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ORIGINAL RESEARCH

Obstructive sleep apnea in patients undergoing supracricoid horizontal or frontolateral vertical partial laryngectomy

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OBJECTIVE: To assess obstructive sleep apnea (OSA) in patients undergoing supracricoid horizontal partial laryngectomy (SCPL) or frontolateral vertical partial laryngectomy (VPL) for the treatment of laryngeal carcinoma and correlate it with age, body mass index, physical examination, and upper airway evaluation.

STUDY DESIGN AND SETTING: A prospective study was carried out involving 22 patients between 50 and 80 years of age divided into 2 equal groups. The patients underwent SCPL and VPL, and were evaluated by anamnesis, otolaryngologic examinations, nasopharyngolaryngoscopy, and polysomnography.

RESULTS: A significant direct correlation was observed between the apnea/hypopnea index (AHI) and age of the patients. An inversely proportional relation was found between glottic opening and AHI. The presence of OSA was 81% in SCPL and 91% in VPL.

CONCLUSION: We observed a high incidence of OSA in patients undergoing SCPL and VPL.

Laryngeal cancer is the second most frequent tumor in the head and neck region, primarily affecting males 40 years of age and older. Risk factors include tobacco smoking and alcoholism.[2]

The glottic region is the site most frequently affected by cancer of the larynx. One of the most common symptoms at the onset of the disease is dysphonia. When diagnosed promptly and treated, the prognosis is excellent, with a 90% and 85% survival at 5 years in stages I and II.[3]

Laryngeal cancer can be treated with surgical resections, radiation therapy, and chemotherapy. Partial laryngectomy is designed to preserve the respiratory, voice, and swallowing functions.[4,5] New partial laryngectomy techniques and new concepts in conservation surgery for the treatment of laryngeal carcinomas are based on the knowledge of the anatomy of that organ, as well as the role of its surrounding tissues as a barrier to tumor growth, and have contributed to its widespread use.

The horizontal supracricoid (SCPL)[6-9] and the vertical frontolateral (VPL)[10-12] are the most common types of partial laryngectomy carried out in the Department of Head and Neck Surgery at Universidade Federal de São Paulo-Escola Paulista de Medicina (UNIFESP-EPM). These surgeries are indicated in cases of glottic T2 or T1b tumors affecting the anterior commissura. Lesions having such features allow most frequently for a partial laryngectomy. An endoscopic CO_2 laser resection is carried out for T1a, T1b, and T2 tumors with a discrete involvement of the anterior commissura.

Obstructive sleep apnea (OSA) is a prevalent disease worldwide, afflicting approximately 9% of the male and 4% of the female population.[1] Although there is no specific report on the occurrence of OSA after partial laryngectomy,

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incidence can reach 91.7% among individuals undergoing head and neck surgeries.[5] There are a few studies correlating OSA with anatomic changes in patients undergoing partial laryngectomy. In a study with 24 patients undergoing different head and neck surgeries, an incidence of 91.7% OSA was observed.[6] Another study shows the presence of OSA of probable laryngeal origin in 3 patients who were treated initially for glottic cancer.[7]

It was by observing the respiratory glottis spaces, often reduced whether by the redundancy of mucosa, or by the very volume that occupied the shred at reconstruction, that we became motivated to study the respiratory pattern during sleep in the patients we operated on.

The purpose of this study was to assess the occurrence and severity of OSA in patients undergoing LPHS or VFL for the treatment of laryngeal carcinoma and correlate it with the age of the patients, the body mass index (BMC), physical examination, and UAW evaluation with nasopharyngolaryngoscopy.

METHODS

A prospective study was conducted among patients from the Department of Head and Neck Surgery at UNIFESP-EPM who previously underwent SCPL or VPL for squamous cell carcinoma (SCC) of the larynx in stages I and II in the last 6 years. Fifty-three patients were selected for this study. Twenty-seven patients underwent HSCPL (horizontal supracricoid partial laryngectomy), and 26 underwent VFLPL (vertical frontolateral partial laryngectomy). Twenty-two patients agreed to take part in the study. All patients who agreed to take part in the study were asked to read the Patient's Free and Aware Informed Consent Document (approved by the Research Ethics Committee of UNIFESP-EPM, filed under #0035/03, according to resolution number 196/96 of the Brazilian Health Federal Council).

The study involved 22 patients, including 11 patients undergoing SCPL and 11 undergoing VPL. Their ages ranged from 50 to 80 years, with an average of 65.5 years. Twenty patients were male and 2 were female (1 female underwent SCPL, 1 female underwent VPL).

Patients were evaluated based on detailed clinical history and using the Epworth Sleepiness Scale[8] to assess their degree of sleepiness. The physical examination assessed BMI according to the World Health Organization (WHO),[9] the relationship between base of tongue and oropharynx using the Modified Mallampati Classification,[10] and the degree of hypertrophy of the palatine tonsil. The patients also underwent nasopharyngolaryngoscopy and polysomnography using the Meditron unit with 13 recorded channels including: electrocardiogram, oculogram, submental and anterior tibial electromyography, nasal and oral airflow, thoracic and abdominal movements, body position, and O_2 saturation. Sleep stages were scored according to the manual of Rechstaffen and Kales.[11] The number of arousals was counted using the American Sleep Disorder Association (ASDA) criteria (1991).[12] Respiratory events and apnea and hypopnea index (AHI) per hour were assessed according to the American Academy of Sleep Medicine, 1999 (AASM)[13] as follows: normal, ≤5/hr; mild, 5 to 15/hr; moderate, 15 to 30/hr; severe, >30/hr.

For the statistical study, a descriptive analysis was conducted for all variables used in the study. We did not separate the individuals for gender and age because both groups were similar with these characteristics.

The χ^2 test or Fisher's exact test was applied to the qualitative variables to determine any association between the 2 groups. For quantitative variables, homogeneity of variances was tested with the Levene test, and normality of data was tested with the Kolmogorov-Smirnov test. Variables that satisfied both of the above criteria were subjected to parametric tests; otherwise they were subjected to non-parametric tests. To compare both groups, we used the *t* test (parametric) and Mann-Whitney *U* test (non-parametric). In all cases, the level of significance for rejection of the null hypothesis was always set an amount ≤0.05 or 5%. The statistical significance calculated is indicated by an asterisk (*).

RESULTS

Among patients undergoing SCPL and VPL, occurrence of OSA was 91% and 81%, respectively. The severity of apnea/hypopnea was measured by AHI, and a large majority of patients had AHI considered mild to moderate (n = 14 of 22) and severe (n = 5 of 22), as shown in Table 1.

All patients presenting a AHI >15 underwent nCPAP treatment. Results are not treated in this study because they go beyond the focus of this research.

According to the statistical analysis, there was only a positive correlation (*) between the AHI and age of the patients (Figs 1-3). An inversely proportional relation be-

Table 1
Results for patients undergoing SCPL and VPL

Variable	SCPL (%) n = 11	VPL (%) n = 11
AHI classification*		
Normal	1 (9.1)	2 (18.2)
Mild	5 (45.5)	6 (54.5)
Moderate	2 (18.2)	1 (9.1)
Severe	3 (27.3)	2 (18.2)
AHI†		
Average ± SD	20.6 ± 17.8	18.2 ± 22.2
Median	13.0	9.0
Range	3–58	3.5–78

AHI, apnea/hypopnea index.
*χ^2 = 0.96, *P* = 1.
†*P* = 0.31, Mann-Whitney *U*-test.

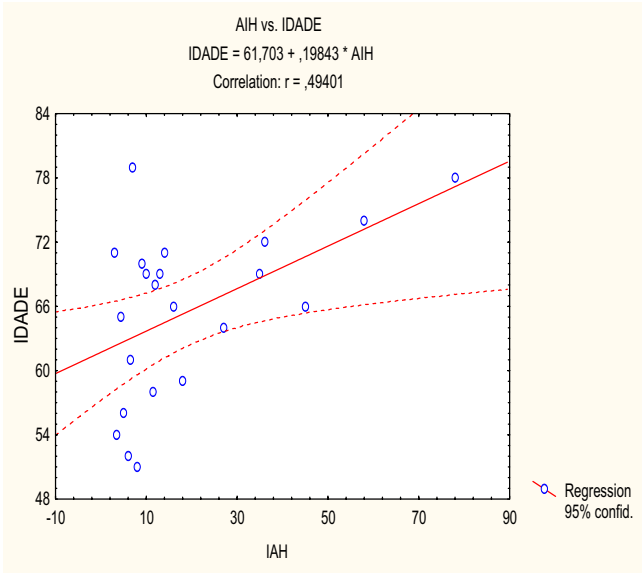

Figure 1 Correlation between apnea/hypopnea index and age for both groups of study patients.

tween BMI and glottic opening was also noted, but this was statistically insignificant.

DISCUSSION

Partial laryngectomy is an effective method of controlling cancer of the larynx. The greatest challenge in this form of treatment is to effectively preserve the laryngeal functions. In this type of surgery, the importance of treatment is preservation of the airflow passage and, especially, voice, produced by the neoglottis, because therapeutics leads to a reduction of the glottic opening (GO), which varies depending on the degree of tumor resection.

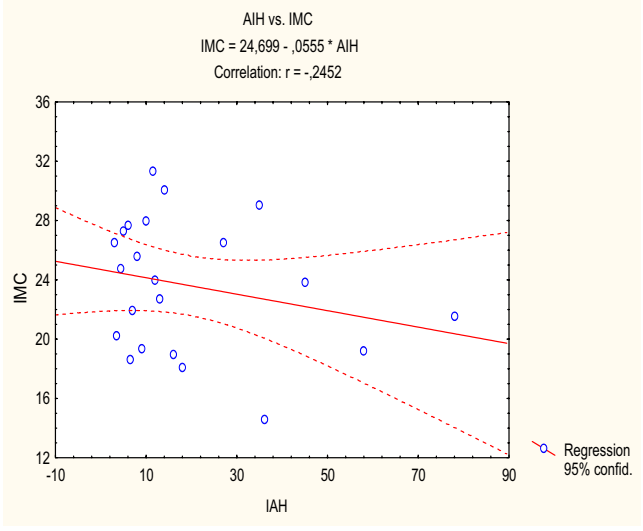

Figure 2 Correlation between apnea/hypopnea index and body mass index for both groups of study patients.

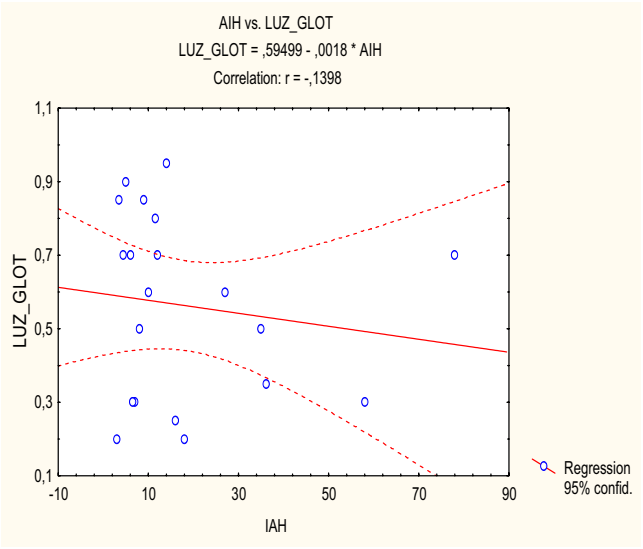

Figure 3 Correlation between apnea/hypopnea index and glottic opening for both groups of study patients.

Obstructive sleep apnea is generally due to an obstructive change in UAW structure at the oropharyngeal or hypopharyngeal level.[14] In our patients, the laryngoscopic examination showed massive thickening of the arytenoid mucosa and reduction of the GO. This is one of the reasons for suspecting a probable laryngeal origin, not pharyngeal, in addition to the observation of complaints of snoring and fatigue in some patients.

We studied 22 patients, 11 undergoing SCPL and 11 undergoing VPL, with 10 males and 1 female in each group. Among the predictive factors for OSA, the results achieved in this study are consistent with the results of other studies (i.e., higher prevalence among men; relationship to age).[15,16]

One of the main factors associated with the development of OSA is BMI.[13] We observed only 2 patients with degree I obesity, in the group of patients undergoing VPL (Table 3), and neither had OSA.

The Epworth Sleepiness Scale was used in this project. We found a low level of sleepiness, ranging from 0 to 5 (SD = 1.7 ± 1.5) in the group of patients undergoing SCPL and from 0 to 6 (SD = 2.2 ± 1.9) in the group of patients undergoing VPL. Results showed no statistical difference between the groups.

We think it important to report the TNM staging of that population, which showed that most patients were early tumor bearers, except for one in the SCPL group (Table 2), which reflects our standard practice of performing major surgeries for tumors at more advanced stages or involving bilateral vocal folds (horseshoe-shaped lesions). The types of surgeries mentioned allow the patient to maintain near-normal physiologic functions, which leads to a significant improvement in quality of life and social interaction. Most study patients were staged as T1bN0M0, after reconstruction with cricohyoidoepiglottopexy (CHEP) type 2 in the group of patients undergoing SCPL, and as T1aN0M0, after reconstruction of a bipedicled flap of the sterno-hyoid mus-

Table 2
Results for patients undergoing SCPL

Patient (n = 11)	Age	Mallanpati	BMI	AHI/hr	Epworth	TNM	Glottic opening, %	PO time, days
1	59	II	19	18	2	T2NoMo	20	418.00
2	71	II	25	3	0	T3NoMo	20	1635.00
3	66	I	24	45	0	T1bNoMo	80	1971.00
4	66	I	19	16	2	T1bNoMo	25	1738.00
5	69	I	23	13	5	T1bNoMo	80	362.00
6	79	II	22	7	1	T1bNoMo	30	1457.00
7	74	I	19	58	3	T2NoMo	30	1390.00
8	69	II	28	10	1	T1bNoMo	60	1352.00
9	51	II	26	8	1	T1bNoMo	50	936.00
10	68	II	24	12	3	T1bNoMo	70	1488.00
11	72	II	15	36.1	1	T1bNoMo	35	265.00
Average ± SD	67.6 ± 7.5	I = 4 (36.4%) II = 7 (63.6%)	22.1 ± 4.0	20.6 ± 17.8	1.7 ± 1.5		45.5 ± 23.5	1182.9 ± 594.6
Range	51–79		14.6–28.0	3–58	0–5		20–80	

BMI, body mass index; *AHI*, apnea/hypopnea index; *PO*, postoperative.

cle (Bailey), in the group undergoing VPL (Tables 2, 3). Both groups showed no significant difference when correlating the techniques with AHI (e.g., the severity of OSA was equal in both groups). The anatomic change in the UAW was greater in the SCPL group due to a greater resection of the anatomic structures of the larynx and a greater reduction of the laryngeal cleft of the neoglottis.

Radiation therapy was only applied to 1 patient in the SCPL group, whose neck showed a metastatic lymph node in the anatomopathology examination (patient 1, Table 2). This individual had AHI of 18/hr and is considered to have moderate apnea. In a study by Friedman et al,[13] of 24 patients who underwent resections for head and neck tumors located at the base of tongue, pharynx, and supraglottic region, 10 patients (41.7%) received RDT and had AHI >15/hr. All patients undergoing RDT (100%) had OSA.[6] Irradiation would theoretically stiffen the soft tissues and consequently would not favor OSA. On the other hand, reconstructive techniques would tend to narrow the UAW, therefore, it would be worth comparing patients undergoing these treatments (surgery vs radiation therapy). As can be observed in our study, only one patient underwent RDT. This is not enough information to consider RDT as a factor in developing OSA.

It seems unlikely that patients in our study suffered from OSA before the surgical procedure. When interviewed, they denied excessive sleepiness during the daytime and had no

Table 3
Results for patients undergoing VPL

Patient (n = 11)	Age, y	Mallanpati	BMI	AHI/hr	Epworth	TNM	Glottic opening, %	PO time, days
1	69	II	29	35	4	T1aNoMo	50	963.00
2	52	II	28	6	2	T1aNoMo	70	1713.00
3	58	II	31	11.5	2	T1aNoMo	80	122.00
4	71	III	30	14	3	T1aNoMo	95	4447.00
5	78	I	22	78	0	T1bNoMo	70	1186.00
6	56	I	27	5	1	T1aNoMo	90	788.00
7	54	I	20	3.5	6	T1bNoMo	85	751.00
8	61	III	19	6.5	1	T2NoMo	30	135.00
9	65	III	25	4.4	1	T1aNoMo	70	651.00
10	70	I	19	9	0	T1aNoMo	85	1745.00
11	64	I	26	27	4	T1aNoMo	60	122.00
Average ± SD	63.5 ± 8.1	I = 5 (45.4%) II = 3 (27.3%) III = 3 (27.3%)	25.1 ± 4.5	18.2 ± 22.2	2.2 ± 1.9		71.4 ± 19.1	1136.5 ± 1246.0
Range	52–78		18.6–31.4	3.5–78	0–6		30–95	122.0–4,447

BMI, body mass index; *AHI*, apnea/hypopnea index; *PO*, postoperative.

complaints of nocturnal snoring and arousals during sleep. Their physical otolaryngologic examination did not show major changes (Tables 2, 3). In a study conducted in Brazil, the presence and severity of OSA were correlated with the findings of a systematized otolaryngologic examination. As a predictive factor for OSA, Laccourrye et al found a correlation with obesity, modified Mallampati Classification, and the concomitant presence of at least 3 anatomic changes in the soft tissues of the pharynx.[8] In our study, we did not find changes of similar importance likely to contribute to the development of OSA. Several studies were conducted in an attempt to identify the main anatomic changes correlated with OSA. A study with 172 patients subjected to a specific physical examination for OSA assessed its correlation with 4 anatomic criteria: relationship between base of tongue and oropharynx (modified Mallampati classification), palatine tonsil size, body mass index (BMI), and cervical measures of the distances between mentum and thyroid cartilage (thyroid–mentum) and between mentum and the hyoid bone (hyoid–mentum). The authors concluded that the first three criteria were correlated with the presence of OSA.[10]

The most striking laryngologic finding is the presence of reduced GO in the SCPL group, with an average of 45% of the normal opening against a laryngeal penetration of 71.4% on the average in VPL group (Tables 2, 3). This is a significant difference between the groups. This reflects the most severe consequence of the treatment of glottic tumors by partial laryngectomy, which is the reduction of GO, but despite the difference between the openings of the neoglottis, no higher incidence of OSA was observed in the group of patients undergoing SCPL.

In the group of study patients, most had mild and moderate AHI, with 11 patients in the group of patients undergoing SCPL and 8 in the VPL group (Table 1). Patients with mild, moderate, and severe levels (i.e., AHI $\geq$5/hr to $\geq$30/hr) equaled 19, which shows high AHI (86.4%). Apnea and hypopnea index of $\geq$15/hr presents sensitivity and specificity of 100% and 93%, respectively[17] for the diagnosis of OSA. For AHI $>$10/hr, sensitivity and specificity for the diagnosis of OSA is 100%.[18]

With respect to the start of symptoms during the postoperative period, anamnesis and otolaryngologic, nasopharyngolaryngoscopic, and polysomnographic examinations are very important to show any UAW obstruction in the area of the laryngeal reconstruction only. Findings showed that symptoms started many weeks after the surgical procedure, at the time the pharyngeal and glottic edema disappeared. UAW obstruction was probably present from the beginning, and its diagnosis is impossible because of the temporary tracheostomy. The fibroscopic examination carried out on these patients showed thickening of the arytenoid mucosa and reduction of the glottic opening. This raises the suspicion that the cause is of laryngeal origin, not pharyngeal origin. Obstructive sleep apnea can be diagnosed easily when the symptoms appear, however this data can be underestimated in cases of surgery for laryngeal cancer and can be confounded with symptoms of depression during the postoperative period. In these cases, it would be necessary to pay closer attention to the symptoms of changes in sleep before carrying out surgery on the larynx (glottic) for cancerous lesions. In particular, sleep habits, nocturnal snoring, and sleepiness or excessive fatigue during the daytime should be researched. When these symptoms appear during the postoperative period, we should consider performing a polysomnographic study to confirm OSA.

This study presents obstruction at the level of the larynx as a possible cause of OSA. Another study reports 3 cases of OSA of laryngeal origin, which was confirmed with polysomnography after reconstruction in patients undergoing SCPL for glottic carcinoma and proposes CO_2 laser treatment, resulting in improvement in one patient.[7]

The relationship between laryngeal changes and presence of OSA was studied, and a direct relationship was found between excess mucosa in the supraglottic region and the presence of OSA. The case of two patients who clinically presented symptoms of OSA was reported and diagnosis was confirmed by polysomnography as a cause of OSA.[19]

The likelihood of developing OSA after partial laryngectomy should always be considered, and in case of suspicion of OSA, polysomnography is recommended for further investigation. Our results show the need for more studies, with larger patient samples, and we hope this is a seed for further studies regarding OSA and partial laryngectomy.

CONCLUSIONS

We observed a high occurrence of OSA among patients undergoing SCPL and VPL (81% and 91%, respectively). This characteristic was similar in both groups. A majority of the study patients presented mild-to-moderate obstructive sleep apnea. The only significant positive correlation with apnea and hypopnea index was the age of the patients (e.g., the older the laryngectomized patient the greater the likelihood of presenting obstructive sleep apnea). There was no significant correlation between glottic opening and OSA, however, it was observed that the less the glottic opening, the greater is the likelihood of developing OSA.

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