CLINICAL STUDY

HYPOPHARYNGEAL PROCEDURES COMBINED WITH UVULOPALATOPHARYNGOPLASTY FOR SURGICAL TREATMENT OF OBSTRUCTIVE SLEEP APNEA

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SUMMARY

Objective: The aim of this study was to evaluate the effectiveness of the hypopharyngeal surgical procedures combined with uvulopalatopharyngoplasty (UPPP) in moderate and severe obstructive sleep apnea (OSA) patients.

Patients and Method: We conducted a retrospective analysis of ninety-six patients underwent multilevel surgery. UPPP was combined with five different hypopharyngeal procedures (radiofrequent ablation of the tongue base, genioglossus advancement, hyoid suspension, thyrohyoid suspension and transcervical tongue base suspension). Five surgical combinations were compared for pre- and post-operative AHI and the lowest O2 saturation values. The complications were also noticed.

Results: The mean AHI for each group decreased significantly and the mean LO2 Sat increased significantly after the procedures ($p<0.05$). We did not see differences between five groups when the pre-operative and post-operative the mean AHI and the mean Lsat O2 values were compared ($p>0.05$). Minor complications were seen in three patients.

Conclusions: Hypopharyngeal surgery combined with UPPP in moderate or severe OSA is associated with improved post-operative AHI and subjective outcomes.

Keywords: Hypopharyngeal surgery, obstructive sleep apnea, uvulopalatopharyngoplasty

TIKAYICI UYKU APNE CERRAHİ TEDAVİSİNDE UVULOPALATOFARİNGOPLASTİ İLE BERABER UYGULANAN HİPOFARENGEAL YÖNTEMLER

ÖZET

Amaç: Çalışmanın amacı uvulopalatofaringoplasti (UPPP) ile beraber uygulanan hipofarengeal cerrahi yöntemlerin orta ve ağır tıkayıcı uyku apne (TUA) hastalarındaki etkinliğinin değerlendirilmesi idi.

Hastalar ve Yöntem: Çok düzeyli cerrahi uygulanan doksanaltı hastanın retrospektif analizi yapıldı.UPPP, beş farklı hipofarengeal alana yönelik yöntemle kombine edildi (dil kökünün radyofrekans ablasyonu, genioglossus ilerletme, hyoid askısı, tirohyoid askısı ve transservikal dil kökü askısı). Beş cerrahi kombinasyon, pre- ve postoperatif AHI ve en düşük O2 satürasyon değerleri ile karşılaştırıldı. Komplikasyonlar kaydedildi.

Bulgular: Cerrahi prosedürler sonrasında her bir grupta ortalama AHI anlamlı olarak azalmış ve en düşük O2 satürasyon değerleri anlamlı olarak yüksek bulundu ($p<0.05$). Beş grup arasında preoperatif ve postoperatif ortalama AHI ve ortalama en düşük O2 satürasyon düzeyleri arasında anlamlı fark yoktu ($p>0.05$). Üç hastada minör komplikasyon izlendi.

Sonuç: UPPP ile beraber uygulanan hipofarengeal cerrahi yöntemler, orta veya ağır OSA'da postoperatif AHİ ve subjektif yakınmalarda düzelme sağlamaktadır.

Anahtar Sözcükler: Hipofarengeal cerrahi, tıkayıcı uyku apnesi, uvulopalatofaringoplasti

INTRODUCTION

Obstructive sleep apnea (OSA) defined; abnormally elevated AHI (>15) and symptoms of daytime somnolence that affects up to 2-4% of adults and results in significant morbidity, mortality, and cost to society. Successful treatment of OSA has been demonstrated to improve cardiovascular morbidity and reduce motor vehicle accidents and overall mortality.[1]

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Received: 26 June 2013, revised for: 08 January 2014, accepted for publication: 30 January 2014

Nasal continuous positive airway pressure (CPAP), is the standard therapy for adults with OSA, however, the effectiveness of CPAP is limited by compliance problems. 20% and 40% of patients will not use CPAP at all, because of compliance and/or tolerance problems. Therefore, surgical treatment modalities such as multilevel surgery were developed to prevent upper airway collapse.[2]

Surgical treatment of OSA begins with evaluation of site(s) of the upper airway narrowing or collapse. Surgical approaches for OSA patients functionally targets the retropalatal and the hypopharyngeal regions.[3] Fujita and Simmons[4] described three types of upper airway collapse. Retropalatal collapse alone (type I), both retropalatal

and hypopharyngeal collapse (type II) and, hypopharyngeal collapse alone (type III).

Uvulopalatopharyngoplasty (UPPP), first described by Fujita et al.[5] in 1981, is used for treatment of the retropalatal collapse. For type II and type III collapses, the response rate of UPPP alone, for surgical treatment of OSA, is shown to be only 5,3 %.[6] Therefore, several procedures have been developed to achieve successful response rates in OSA patients with hypopharyngeal obstruction. Surgical treatment of hypopharyneal collapse includes many procedures such as genioglossus advancement, tongue base radiofrequency treatment, surgical reduction of the tongue base (midline glossectomy), hyoepiglottoplasty, hyoid or thyrohyoid suspension, and tongue base suspension sutures with different surgical approaches and techniques and many studies have reported the results of the procedures for multilevel surgery for OSA patients.[7-12]

The objective of this study was to evaluate the success of one stage, mutilevel surgery in moderate and severe OSA patients and to compare the responce rates and complications of five different popular hypopharyngeal surgical procedures combined with UPPP.

MATERIAL and METHODS

Patients who presented to our otorhinolaryngology clinic from Nov 2007 to May 2011 because of snoring or suspicion of OSA were evaluated by history, physical examination including Muller maneuer with fiberoptic nasopharyngoscopy, and full overnight polysomnography. Patients with moderate to severe OSA, both narrowing at the palatal and hypopharengeal levels were advised a multilevel surgical approach. The patients were consisting of refusal or non-acceptance of CPAP treatment. Standard overnight polysomnography was performed in all subjects using the Compumedics Voyager Digital Imaging E-series system (Compumedics®, Melbourne, Victoria, Australia). Polysomnography included an electrocardiogram, four electroencephalogram channels, electro-oculogram, bipolar surface electromyograms of the submentalis and bilateral anterior tibialis muscles, and position sensors to record body position and movements. Respiratory monitoring consisted of nasal and oral airflow measures, pulseoximetry, a tracheal microphone, thoracic and abdominal respiratory efforts and simultaneous video recording.

Sleep staging was performed according to the standard criteria set by the American Academy of Sleep Medicine (Mild OSA: AHI ¸5 and <15, moderate OSA: AHI ¸15 and <30 and severe OSA: AHI ¸30)[9]. Apneas were defined as complete cessations of airflow for at least 10 seconds and hypopneas were defined as periods of reduction of at least 50% oronasal airflow during minimally 10 s. The Apnea-Hypopnea Index (AHI) was defined as the number of apneas and hypopneas per hour.[10] Full overnight polysomnography was repeated 3–9 months (mean 6.3 months) postoperatively. The body mass index (BMI) was calculated by dividing weight (kg) by the square of length (m^2).

Surgical procedures for treating the obstructions at the palatal and hypopharengeal levels described below.

Uvulopalatopharyngoplasty:
Uvulopalatopharyngoplasty (UPPP) was performed according to Fujita's technique. The uvula was excised to create more retropalatinal space. The anterior and posterior tonsillar pillars were trimmed and reoriented and tonsillectomy was performed if it had not been done previously.[5]

Radiofrequent ablation of the tongue base: Radiofrequent ablation of the tongue base (Ellman®) was used to provide volume reduction and stiffening at the tongue base. About 400 J energy was delivered with an exclusive needle device through the dorsal surface of the tongue.[11,12]

Genioglossus advancement A standard anterior mandibular osteotomy, limited to advancement of a rectangular window of the mandible including the genial tubercle and genioglossus musculature with rotation of the segment, was performed. The outer cortex and medulla were removed. The lingual cortical plate advanced and fixed with bone screws. Steroids and i.v analgesics were used routinely after this procedure for postoperative oedema and pain. Patients were usually dismissed 48–72 h postoperatively.[13]

Hyoid suspension: A 2 cm incision was made under the chin of the midline and using blunt dissection, the soft tissues overlying the mandible were cleaned. After insertion of the first screw, the inserter was positioned perpendicular to the mandible, firm pressure applied and the screw is inserted into the inferior edge of mandible. A loop of 1.0 polypropylene suture is preloaded to the screw by the manufacturer. A second 5-6 cm incision was made over the hyoid and after subcutaneus tissue dissected, the infrahyoid muscles seperated from the hyoid by using electrocautery. Then, a hyoid retracted and stabilizied by a hook and the suture passed and tunneled at the subplatysma layer from the mandible incision into the hyoid incision. One

free end of the polypropylene suture was then passed through the suprahyoid muscles, catching a full thickness bite of the tissue. This procedure enhanced the anterosuperior repositioning of the tongue base and enlarged the hypopharyngeal airway in lateral dimension.[14]

Thyrohyoid suspension: After a horizontal incision at the level of the membrana thyrohyoidea , the strap muscles were divided just below and superior to the hyoid. The hyoid was mobilized in anteroinferior direction. An 1-0 silk suture was passed around the hyoid approximately 1 cm lateral to the midline. It was then passed through the thyroid ala appoximately 1 cm from the notch. A second suture was placed starting at the level of the lesser cornu and ending 2 cm from the thyroid notch. This sequence was repeated on the opposite side. Most patients are able to swallow normally. Some do need the intravenous support of fluids for 2 to 4 days.[15]

Transcervical tongue base suspension: The transcervical tongue base suspension procedure was performed through a submental incision. A small hole was created with a drill on the mandible and the 1.0 polypropylene suture attached. A black silk suture was passed through the same incision to the right side of the tongue base from the floor of the mouth and the polypropylene suture was passed to the tongue base on the opposite side. To keep the vascular bundle safe, we passed the suture passer in the middle one third of the tongue base, by palpating the base of the tongue. The polypropylene suture was then passed across the tongue base with a free cutting needle to the temporary suture loop. The black silk suture loop pulled the polypropylene suture back to the submental incision area in the floor of the mouth muscles. The polypropylene suture was tied with maximal force on the mandible hole and the submental skin incision was closed. At the end of the procedure a deep dimple on the base of the tongue was created and could be seen with fiberscopic endoscopy. Patients were hospitalized at least two nights. A prophylactic antibiotic and systemic corticosteroid were given for possible edema of the tongue.[16]

We then compared the results for combination of UPPP with different five hypopharengeal procedures according to the preoperative and postoperative AHI and lowest O2 saturation (LO2 Sat) values as criteria for successful surgical outcomes. We used the χ^2 test to determine whether there was a difference in the share of patients with a successful outcome among treatments, and $P<.05$ was considered statistically significant. Also postoperative complications were noticed for each procedure if existed.

RESULTS

Ninety-six patients underwent multilevel surgery. Baseline characteristics and polisomnographic findings of the subjects are summarized in table 1. UPPP was combined with, radiofrequency ablation of the tongue base (Group 1), genioglossus advancement (Group 2) and hyoid suspension (Group 3) at 15 patients for each group. At 29 patients UPPP + thyrohyoid suspension (Group 4) and at 22 patients UPPP + transcervical tongue base suspension (Group 5) were performed. Between five groups,, there were no significant preoperative differences in patient characteristics and polisomnographic findings. The mean AHI for each group decreased significantly and the mean LO2 Sat increased significantly after the procedures ($p<0.05$). The differences in AHI and LO2 Sat values for pre- and post operative for each group are shown in table 2. We did not see differences between five groups when the pre-operative and post-operative the mean AHI and the mean lsat O2 values were compared ($p>0.05$).

Post-operative follow-up and complications: The mean follow-up duration was 7,3 months (4-10 months) for all patients. In the subjective evaluation the post-operative patient comfort was better in the group 1 and worst in the group 3. Complications were seen in three patients. A long-lasting dysphagia (for 4,5 months) in a patient with UPPP + hyoid suspension, infection in a patient with UPPP +genioglossus advancement (the sutue material was removed at the third month, post-operatively) and ulceration at the tongue base due to the necrose in a patient with UPPP + radiofrequent ablation of the tongue base on the third week were seen. We did not encounter postoperative haemorrhage, tongue base abscess, compromised airway, or velopharyngeal insufficiency in any patient postoperatively.

Table I. Characteristics of the study population

n=96	Mean ± SD
Baseline characteristics	
Age (years)	47.1 ± 10.6
BMI (kg/m²)	32 ± 8.4
ESS	8 ± 6.5
Polysomnographic parameters	
Sleep efficiency (%)	80.4 ± 14.9
AHI (event/h)	36.7 ± 13.4
AHI-supine (event/h)	42.4 ± 10.5
AHI-REM (event/h)	39.8 ± 13.3
Mean SpO2 (%)	91.6 ± 5.7
Min SpO2 (%)	52.47 ± 22.47

Notes: BMI: Body mass index, ESS: Epworth Sleepiness scale, AHI: Apnea hipopnea index, REM: Rapid eye movement,

Table 2. Surgical outcomes of 5 groups (*AHI:* apnea hypopnea index, LoSaO2: lowest O2 saturation)

	n	PRE-OP MEAN AHI	POST-OP MEAN AHI	p	PRE-OP LoSaO2	POST-OP LoSaO2	p
GROUP-1	15	33.2 ± 3.8	9.5 ± 2.1	<0.001	80.8 ± 0.9	95 ± 1.4	<0.001
GROUP-2	15	38.9 ± 4.2	9.8 ± 1.2	<0.01	78.3± 1.9	96.1 ± 0.8	<0.01
GROUP-3	15	41.6 ± 4.7	11.4 ± 2.1	<0.001	74.2 ± 2.6	92.7 ±1.1	<0.001
GROUP-4	29	33.2 ± 3.8	9.5 ± 2.1	<0.05	80.8 ± 0.9	95 ± 1.4	<0.05
GROUP-5	22	38.9 ± 4.2	9.8 ± 1.2	<0.05	78.3 ± 1.9	96.1 ± 0.8	<0.05

DISCUSSION

The most important part of surgical treatment of OSA is determining the correct site(s) of the obstruction and deciding the target levels for surgery. A variety of intervention have been reported as part of multilevel treatment in severe OSA and CPAP failure or non-acceptance in one or multi-stages.[7-17] We performed multilevel surgery in an one stage procedure as the patients are more prone to become discouraged in completing the advised treatment and will be treated only partly. The results of our case series document statistically significant improvement, with moderate or severe OSA, for outcome measures including AHI and LO2 Sat. Although results for the various procedures or combinations of procedures vary widely, it is clear that these procedures developed to treat hypopharyngeal obstruction, offer substantial improvement in surgical outcomes compared with palate surgery alone.

UPPP is the most used surgical therapy for OSA and only 40% of patients who undergo the procedure obtain an AHI of less than 20, which is not judged an adequate surgical outcome. In patients with hypopharyngeal obstruction and for severe OSA, the success rate of UPPP alone was reported as low as 5% to 10%.[6] Severe OSA is generally associated with hypopharyngeal collapse, therefore multilevel surgery is suggested for these patients. UPPP with genioglossal advancement, maxillomandibular advancement, hyoid advancement, or thyrohyoid suspencion has been reported the decrease in AHI ranged from 10% to 60% in different studies.[10]

Hyomandibular and thyrohyoid suspensions allow for potential widening of lateral hypopharyngeal airway. Division of the infrahyoid musculature allows partial seperation of the larynx from the hyoid and tongue base, and this seperation keep the pulling force of intrathoracic structures from the hypopharyngeal structures seperate and this procedure also avoids the collapse of flaccide structures of upper airway during the inspiration. Prolonged odynophagia, disphagia, speech problems, hematoma, infection and pain are the potential complications of hyoid and thyrohyoid suspencion.[18] Richards et al.[19] reported short term complications of regarding taste, speech, swallowing and pain complaints, in 6 of 26 patients who underwent hyoid suspension. They reported no long term complications in their mean 13 months follow-up. There were no bleeding or airway problems in our patients. Only in one patient disphagia was prolonged for 4,5 months. Fujita and Woodson mentioned that, prolonged disphagia in these patients may benefit from instructions on a supraglottic swallow modifications such as tongue push or elevation with throat cleaning. In different series, success rates 60% to 78% are reported for combinations of UPPP with hyoid suspencion or hyoid suspension and genioglossal advancement.[3,20] Riley et al.[10] proposed genioglossus advancement with hyoid suspension and UPPP as the phase I approach and the success rate has been reported to be 60% to 80% and phase II surgery included maxillary and mandibular advancement with a high success rate of 95%, however it has it is not widely accepted by many patients. Tongue base reduction with hyoepiglottoplasty using a cervical approach is another procedure proposed by Chabolle et al.[21] The overall success rate for this procedure was reported to be 80%.

Tongue base reduction with temperature-controlled radiofrequency has been searched by some authors.[3,7,11,12] Li et al.[22] evaluated the long-term outcomes of temperature-controlled radiofrequency reduction of the tongue baseand they found an improvement in the apnea index but worsening of hypopnea index. The success of RF tongue base reduction may diminish with time. Stuck et al.[11] reported no significant change in AHI but improvement in snoring and day-time sleepiness after RF tissue reduction. We observed the improvement in the patients who underwent tongue base RF combined with UPPP after postoperatively 4 weeks. Fibbi et al.[23] compared the short term and long term surgical successe of tongue base suspension and radiofrequency volume reduction. The success rates were 67% and 76% after 6 months; and decreased to 42% and 33% after 2 years for tongue base suspension and radiofrequency volume reduction, respectively. Their results suggest us to control our long term results after at least second year. Pazos et al.[24] noticed temporary tongue base neuralgias in 4 cases and tongue base abscesses in 2 cases, in their studies which consisted 25 tongue base RF procedures.In our study in one patient ulceration at the tongue base due to the necrosis was observed.

Another hypopharengeal procedure is tongue suspension suture. The tongue base suspension procedure represents a minimally invasive technique to improve tongue base collapse in patients with severe OSA. This procedure is easy to perform and it is a good alternative to other aggressive operative techniques. Sezen et al.[25] reported 60 % success at the postoperative sixth month and Omur et al.[26] reported 81% success rates for the tongue suspension suture combined with UPPP in the patients with moderate to severe OSA. They proposed the strong

tightness of the suture and the low position of the suture are the main factors in the outcome and they noticed neither tongue necrosis nor other serious complications were detected. Handler et al.[27] compared suture based hypopharyngeal procedures alone and with multilevel surgery in a recent review. Their review showed that surgical success rate of tongue suspension alone was 36,6 %, tongue suspension with UPPP was 62.3%, UPPP with genioglossus advancement or genioglossus advancement with hyoid suspension was 61,1%.[25] Our study is compatible with their results.

CONCLUSION

Five different hypopharyngeal procedures combined with UPPP have performed with minor complications. These procedures demonstrated significant improvements in the polysomnographic findings in patients with moderate or severe OSA. In postoperative follow-up, there is no significant differences between the five combinations, when the polysomnographic and subjective findings were compared. Future research should include larger, higher level studies that compare surgical treatments and identify factors associated with outcomes.

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