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ORIGINAL RESEARCH

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Characteristics of obstructive sleep apnea syndrome in patients with partial laryngectomy

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Abstract

Objectives: The impacts of partial laryngectomy on sleep-disordered breathing were rarely investigated and reported in a limited number of patients. The aim of this study was to assess the prevalence of obstructive sleep apnea-hypopnea syndrome (OSAHS) in patients with partial laryngectomy.

Study design: Case series.

Methods: All patients undergoing partial laryngectomy by open approach (frontolateral vertical partial laryngectomy and supracricoid horizontal partial laryngectomy) for squamous cell carcinoma of the larynx between January 2006 and December 2019 were enrolled. Listed patients were contacted via telephone to propose participating in the study and plan a sleep study: self-assessments of sleep quality using the Pittsburgh Sleep Quality Index (PSQI) following a home sleep recording using respiratory polygraphy. Daytime sleepiness was also self-assessed by using the Epworth sleepiness scale.

Results: Twenty patients with sleep record were included to the analyses. There were 11/20 patients (55%) diagnosed with moderate to severe OSASH. No relationship between OSAHS severity and age as well as body mass index (BMI) was observed. The Epworth sleepiness score was not necessarily high in patients with moderate/severe OSASH. Type of partial laryngectomy did not influence apnea-hypopnea index (AHI) results. There was no difference in terms of age, BMI, gender, type of partial laryngectomy, and the presence of adjuvant radiotherapy between two groups AHI < 15/h and AHI ≥ 15/h.

Conclusion: A sleep study screening for OSAHS should be considered in patients with partial laryngectomy in order to improve their sleep quality and quality of life even though they did not exhibit daily sleepiness and obesity.

KEYWORDS
apnea-hypopnea index, obstructive sleep apnea-hypopnea syndrome, partial laryngectomy, respiratory polygraphy, sleep quality

1 | INTRODUCTION

Sleep disorder is one of the main complaints of cancer patients. Most studies have focused on insomnia and cancer-related fatigue.[1] However, few studies focused on obstructive sleep apnea-hypopnea syndrome (OSAHS) in a small number of patients with head and neck cancer, especially in some after treatment. Head and neck tumors may cause anatomic abnormalities of the upper airway. Treatments including surgery and radiation may further engender airway narrowing and architectural modifications. Moreover, these therapies induced neurosensory dysfunction affecting feedback from the upper airway to the pharyngeal dilatators.[2] Thus, patients with head and neck cancer of the laryngopharynx are at significant risk of OSAHS.[2] Faiz et al, in a series of 56 patients with head and neck cancers, showed a significant sleep-related breathing disorder was noted in 93% of patients, and 84% met clinical criteria for OSAHS.[1]

Other compounding causes for sleep disturbance which is specific to head and neck cancers include pain, depression, nicotine and alcohol use, and xerostomia.[3] Poor impact on sleep due to xerostomia, occurring after radiation therapy, is a common complaint of patients with head and neck cancer. Xerostomia can lead the excessive consumption of liquids resulting in nocturia, frequent arousals, and difficulty in returning to sleep after awakening. Similarly, post-therapeutic swallowing disorders can also result in frequent arousals due to salivary stasis during sleep. Disfiguring surgery and functional loss of upper aerodigestive tract (eating, speaking, and swallowing) may also predispose those patients to depression. Thus, the features of OSAHS in patients with head and neck cancers may be untypical. Since OSAHS without treatment is at risk of high overall mortality, it is recommended conducting a sleep study for patients with unexplained daytime sleepiness.[4] However, for asymptomatic individuals or some with unrecognized symptoms, especially in ones with head and neck cancers, current screening tools cannot be reliable. Thus, seeking anatomical abnormalities of upper airway, which may be predictive factors for OSAHS, should be considered. So, identifying OSAHS in these patients are able to decrease their overall symptom burden.[1]

The larynx that forms the junction between the upper and lower airways contributes also to OSAHS physiopathology.[2] However, the impacts of partial laryngectomy on sleep-disordered breathing are rarely investigated and reported in a small number of patients.[5-7] Laryngeal function preservation surgery modifies the anatomical structure of the pharynx and larynx which may affect the mechanoreceptor pathway and laryngeal sensitivity leading to the occurrence or aggravation of OSAHS.[2] Teleologically, any anatomic/physiologic alterations of the Starling resistor segment of laryngopharynx would have an effect on airway stability/collapsability thus altering Pcrit. Therefore, patients with partial laryngectomy using open approach are at high risk for OSAHS. Unfortunately, sleep quality and OSAHS screening are rarely investigated in routine practice in these patients. The aim of this study was to assess the prevalence of OSAHS in our patients with open conservation partial laryngectomy.

2 | METHOD

Case series were studied in our ENT—head and neck surgery department of the University Hospital of Nancy from November 1, 2018 to June 30, 2020. All patients undergoing partial laryngectomy by using open approach (frontolateral vertical partial laryngectomy (VLP) and supracricoid horizontal partial laryngectomy (SCLP)) for squamous cell carcinoma of the larynx between January 2006 and December 2019 were enrolled in this study. Relevant patients were identified by performing a search on the hospital's computerized database based on coding of medical diagnoses (CIM—10) via our Medical Information Department. The exclusion criteria were the following: tracheotomized patients, the end of treatments less than 3 months, total laryngectomy, patients with active disease or suspected recurrence, partial laryngectomy using exclusive endoscopic approach with or without LASER, patients with diagnosed OSAHS before surgery, and patients refusing to participate in the study. For maximizing the homogeneity of patients according to surgical approach, patients receiving exclusive laser excision were excluded since this approach without opening the thyroid cartilage or sectioning prelaryngeal muscles did not require any reconstructions of the larynx or any pexy as open approaches. The main reason why patients' refusal to participate was the distance from their house to our tertiary hospital. Candidates were offered via telephone to suggest taking part in this study and program a sleep study.

A sleep study was carried out with self-assessments of sleep quality by using the Pittsburgh Sleep Quality Index (PSQI) and a home sleep recording by using respiratory polygraphy (NOX T3 Portable Sleep Monitor; ResMed, San Diego, California). The PSQI ranges from "0" (no difficulty) to "21" (severe difficulties) in all areas of sleep. A global sum of "5" or greater indicates a "poor" sleeper. Daytime sleepiness was also self-assessed by using the Epworth sleepiness scale. If patients had a sleep record after partial laryngectomy but before the onset of this study, their sleep recording reports were retrieved from the doctor who carried out the examination and taken into account for final analyses. However, the self-assessments of sleep quality and daily sleepiness were not retrospectively performed in order to avoid recall bias in these patients.

The recordings were made according to the recommendations of the French Society for Sleep Research and Sleep Medicine. Sleep recordings were analyzed according to the report of the French National Authority for Health in 2014.[8] The total sleep time, the AHI (defined by the number of apnea and/or hypopnea per hour of sleep) and the oxygen desaturation index (ODI, defined by the number of desaturation in oxygen of at least 3% per hour of sleep) were collected. OSAHS was diagnosed in case of AHI equal to 5/h or more. OSAHS severity was defined as mild for AHI between 5 and 15/h, moderate from 15 to 30/h and severe more than 30/h. Management of OSAHS was then performed according to results of sleep recording and the recommendations of the French National Authority for Health in 2014. If the sleep recording time was too short (<4 hours) or there were any technique problems raised during the recording (loss of sensor, defect in the power supply to the polygraph), a new sleep recording was planned. All involved patients gave their informed consent prior to study inclusion. This study was approved by the institutional review board of University Hospital of Nancy, France.

3 | STATISTICAL ANALYSIS

All statistical analyses were performed with SAS version 9.1 (SAS Institute, Inc., Cary, North Carolina). Descriptive statistics for quantitative variables were expressed as mean ± SD and as percentages for qualitative variables. The normality of continuous variables was tested with the Shapiro-Wilk test. Characteristics between groups were compared using the χ^2 for categorical variables and the Wilcoxon-Mann-Whitney test for continuous variables (due to the lack of conditions to perform the parametric tests). A two-tailed value of $P < .05$ was considered statistically significant.

4 | RESULTS

A total of 67 patients underwent a partial laryngectomy with open approach from 2006 to 2019 in our tertiary hospital. Eight patients were dead, 11 (16.4%) were lost to follow-up, 48 (71.6%) were regularly followed up until the studied period. Among these 48 patients, 19 were unreachable despite of phoning at least three times, 9 refused to participate in the study (5 for distance from home to hospital, 2 for "good" self-qualified sleep, and 2 for other medical problems), and 9 had a sleep record before the onset of the study. So, 20 patients with sleep record were included to analyses.

Table 1 presented characteristics of patients having sleep record. Mean age was 66 years old. Mean time from surgery to the sleep study was 4.6 years. Twelve patients (60%) had frontolateral vertical partial laryngectomy (VPL) and 8 (40%) supracricoid horizontal partial laryngectomy (SCPL). Adjuvant radiotherapy was performed in 10 patients (50%). Eleven patients self-assessed their daytime sleepiness using ESS. All ESS were less than 10/24 whereas 5/8 patients fulfilling the PSQI questionnaire had a score > 5 indicating as "poor sleepers". Mean body mass index (BMI) was 26.28 kg/m^2.

Table 2 demonstrated OSAHS severity according to AHI classification. There were 11/20 patients (55%) diagnosed moderate to severe OSASH.

OSAHS severity was divided into two groups (AHI < 15/h not requiring any treatments and AHI ≥ 15/h requiring specific treatments). There were no statistically significant differences between two groups in terms of age, BMI, gender, type of partial laryngectomy, and the presence of adjuvant radiotherapy (Table 3).

TABLE 1 Characteristics of patients

Patient	Gender	Age	BMI	ESS	PSQI	Interval[a]	AHI	ODI	Type of surgery	Adjuvant radiotherapy
1	F	63	23,44			13 years	9	3	VPL	Yes
2	M	73	23,04	7	11	7 years	4	2	VPL	No
3	M	53	27,15			6 months	42	30	SCPL	Yes
4	M	72	27,47			13 years	38	33	VPL	No
5	F	69	31,60	8		3 years	37	27	VPL	No
6	M	65	32,36			1 year	14	13	SCPL	Yes
7	M	54	28,73	9	11	3 months	42	30	VPL	No
8	M	71	35,00	0		2 years	13	12	VPL	No
9	F	70	25,86	5	7	12 years	14	15	VPL	Yes
10	M	64	30,49			3 years	28		VPL	No
11	M	59	31,17			1 year	56	50	VPL	No
12	M	60	20,23	8	17	6 months	31	22	SCPL	Yes
13	M	58	29,63			3 years	35	33	VPL	No
14	M	68	24,74	0	1	3 years	19	19	SCPL	No
15	F	49	14,82	1	3	4 years	6	6	SCPL	Yes
16	M	70	25,22			9 years	7	3,5	SCPL	No
17	M	74	24,73	0	4	1 year	12	8	VPL	Yes
18	M	65	22,53	5	10	9 years	15	12	VPL	Yes
19	M	57	21,47			1 year	60	57	SCPL	Yes
20	F	55	25,97	7		6 years	9	11	SCPL	Yes

Abbreviations: AHI, apnea/hypopnea index; BMI, body mass index (kg/m^2); ESS, Epworth sleepiness scale; ODI, oxygen desaturation index; PSQI, Pittsburgh Sleep Quality Index; SCPL, supracricoid partial laryngectomy; VPL, vertical partial laryngectomy.
[a]Interval from surgery to the sleep study.

TABLE 2 OSAHS severity according to AHI classification

	Total (n = 20)	VPL (n = 12)	SCPL (n = 8)
No	1	1	0
Mild	8	4	4
Moderate	3	2	1
Severe	8	5	3

Abbreviations: SCPL, supracricoid partial laryngectomy; VPL, vertical partial laryngectomy.

TABLE 3 Comparison between two groups with AHI cut-off at 15/h

	AHI		
	<15/h (n = 9)	≥15/h (n = 11)	*P*
Age ± SD, years	65.6 ± 8.6	61.7 ± 6.3	.2
BMI(kg/m²)	25.6 ± 5.7	26.8 ± 4.0	.65
Gender			
Male, n = 15	5	10	.13
Female, n = 5	4	1	
Surgery			
VPL, n = 12	5	7	1
SCPL, n = 8	4	4	
Adjuvant radiotherapy			
No, n = 10	3	7	.37
Yes, n = 10	6	4	

Abbreviations: SCPL, supracricoid partial laryngectomy; VPL, vertical partial laryngectomy.

5 | DISCUSSION

Our findings demonstrated particular characteristics of OSAHS in patients with partial laryngectomy for squamous cell cancer of the larynx as the following: (a) high rate of OSAHS in these patients; (b) No relationships between OSAHS severity and age as well as BMI; (c) High ESS is not necessary in patients with moderate/severe OSASH; and (d) No associations between the types of partial laryngectomy and AHI results.

Although laryngeal origin of OSAHS was reported in patients with partial laryngectomy by Rombaux et al in 2000,[5] no studies were carried out for assessing the prevalence or screening of OSAHS in these patients until now. Nevertheless, these patients having anatomical abnormities predicted for severe OSAHS, for example, upper airway narrowing due to pharyngolaryngeal edema after chemoradiotherapy or scarring sclerosis of larynx after partial laryngectomy. Sleep disorders are often unrecognized by patients and their doctors because they pay essentially attention to the prognosis, the progression of the disease and side effects of treatments. Thus, screening and assessing sleep disorders, especially OSAHS, to improve the quality of sleep and by consequent the quality of life of patients with treated laryngeal cancer play an important role in management of head and neck cancers. In parallel, the treatment of OSAHS may reduce metabolic, cardiovascular complications linked to OSA.

Our findings showed a high rate of OSAHS in patients with partial laryngectomy in comparison to the estimation of the prevalence of French adults aged 30 to 69 years in general population (about 36%).[9] Our results are in line with other studies.[6,7] Israel et al[6] investigated OSAHS in 22 patients with partial laryngectomy for stages I and II squamous cell carcinoma of the larynx. Eleven patients underwent SCPL and 11 with VPL. OSAHS was observed in 10/11 patients with SCPL and 9/11 patients with VPL, in whom apnea/hypopnea index (AHI) ≥ 15 was observed in 5/11 patients with SCPL and in 3/11 patients with VPL.[6] Ouyang et al[7] demonstrated an increase of AHI after tracheotomy decannulation compared with before surgery. The occurrence of OSAHS in patients is due to damage of the supporting structures and architectures of hypopharynx and larynx after surgery leading to collapse easily of the soft tissue of the lower pharynx and larynx during sleep. The role of resected cervical muscles during the open partial laryngectomy procedure in the development of OSAHS after surgery remains unknown. Perhaps the sacrifice of those muscles and ansa cervicalis contributes more to loss of tracheal traction/airway stability. Further studies are necessary to understand the mechanism of OSAHS after open partial laryngectomy. Moreover, it has been demonstrated the feedback loop between laryngeal mechanoreceptors and pharyngeal dilators.[10] The results of Horner et al's study supported that subglottal receptors may contribute to pharyngeal dilator muscle activation.[11] Also, it had been demonstrated that the internal branch of the superior laryngeal nerve plays a role in airway patency during sleep.[2] Thus, partial laryngectomy may alter laryngeal mechanoreceptors and their role in airway stability. On the other hand, the proliferation of mucosa[7] or massive thickening of the arytenoid mucosa[5] observed during laryngoscopy after surgery may cause the obstruction of the entrance of the larynx leading to the occurrence of OSAHS. These abnormalities can be recognized by routine flexible fiberoptic laryngoscopy performed in awake patients that may help to detect some predictors of OSAHS.[12]

Other particularity of OSAHS in these patients is a low score of ESS. Our findings are similar of data published by Ouyang et al.[7] However, the high PSQI in these ones indicates poor sleepers. Thus, ESS is not a reliable tool to recommend performing sleep record in patients with partial laryngectomy. The low score of the ESS reported by these patients may be explained that they are accustomed to this chronic condition since fatigue is often overlooked or considered "normal" and acceptable[13] and that the oncologic outcomes were their main concerns. Sleepiness and intermittent hypoxemia are two factors at risk of cardiovascular diseases in patients with OSAHS. The majority of these patients seem to be not sleepy but they had a high oxygen desaturation index in case of moderate/severe OSAHS. Thus, the treatment of OSAHS in these patients may reduce cardiovascular risks. However, it has been showed that patients without sleepiness had often poor compliance. Hence, the risks of OSAHS have to be well-informed with a close follow-up of treatment in these patients to maximize the compliance rate. This would require follow-up studies to determine if active management improves patient outcomes.

Interestingly, there was no relationship between BMI and AHI in these patients. The strong association between OSAHS and obesity is known. In patients with partial laryngectomy, the origin of OSAHS is, however, due to modified anatomical and structural pharynx and larynx. Unfortunately, data on the weight status were displayed in only some patients before surgery because obese and overweight patients may suffer from pre-operative OSAHS. And the fat morphology of the neck can cause difficult endoscopic exposure leading to open partial laryngectomy approaches.

The principal limitation of this study was a restricted number of patients; non-significant results may be due to this issue. Thus, the results were required to interpret cautiously. The study shows that patients with open partial laryngectomy are at high risk of having OSAHS. Other limitation was that sleep recording was performed by using ventilator polygraphy which underestimated AHI. However, this is a useful tool to screen OSAHS. Unknown preoperative OSAHS status and other sleep-disordered breathing are also limitations of our study. This study could, however, be a harbinger to plan a well-designed prospective study with a large number of patients undergoing sleep study before and after the surgery to determine the prevalence of OSAHS in post partial laryngectomy.

6 | CONCLUSION

Sleep study, especially OSAHS screening, needs regarding in patients with partial laryngectomy to improve their sleep quality and quality of life even though they did not exhibit daily sleepiness and obesity.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

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REFERENCES

1. Faiz SA, Balachandran D, Hessel AC, et al. Sleep-related breathing disorders in patients with tumors in the head and neck region. *Oncologist*. 2014;19(11):1200-1206.
2. Dedhia RC, Rosen CA, Soose RJ. What is the role of the larynx in adult obstructive sleep apnea? *Laryngoscope*. 2014;124(4):1029-1034.Review.
3. Shuman AG, Duffy SA, Ronis DL, et al. Predictors of poor sleep quality among head and neck cancer patients. *Laryngoscope*. 2010;120(6):1166-1172.
4. Jonas DE, Amick HR, Feltner C, et al. Screening for obstructive sleep apnea in adults: evidence report and systematic review for the US preventive services task force. *JAMA*. 2017;317(4):415-433.
5. Rombaux P, Hamoir M, Plouin-Gaudon I, Liistro G, Aubert G, Rodenstein D. Obstructive sleep apnea syndrome after reconstructive laryngectomy for glottic carcinoma. *Eur Arch Otorhinolaryngol*. 2000;257(9):502-506.
6. Israel Y, Cervantes O, Abrahão M, et al. Obstructive sleep apnea in patients undergoing supracricoid horizontal or frontolateral vertical partial laryngectomy. *Otolaryngol Head Neck Surg*. 2006;135(6):911-916.
7. Ouyang L, Yi L, Wang L, Tang Q, Yang X, Li S. Obstructive sleep apnea in patients with laryngeal cancer after supracricoid or vertical partial laryngectomy. *J Otolaryngol Head Neck Surg*. 2019;48:26.
8. Haute Autorité de Santé. *Évaluation clinique et économique des dispositifs médicaux et prestations associées pour prise en charge du syndrome d'apnées hypopnées obstructives du sommeil (SAHOS). Révision de catégories homogènes de dispositifs médicaux—Volet médico-technique et évaluation économique*. Saint-Denis La Plaine: HAS; 2014.
9. Benjafield AV, Ayas NT, Eastwood PR, et al. Estimation of the global prevalence and burden of obstructive sleep apnoea: a literature-based analysis. *Lancet Respir Med*. 2019;7(8):687-698.
10. White DP. Pathogenesis of obstructive and central sleep apnea. *Am J Respir Crit Care Med*. 2005;172:1363-1370.
11. Horner RL, Innes JA, Holden HB, Guz A. Afferent pathway(s) for pharyngeal dilator reflex to negative pressure in man: a study using upper airway anaesthesia. *J Physiol*. 1991;436:31-44.
12. Bolzer A, Toussaint B, Rumeau C, Gallet P, Jankowski R, Nguyen DT. Can anatomical assessment of hypopharyngolarynx in awake patients predict obstructive sleep apnea? *Laryngoscope*. 2019;129:2782-2788.
13. Qian W, Haight J, Poon I, et al. Sleep apnea in patients with oral cavity and oropharyngeal cancer after surgery and chemoradiation therapy. *Otolaryngol Head Neck Surg*. 2010;143:248-252.

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