

ORIGINAL ARTICLE

Pressure Changes in the Middle Ear After Uvulopalatal Flap Surgery

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Objective: To examine the middle ear pressure changes after the uvulopalatal flap surgery.

Materials and Methods: Fifty-three patients were scheduled to undergo uvulopalatal flap surgery with or without tonsillectomy; and 25 patients were admitted to clinic acted as the control group. The middle ear pressure was measured using tympanogram at the beginning of the study, and postoperatively at the 1st. month and the 6th. month for the study group, and at the 6th. month for the control group. The results were compared with respect to the type of surgery. In the groups that underwent surgery, both those with and without ear pain had middle ear pressure comparisons done.

Results: Both groups showed a statistically significant negative change in the tympanogram value. While the negative change continued throughout the 6 months period, a slight improvement was seen when comparing the first and sixth postoperative month. The normalization of the middle ear pressures, at the first to the sixth postoperative month, was statistically significant. The negative change was significantly higher in the group that had postoperative ear pain complaints.

Conclusion: Uvulopalatal flap surgery, or uvulopalatal flap surgery with tonsillectomy, cause negative pressure changes in the middle ear and by the time, this pressure changes return to normal. Patients who are going to undergo these procedures should be informed that they might experience some ear discomfort after the surgery.

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Introduction

Obstructive sleep apnea syndrome is seen in 1% to 5% of adult males and in 1.2% to 2.5% of adult females [1]. Surgery to correct snoring and obstructive sleep apnea syndrome has made great progress in the last 20 years. One recent technical development is uvulopalatopharyngoplasty; it is one of the most-common procedures to eliminate snoring [2]. Many different techniques are used in uvulopalatal surgery.

Uvulopalatal flap surgery has emerged in the past 20 years, and is considered to be a minimally invasive modification of uvulopalatopharyngoplasty, with comparable success rates [3]. Various therapeutic applications in ear, nose, and throat diseases—especially after the nasal, oropharynx, and nasopharynx procedures—have been shown to cause

negative changes in middle ear pressure [4-6]. Bilateral anterior and posterior nasal packings, prolonged nasotracheal intubation, and nasogastric tube insertion have been shown to decrease the middle ear pressure, but after the removal of the nasal packings and tubes, the pressure returns to the baseline level [5-7,8]. There are several publications that focus on the changes in middle ear pressure after uvulopalatopharyngoplasty [9,10]. There is no information in the literature about the effects of soft palate procedures (specifically uvulopalatal flap surgery- a mucosal procedure that does not require any muscular incisions) on the middle ear pressure.

In this study, we investigated whether there is a negative change in the middle ear pressures after uvulopalatal flap surgery.

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Materials and Methods

This study was done from January 2007 to March 2009 at the Dr. Lütfi Kırdar Kartal Training and Research Hospital, in the Otolaryngology Head and Neck Surgery clinic. Uvulopalatal flap surgery was performed on 60 patients, and on 25 control patients, no surgical procedure was performed. Both groups were informed about the study procedure, and informed consent forms were signed for all of them. The study was approved by our institutional review board.

Patients were admitted to our clinic with complaints of snoring, and a detailed history was taken from all patients and spouses. Each patient received an ear, nose, and throat examination, including flexible fiberoptic nasopharyngoscope, and the Müller maneuver. Patients who also had a deviated septum also had a septoplasty 3 months before the initial polysomnography. Patients were also seen by the chest disease specialists. All polysomnographies were done at the Dr. Lütfi Kırdar Kartal Training and Research Hospital and Süreyyapaşa Pulmonary Diseases Training and Research Hospital Sleep Laboratories. According to their apnea/hypopnea index scores, the patients were divided into 4 subgroups (0-5, simple snoring; 5-15, mild obstructive sleep apnea syndrome; 15-30, moderate obstructive sleep apnea syndrome; 30

and higher, severe obstructive sleep apnea syndrome). The patients' history, examination findings, and polysomnography results were evaluated by attending physicians from ear, nose, and throat and chest clinic, and treatment was determined. None of the patients in the study and the control group have history of prior tonsillectomy, oropharyngeal surgery and trauma. Patients with chronic nasal and nasopharyngeal diseases such as nasal polyposis, vasomotor or allergic rhinitis were not included in the study in both groups. Also patients who have had a plan for flying and diving during the study period, were not included to the study.

Patients with severe obstructive sleep apnea syndrome were recommended to have continuous positive airway pressure or bi-level positive airway pressure treatment. Patients who were chosen for the uvulopalatal flap surgery were selected according to the criteria in Table 1. Patients with contraindications for the uvulopalatal flap surgery were not recommended for surgery (Table 1).

After physical examination and endoscopic examination, patients who met the criteria, underwent uvulopalatal flap surgery, and in those patients whose tonsils obstructed more than the 50% of the upper respiratory tract, an uvulopalatal flap and tonsillectomy were performed. All surgeries were performed by the same surgeon.

Table 1. Serum total IgE levels, Blood eosinophil count (mean \pm standard deviation), Allergen-specific IgE (+) persons (%) in blood samples taken from patients with and without chronic otitis media

Indications of Surgery	Contraindications of surgery
*Complaints of snoring, witnessed apnea and daytime sleepiness	* Length of soft palate < 25 mm
*Age > 18	*Dysphagia and disorders of speech
*AHI > 0 and AHI < 30	*Active upper airway infection
*BMI < 30	*Neurologic disorders
*No nasal stenosis	*Positive pregnancy test or lactation period
*Shown retropalatal obstruction with physical examination	*BMI > 30
	*Unstable physiologic disorders
	*Severe cardiovascular or pulmonary disorders

AHI: Apnea/hypopnea index (events / hour), BMI: Body mass index (kg/ m²)

All patients were subject to microscopic ear examination, and 1 day before the procedure were subject to tympanogram with the Interacoustic AZ7 device (Assens, Denmark). Those with abnormal tympanic membrane appearance and those with non-type A tympanogram curves were excluded from the study. Four patients with chronic serous otitis media with effusion, and 2 with chronic suppurative otitis media were excluded from the study. One patient who had received a tracheotomy for postoperative subglottic stenosis also was excluded from the study, with the final number of 53 patients. Tympanograms were obtained 1 day before the surgery, and 1 and 6 months postoperatively, and the middle ear pressure changes were compared with those who had a uvulopalatal flap surgery, and those who had a tonsillectomy as well as uvulopalatal flap surgery. At the same time, there were 25 control patients who had a tympanogram at the beginning of the study and 6 months later. These patients were those seen in our clinic with no ear or snoring complaints, and all had normal ENT examinations. All patients in both groups had received detailed ear nose and throat examination including otomicroscopy monthly during the study period, to rule out an unexpected situation that could effect the middle ear pressure.

In evaluating the tympanogram curves, -99 and +40 was considered type A, -100 to -350 was considered type C, and those which did not create a peak were considered as type B curves.

Statistical Analysis

In examining the findings of the study, statistical analysis NCSS 2007 and PASS 2008 Statistical Software (Utah, USA) were used. Study data were used to evaluate the descriptive statistical methods (average, standard deviation, frequency), as well as to compare quantitative data showing normal distribution of parameters between 2 groups, using t test comparisons. Abnormally distributed parameters between 2 groups were tested using the Mann-Whitney U test. Nonnormal distribution of parameters within the group was evaluated using the Wilcoxon sign test. The comparison of the qualitative data was

done using the chi-square test and the McNemar test. A confidence interval of 95% and significance was taken as $p < .05$.

Results

Ages ranged between 21 and 67, with 24 female (30.8%) and 54 male (69.2%). Bilaterally testing reveals, a total of 78 cases with a total of 156 ears. The study group was composed of 53 patients, and the control group was composed of 25 patients. The apnea/hypopnea index scores of the study group ranged between 3.8 and 29, with a mean of 15.40 ± 6.49 . There was no statistical significant difference in the age and sex of the study and control group patients ($p > .05$).

The study group had 35 patients (66%) who underwent uvulopalatal flap, and 18 patients (34%) who underwent a uvulopalatal flap plus tonsillectomy. In the study group, 19 patients (30.2%) had postoperative ear complaints. In 10 of these cases (52.63%) feeling of stuffiness, 3 had pain and the feeling of stuffiness (15.78%), and 6 patients (31.57%) had decreased hearing. There was no retraction or hyperemia detected in the postoperative ear examination of the patients. None of the patients had a flat type (Type B) tympanogram curve. In those patients with ear complaint for 1 month postoperatively, the symptoms did not get worse in the long-term, and did not need to be treated for their ear complaints.

As for snoring, 6 months postoperatively, 3 patients (5.7%) reported a worsening, 12 patients (22.6%) reported a slight decrease, 29 patients (54.7%) reported a moderate decrease, and 9 patients (17%) reported a remarkable decrease. Concerning the complaints of apnea, 3 patients (5.7%) reported a worsening, 14 patients (26.4%) reported a slight decrease, 30 patients (56.6%) reported a moderately decrease, and 6 patients (11.3%) reported a remarkable decrease.

There was no significant difference ($p > .05$) in the study and control groups with regard to the preoperative period tympanogram levels (Table 2). In the study group, a significant difference seen in the

preoperative versus 6-month postoperative tympanogram level ($p < .01$). In the control group, there was no significant difference in the tympanogram results ($p > .05$) (Table 2). No significant difference was seen in the preoperative, 1-month, and 6-month tympanograms of patients who had uvulopalatal flap versus uvulopalatal flap plus tonsillectomy ($p > .05$). This indicates comparable middle ear pressure before and after the procedures (Table 2). In the patients who had only a uvulopalatal flap, there was a significant difference in preoperative versus 1- and 6-month tympanogram results ($p < .01$) and a significant difference in 1- versus 6-month tympanogram results ($p < .05$). In the patients with uvulopalatal flap plus tonsillectomy, there was a significant difference in the preoperative versus 1- and 6-month tympanogram results ($p < .01$), and a significant difference in the 1- versus 6-month tympanogram results ($p < .05$; Table 2).

The preoperative middle ear pressures of those who had postoperative ear complaints were significantly less than those who did not have postoperative ear complaints ($p < .01$). The 1- and 6-month tympanogram results of these patients were significantly lower than those of patients who did not have postoperative ear complaints ($p < .01$; Table 2).

In the study group, tympanogram changes from preoperative to 1- and 6-months were statistically significant ($p < .05$). Preoperatively, 100% of the cases were type A and postoperatively, 90.6% were type A. Type C was 0% preoperatively, and 9.4% postoperatively. In the control group, there was no significant change seen in the tympanogram types ($p > .05$; Table 3). There was no significant difference in the tympanogram types by type of operation performed (preoperatively versus 1 and 6 months) ($p > .05$; Table 3).

In those with postoperative ear complaints, the type C ratio (40.6%) was significantly higher than the type C ratio of those without postoperative ear complaints at 1 month (4.1%) ($p < .01$). At 6 months, the type C ratio of those with ear complaints (18.7%) versus the type C ratio of those without ear complaints (5.4%) was significantly higher ($p < .01$; Table 3). In those with

postoperative ear complaints, there was a significant change in the preoperative versus 1-month tympanogram results ($p < .01$). There was a significant difference in the preoperative versus 6-month tympanogram result ($p < .05$). There was a significant difference seen in the postoperative 1- versus 6-month tympanogram results ($p < .05$). The ratio of type C was 40.6% at 1 month postoperatively and 18.7% at 6 months. In those without ear complaints, there was no significant difference in the preoperative and 6-month tympanogram types ($p < .05$; Table 3).

Discussion

There are different procedures outlined in the literature for snoring and obstructive sleep apnea^[11-13]. The most common application of this surgery is uvulopalatopharyngoplasty with a success rate of 80% in carefully selected patients, which also shows a significant decrease in apnea/hypopnea index levels^[12]. The uvulopalatal flap is a modification of uvulopalatopharyngoplasty and was first described by Powell in 1993 as a less invasive and relatively reversible, successful technique^[13].

In our clinic, patients with appropriate indications for surgery undergo uvulopalatal flap or uvulopalatal flap plus tonsillectomy procedures. Because of the possible pain, difficulty in swallowing, uvulopharyngeal insufficiency, and nasopharyngeal stenosis after uvulopalatopharyngoplasty, its use has become limited in the recent years^[14,15]. Uvulopalatal flap accounts for less tissue loss than uvulopalatopharyngoplasty, and also, does not lead to as many possible complications. Additionally, uvulopalatal flap is a mucosal procedure, without an incision into the muscle, and so, leads to less bleeding. Postoperative speech and swallowing problems are seen less^[13,16]. Neruntarat and associates reported that uvulopalatal flap patients had less postoperative pain, the observed Epworth Sleepiness Scale values were normalized, the success rate was 88%, and there were significantly fewer complications in these patients than in patients who underwent uvulopalatopharyngoplasty^[16]. The shorter operation time in uvulopalatal flap surgery is another advantage, to the uvulopalatopharyngoplasty procedure.

Table 2. Evaluation of Preoperative and Postoperative Tympanogram Results Regarding Operation Type and Ear Complaint.

	Type of operation		Postoperative ear complaint			
	Uvulopalatal Flap (n=70)	Uvulopalatal Flap +Tonsillectomy (n=36)	+P	Present (n=32)	Absent (n=74)	+P
	Mean \pm SD (median)	Mean \pm SD (median)		Mean \pm SD (median)	Mean \pm SD (median)	Mean \pm SD (median)
Preoperative tympanogram	-39.93 \pm 37.08 daPa (12.5)	-34.86 \pm 39.01 daPa (25)	.796	-55.62 \pm 38.57 daPa(50)	-24.05 \pm 33.06 daPa(0)	-33.58 \pm 37.57daPa (25)
1st month tympanogram	-50.07 \pm 63.22 daPa (37.5)	-65.97 \pm 54.82 daPa(62.5)	.075	-110.31 \pm 53.88 daPa(100)	-31.75 \pm 46.68 daPa(0)	-28.40 \pm 36.47 daPa (0)
6th month tympanogram	-42.93 \pm 51.57 daPa (25)	-47.92 \pm 42.83 daPa(50)	.357	-77.50 \pm 49.90 daPa(75)	-30.40 \pm 40.81 daPa(0)	-44.62 \pm 48.63 daPa(50)
Preoperative- 1st month ++p	0.009**	0.006**		0.001**	0.102	
Preoperative- 6th month ++p	0.001**	0.001**		0.001**	0.105	0.001**
1st month- 6th month ++p	0.045*	0.011*		0.001**	0.645	
+ Mann Whitney U test	++ Wilcoxon sign test					
* $p < .05$	** $p < .01$					

Table 3. Evaluation of Tympanogram Curve Types During Treatment Regarding Type of Surgery and Absence and Presence of Ear Complaints.

Type of surgery		Postoperative ear complaint							
	Uvulopalatal Flap (n=70) (%)	Uvulopalatal Flap +Tonsillectomy (n=36) (%)	+P	Present (n=32) (%)	Absent (n=74) (%)	+P	Study (n=106)	Control (n=50)	+P
Types of preoperative tympanogram	Type A	70 (100)	36 (100)	-	32 (100)	74 (100)	-	106 (100%)	50 (100%)
	Type C	-	-	-	-	-	-	-	-
Types of 1st month tympanogram	Type A	59 (84.3)	31 (86.1)	.804	19 (59.4)	71 (95.9)	.001**		
	Type C	11 (15.7)	5 (13.9)		13 (40.6)	3 (4.1)			
Types of 6th month tympanogram	Type A	61 (87.1)	35 (97.2)	.093	26 (81.3)	70 (94.6)	.031*	96 (90.6%)	47 (94.0%)
	Type C	9 (12.9)	1 (2.8)		6 (18.7)	4 (5.4)		10 (9.4%)	3 (6.0%)
Preoperative - 1st month ++p	0.001**	0.063		0.001**	0.250				
Preoperative- 6th month ++p	0.004**	1.000		0.031*	0.125		0.002**	0.250	
1st month - 6th month ++p	0.754	0.125		0.039*	1.000				
+ chi-square test	++ McNemar test	* $p < .05$	** $p < .01$						

The Eustachian tube functions can be affected during the soft palate surgery for several reasons, including injury, tension, pain, swallowing problems, and long-term scar formation. The muscle incision in the uvulopalatopharyngoplasty procedure, interferes with the eustachian tube physiology, because these are the same muscles for the function of the eustachian tube. Even though the uvulopalatal flap surgery and tonsillectomy do not directly damage these muscles, there can still be various factors that lead to changes in the middle ear pressures in the postoperative period. The Eustachian tube is an important part of the middle ear air control. However, not much known about the qualitative and quantitative physiological parameters of gas transfer from the nasopharynx. The eustachian tube is closed at rest, but the opening is an active action. During swallowing and yawning, the tensor veli palatini muscle allows part of the tube to open. Opening the tube creates a volume with lower pressure in the tube lumen than the nasopharynx and the middle ear. With air going into the middle ear, a lower pressure is created, and the air moves from the nasopharynx to the newly created volume of space allowing for healthy circulation of air in the middle ear [17]. After the surgical procedure, the properly coordinated activity of the muscles of the nasopharynx and eustachian tube, as well as those needed for the proper air flow in the middle ear, may be reduced owing to inflammation in the lower nasopharynx and soft palate, limitation of motion due to pain, and direct surgical intervention to the muscles. In addition, incorrect and noneffective swallowing owing to pain or improper nasopharyngeal and Eustachian tube coordination can affect middle ear airflow. In the uvulopalatopharyngoplasty procedure, the direct manipulation of the tensor veli palatini or levator veli palatini can affect the middle ear pressure. Manipulation of the soft palate may cause damage, tension changes, partial tears, or hematomas. Changes in tension of the soft palate can negatively affect the tensor veli palatini muscular function [9]. The tensor veli palatini and levator veli palatini play the most-important role in opening the eustachian tube [18]; considering the small size of the salpingopharyngeus, it is believed to have a minor role in this function [19].

In uvulopalatopharyngoplasty, an incision is made to the complete thickness of the soft palate, and even though point of attachment of the tensor veli palatini and levator veli palatini is on the posterior side of the soft palate, this incision can still lead to the eustachian tube dysfunction [19]. A deep, paraulvular incision to the levator veli palatini can lead to muscle dysfunction. It has been seen in primate studies that tensor veli palatini paralysis causes reversible serous otitis [20]. Finkelstein and associates showed that in 30 cleft-palate patients with unilateral levator veli palatini paralysis, only 3 had chronic otitis, leading to the conclusion that the levator veli palatini did not play a major role in the tubal opening mechanism [21].

Significant negative changes in the middle ear pressure have been shown after uvulopalatopharyngoplasty and tonsillectomy [9,10,22]. In our study, we found in the 1st. and 6th. postoperative months that uvulopalatal flap and uvulopalatal flap plus tonsillectomy patients had a significantly negative pressure changes in the middle ear. This change was more apparent in the uvulopalatal flap plus tonsillectomy group. This change was seen in the first postoperative month and was shown to have become significantly normalized in the sixth postoperative month. When evaluating the pressure values, in the tympanogram changes between mean preoperative and the sixth postoperative month for the uvulopalatal flap group was -3 daPa (median value change of 12.5), and in the uvulopalatal flap plus tonsillectomy group was -7 daPa (median value change of 25). Negative pressure changes seen because of edema, inflammation, and decreased activity seen in the soft palate due to pain in the first month was normalized over the course by the sixth month after surgery. We believe that procedures performed on the soft palate and the tonsillectomy procedure change the eustachian tube function causing the middle ear pressure changes. Tympanometry was used to estimate the middle ear pressure, which provides an objective and reproducible measure of pressure in the middle ear cavity behind an intact tympanic membrane [23]. Previous studies documented that tympanometry is a useful tool for measuring

middle ear status and pressure [24-27]. Daily, serial tympanometric measurements may contain information on the constitutional efficiency of Eustachian tube function. Preliminary data analyses suggest that the longitudinal tympanometric data contains important information on constitutional eustachian tube function [28]. Negative pressure changes that are severe and long-lasting can lead to hearing loss, and audiologic testing must be done on these patients. Sixteen patients in the first postoperative month, and 10 patients in the sixth postoperative month were type C, and there was no significant difference between the two surgical groups ($p < .01$). Evaluating intergroup changes, in the uvulopalatal flap group, the incidence of type C was statistically significant (Table 3). None of the patients was type B in the first as well as sixth postoperative months; this shows that there were no significant middle ear changes in the middle ear pressure owing to the procedure. We found the numeric change in pressure more valuable than the tympanogram type changes. We also found a significant change in the uvulopalatal flap group, but none of the type C tympanogram patients had a middle ear pressure less than -200 daPa. Preoperative values of those patients were -80 daPa and above, indicating that they were close to the limits of type C, but still classified as type A.

Both blunt and sharp dissection techniques leading to tissue trauma, done in uvulopalatal flap and tonsillectomy, can lead to edema and/or lymphatic drainage problems in the nasopharynx. This can lead to the swelling of the peritubal lymphatic plexus and middle ear capillary pressure changes. Another effect can be mucosal swelling and air absorption into the ear, leading to narrowing the entry of the eustachian tube and ultimately, leading to intratympanic compliance changes. Even though the uvulopalatal flap does not involve any cutting of the muscle; the tissue trauma, edema, fibrosis, and inflammation that develop postoperatively can lead to dysfunction of the muscle and middle ear pressure changes. As the tissue heals, inflammation and lymphatic swelling subsides, and the middle ear function returns to normal [29]. Another reason for negative pressure in the middle ear

in uvulopalatal flap surgery is pain, and therefore, decrease in swallowing, which is important for the opening of the eustachian tube [30]. According to Bonding and Tos, normalization of middle ear pressure after surgery is lessening of pain, and increased swallowing in the days after the procedure [4].

There were no other major complications encountered (difficulty in swallowing, speech disorders, velopharyngeal insufficiency). None of the patients had pain to the point of extending their hospital stay or affecting their eating. Nineteen of the patients (32 patients) had first-month postoperative ear complaints. Referring to ear pain is a well-known complication of uvulopalatal surgery [31]. It is hard to know where postoperative ear pain originates from negative pressure of middle ear or referring pain from the surgical area.

When looking at the tympanogram values of the patients with postoperative ear complaints, the 1st- and 6th month- tympanogram values show negative pressure changes. There was a significant increase in changes when comparing those who had postoperative ear complaints with those who did not have postoperative ear complaints. The decreasing values for those with ear complaints in the first postoperative month led to decrease in ear complaints in the sixth postoperative month.

Until now, the literature has only examined the short-term middle ear pressure changes and short-term negative tympanogram value changes in patients who have had uvulopalatopharyngoplasty or tonsillectomy [4,10,22]. Only Marais and associates have examined the middle ear pressure changes until the third postoperative month in their laser-assisted uvuloplasty patients [32]. The paraulvular muscle incision made in laser-assisted uvuloplasty, as well as the laser's thermal and biological effect, causes different effects on the soft palate and therefore, middle ear pressure. Uvulopalatopharyngoplasty affects the middle ear pressure differently, as well, because the surgical area is larger, the incision is made at full thickness, and most probably affects the tensor veli palatini and levator veli palatini muscles. It most likely does not involve only a mucosal incision as in the uvulopalatal flap surgery.

We recommend uvulopalatal flap surgery for snoring and sleep apnea correction, as it has a high surgical success rate and involves fewer possible complications to the alternative methods. Patients who have uvulopalatal flap surgery may have negative pressure changes within the first month postoperatively, but this will normalize over time. For this reason, during the preoperative consultation, the patient should be informed that they might have postoperative ear complaints, and those who do have ear complaints after the procedure should be followed more closely. We believe that the effect of uvulopalatal flap on middle ear pressure is less than that of the alternative procedures, and the future studies concerning the middle ear pressure changes by the other surgical techniques will hopefully enlarge our horizon.

Conclusion

In our study group, both uvulopalatal flap and uvulopalatal flap plus tonsillectomy patients had significantly negative changes in the middle ear pressure. These middle ear changes were more pronounced in the uvulopalatal flap plus tonsillectomy group. This negative pressure change was more significant in the first and sixth postoperative months in those patients who had postoperative ear complaints when compared to those who did not have postoperative ear complaints. The negative pressure change seen in the middle ear in the first postoperative month, was significantly lessened by the sixth month.

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