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Various combinations of velopharyngeal and hypopharyngeal surgical procedures for treatment of obstructive sleep apnea: Single-stage, multilevel surgery☆,☆☆

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ABSTRACT

Objective: The aim of this study was to investigate the safety and outcomes of velopharyngeal surgeries combined with hypopharyngeal surgeries as single-stage interventions for treatment of obstructive sleep apnea (OSA).

Methods: Retrospective analysis of operated patients. The velopharyngeal surgical interventions were uvulopalatal flap, anterior palatoplasty, expansion sphincter pharyngoplasty, transpalatal advancement pharyngoplasty, Cahali lateral pharyngoplasty, Z-palatoplasty, and modified uvulopalatopharyngoplasty. The hypopharyngeal surgical interventions were tongue base suspension, mucosal sparing partial glossectomy, genioglossus advancement, mandibulohyoid suspension, thyrohyoid suspension, and epiglottoplasty.

Results: Forty-one patients were enrolled after inclusion and exclusion criteria. The evaluation of symptoms and polysomnographic findings were performed preoperatively and at a minimum of 3 months postoperatively. The mean age was 42.17 ± 9.50 years and the mean follow-up time was 6.8 ± 6.0 months. After single-stage multilevel surgery, the mean apnea hypopnea index (AHI) improved from 29.13 ± 15.87 events/h to 14.28 ± 16.14 events/h ($p < 0.001$). According to the classical definition of success criteria (>50% reduction in AHI and postoperative AHI < 20 events/h), the surgical success rate was 56%, with cure of OSA (AHI < 5 events/h) in 41% of study population. The combined surgeries also improved Epworth scores, snoring scores, and respiratory parameters significantly (in all $p < 0.05$). The major complications were bleeding requiring re-admission in surgery room and severe tongue base edema which regressed by steroid administration. The minor complications were pain, difficulty in swallowing, velopharyngeal insufficiency, regurgitation, minor bleeding, and occlusion disorder. The mean postoperative period to beginning of normal feeding was 1.81 ± 1.01 days. The percentage of pain, the number of patients with major bleeding, and the need for patient-controlled analgesia were higher in patients undergoing tissue resection/ablative hypopharyngeal procedures. The mean postoperative period to beginning of normal feeding was shorter in patients undergoing suture/repositioning hypopharyngeal procedures.

Conclusion: According to outcomes of this study, OSA patients with multilevel obstructions can benefit from combined surgeries for velopharyngeal and hypopharyngeal regions at the same operation stage, without experiencing persistent complaints. It is promising that, despite multiple levels of obstruction was operated at single-stage, airway safety was preserved in all patients.

1. Introduction

Obstructive sleep apnea (OSA) is characterized by repetitive episodes of partial or complete upper airway collapse during sleep. It is associated with increased risk of cardiovascular morbidity and impairs the quality of life due to excessive daytime sleepiness [1–3]. To solve this collapse, continuous positive airway pressure (CPAP) treatment remains as the first choice of treatment modalities [4]. However, remarkable number of patients cannot tolerate CPAP [5,6], and surgical treatment becomes an alternative.

Mainly, there are two potential dynamic obstruction sites in the upper airway: velopharyngeal and hypopharyngeal regions. We know that the primary site of airway obstruction is at the level of the palate, in 50%–80% of OSA cases [7,8]. However, OSA is usually caused by multilevel obstructions, hence single surgical interventions aiming to correct only velopharyngeal region cannot eliminate all of the obstructions through the upper airway. In case of multilevel obstructions, multilevel

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surgery should be performed which can be applied as a single-stage or multi-stage. In 1986, Riley et al. have first demonstrated multilevel surgery for OSA patients with multiple obstructions by using combined maxillary, mandibular, and hyoid advancement [9]. After that, multilevel reconstruction surgeries performed by many surgeons have showed improved outcomes in relieving OSA. Today, multilevel surgical approach for OSA is accepted as a more standard treatment method than before [10–15].

Although multilevel surgery for OSA has been increasingly common, the safety of concurrent surgeries is still a question mark in the minds. Major concerns regarding multilevel OSA surgery are about multiple levels of operation sites through the upper airway, which may increase risk of airway collapse and cause more morbidities and complications such as pain, bleeding, difficulty in swallowing, etc. The aim of this study was to assess polysomnographic outcomes and complication rates of patients who underwent both velopharyngeal and hypopharyngeal surgery as a single-stage multilevel surgical intervention for treatment of OSA.

2. Materials and methods

2.1. Study protocol and patients

The patients with OSA, who underwent velopharyngeal and hypopharyngeal surgeries as a single-stage, multilevel surgery between 2009 and 2015, were included after follow-up charts review. The diagnostic work-up consisted of patient history, physical examination, and a full overnight PSG. All patients in this study were whom CPAP therapy had been offered firstly, but they had refused or terminated the CPAP therapy for any reason. Each patient underwent different combinations of OSA surgeries, but did at least one velopharyngeal and one hypopharyngeal surgery. Patients were operated on by the same surgery team (M.G., T.A., O.K., M.B.) who follow the same operative techniques. The patients were excluded if they; [1] were previously operated OSA patients, [2] had no description of preoperative or postoperative PSG data, [3] underwent multi-stage OSA surgeries, or [4] underwent any additional nasal or pharyngeal surgery or CPAP therapy before postoperative PSG.

2.2. Surgical procedures

The type of the surgery was decided according to patients' clinical findings, anthropometric and anatomic characteristics, and endoscopic examinations. Tonsil grade, Mallampati score, modified Muller's maneuver, retropalatal collapse pattern, and hypopharyngeal obstruction were evaluated. Also, some of the patients underwent drug-induced sleep endoscopy (DISE) to confirm the decision of what type of surgical intervention will be performed.

In each patient, the velopharyngeal surgery was performed first, and then the hypopharyngeal surgery was performed. The velopharyngeal surgical interventions were uvulopalatal flap (UPF), anterior palatoplasty (AP), expansion sphincter pharyngoplasty (ESP), Cahali lateral pharyngoplasty (CLP), transpalatal advancement pharyngoplasty (TPAP), Z-palatoplasty (ZPP), and modified uvulopalatopharyngoplasty (modUPPP). The UPF was performed as described by Powell et al. [16]. The AP was performed as described by Pang et al. [17]. The ESP was performed as Pang and Woodson have described and then have modified with “tunnel method” [18,19]. The CLP was performed as described by Cahali [20]. The TPAP was performed as described by Woodson and Toohill [21], but using the “propeller incision” that was described by Shine and Lewis [22]. The ZPP was performed as described by Friedman et al. [23]. The modUPPP was performed as shown by Li et al. [24].

The hypopharyngeal surgical interventions were tongue base suspension (TBS), mucosal sparing partial glossectomy (MSPG), genioglossus advancement (GGA), epiglottoplasty, mandibulohyoid suspension (MHS), and thyrohyoid suspension (THS). The MHS and THS were performed as described by Riley et al. in 1984 and in 1994, respectively [25,26]. The MSPG was performed as Badi and Woodson have introduced [27]. The TBS was performed as described by Omur et al. [28]. The GGA was performed as described by Riley and Li [29]. Epiglottoplasty was performed using the coblation.

2.3. Primary outcomes

As the primary outcomes, AHI levels were compared before and after surgery. Surgical success was defined as co-existence of 1) 50% or greater reduction in preoperative AHI, and 2) postoperative AHI to <-20 events/h [30]. OSA cure was defined as a postoperative AHI of fewer than 5 events/h.

2.4. Secondary outcomes

The Epworth Sleepiness Scale (ESS) for evaluation of daytime sleepiness symptoms and the visual analog scale (VAS) for subjective evaluation of snoring before and after the surgery were used. The other secondary outcomes were the minimum oxygen saturation ($minO_2$), the mean oxygen saturation ($meanO_2$), oxygen desaturation index (ODI), and the percentage of sleep time with saturation below 90% ($SaO_2 < 90\%$). Complications, the postoperative period to beginning of normal feeding, and weight gain or loss before and after surgery were recorded. When required, the patients received intravenous tramadol by the way of patient-controlled analgesia (PCA) after surgery, using a PCA device.

2.5. Statistical analyses

Statistical analyses were performed by using SPSS for Win. Ver. 15.0 (SPSS Inc., Chicago, IL., USA). The variables were expressed as mean ± standard deviation (SD). Comparisons of preoperative and postoperative parameters in each surgery group were evaluated by using Wilcoxon test. Significance was defined as $p < 0.05$.

3. Results

The study population consisted of 1 female and 40 male patients with a mean age of 42.17 ± 9.50 years. The mean body mass index was 27.18 ± 2.69 kg/m^2, and the mean follow-up period was 6.8 ± 6.0 months. The types of surgical interventions are seen in Table 1. The mean AHI in the study group before and after surgery was 29.13 ± 15.87 events/h and 14.28 ± 16.14 events/h, respectively. The difference between pre- and post-operative AHI levels was statistically significant ($p < 0.001$) (Table 2). According to the classical definition of success criteria as aforementioned, the surgical success occurred in 23 of the 41 patients (56.1%), with cure of OSA in 17/41 patients (41.4%) (the percentage of surgical success includes the percentage of surgical cure).

Table 1
Types of velopharyngeal and hypopharyngeal surgical interventions.

Velopharyngeal surgeries	Hypopharyngeal surgeries
Anterior palatoplasty (n = 13)	Tongue base suspension (n = 24)
Cahali lateral pharyngoplasty (n = 11)[b]	Thyrohyoid suspension (n = 9)
Expansion sphincter pharyngoplasty (n = 10)[b]	Mucosal sparing partial glossectomy (n = 6)
Tonsillectomy (n = 7)[a]	Mandibulohyoid suspension (n = 2)
Uvulopalatal flap (n = 6)	Genioglossus advancement (n = 2)
Modified UPPP (n = 2)[b]	Epiglottoplasty (n = 1)
Z-palatoplasty (n = 2)[b]	
Transpalatal advancement pharyngoplasty (n = 2)	

[a] Only 1 patient underwent tonsillectomy alone as a velopharyngeal part of multilevel surgery. Other 6 patients underwent tonsillectomy combined with uvulopalatal flap or anterior palatoplasty.
[b] Includes tonsillectomy as a part of surgical technique.

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