidectomy or tracheostomy. UPPP was the first operation specifically designed to address the palatal abnormalities seen in many patients with OSA. Subsequently, other procedures have been introduced, but UPPP remains the most commonly performed operation for OSA in adults.

The most recent surgical treatment for snoring and OSA is laser-assisted uvuloplasty (LAUP). It differs from other OSA surgeries because it can be performed in the office using only local anesthesia and no sedation. Many studies reported surgical response rates for LAUP of 54–87%.<sup>5,6,7</sup>

Because snoring and OSA are composed of patients with wide spectrum of disease severity and multiple sites of obstruction. A hypopharyngeal surgical approach consisting of mandibular osteotomy with genioglossus advancement (GA),

and hyoid myotomy with suspension (HM) has been proposed by Riley et al.<sup>8</sup> Since there are both medical and surgical treatment options the aim of this study was conducted to evaluate patient selection, criteria, polysomnographic findings, and postoperative complications of the treatment modalities for this group of patients.

## Materials and Methods

### Patients

During 20 months, 342 consecutive patients (302 men, 40 women), aged 21–58 years, were evaluated for treatment of snoring and sleep apnea at Vajira Hospital. Patients were advised to bring their bed partners to the evaluation. The initial visit included a complete history, physical examination, and otolaryngologic examination. Fiberoptic pharyngoscopy with Mueller's maneuver was performed at the level of the nasopharynx and the base of tongue. Initial body weights and heights were obtained, and their body mass index (BMI) was calculated. A lateral cephalometric radiograph and panoramic radiograph of the mandible were also obtained for patients who were considered candidates for additional hypopharyngeal surgery.

After a diagnosis of snoring or OSA was made, patients were advised on various treatment options for their diseases. When appropriate, patients were encouraged to lose weight, avoid sleep supine if their problem was positional, lengthen their bedtime, and avoid alcohol and tobacco. Medications were tried to optimize nasal patency. Continuous positive airway pressure (CPAP), oral appliance, and surgical options were reviewed with each patient.

### Surgery

Patients with primary snoring were encouraged to undergo LAUP. Those with mild OSA were encouraged to undergo LAUP or UPPP

depending on their preference. If these patients demonstrated significant preoperative lateral pharyngeal or base of tongue collapse on the Mueller's maneuver, they were offered additional hypopharyngeal surgery as a more aggressive alternative to UPPP alone.

Patients with moderate ( $RDI \geq 20$  and  $< 40$ ) or severe ( $RDI \geq 40$ ) OSA usually had multiple sites obstruction and were offered additional hypopharyngeal surgery or tongue base suspension. The patients with more severe OSA were referred for CPAP, to expeditiously treat their OSA and so that CPAP was available for the preoperative period. A small number of patients with moderate or severe OSA who already had CPAP request treatment with LAUP alone.

A standard technique for UPPP was used as described originally by Fujita et al<sup>4</sup> (Fig 1). The LAUP procedures were performed with carbon dioxide laser at a setting of 18 W continuous mode. Uvular and palatal reduction was performed, as were bilateral vertical trenches through the palate.<sup>9</sup> The patients received postoperative antibiotic and analgesic. The number of stages ranged from 1 to 4, with each stage separated by a minimum of 4 weeks.

Additional hypopharyngeal surgery comprised genioglossus advancement (GA) (Fig 2) and hyoid myotomy with suspension (HM) (Fig 3), using the modification in which a window is created in the mandibular symphysis to incorporate the genial tubercle, instead of an inferior sagittal



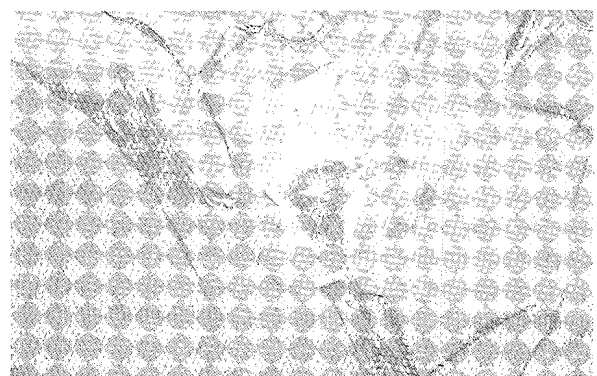
**Fig 1.** Uvulopalatopharyngoplasty preoperative (left), postoperative (right)

osteotomy<sup>8</sup>, and a second modification in which the middle portion of hyoid bone is advanced over the thyroid cartilage (Fig 4), instead of being suspended from the inferior mandible.<sup>10</sup>

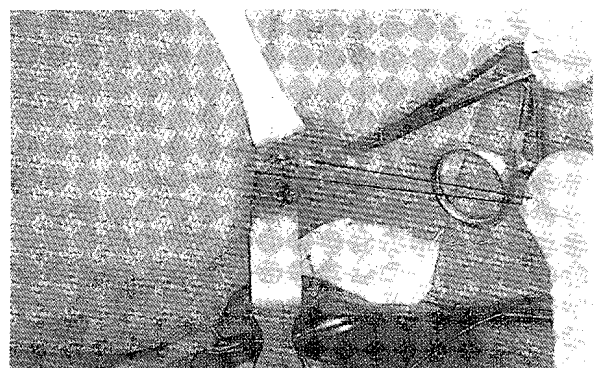
In well-tolerated patients, HM could be performed under local anesthesia as a separated procedure from UPPP and GA. Tongue-base suspension was performed in patients with obvious tongue-base collapse.<sup>11</sup> Modification was conducted that suture material could be tied together at the outer surface of the mandible (Fig 5).

### Mueller's maneuver

Mueller's maneuver was performed with the patient in sitting position. The degree of collapse was graded separately at the palatal area, the lateral pharyngeal walls, and the base of tongue as follow : 0 for no collapse, 1+ for a 25% reduction in cross-sectional area, 2+ for a 50% reduction in area, 3+ for a 75% reduction in area, and 4+ for complete obstruction.



**Fig 2** Genioglossus advancement



**Fig 3** Hyoid myotomy with suspension

## Epworth Sleepiness Scale (ESS)

The ESS questionnaire determines the likelihood of dozing in eight situations, from highly soporific situations (lying down in the afternoon) to much less soporific ones (talking to someone)<sup>12</sup>. The patient rates each situation from 0 to 3, with 3 being the highest likelihood, giving a total range of scores from 0 to 24. A score of less than 8 is considered within normal limits, and a score greater than 9 is suggestive of sleep apnea.

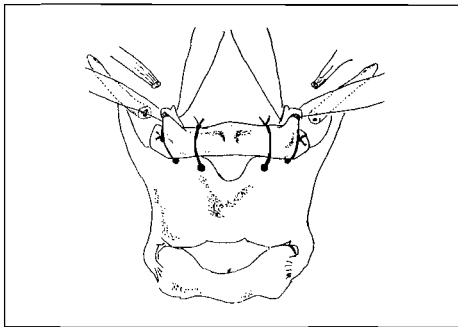


Fig 4 Hyoid myotomy with suspension (modification)

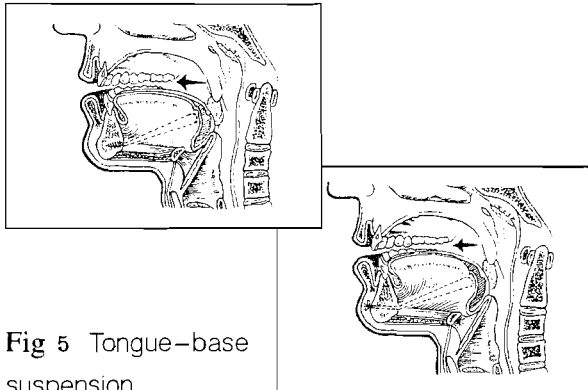


Fig 5 Tongue–base suspension.

Ari's technique (left) Modification (right)



Fig 6 Polysomnographic study

## Polysomnography

Patients were evaluated preoperatively and then at least 3 months postoperatively by polysomnography (Fig 6). The study consisted of nocturnal polysomnographic monitoring, including electroencephalogram, electrooculogram, chin and leg electromyogram, and electrocardiogram. Respiration was investigated by oronasal airflow, thoracic and abdominal movements conductive plethysmography, snoring sounds, and oxygen saturation (pulse oximetry). Records were scored following the criteria of Rechtschaffen and Kales's<sup>13</sup> for sleep wake determination, and the criteria for determining other sleep syndromes were based on the international classification of sleep disorders. abnormal breathing patterns were scored using the current criteria for identifying sleep apnea and sleep hyponea<sup>14</sup>. Differences between preoperative and postoperative data were assessed using the paired Student's *t*-test for means. Chi square tests provided between group comparisons of categorical variables. Wilcoxon's rank test was used when data were skewed.

## Results

There were 324 patients (95.3%) who enrolled in this study for the treatment of snoring and OSA, 161 (49.7%) were determined to be candidates for surgical treatment. Thirty-two patients underwent a trial of CPAP prior to surgery. In addition, most patients with severe OSA (RDI > 40) the lowest oxygen saturation < 70% were prescribed CPAP preoperatively. The remaining patients (50.3%) chose nonsurgical interventions including behavioral modification 98 (60%), dental appliances 16 (10%) or CPAP 49 (30%).

### LAUP

All patients for whom snoring data were available (75 of 80) reported an improvement in the volume and frequency of snoring. This was a subjective determination based on

questionnaires of the patient and sleep partner that were conducted at least 3 months after surgery. They were asked whether the snoring volume had changed and to what degree, and if the snoring occurred less frequently each night or on fewer nights per week. Simple snoring was completely cured in 32 patients (42.6%), 50% to 90% improved in 36 (48%), and less than 50% improved in 7(9.3%). Overall, 85% of patients (64 of 75) had greater than 70% improvement in their snoring.

Preoperative and postoperative Mueller's maneuver data were available for 62 patients, with palatal collapse decreasing from  $2.5 \pm 1.5$  to  $0.9 \pm 1.5$  ( $p < 0.001$ ). No significant change was seen in collapse of the lateral pharyngeal walls or the base of tongue. Thirty OSA patients (25 men, 5 women) age  $48.2 \pm 5.4$  years were performed LAUP. This group had a mean ESS score of  $8.8 \pm 5.6$ , a mean RDI of  $38.3 \pm 3.7$ , and a mean LSAT of  $80.3 \pm 5.2\%$ . The degree of palatal collapse note on the Mueller's maneuver was  $2.2 \pm 1.3$ . A total 72 LAUP procedures were performed (mean per patient,  $2.4 \pm 1.2$ ; range 1 to 4). Postoperative ESS score fell to  $6.6 \pm 4.2$  and postoperative palatal collapse fell to  $1.2 \pm 0.9$  which were statistically significant difference from preoperative data.

UPPP patients when compared with LAUP patients had significantly higher mean preoperative RDI, and lower oxygen saturation. UPPP patients had higher mean BMI. There were no significant differences between UPPP patients and LAUP patients in their age and sex (table 1). Postoperative RDI was reduced a mean of 44% in UPPP-treated patients ( $42.1 \pm 5.0$  to  $23.5 \pm 2.7$ ,  $p < 0.001$ ). The postoperative RDI was reduced by a mean of 42% in LAUP patients ( $38.3 \pm 3.7$  to  $22.2 \pm 4.4$ ,  $p < 0.01$ ). Postoperative LSAT increased significantly from  $78.8 \pm 2.1$  to  $87.5 \pm 3.2\%$  ( $p < 0.05$ ) in UPPP patients and increased significantly from  $80.3 \pm 5.2$  to  $88.6 \pm 2.2$  ( $p < 0.05$ ) in those treated with LAUP. A successful surgical response (defined as  $> 50\%$  reduction in the

**Table I** Results in patients who completed LAUP and UPPP treatment for obstructive sleep apnea.

Parameter	LAUP patient (n = 30)	UPPP patients (n = 23)	p-Value
Sex	25 M/5F	20 M/3F	NS
Age	$48.2 \pm 5.4$	$46.2 \pm 6.5$	NS
BMI	$29.5 \pm 0.7$	$32.1 \pm 0.7$	$< 0.05$
Preoperative ESS	$8.8 \pm 5.6$	$8.9 \pm 5.2$	NS
Postoperative ESS	$6.6 \pm 4.2$	$5.9 \pm 3.1$	NS
Preoperative RDI	$38.3 \pm 3.7$	$42.1 \pm 5.0$	$< 0.001$
Postoperative RDI	$22.2 \pm 4.4$	$23.5 \pm 2.7$	NS
Preoperative LSAT	$80.3 \pm 5.2$	$78.8 \pm 2.1$	$< 0.05$
Postoperative LSAT	$88.6 \pm 2.2$	$87.5 \pm 3.2$	NS
Palatal collapse (pre)	$2.2 \pm 1.3$	$2.5 \pm 1.4$	NS
Palatal collapse (post)	$1.2 \pm 0.9$	$1.4 \pm 1.1$	NS
Surgical response (%)	66.7	69.6	NS
Follow-up (months)	$8.9 \pm 5.2$	$10.3 \pm 6.7$	NS

BMI = body mass index, ESS = Epworth sleepiness scale, RDI = respiratory disturbance index, LSAT = lowest oxygen saturation, NS = not significant

postoperative RDI compared with the preoperative value) was achieved in 16 (69.6%) of UPPP-treated and 20 (66.7%) of LAUP-treated patients.

Postoperative complications in the LAUP patients included bleeding (2/3), temporary velopalatal insufficiency (3/30). Postoperative complications in the UPPP patients included bleeding (2/23), temporary velopharyngeal insufficiency (3/23). Bleeding was easily controlled in all cases with suture and no one required a blood transfusion. There were no emergent airway complications, no cases of permanent velopalatal insufficiency, and no deaths in this study.

### **Hypopharyngeal surgery**

Twenty-two patients underwent UPPP, GA, and HM (20 men, 2 women; mean age,  $46.1 \pm 11$  years; mean BMI,  $31.4 \pm 4.8$ ). The demographic, polysomnography, and anatomical data for the entire group are indicated in (Table II). Postoperative follow-up was  $10.2 \pm 8.4$  months.

**Table II** Hypopharyngeal surgery

Parameter	Preoperative	Postoperative	p-value
BMI	31.4±4.8	30.7±4	NS
ESS	12.1±4.9	4.5±4.1	<0.001
RDI	56.6±18.8	22.3±22.3	<0.001
LSAT	76.1±11.2	87.3±11.1	<0.001
Sleep efficiency	81.1±14.3	90.1±7.2	<0.05
Mueller's maneuver			
<i>Palate</i>	3.2±1.1	0.9±0.3	<0.001
<i>Lateral pharyngeal wall</i>	2.6±0.8	1.9±1.2	<0.05
<i>Base of tongue</i>	2.1±1.3	0.7±0.8	<0.05

BMI = body mass index, ESS = Epworth sleepiness scale RDI = respiratory disturbance index. LSAT = lowest oxygen saturation, NS = not significant

The mean ESS score fell from 12.1 ± 4.9 to 4.5 ± 4.1 (p < 0.001). The RDI decreased in 90% of these patients (20 of 22), and 63.6% (14 of 22) were considered a success by having a reduction in RDI of more than 50%.

Snoring data showed an improvement in the volume and frequency of snoring; it was completely cured in 10 patients (45%), 50 to 90% improved in 10 (45%), and 25% or less improved in 2 (9%). Nineteen of 22 patients (86.4%) had greater than 70% improvement in snoring. The mean palatal collapse decreased from 3.2 ± 1.1 to 0.9 ± 0.7 (p < 0.001), the mean lateral pharyngeal wall collapse decreased from 2.6 ± 0.8 to 1.9 ± 1.2 (p < 0.05), and the mean base of tongue collapse decreased from 2.1 ± 1.3 to 0.7 ± 0.8 (p < 0.05). Complications included two gingivolabial sulcus incision dehiscence (all healed spontaneously), one extruded screws and mandibular bony segments, one case of moderate ecchymosis and edema of the neck and face skin without airway compromise, and two gingivolabial sulcus wound infection that resolved with local wound care and antibiotics. Three patients reported transient paresthesia of the mandibular incisors that resolved after 3 months.

### **UPPP and Tongue-base suspension**

Six patients underwent UPPP and tongue base suspension (five men, one women : mean age 48.8 ± 8.1 years; mean BMI, 29.8 ± 6.2) ESS scores decreased from 10.8 ± 5.2 to 6.8 ± 5.4 (p < 0.05). There were 4 cases of surgical success for OSA, and the overall mean RDI decreased from 25.4 ± 4.9 to 18.2 ± 11.7 (p < 0.05). All of the patients reported an improvement in the volume and frequency of snoring; it was completely cured in two patients (33%) and 50% to 90% improvement in the other. The average follow-up time was 7.8 ± 2.1 months. There were two cases of ecchymosis and edema of the floor of mouth. The mean palatal collapse decreased from 3.1 ± 0.5 to 0.8 ± 0.5 (p < 0.05), the mean lateral pharyngeal wall collapse decrease from 2.2 ± 0.9 to 1.5 ± 1.1 (p < 0.05), and the mean base of tongue collapse decreased from 2.4 ± 0.9 to 0.9 ± 0.9 (p < 0.05). Postoperative LSAT increased significantly 79.8 ± 1.4 to 88.2 ± 4.5% (p < 0.05). Hyoid myotomy and suspension could be done under local anesthesia with mild oral or intravenous sedation in 5 cases after UPPP and GA procedures.

### **Discussion**

Snoring may originate from vibration of the soft tissue structures in the pharynx, including the soft palate, uvula, tonsils, tonsillar pillars, tongue base, and posterior and lateral walls of the pharynx. These vibrations occur because of airflow turbulence in the sleeper's pharynx, originating either in the nose or in the oropharynx. The turbulent airflow produces a fighter-valve effect in the collapsible pharyngeal tissues.<sup>15</sup> Snoring has long been described as a socially disturbing problem. Only relatively recently has the adverse medical effects of snoring and its association with obstructive sleep apnea.

The diagnosis of snoring is made primarily by history, much of which can be obtained from the patient's bed partner. The character and consistency of the snoring are examined to determine its severity and possible presence of OSA. Frequent episodes of breathing cessation followed by sudden and intensified snoring is a strong indication of OSA. A detailed survey that explores the snore's medical condition, sleep position, alcohol and sedative intake, weight changes, and daytime performance is an important part of the history. Physical examination should include complete evaluation of the upper airway, including nose, nasopharynx, oral cavity, oropharynx, hypopharynx, and larynx. Flexible fiberoptic nasolaryngoscopy completes this examination. The Mueller's maneuver is also performed; it consists of inhaling against a closed mouth and nose to create maximum negative pressure in the upper airway. It aids in the detection of any collapsing site in the pharynx, and is an important part of the examination in understanding the site and the pathophysiology of the pharyngeal obstruction.<sup>16</sup> It is repeated at the tongue base level as well.

It is prudent to attempt medical intervention or behavioral modification in appropriate circumstances. Sleep positioning may be sufficient in mild grade of snoring. Nasal allergies should be treated when present. Elimination of tranquilizers and sleeping pills, avoidance of alcohol prior to sleep, weight reduction using strict dietary measures, and daily exercise are imperative. Exposure to upper airway irritants, such as smoke and fumes, must be eliminated. Because both medical and behavioral management require prolonged follow-up and adherence to a restrictive lifestyle, not all patients are able to comply.<sup>17</sup> Additionally, many patients do not respond to conservative treatment measures. In this study, there was 49.7% of patients who had surgical treatments. It is generally preferred by young and middle aged individuals.

LAUP is a technique developed by Kamami in France in the late 1980.<sup>18</sup> The procedure is designed to improve the airway obstruction and soft tissue vibration at the level of the soft palate by reducing, reshaping and stiffening the tissue of the velum and the uvula. Krespi et al<sup>19</sup> reviewed patients who underwent LAUP in the office, with a 3 month to 2 year follow-up. They reported that 84% had snoring eliminated, and an additional 7% had a reduction in snoring. Carenfelt<sup>20</sup> reported 85% total or near-total elimination of snoring during short-term follow-up of 60 patients. Kamami,<sup>9</sup> in a review of 31 patients with a maximal follow-up of 18 months, reported 77% elimination or significant reduction of snoring. This study resulted in 85% elimination or significant reduction of simple snoring.

The reported complications for LAUP are rare. Moderate to severe pain is the major side effect of the procedure. Pain intensity reaches its peak 4 days postoperatively, with complete relief of symptoms in 8-10 days. Healing occurs by formation of white eschar in 3-5 days following the procedure. Intraoperative bleeding occurs in about 3% of the patients. No patients have required hospital admission or transfusion. Velopharyngeal stenosis has not been encountered because, by using the special handpiece with backstop to make the palatal incisions, the nasopharyngeal mucosa is protected from injury. Approximately 40% of patients may complain of a scratchy or dry mucus sensation in the throat.<sup>19</sup> This is usually self-limited and resolved within 2 months. LAUP is an effective method for treating patients with loud, habitual snoring. It offers several advantages to the classic UPPP, including reduced cost, decreased operative morbidity, diminished postoperative pain, and abbreviated convalescence period, as well as avoidance of general anesthesia.

Obstructive sleep apnea is a common event, occurring to a significant degree (> 5 events /hour of sleep) in 4-9% of the population.<sup>21</sup> Severe



disease (> 20 events/hour) is associated with excess mortality and presents with complaints related to excessive daytime sleepiness, disturbed sleep, morning headache, impotence, and heavy snoring. There is evidence that sleep apnea, is associated with the development of a chronic illness with cardiopulmonary and neuropsychological symptoms and signs. Neuropsychological deficit has been demonstrated most convincingly in patients with severe disease. They demonstrated deficits in a number of cognitive processes, including intellectual abilities, executive functions, memory, and learning.<sup>22</sup>

In a study by He et al,<sup>23</sup> the cumulative survival after 5 years in treated and untreated patients with an apnea index greater than 20 showed that cumulative survival was 100% for CPAP treated group versus about 75% for the untreated group.

Despite even the most persuasive reasoning and entreaty, too many patients with significant OSA cannot or will not follow recommended medical treatments. While CPAP has been demonstrated as effective in suppressing obstructive sleep apnea, long-term compliance remains a major problem. Many studies<sup>24,25,26</sup> report that patients with moderate to severe sleep apnea use their CPAP only a mean of 4.7 h/night. A mean 68% of their total sleep time. However, full-time use of CPAP is necessary to control the consequence of OSA. Although CPAP has demonstrated efficacy, compliance remains a problem that is not an issue in patients successfully treated with surgery.

Many treatment options are available to patients with OSA. Nonsurgical treatment modalities include weight loss, positional devices, dental appliances, avoiding alcohol and sedatives, and CPAP. Although conservative options such as weight loss and avoiding alcohol are successful in some patients, too many are unable to change their lifestyles. Surgical treatments for OSA become

particularly important when initial medical treatments have failed.

Patients who cannot comply with medical therapies for their OSA then become at risk for the serious medical consequences of OSA : cardiac arrhythmias, systemic and pulmonary hypertension, myocardial infarction, cerebrovascular accidents, and a two to three fold increase in the risk of motor vehicle accidents.<sup>27</sup> The goal of treatment in patients with OSA should be to reduce the level of apnea to a level at which there is no significant morbidity or mortality. Limited retrospective mortality data suggested that there is an increased mortality rate in untreated OSA patients with > 20 apnea/h sleep.<sup>23</sup>

Since UPPP was first introduced by Fujita et al. in 1981,<sup>4</sup> many other surgical procedures have been developed to enlarge the compromised upper airway in patients with OSA. LAUP, introduced as an outpatient palatal surgery to treat snoring, has been accepted by many surgeons as an alternative palatal surgery for the treatment of OSA.

For the treatment of OSA, Kamami<sup>6</sup> reported on 63 patients. He found that 87% of the patients were responders, defined as a > 50% reduction in their postoperative RDI. Mickelson<sup>5</sup> found that 53.8% of the patients had reduction in their RDI by > 50%. In this study, it was found that 66.7% had a > 50% reduction in the postoperative RDI.

LAUP for the treatment of OSA must be compared with UPPP, the standard palatal procedure performed today. The efficacy of UPPP in this study was found an overall response rate of 69.6%. Sher et al analyzed mean baseline and postoperative data on 992 patients in a recent review. This meta-analysis of the surgical efficacy of UPPP reported in 37 different surgical series found overall response rate of 40.9%.<sup>28</sup> LAUP result in this study compares favorably with UPPP-treated patients. LAUP-related complications, for OSA included bleeding, temporary velopharyngeal

insufficiency, and dry throat. UPPP-related complications included bleeding, velopharyngeal insufficiency, voice change, foreign body sensation, nasopharyngeal stenosis, perioperative upper airway obstruction and death. This, LAUP appeared to be safer than UPPP, consisted with previously reported postoperative complication rates.

LAUP is a viable surgical alternative to UPPP in many patients. Careful patient selection is critical when deciding which surgical procedure will be best for the individual patient. It may actually be preferable to UPPP in some cases because it is less expensive, does not require a general anesthetic or hospital admission. In addition, patients undergoing LAUP have to be able to follow postoperative instructions to make it a safe procedure. In patients with marked tonsillar hypertrophy or prominent posterior wall rugae or who cannot tolerate a local procedure. UPPP with or without a tonsillectomy is preferable. For this reason and for the purpose of evaluating treatment outcome, all patients should have preoperative and postoperative polysomnography.

Hypopharyngeal surgical with UPPP was most effective surgical approach for patients with OSA in this study, as assessed by improvements in polysomnography, ESS, and upper airway dimension. Patients reported improvements in daytime somnolence as demonstrated by a decrease in mean ESS scores from 12.1 to 4.5. There was also marked improvement in the upper airway dimensions as measured by the Mueller's maneuver, especially at the level of the palate and the base of tongue. The patients who underwent this more aggressive surgery manifested the more severe degree of preoperative sleep disturbance and EDS; therefore it was believed that the increased cost and potential operative morbidity were justified. More over, hyoid myotomy with suspension could be performed under local anesthesia. Because the anatomical obstruction associated with OSA may occur at multiple sites

and in severe cases usually does, it is logical to focus the surgical attack to address each of these sites.

Hypopharyngeal surgery comprised two procedures (GA and HM) performed during a single operation or separated operation by Riley et al.<sup>8</sup> using the modification in which a window is created in the mandibular symphysis to incorporate the genial tubercle and a second modification in which the hyoid is advanced over the thyroid cartilage. In patients with tongue base obstruction, success with uvulopalatopharyngoplasty was sometimes as low as 5%.<sup>26,29</sup> With this realization in mind, surgical techniques were developed to try to treat this portion of the airway and to improve surgical success. This has included reduction in the size of the tongue, genioglossus advancement through mandibular osteotomy, hyoid suspension, and maxillomandibular advancement surgery. By using this comprehensive surgical approach success rates approaching 90% have been achieved from these procedures.<sup>8</sup> Although these much higher success rates were achieved with these approaches, they may be accepted poorly by patients because of their aggressive nature, potential for prolonged treatment time, and risk of complication. Ari DR<sup>11</sup> et al borrowed technology developed for transvaginal cystourethropexy and adapted it this problem. This procedure is performed under general anesthesia and takes 10 to 30 minutes to complete. It is simple, fast and easily reversible. Its result was comparable with previous reports with less complications. Complications to be concerned about are infection, postoperative swelling, damage to Wharton's duct, and potential osteomyelitis.

Contraindications of this surgery would include all contraindications to any apnea surgery as far as the patient's general health. The major other contraindication would be if the primary level of obstruction is palatal portion rather than hypopharyngeal portion. Marked macroglossia

and severe tongue grooving based oropharyngeal endoscopy would prove to be relative contraindications to this procedure, as well. Any abnormalities of the mandible bone, severe periodontal disease, poor oral hygiene, or significant bone absorption in the area of the screws to be placed also would be contraindications to this procedure. In this study, it was no need to use titanium screw. The suture material could be tied together at the outer surface of the mandible. Its result was comparable with the traditional procedure with less complications.

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