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Long-term outcomes of cases after uvulopalatopharyngoplasty surgery: a retrospective study

Arzubetül Duran[1], Ali Vefa Yücetürk[2]

[1]Department of Otorhinolaryngology and Head&Neck Surgery, Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital, Ankara, Turkiye

[2]Department of Otorhinolaryngology and Head&Neck Surgery, İzmir Can Hospital, İzmir, Turkiye

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ABSTRACT

Aims: This study aims to evaluate late-term postoperative anatomical, radiological, and polysomnographic study findings after uvulopalatopharyngoplasty surgery and describe the relationships between these findings.

Methods: This cross-sectional, retrospective study had a population of all cases undergone mentioned surgery in the department of otolaryngology at a university hospital between January 2005 and December 2008. Demographic variables (age, gender, time after the surgery), body mass indexes, Epworth Sleepiness Scale scores, anatomic variables (routine and non-routine examination findings and measurements), radiographic variables (computed tomography scans data), polysomnographic variables (Apnea-hypopnea indexes, mean and minimum oxygen saturations) were assessed. The results were reported as odds ratio (95% CI) and $p<0.05$ was considered to indicate statistical significance.

Results: The study sample was composed of 21 cases with available data. There were no statistically significant differences in the distribution of any of the study variables between subjects in different Obstructive Sleep Apnea Syndrome severity groups other than the higher age of the mild group. Severity categories were merged and compared, such as having the syndrome or having a moderate/severe syndrome. A resected uvula was more common in the moderate plus severe Obstructive Sleep Apnea Syndrome (apnea-hypopnea index>15) group (8 vs 2, p=.009). The mean upper alveolar arcus width differed among apnea-hypopnea index<15 and apnea-hypopnea index>15 groups, 4.15±0.21 and 3.93± 0.26, respectively (p=0.04). There was no significant correlation between the Apnea-hypopnea index and the other variables but there were moderate to strong significant correlations between other variables.

Conclusion: Uvular length, uvular width and the measurement of the upper alveolar arcus (indicating the maxillary transverse width) differ in cases who have undergone uvulopalatopharyngoplasty surgery and fell into different Obstructive Sleep Apnea Syndrome severity groups determined by a polysomnographic study.

Keywords: Maxillary transverse width, obstructive sleep apnea syndrome (OSAS), polysomnography, uvula, uvulopalatopharyngoplasty (UPPP)

INTRODUCTION

Obstructive sleep apnea syndrome (OSAS) is within the scope of sleep-related breathing disorders. It is characterized by recurrent episodes of upper airway obstruction during sleep with a decrease in blood oxygen (O_2) saturation.[1,2] If snoring does not accompany OSAS, it is called primary snoring. While primary snoring causes social problems, OSAS can lead to symptoms that significantly reduce the quality of life and even life-threatening problems. The incidence of OSAS is between 0.8% and 4% by screening tests.[3] When sleep is interrupted, the cycle structure and sleep pattern change, and excessive daytime sleepiness occurs. Also, the rate of cardiovascular mortality and morbidity is high in OSAS. It was only in the second half of the 20th century that snoring surgery was developed, and the research in the field of sleep revealed the relationship between apnea and upper airway obstruction that makes uvulopalatopharyngoplasty (UPPP) becomes widespread as a surgical technique other than tracheotomy in the treatment of OSAS.

UPPP is a surgical treatment method for primary snoring and OSAS. When we look at the literature regarding postoperative polysomnographic findings of the UPPP surgery, a 50% decrease was observed in 50% of the patients.[4] OSAS and its treatment remain up-to-date as an area where research continues.

Corresponding Author: Arzubetül DURAN, drabduran@gmail.com

Although the UPPP operation has been performed for a long time, a multidisciplinary approach between clinics for the approach to sleep-related breathing disorders developed recently. This problem, which exists at the diagnosis stage of OSAS, is also encountered during the evaluation stage of the treatment. In some studies, postoperative success has been reported without polysomnographic examination,[5] and the existing postoperative findings mostly belong to the early period.

The study aims to answer the following clinical questions: "What are the late-term polysomnographic findings among patients underwent UPPP surgery? What are the relationships between those findings and anatomical factors observed clinically or radiologically?" Regarding the second question, we hypothesized that the frequency of anatomical and radiological examination results are equal in the OSAS groups defined according to the polysomnographic findings.

METHODS

Study Design and Ethics

The investigators designed and implemented this cross-sectional study as a medical expertise thesis in the field of otorhinolaryngology, permission was obtained from the relevant institution (2007-084). Ethics committee approval is not required for this study since this is produced from a medical expertise thesis before 2020. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. The study population was composed of all cases undergone UPPP surgery in the department of otolaryngology at the Manisa Celal Bayar University Hospital between January 2005 and December 2008. Cases with body mass index (BMI)<35 kg/m² at the time of surgery, cases with a polysomnographic sleep study at least 6 months after the surgery, and cases with a complete postoperative examination at least 6 months after the surgery were included. Cases with a history of smoking and nasal pathologies were excluded.

Variables

Demographic variables (age, gender, time after the surgery), body mass index (BMI), Epworth sleepiness scale (ESS) scores, anatomic variables, radiographic variables, and polysomnographic variables were collected from hospital information system files.

The following were evaluated during the detailed examination of the patients (categorical anatomic variables): 1) presence of any craniofacial anomaly; 2) any nasal pathologies (mucosal color, septal deviation, turbinate hypertrophy, presence of any polyp/mass, nasal valve angles), 3) oropharyngeal examination including the Mallampati index (I, II, III, IV), 4) evaluation of soft palate, uvula, tongue position, and lateral pharyngeal bands, 5) a flexible nasopharyngoscopy for the Müller maneuver (at the level of soft palate and tongue base) and the structure of the epiglottis (or presence of epiglottic collapse).

Continuous anatomic variables were 1) the neck circumference in cm (measurement above the prominentia thyroidea when the mouth is closed and the head is in a neutral position), 2) the distance between the mandible and the thyroid cartilage (With a closed mouth and head in a neutral position, the distance between the gnation and the prominentia thyroidea), 3) mandible to sternum distance (the distance between gnation and incisura jugularis in neutral position, mouth closed and head in neutral position), 4) maximum mouth opening in cm (distance between the lower and upper incisive teeth at the midline when the patient opens his mouth as wide as possible), 5) measurements of the width and length of the uvula, the distance between the hard palate and the root of the uvula (measurement of the distance of the posterior edge of the hard palate in the midline to the root of the uvula), 6) upper alveolar arch width measurement (distance between the last molar teeth in the upper alveolar arch in the horizontal plane), 7) palatal height (measurement of the distance of the point where the palate is at its most dome to the horizontal plane between the last upper molar teeth), 8) measurement of the distance from the posterior uvula/soft palate to the posterior pharyngeal wall with flexible nasopharyngoscopy. 9) Measurement of the distance from the base of the tongue to the posterior pharyngeal wall.

Radiological variables were recorded if present. These were the distance between the posterior end of the hard palate and the lower end of the uvula, the narrowest distance between the base of the tongue and the posterior wall of the pharynx, the distance between the most protruding part of the soft palate and the posterior wall of the pharynx, and the distance between the lower end of the soft palate and the superior of the nasopharynx were measured in the topogram. In addition, the air column area between the back surface of the soft palate and the back wall of the nasopharynx, the air column area between the lower end of the soft palate and the upper end of the epiglottis, and the boundaries of the soft palate area were manually drawn in the topogram. These areas were evaluated with an automatic area calculation program. In the axial plan, the boundaries of the smallest air column area in the sections where the soft palate was visible and the smallest air column area at the tongue root level were drawn manually and evaluated with an automatic area calculation program. Computed

tomography examinations of the cases were performed on the Siemens Somatom Emotion, Helical Computed Tomography device. Scans were performed with section thickness of 5 mm, table movement of 7.5 mm, 100 mAs, and 130 kV settings, and the region between the nasopharynx and C4-C5 was scanned. All images were obtained with the patient in the supine position and the head in a neutral position. The sections taken were perpendicular to the airway to obtain an accurate measurement of the airway area.

All-night polysomnography (PSG) recordings of the patients were made with a comprehensive portable polysomnography device (Somté PSG System, Compumedics Ltd., Abbotsford, Australia) in a single room of the hospital, without the supervision of a sleep technician. Pre-sleep evaluations and post-sleep evaluations were made under the supervision of a technician. According to the current classification, a Level II: Comprehensive portable PSG was performed.[6] The patient was awake and got ready for examination with a portable PSG in the sleep unit before the sleep study. Electrodes were connected according to the international 10-20 system, and the case recording were adjusted according to the algorithm. Electroencephalography (EEG), electrooculography (EOG), jaw electromyography (EMG), respiratory effort, oximetry, body position, air flow, pulse, and leg movements were recorded with a polysomnographic digital sleep system. The parameters evaluated with the PSG were total recording time, total sleep time, sleep efficiency, total rapid eye movement (REM) sleep, REM latency, duration of sleep stages and their ratio to total sleep time, number of apneas and hypopneas, mean duration of apnea/hypopnea (sec), the longest duration of apnea/hypopnea (sec), apnea index, apnea-hypopnea index (AHI), the proportion of sleep spent in the supine position, supine AHI, non-supine AHI, AHI in the REM period, AHI in the non-REM period, mean and minimum oxygen saturations.

Surgical Procedure

Surgery was performed under general anesthesia with orotracheal intubation. The case was in a supine position with the head in hyperextension position, and a Davis Boyle mouth gag attached for exposure. To determine the amount of tissue that can be removed safely, the contact surface of the soft palate and the posterior pharynx wall was found by palpation with the Yankauer aspirator tip. Approximately 5-8 mm distal to this point, just superior to the musculus levator veli palatini, was marked with monopolar cautery as the upper surgical border. A tampon was placed in the nasopharynx. A total of 4-8 cc of lidocaine with adrenaline (20 mg Lidocaine Hydrochloride and 0.0125 mg Epinephrine base per 1 ml) diluted one-to-one with 0.9% NaCl solution was infiltrated into the bilateral anterior plicas and uvula. If the patient was not tonsillectomized, the operation was started with a tonsillectomy. First, the anterior plica of the right tonsil was incised with a No. 15 scalpel, and dissection was performed with a tonsil spoon by entering lateral to the capsule. The tonsil was held with grasping forceps, and a right tonsillectomy was performed with unipolar cautery. A tampon was placed to provide hemostasis, starting from the lower pole and applying pressure to both poles. Then, left tonsillectomy was performed using the same technique. After waiting the necessary time for hemostasis, the bleeding foci observed in the tonsil area were held with a hemostatic Kelly forceps and cauterized with unipolar cautery. Then, a suspension suture was passed from the end of the uvula with 3/0 non-absorbable suture material suspending the uvula. If the patient had a tonsillectomy, a strip-shaped tissue approximately 2-3 mm wide was resected from bilateral anterior plicas with a No. 15 scalpel and tissue scissors.

An incision followed by a resection was made in a horizontal plane, forming a right angle with the anterior plica incision while considering the mark on the soft palate. Approximately 1-1.5 cm incisions were made on the posterior plicas, starting from the junction with the uvula and extending to the superior and the lateral directions obliquely, to ensure no tension during the suturing. The anterior and the posterior mucosa were sutured with 3/0 absorbable suture material, passing through the mucosa and constrictor pharyngeal muscle buried inside. To ensure that the oropharyngeal opening was rectangular, bilateral anterior and posterior plicas were sutured mutually with 3/0 absorbable suture material without closing the inferior parts of the tonsillar lodges. The inferior and posterior 1/3–2/3 portion of the uvula was resected, and the mucosa was approximated with absorbable sutures. The tampon from the nasopharynx was removed.

The cases were started on postoperative amoxicillin–clavulanate oral suspension as antibiotherapy and paracetamol oral suspension as analgesic for one week. Intramuscular analgesic (diclofenac sodium, 75 mg in 3 ml) was administered to patients on demand within the first 24 hours postoperatively. No significant early complications developed in cases hospitalized for an average of one day. It was recommended to follow a tonsil diet for one week.

Statistical Analysis

Demographic variables (age, gender, time after the surgery), BMI, ESS scores, anatomic variables, radiographic variables, polysomnographic variables were characterized using descriptive statistics. Chi-square tests were performed for categorical variables.

Student's t-test was performed for continuous variables following the normal distribution or Mann-Whitney U test for continuous variables not following the normal distribution, while performing a bivariate analysis. A Pearson correlation coefficient was performed to evaluate the relationship between sturdy variables. The results were reported as odds ratio (95% CI) and P<.05 was considered to indicate statistical significance. SPSS 26 for Windows (SPSS Inc, IBM Corp, Armonk, NY) was used for all statistical analyses.

RESULTS

During the retrospective search, 62 subjects were screened for eligibility. The final sample comprised 21 subjects with a mean age of 49.52±9.58 years and 19(90.5%) were male. The mean time between surgery and the PSG was 24.80 (±9.40) months. Table 1 summarizes descriptive study variables and examination findings grouped by OSAS presence and severity. The mild OSAS group had a mean age of 60±9.1 years, which is higher than other groups

Table 1.Summary of descriptive study variables and examination findings grouped by OSAS presence and severity

		All Sample (n=21)	Primary snoring (n=7)	Mild OSAS (n=4)	Moderate OSAS (n=2)	Severe OSAS (n=8)	p
Age		49.52 (±9.58)	46 (±9.6)	60 (±9.1)	54.5(±2.1)	46.13(±7.1)	0.04†
Sex	**Male**	19(90.5)	7(100)	4(100)	1(50)	7(87.5)	
	Female	2 (9.5)	0	0	1(50)	1(12.5)	
Body mass index		28.49 (±3.14)	27.64(±1.39)	28.30(±2.71)	31.37 (±5.58)	28.62(±3.97)	0.56
Surgery to PSG (mts)		24.80(±9.40)	21.5 (±7.0)	31.5(±6.2)	21.25 (±7.0)	24.2(±12.2)	0.43
ESS		6.57(± 5.38)	5.4(±3.1)	3 (±3.5)	6.5(±6.3)	9.3(±6.7)	0.24
Dental occlusion	**Retrognathic**	1 (4.8)	0	0	0	1(12.5)	
	Orthognathic	18(85.7)	6(87.5)	4(100)	2(100)	6(75)	
	Prognathic	2 (9.5)	1(14.3)	0	0	1(12.5)	
Mallampati score	**1**	9 (42.9)	2(28.6)	2(50)	0	5(62.5)	
	2	9 (42.9)	3(42.9)	2(50)	2(100)	2(25)	
	3	3 (14.3)	2(28.6)	0	0	1(12.5)	
Muller's maneuver at soft palate	**0**	1 (4.8)	0	0	1(50)	0	
	I	1 (4.8)	1(14.3)	0	0	0	
	II	8 (38.1)	3(42.9)	1(25)	0	4(50)	
	III	5 (23.8)	0	1(25)	1(50)	3(37.5)	
	IV	6 (28.6)	3(42.9)	2(50)	0	1(12.5)	
Muller's maneuver at base of tongue	**I**	1 (4.8)	1(14.3)	0	0	0	
	II	10(47.6)	3(42.3)	1(25)	1(50)	5(62.5)	
	III	5 (23.8)	0	2(50)	1(50)	2(25)	
	IV	5 (23.8)	3(42.3)	1(25)	0	1(12.5)	
Soft palate elongation	**Normal**	18(85.7)	5(71.4)	4(100)	2(100)	7(87.5)	
	Elongated	3 (14.3)	2 (28.6)	0	0	1(12.5)	
Soft palate thickness	**Normal**	19(90.5)	6(87.5)	3 (75)	2(100)	8(100)	
	Thickened	2 (9.5)	1(14.3)	1(25)	0	0	
Soft palate webbing	**Normal**	19(90.5)	6(87.5)	3 (75)	2(100)	8(100)	
	Webbing	2	1(14.3)	1(25)	0	0	
Uvula examination	**Normal**	11(52.4)	5(71.4)	4(100)	0	2(25)	
	Resected	10(47.6)	2 (28.6)	0	2(100)	6(75)	
Uvula thickness	**Normal**	9(42.9)	5(71.4)	3(75)	0	1(12.5)	
	Resected	10(47.6)	2 (28.6)	0	2(100)	6(75)	
	Thickened	2 (9.5)	0	1(25)	0	1(12.5)	
Tongue	**Normal**	13(61.9)	5(71.4)	3 (75)	1 (50)	4 (50)	
	Macroglossic	8(38.1)	2 (28.6)	1(25)	1 (50)	4 (50)	
Lat. phary.bands	**Normal**	15(71.4)	5(71.4)	4(100)	1(50)	5(62.5)	
	Hypertrophic	6(28.6)	2 (28.6)	0	1(50)	3(37.5)	

Data was presented as n (percentage) for categorical variables, mean (± standard deviation) for continuous variables following the normal distribution, and median (Interquartile range) for continuous variables not following the normal distribution unless otherwise specified. p values for continuous variables are calculated by One-way ANOVA (analysis of variances) test, †: Tukey's post hoc comparison.

Data was presented as n (percentage) for categorical variables.

OSAS: Obstructive sleep apnea syndrome, PSG: Polysomnography, ESS: Epworth sleepiness scale score, Lat. phary.: Lateral pharyngeal

(p=0.04). There were no other statistically significant differences in the study variables between subjects in different OSAS severity groups. Categorical variables are not compared according to OSAS severity because of the small number of subjects and conceptually relevant cells are merged for further analysis.

As the primary eligibility criteria were having a UPPP surgery, subject categories were merged and compared from a sleep surgery perspective. Table 2 summarizes descriptive study variables and examination findings grouped by OSAS presence (AHI>5 events/hour), and moderate OSAS plus severe OSAS presence (AHI>15

Table 2.Summary of descriptive study variables and examination findings grouped by OSAS presence and moderate OSAS plus severe OSAS presence

		All Sample (n=21)	AHI>5 (n=14)	AHI<5 vs >5 p	AHI<15 (n=11)	AHI>15 (n=10)	AHI<15 vs >15 p
Age		46 (±9.6)	51.29 (±9.60)	0.24	51.09 (±11.41)	47.80 (±7.28)	0.44
Gender	**Male**	7 (100)	12 (87.5)	0.53*	11 (100)	8 (80)	0.21*
	Female	0	2 (14.3)		0	2 (20)	
Body mass index		27.64 (±1.39)	28.92 (±3.70)	0.27	27.88 (±1.86)	29.17 (±4.13)	0.38
Surgery to PSG (mts)		21.5 (±7.0)	27 (12.25)	0.36##	8.17 (±2.46)	24.4 (±11.03)	0.85
ESS		5.4 (±3.1)	7.14 (±6.23)	0.50	4.54 (±3.35)	8.80 (±6.42)	0.06
Dental occlusion	**Retrognathic**	0	1 (7.1)	0.68	0	1 (10)	0.55
	Orthognathic	6 (87.5)	12 (85.5)		10 (90.9)	8 (80)	
	Prognathic	1 (14.3)	1 (7.1)		1 (9.1)	1 (10)	
Mallampati score	**1**	2 (28.6)	7 (50)	0.36	4 (36.4)	5 (50)	0.77
	2	3 (42.9)	6 (42.9)		5 (45.5)	4 (40)	
	3	2 (28.6)	1 (7.1)		2 (18.2)	1 (10)	
Muller's maneuver at soft palate	**0**	0	1 (7.1)	0.21	0	1 (10)	0.16
	I	1 (14.3)	0		1 (9.1)	0	
	II	3 (42.9)	5 (37.5)		4 (36.4)	4 (40)	
	III	0	5 (37.5)		1 (9.1)	4 (40)	
	IV	3 (42.9)	3 (21.4)		5 (45.5)	1 (10)	
Muller's maneuver at base of tongue	**I**	1 (14.3)	0	0.10	1 (9.1)	0	0.33
	II	3 (42.3)	7 (50)		4 (36.4)	6 (60)	
	III	0	5 (37.5)		2 (18.2)	3 (30)	
	IV	3(42.3)	2 (14.3)		4 (36.4)	1 (10)	
Soft palate elongation	**Normal**	5(71.4)	13 (92.9)	0.24*	9 (81.2)	9 (90)	1.00*
	Elongated	2 (28.6)	1 (7.1)		2 (18.2)	1 (10)	
Soft palate thickness	**Normal**	6 (87.5)	13 (92.9)	1.00*	9 (81.2)	10 (100)	0.47*
	Thickened	1 (14.3)	1 (7.1)		2 (18.2)	0 (0)	
Soft palate webbing	**Normal**	6 (87.5)	13 (92.9)	1.00*	9 (81.2)	10 (100)	0.47*
	Webbing	1 (14.3)	1 (7.1)		2 (18.2)	0	
Uvula examination	**Normal**	5 (71.4)	6 (42.9)	0.36*	9 (81.2)	2 (20)	0.009*
	Resected	2 (28.6)	8 (51.7)		2 (18.2)	8 (80)	
Uvula thickness	**Normal**	5 (71.4)	4 (28.6)	0.15	8 (72.7)	1 (10)	0.011
	Resected	2 (28.6)	8 (51.7)		2 (18.2)	8 (80)	
	Thickened	0	2 (14.3)		1 (9.1)	1 (10)	
Tongue	**Normal**	5 (71.4)	8 (51.7)	0.65*	8 (72.7)	5 (50)	0.38*
	Macroglossic	2 (28.6)	6 (42.9)		3 (27.3)	5 (50)	
Lateral pharyngeal bands	**Normal**	5 (71.4)	10 (71.4)	1.00*	9 (81.2)	6 (60)	0.36*
	Hypertrophic	2 (28.6)	4 (28.6)		2 (18.2)	4 (40)	

Data presented as n (percentage) for categorical variables, mean (± standard deviation) for continuous variables following the normal distribution, and median [Interquartile range] for continuous variables not following the normal distribution unless otherwise specified. p values for categorical variables are the two-tailed p-value computed using the t distribution, Pearson Chi-Square unless otherwise specified, *: Fisher's exact test. p values for continuous variables are calculated by Student's t-test unless otherwise specified, ##: Mann-Whitney U test. AHI: Apnea-hypopnea index, PSG: Polysomnography, OSAS: Obstructive sleep apnea syndrome, ESS: Epworth Sleepiness scale score, PSG: Polysomnography.

events/hour). There were no statistically significant differences in the distribution of any of the study variables between subjects in primary snoring (AHI<5 events/hour) and OSAS (AHI>5 events/hour) groups. On the other hand, the ESS Score of subjects in the primary snoring plus mild OSAS (AHI<15 events/hour) and moderate plus severe OSAS (AHI>15 events/hour)groups were 4.54 (±3.35) and 8.80 (±6.42), respectively (p-=0.06). A resected uvula was more common in the moderate plus severe OSAS (AHI>15 events/hour) group.

After the descriptive examination variables, Table 3 summarizes examination measurements grouped by OSAS presence (AHI>5 events/hour), OSAS severity, and moderate OSAS plus severe OSAS presence (AHI>15 events/hour). The average SaO_2 % was different between groups as expected. Uvular width and uvular length were constant in the moderate OSAS group, which is 0 mm. Similar to examination findings, resected uvulas in the moderate plus severe OSAS (AHI>15 events/hour) group caused a difference in mean uvular width and uvular length, 0 [6.00] mm and 0 [1.00] mm, respectively (p-=0.005 and p=0.003). Upper alveolar arcus width was different among AHI<15 events/hour and AHI>15 events/hour groups 4.15 (±0.21) and 3.93 (±0.26), respectively (p=0.05).

Table 4 summarizes CT scan-related variables, grouped for OSAS presence and severity. No Mild OSAS cases had CT scans. There were no statistically significant differences in the study variables between subjects in the groups.

In Table 5, correlations between study variables are summarized. Pearson correlation coefficient was performed to evaluate the relationship between the age and the other study variables. The results indicated that the relationships were not significant. There were a few significant strong relationships between some descriptive variables, previously described and reported as the pathophysiology of OSAS.

Table 3. Summary of examination measurements grouped by OSAS presence, OSAS severity, and moderate OSAS plus severe OSAS presence

	All (n=21)	Primary snoring, AHI<5 (n=7)	Mild OSAS (n=4)	Moderate OSAS (n=2)	Severe OSAS (n=8)	p	AHI>5 (n=14)	AHI<5 vs >5 p	AHI<15 (n=11)	AHI>15 (n=10)	AHI<15 vs >15 p
Average SaO_2%	92.0 (± 3.5)	94.0 (±2.5)	92.7 (±1.7)	93.5 (±0.7)	89.5 (±4.2)	0.07	91 (±3.67)	0.06	93.54 (±2.25)	90.3 (±4.08)	0.43
Minimum SaO_2%	57.00 [90.50]	85.00 [90.00]	39.50 84.25]	68 [0]	31.00 [68.25]	0.65#	59.5 [79.00]	0.28##	79.00 [86.00]	42.20 [72.25]	0.42##
Neck circ. (cm)	41.28 (±3.44)	41.21 (±2.03)	41.25 (±4.29)	39.75 (±0.35)	41.75 (±4.62)	0.92	41.32 (±4.03)	0.94	41.22 (±2.83)	41.35 (±4.17)	0.93
Mand. to thyroid (cm)	6.00 [0.75]	7.00 [1.50]	7.00 [0.75]	8.25 [.]	6.25 [1.00]	0.06#	6.8 (±0.81)	0.70	7.00 (±0.63)	6.8 (± 0.94)	0.57
Mand.to sternum (cm)	11.50 [2.00]	12.00 [1.50]	12.25 [1.00]	13.50 [.]	12.00 [3.00]	0.83#	12.67 (±0.81)	0.67	12.36 (±0.83)	12.80 (± 2.14)	0.55
Interincisive width (cm)	4.76 (±0.75)	5.00 (±1.00)	4.87 (±0.62)	5.00 (±0.00)	4.43 (±0.62)	0.50	5 [1.00]	0.68##	5.00 [1.00]	5.00 [1.00]	0.22
Uvular width (mm)	0 [5.00]	6.00 [7.00]	6.00 [10.25]	0	0 [6.00]		0[5.25]	0.17##	6.00 [2.00]	0 [6.00]	***0.005***##
Uvular length (mm)	0 [5.00]	5.00 [10.00]	5.00 [3.00]	0	0 [5.00]		0 [5.00]	0.12##	5.00 [3.00]	0 [1.00]	***0.005***##
Alveolar arcus width (cm)	4.04 (±0.26)	4.11 (±0.23)	4.22 (±0.18)	4.20 (±0.42)	3.86 (±0.19)	0.058	4.01 (±0.27)	0.42	4.15 (±0.21)	3.93 (± 0.26)	0.04
Palatal height (cm)	2.65 (±0.35)	2.82 (±0.42)	2.62 (±0.25)	2.75 (±0.35)	2.48 (±0.30)	0.32	2.50 [0.40]	0.17##	2.75 (±0.36)	2.54 (±0.31)	0.17
Hard palate to proximal uvula (cm)	3.42 (±0.41)	3.30 (± 0.40)	3.47 (±0.05)	3.25 (±0.35)	3.56 (±0.54)	0.62	3.45 [0.23]	0.19##	3.36 (±0.32)	3.50 (±0.50)	0.46
Retrophar. dist. (mm)	6.00 (±1.84)	6.14 (±1.46)	5.50 (±2.08)	9.00 (±1.41)	5.37 (±1.59)	0.07	5.92 (±2.05)	0.80	5.90 (±1.64)	6.10 (± 2.13)	0.82
BOT to posterior pharyngeal dist. (mm)	7.14 (±1.82)	6.71 (±1.88)	6.25 (±0.95)	9.00 (±2.82)	7.50 (±1.77)	0.30	7.35 (±1.82)	0.46	6.54 (±1.57)	7..80 (±1..93)	0.11

Data presented as mean (± standard deviation) for continuous variables following the normal distribution, median [Interquartile range] for continuous variables not following the normal distribution unless otherwise specified. Uvular width and uvular length were constant in the moderate OSAS group, which is 0 mm. p values are Student's t-test unless otherwise specified, OSAS: Obstructive sleep apnea syndrome, #: Kruskal-Wallis Test, ##: Mann-Whitney U test, SaO_2: Oxygen saturation, Circ.: Circumference, Mand.: Mandible, Retrophar.: Retropharyngeal, Dist.: Distance, BOT: Base of tongue.

Table 4.Computed tomography scan related variables, grouped for OSAS presence and severity

	All (n=9)	Primary Snoring (n=3)	Moderate OSAS (n=1)	Severe OSAS (n=5)	p	AHI>15 (n=6)	AHI<15 vs >15 p
Hard palate-distal soft palate (mm)	29.57 (±5.44)	31.86 (±6.72)	28.60	28.40 (±5.54)	0.73	28.43 (±4.95)	0.40
Minimum distance, BOT-posterior pharyngeal wall (mm)	7.18 (±3.63)	5.83 (±3.55)	13.80	6.68 (±2.73)	0.14	7.86 (±3.80)	0.46
Minimum distance, soft palate-posterior pharyngeal wall (mm)	3.42 (±1.30)	3.60 (±1.40)	4.70	3.06 (±1.35)	0.56	3.3 (±1.38)	0.79
Distal soft palate-superior nasopharyngeal wall (mm)	37.16 (±7.22)	39.36 (±5.15)	32.40	36.80 (±9.03)	0.75	36.06 (±8.27)	0.55
Air column area, posterior surface of the soft palate - posterior nasopharyngeal wall (cm^2)	1.63 (±0.59)	2.16 (±0.79)	1.39	1.36 (±0.28)	0.17	1.36 (±0.25)	0.05
Air column area, distal soft palate–superior edge of the epiglottis(cm^2)	3.08 (±0.50)	3.33 (±0.39)	3.30	2.88 (±0.57)	0.49	2.95 (±0.54)	0.32
Sagittal area, soft palate (cm^2)	3.12 (±0.95)	3.22 (±0.65)	2.60	3.17 (±1.23)	0.87	3.08 (±1.13)	0.85
Minimum air column area, axial, BOT level (cm^2)	2.26 (±0.84)	2.33 (±1.11)	3.18	2.03 (±0.71)	0.51	2.22 (±0.79)	0.86
Minimum air column area, axial, soft palate level (cm^2)	1.35 (±0.71)	1.94 (±0.58)	1.18	1.03 (± 0.66)	0.22	1.06 (±0.60)	0.07

Data presented as mean (± standard deviation). One-way ANOVA(analysis of variances) test compared means of OSAS severity groups. For comparing AHI <15 vs AHI>15 groups, we run Student's t-test. All data are calculated on CT scans. No Mild OSAS cases had CT scans. OSAS: Obstructive sleep apnea syndrome, BOT: Base of tongue.

Table 5. Correlations betweenstudy variables

		Age	Body mass index	ESS	Surgery to PSG time(mts)	AHI	Average SaO2%	Minimum SaO2%	Neck circ. (cm)	Interincisive width (cm)	Mand. to thyroid (cm)	Mand.to sternum (cm)	Uvular width (mm)	Uvular length (mm)	Alveolar arcus Width(cm)	Palatal height (cm)	Hard palate-prox. uvula(cm)	Retrophar. dist. (mm)
Body mass index	r																	
	p	.38																
ESS	r		.57															
	p	.28	.006															
Surgery to PSG time (mts)	r																	
	p	.22	.49	.25														
AHI (Ev/h)	r																	
	p	.49	.84	.11	.65													
Average SaO_2%	r					-.82												
	p	.55	.87	.30	.33	.001												
Minimum SaO_2%	r*						.44											
	p	.79	.60	.91	.76	.28	.04											
Neck circ. (cm)	r						-.56											
	p	.60	.19	.24	.41	.16	.001	.86										
Interincisive width (cm)	r								-.49									
	p	.86	.13	.16	.95	.13	.12	.45	.02									
Mand. to thyroid (cm)	r*									.42								
	p	.80	.99	.19	.36	.19	.41	.89	.85	.05								

Table 5. Correlations betweenstudy variables (Continued)

		Age	Body mass index	ESS	Surgery to PSG time (mts)	AHI	Average SaO2%	Minimum SaO2%	Neck circ. (cm)	Interincisive width (cm)	Mand. to thyroid (cm)	Mand.to sternum (cm)	Uvular width (mm)	Uvular length (mm)	Alveolar arcus Width(cm)	Palatal height (cm)	Hard palate-prox. uvula(cm)	Retrophar. dist. (mm)
Mand.to sternum (cm)	r*																	
	p	.82	.73	.84	.54	.89	.86	.24	.63	.76	.15							
Uvular width (mm)	r*																	
	P	.60	.55	.19	.07	.07	.85	.41	.22	.63	.81	.71						
Uvular length (mm)	r*				.48	-.43							.96					
	p	.49	.90	.25	.02	.05	.71	.62	.41	.58	.97	.58	.001					
Alveolar arcus width (cm)	r		.44										.58	.46				
	p	.14	.04	.70	.61	.05	.64	.55	.24	.40	.46	.86	.005	.03				
Palatal height (cm)	r									.43	.23							
	p	.58	.90	.77	.35	.15	.15	.65	.64	.04	.30	.58	.34	.64	.58			
Hard palate-prox. uvula (cm)	r		.45	.43								-.46						
	p	.47	.03	.04	.51	.87	.53	.12	.79	.94	.33	.03	.66	.52	.90	.29		
Retrophar. dist. (mm)	r																	
	p	.95	.31	.48	.51	.81	.67	.97	.73	.93	.32	.85	.82	.68	.85	.62	.18	
BOT to post. pharyn. dist.(mm)	r			.45			-.46											
	p	.89	.24	.04	.99	.20	.03	.41	.13	.84	.67	.21	.67	.66	.34	.78	.80	.26

r: Pearson correlation, r*:Sprearman's rho, p: Significance, ESS: Epworth sleepiness scale score, PSG: Polysomnography, AHI: Apnea hypopnea index (event/hour), SaO_2: Oxygen saturation, Circ.: Circumference, Mand.: Mandible, Retrophar.: Retropharyngeal, Dist.: Distance, BOT: Base of tongue

There was a significant moderate negative relationship between inter-incisive width and neck circumference, r=-.49; p=.02. Also, inter-incisive width was correlated with mandible to thyroid distance moderately (r=.42; p=0.05). Likewise, there was a significant moderate positive relationship between inter-incisive width and palatal height, r=.43; p =.04. Uvular width and uvular length were correlated strongly, as expected. There were significant moderate positive relationships between upper alveolar arcus width and BMI and uvular length (r=.44; p=.04 and r=.46;p=.03 respectively). There was a significant strong positive relationship between upper alveolar arcus width and uvular width (r=.58; p=.005). We measured the distance between the distal hard palate to the proximal uvula for assessing the prolapsus of the soft palate. There were significant moderate positive relationships between this measurement and BMI and uvular length (r=.45; p=.03 and r=.43;p=.04 respectively). There was a significant moderate negative relationship between the mentioned distance and mandible to sternum distance, r=-.46; p=.03. There was a significant moderate positive relationship between the distance from the base of the tongue to the posterior pharyngeal wall and the ESS score, r=.45; p=.04. There was a significant moderate negative relationship between the distance from the base of tongue to the posterior pharyngeal wall and the average SaO_2%, r=-.46; p=.03.

DISCUSSION

The UPPP surgery has been performed for decades. We conducted this study to examine the relationship between late-termpolysomnographic findings and clinical/radiological examination characteristics. The study hypothesized that the frequency of anatomical and radiological examination findings was the same in OSAS groups defined by polysomnographic findings. Study findings were diversified using specific examination measurements not used in the routine otorhinolaryngological examination of OSAS cases.

The results of this study confirm the hypothesis that when patients who underwent UPPP surgery were grouped according to late-term polysomnography findings, there was no difference between the groups except for uvula findings, in general. Both uvular examination and uvular measurement findings were significantly different in cases with AHI>5 events/hourand AHI>15 events/hour cases, indicating that

uvular resection is more common in the OSAS group and the moderate plus severe OSAS group. However, the correlation coefficients performed to evaluate the relationship between uvular measurements and the AHI indicated that the relationships were not significant. Based on the results of this study, it seems that the resection of the uvula does not prevent cases from having moderate or severe OSAS.

Another significantly different measurement was the width of the upper alveolar arcus, which is narrower in the AHI>15 events/hour group. Although this measurement was not significantly correlated to the AHI, it was significantly correlated to the BMI, the uvular width, and the uvular length. The correlation coefficient results indicated that the relationship between all the other non-routine measurements and the AHI wasn't significant.
Due to the complexity and heterogeneity in its pathophysiology, OSAS presents a challenge for clinicians involved in its evaluation and management. With the definition of OSAS phenotypes by Eckert et al.,[7] the pathophysiology has become more understandable. However, each country, region, and clinic may have differences in health management, socio-economic standards, cultural perception, social and health priority, understanding, and awareness about primary snoring and OSAS as a problem and the need for diagnosis and treatment. Several consensus statements and guidelines for the evaluation and management of adult OSAS patients have been published in the last 3 decades throughout the world. These summarize and consolidate the available knowledge on the diagnosis and treatment of OSAS.[9] Yet, most of these did not elaborate on specific indications of surgical treatments in detail.

Therefore, in a recent study establishing a panel of otolaryngology/head and neck surgery experts in snoring and OSA to develop statements on diagnosing and treating snoring and OSAS in adults, surgical treatment and various aspects of palatal surgery are discussed.[10] The presence of a long soft palate/large uvula and a large tongue are stated to be important risk factors with a consensus of 100%. Uvular length is still a point to check in preoperative sleep surgery patients. However, in this study uvula length was significantly longer in the group with AHI 0–15 events/hour than in the AHI>15 events/hour group.

An overnight polysomnographic study is the most reliable confirmatory investigation for OSAS diagnosis nevertheless the precise localization of the site of obstruction of the airflow cannot be detected in this way. Imaging modalities such as X-ray cephalometry, sleep videofluoroscopy, CT scanning, and magnetic resonance imaging (MRI) have been used to detect the obstruction site and other structural abnormalities. A meta-analysis of 25 studies has shown a strong correlation between certain craniofacial morphology variables in adult subjects with OSAS.[11] Although there was no significant difference between the cephalometric measurements of the groups in this study, when the current literature is searched, it is clear that clinical cephalometric studies are still worth conducting to elucidate the exact relationship between craniofacial features and OSAS.

A narrow maxilla in its transverse dimensions is known to be associated with upper airway obstruction. As most of the radiological data were limited to studies using lateral cephalogram(s), observations related to transverse dimensions that require postero-anterior cephalometric analysis would not be commented upon. Because of that, we measured the upper alveolar width to assess maxillary transverse deficiency and found a narrower mean maxillary width in the AHI>15 events/hour group. However, in a recent study, the maxillary transverse deficiency was identified by a reduction in radiological measurement of inter-premolar distance and intermolar distance, no association was found between the maxillary measurements and obstructive sleep apnea severity.[12] We could not compare our examination findings to CT measurements because of the small number of cases with CT scans. Likewise, no other studies to compare our results of clinical measurements of maxillary transverse width exist.

Limitations

This study's main limitation was that no preoperative data was available before the UPPP surgery to compare the postoperative results. Another limitation is that we reached postoperative data in 21 cases out of 62 cases (33.8%). These were because of the retrospective design of the study, as not every case operated on admitted back with a complaint necessitating a PSG. Also, we had CT scan data of 9 cases. Radiological imaging was not indicated for a postoperative follow-up, and these data were from any other indications of a neck CT scan. However, our data includes non-routine measurements and examinations of late results of a common sleep surgery technique.

CONCLUSION

Uvular length, uvular width and the measurement of the upper alveolar arcus (indicating the maxilla's transverse width) differ in cases who have undergone UPPP surgery and fell into different OSAS severity groups determined by a PSG. These characteristics are still a curious topic among sleep surgeons and are worth studying in future research.

ETHICAL DECLARATIONS

Ethics Committee Approval

Institutional approval was obtained. Ethics committee approval is not required for this study since this is produced from a medical expertise thesis before 2020.

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare**.**

Financial Disclosure

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Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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