Impact of radiotherapy for head and neck cancer on obstructive sleep apnea: a prospective study

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Background: In recent years, a relatively high prevalence of obstructive sleep apnea (OSA) in patients following radiotherapy (RT) for head and neck cancer (HNC) has been reported; however, little is known regarding the impact of RT on sleep disorders and the underlying mechanisms. This aim of this study was to elucidate the pathogenesis of OSA by comparing the clinical and sleep test parameters and magnetic resonance imaging (MRI) findings before and after HNC treatment with radiation.

Methods: This prospective study included patients scheduled for RT with or without chemotherapy or bioradiotherapy for HNC. Patients diagnosed with HNC between May 2017 and August 2020 were consecutively recruited. The results of the sleep tests were analyzed both before and after treatment. The clinical characteristics of the patients and cephalometric and MRI parameters were also measured.

Results: First, a total of 32 patients (64.8±11.8 years old; BMI, 22.7±3.6 kg/m^2) underwent pre-treatment sleep tests. The prevalence of OSA [apnea hypopnea index (AHI) ≥5] in these patients was 81.3% (26 patients) before treatment, and the mean AHI was 20.8±19.0 events/hr. Next, 21 patients performed a sleep test both before and after treatment. Regarding subjective symptoms, there were no significant differences in the Epworth Sleepiness Scale (ESS) (P=0.142) or Pittsburgh Sleep Quality Index (PSQI) (P=0.935) after treatment; however, the BMI and neck circumference significantly decreased after treatment (P<0.0001 and P=0.0001, respectively). The incidence of OSA in these patients was 81.0% (17 patients) before treatment and 85.7% (19 patients) after treatment (P=1.0). Overall, the AHI was not significantly different, changing only from 14.5 to 14.9 after treatment (P=0.147). The MRI parameters showed that the retroglossal pharyngeal area increased significantly after treatment (P=0.007).

Conclusions: This study found that the prevalence of OSA before and after RT for HNC was higher than that in the normal population, despite a significant decrease in BMI and increase in the retroglossal pharyngeal area after treatment. We suggest that physicians who manage patients with HNC should consider the occurrence of OSA before and after treatment.

Keywords: Radiotherapy; head and neck cancer (HNC); obstructive sleep apnea (OSA); magnetic resonance imaging (MRI)

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Introduction

Obstructive sleep apnea (OSA) is a breathing disorder characterized by the repetitive collapse of the pharyngeal airway during sleep, leading to sleep fragmentation and oxygen desaturation. Risk factors for OSA in adults include aging, male gender, obesity, menopause, upper airway anatomy, and craniofacial abnormalities. Furthermore, OSA is an independent risk factor for hypertension, stroke, congestive heart failure, and coronary artery disease, and can thus induce significant morbidity and mortality (1-4).

The prevalence of upper airway tumors and cysts among patients complaining of snoring was 0.24% in a multi-center study (5). The prevalence of OSA with head and neck cancer (HNC) in the upper airway was reported to be 76% in oral cavity, oropharyngeal cancer and 72% in nasopharyngeal cancer (6,7). Because the head and neck areas are important for quality of life (QOL), by regulating functions such as swallowing and respiratory function, the definitive treatment of HNC requires a balance between cure and maintenance of QOL (8). The QOL of patients is considered a priority in the management and survival rate of HNC. For example, total laryngectomy or laryngopharyngectomy are standard procedures for advanced cancers of the larynx and/or hypopharynx, resulting in permanent tracheostomy and potential difficulties with speech and communication. Therefore, definitive radiation therapy (RT) alone, induction chemotherapy, and chemoradiotherapy (CRT) are considered necessary for organ preservation, and are mainstays of locally advanced HNC, but these combined radiation treatments can have serious side effects (9-11). We previously reported a case of severe OSA diagnosed and treated with continuous positive airway pressure (CPAP) after concurrent chemoradiotherapy (CRT) for laryngeal and hypopharyngeal cancer (12). Some authors have previously reported a relatively high prevalence of OSA in patients following RT for HNC, but little is known about the impact of such treatment on sleep disorders and their underlying mechanisms (13,14). To the best of our knowledge, most relevant studies to date have assessed only post-treatment OSA incidence (7,13,15-18). Furthermore, whether there is an association between RT-induced changes in pharyngeal morphology and OSA prevalence remains unknown.

The purpose of this prospective study was to elucidate the pathogenesis of OSA by comparing clinical and sleep test parameters and magnetic resonance imaging (MRI) findings before and after HNC treatment with radiation. The following article was performed in accordance with the STROBE reporting checklist (available at https://apm.amegroups.com/article/view/10.21037/apm-22-267/rc).

Methods

Patients

A prospective study was conducted on consecutive patients diagnosed with HNC at Juntendo University Hospital or Juntendo Urayasu Hospital between May 2017 and August 2020.

Patients with nasopharyngeal, oropharyngeal, hypopharyngeal, and laryngeal cancers were included in the study. Definitive treatments included RT alone, CRT, bioradiotherapy (BRT), and super-selective intra-arterial concurrent chemoradiotherapy (IA-CRT). Almost all of the patients were treated with a radiation dose of 70 Gy in 35 fractions, except one who underwent IA-CRT with a radiation dose of 60 Gy in 30 fractions. The dose was fractionated into 2 Gy per day (five days/week). The exclusion criteria were as follows: (I) age <20 years; (II) treatment for sleep-disordered breathing, including use of oral appliances, CPAP therapy, and upper airway surgery prior to the sleep study; (III) history of surgery for HNC and/or planned adjuvant therapy; (IV) history of severe basic lung disease or neuromuscular disease; (V) presence of unknown untreated neoplasms other than HNC; and (VI) presence of distant metastases.

The Sleepiness Scale (ESS) and Pittsburgh Sleep Quality Index (PSQI) were applied both before and after treatment to evaluate subjective symptoms (19,20). Excessive daytime sleepiness was measured using the ESS, and scores of 11 and above were considered excessive daytime sleepiness. To measure subjective sleep quality, the PSQI, a self-administered questionnaire widely used to evaluate sleep quality, was also applied during the previous month.

This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013), and was approved by the Ethics Committee of Juntendo University
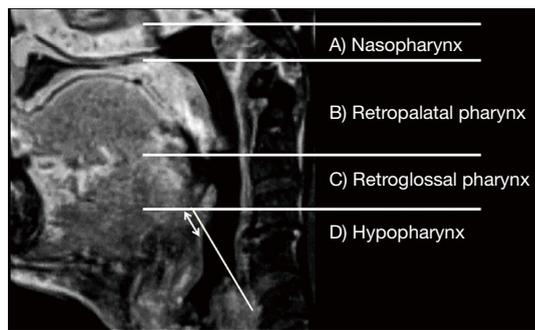
Figure 1 Magnetic Resonance Image findings. Midsagittal Magnetic Resonance Image from the representative subject of laryngeal cancer after RT. Components of the upper airway are denoted. (A) Nasopharynx is the region from the nasal turbinates to the superior part of the soft palate. (B) Retropalatal pharynx is the region from the level of the hard palate to the caudal margin of the soft palate. (C) Retroglossal pharynx is the region from the caudal margin of the soft palate to the base of epiglottis. (D) Hypopharynx is the area from the base of epiglottis to larynx (to the straight line from the entrance of the esophageal orifice to the base of the epiglottis). Double arrow: the width of the epiglottis is the length measured the distance on a straight line from the entrance of the esophageal orifice to the base of the epiglottis.

Faculty of Medicine (# 17-004). Informed consent was obtained from all patients.

Sleep study

The patients underwent overnight polysomnography (PSG) (Alice PDX; Philips Respironics, USA) or a portable sleep-testing device [WatchPat 200 (WP); Itamar Medical Ltd., Israel], supervised by sleep specialists, before and after treatment with HNC. First, all patients were suggested to undergo PSG. WP was performed when the patient did not consent to PSG. Each patient had the same device during the sleep tests, both before and after treatment. Pre-treatment sleep tests, both PSG and WP, were performed on the day before the first day of treatment in our otolaryngology, head, and neck ward. For post-treatment tests, only those who gave consent and had a sleep test during hospitalization were included. Based on our past experience, post-treatment tests were performed 2 months after starting the treatment (12). The results of the sleep test, including apnea-hypopnea index (AHI), lowest oxygen saturation (SO_2), the time of SO_2 less than 90% during sleep (SO_2 <90%), and oxygen desaturation index (ODI), were

evaluated. AHI was defined as the total number of apneas and hypopneas per hour of sleep, while OSA was defined as an AHI greater than five events per hour of sleep, of which ≥50% were obstructive in nature. The severity of OSA was determined as follows: 5≤ AHI <15, mild; 15≤ AHI <30, moderate; and 30≤ AHI as severe (21,22). The lowest SO_2 and the time during which SO_2 <90% were determined using a pulseoxymeter. ODI was defined as 4%ODI, as WP is scored at 4%ODI according to the rules of American Academy of Sleep Medicine by automatic analysis, and the same as PSG in order to match the conditions (23). The PSG analysis was performed by experienced technicians according to the AASM standard scoring rules (23). For WP data, AHI, lowest SO_2, the time of SO_2 <90%, and 4%ODI were analyzed automatically (zzzPAT ver.4.4.65.3). The 4%ODI is defined as a decrease in oxygen saturation exceeding 4% from the preceding baseline, and is the total number of oxygen desaturation events divided by the total monitoring time in hours. The interaction between AHI in PSG and WP was examined using a univariate general linear model (IBM SPSS Statistics; SPSS Inc., USA).

Cephalometric study

A lateral cephalometric radiograph was obtained in the upright position with natural head posture as part of the routine clinical evaluation (DRX-61A; Toshiba, Japan). The exposure parameters were arranged to clearly visualize bony landmarks before processing using an image-processing program (ImageJ; National Institutes of Health, USA). Blind analyses were performed by a single investigator (N.S.). As illustrated in *Figure 1*, the following seven cephalometric variables were measured to map craniofacial skeletal and soft tissue morphology, as described in previous reports (24-26).

MRI

The laryngopharyngeal structures of the patients were evaluated using MRI in the midsagittal plane, before and after treatment. 3D T1-weighted images were acquired using a 3D turbo-field echo sequence, post-contrast with fat-saturation [repetition time (TR)/echo time (TE), 4.6–6.5/1.96–2.02 ms; flip angle, 15°; field of view (FOV), 300 mm], with a 1-mm thickness. A midline image in the sagittal plane was used for measurement. MRI examinations were performed before the start of treatment and two months after the end of RT. During scanning, the patients
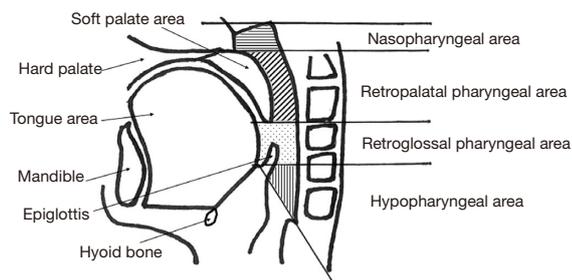
Figure 2 Schematic illustration with some anatomical landmarks. The labeled area and pointed area were denoted with arrows and were measured in this study. Nasopharyngeal area (the horizontal hatched area from the nasal turbinates to the superior part of the soft palate), retropalatal pharyngeal area (the slashed area from the level of the hard palate to the caudal margin of the soft palate), retroglossal pharyngeal area (the botted area from the caudal margin of the soft palate to the base of epiglottis) and hypopharyngeal area (the vertical hatched area from the base of epiglottis to the line from the entrance of the esophageal orifice to the base of the epiglottis) were defined. Soft palate and tongue area which are denoted with arrows were also defined.

were placed in a supine position with their heads fixed in the neutral position in a holding frame, maintained calm breathing, and did not swallow. The blind analysis was performed by a single investigator. Each measurement was performed five times, and the median of the five measurements was used for the final analyses. We mapped the morphology of the pharyngeal structure using slight modifications of previously defined techniques (*Figure 2*) (27-29).

Statistical analysis

All statistical analyses were performed using EZR (The R Foundation for Statistical Computing, Austria) (30). Paired *t*-test was used for normally distributed continuous variables, and the Wilcoxon signed-rank test was used for non-normally distributed continuous variables. A value of P<0.05 was considered statistically significant. All values are shown as mean ± SD or median (interquartile range), unless indicated otherwise. No missing data were observed in this study.

Results

Overall, 32 patients with HNC were included. Of these, 21 patients consented to post-tests (2 underwent RT only, 17 underwent CRT, 1 underwent BRT, and 1 underwent

Table 1 Characteristics of the patients and subjective symptoms and sleep data

Variable	Value
Age, years	64.9±11.8
Sex	Male: 31 (96.9%), female: 1 (3.1%)
Medical history, No. (%)	13 (40.5)
Hypertension	13 (40.5)
Diabetes mellitus	7 (21.9)
Heart disease	4 (12.5)
Lung disease	2 (6.3)
Tumor location, No. (%)	
Nasopharynx	7 (21.9)
Oropharynx	4 (12.5)
Hypopharynx	14 (43.8)
Larynx	7 (21.9)
BMI, kg/m^2	22.7±3.6
Neck circumference, cm	34.4±2.6
Sleep data	
OSA (AHI ≥ 5), No. (%)	26 (81.3)
AHI, events/h	20.8±19.0
Minimum SO$_2$, %	86.8±6.5
SO$_2$ <90%, min	6.6±15.7
ESS score	5.2±3.4
PSQI score	6.3±4.0

N=32. Values are expressed as mean ± SD or number (percentage). BMI, body mass index; OSA, obstructive sleep apnea; AHI, apnea hypopnea index; SO$_2$, oxygen saturation; ESS, Epworth sleepiness scale; PSQI, Pittsburgh Sleep Quality Index.

IA-CRT). The 11 patients who declined to undergo post-treatment sleep tests did so for the following reasons: (I) the first sleep test was more painful and uncomfortable than expected; and (II) severe side effects of radiation therapy, such as sore throat and dermatitis. The AHI interaction between PSG and WP was not significant (P=0.949), indicating that AHI did not differ according to the sleep test device.

Overall, 32 patients underwent pre-treatment sleep tests to assess potential SDB. The clinical characteristics of the patients and the subjective and objective data before treatment are shown in *Table 1*. The prevalence of OSA in

Table 2 Characteristics of the patients, comparison of subjective symptoms pre- and post- treatment

Variable	Sleep test	Pre-treatment	Post-treatment	P value
Age, years		62.2±12.7		
Sex		Male: 20, female: 1		
Tumor location, No. (%)				
Nasopharynx		7 (33.3)		
Oropharynx		4 (19.0)		
Hypopharynx		6 (28.6)		
Larynx		4 (19.0)		
BMI, kg/m^2	All (N=21)	22.4±4.0	20.2±3.4	<0.0001
	PSG (N=9)	23.2±5.1	20.9±4.6	0.0028
	WP (N=12)	21.9±3.3	19.7±2.3	0.0001
Neck circumference, cm	All (N=21)	38.1±2.6	36.8±2.7	0.0001
	PSG (N=9)	37.9±2.9	36.5±3.2	0.00997
	WP (N=12)	38.3±2.5	37.1±2.2	0.0068
ESS score	All (N=21)	5.6±3.4	6.7±3.7	0.142
	PSG (N=9)	6.1±4.2	7.3±4.9	0.217
	WP (N=12)	5.0±2.5	6.2±2.6	0.304
PSQI score	All (N=21)	6.0±4.1	6.3±3.8	0.935
	PSG (N=9)	7.3±4.3	6.5±3.5	0.436
	WP (N=12)	4.5±3.5	6.2±4.2	0.178

N=21. Values are expressed as mean ± SD or number (percentage). PSG, polysomnography; WP, WatchPAT200; BMI, body mass index; ESS, Epworth sleepiness scale; PSQI, Pittsburgh Sleep Quality Index.

pre-treatment HNC was 81.3% (26 patients) and the mean AHI was 20.8±19.0 events/hr (AHI in PSG was 28.2±21.9, AHI in WP was 11.3±7.7).

Later, 21 patients with HNC underwent a sleep test before and after treatment (*Table 2*). Among them, two underwent RT only, 17 underwent CRT, one underwent BRT, and one underwent IA-CRT. Although almost all patients had a complete response (CR) on post-treatment evaluation, one patient with nasopharyngeal cancer (cT4N2M0) had progressive disease (PD) with multiple metastases and had additionally started a molecular targeted drug. For subjective symptoms, there were no significant differences in the ESS (P=0.142) and PSQI (P=0.935) before and after treatment. BMI (P<0.0001) and neck circumference (P=0.0001) significantly decreased after treatment.

The sleep data of the pre- and post-treatment are presented in *Table 3*. The incidence of OSA in these patients was 81.0% (17 patients) before treatment and 85.7% (18 patients) after treatment (P=1.0). Regarding changes in the severity of OSA after treatment of HNC, patients with mild OSA increased from 33.3% to 38.1%, those with moderate OSA decreased from 28.6% to 19.0%, and those with severe OSA increased from 19.0% to 28.6%. There was no significant difference in OSA severity before and after treatment (P=0.064). AHI was increased in 57.1% of the patients (12 patients of the 21 patients, 4 with nasopharyngeal cancer, 1 with oropharyngeal cancer, 5 with hypopharyngeal cancer, 2 with laryngeal cancer) (P=0.327). Overall, the AHI was not significantly altered (from 14.5 to 14.9) after treatment (P=0.147). Similar results of AHI, 4%ODI, and minimum SO$_2$ were obtained for each device. Severe OSA after treatment with CPAP indicated that two patients had accepted CPAP.

Cephalometric parameters are listed in *Table 4*. Cephalometric data showed results similar to those of

Table 3 Sleep data of the patients pre- and post-treatment

Variable	Sleep test	Pre-treatment, No. (%)	Post-treatment, No. (%)	P value
Severity of OSA		17 (81.0)	18 (85.7)	1.0
Non OSA		4 (19.0)	3 (14.3)	0.064
Mild to moderate		13 (61.9)	12 (57.1)	
Severe		4 (19.0)	6 (28.6)	
AHI, events/h	All (N=21)	14.5 (17.3)	14.9 (31.4)	0.147
	PSG (N=9)	21.2 (36.0)	20.6 (60.2)	0.359
	WP (N=12)	10.8 (12.2)	14.5 (21.2)	0.380
4%ODI, events/h	All (N=21)	5.0 (10.4)	4.8 (19.8)	0.191
	PSG (N=9)	5.9 (19.1)	9.8 (35.6)	0.359
	WP (N=12)	4.1 (7.4)	4.4 (11.7)	0.410
Minimum SO_2, %	All (N=21)	89.0 (7.0)	86.0 (8.5)	0.162
	PSG (N=9)	85.0 (12.0)	85.0 (12.0)	0.799
	WP (N=12)	90.0 (6.5)	86.5 (5.5)	0.13
SO_2 <90%, min	All (N=21)	0.1 (6.4)	0.4 (7.3)	0.398
	PSG (N=9)	1.4 (33.9)	0.8 (13.1)	1.0
	WP (N=12)	0.0 (1.3)	0.2 (2.1)	0.202

N=21. Values are expressed as number (percentage). OSA, obstructive sleep apnea; PSG, polysomnography; WP, WatchPAT200; AHI, apnea hypopnea index; ODI, oxygen desaturation index; SO_2, oxygen saturation.

Table 4 Cephalometric parameters

Measurement	Mean ± SD
SNA, °	82.05±4.98
SNB, °	77.64±3.34
ANB, °	4.41±2.63
Facial axis angle, °	88.05±3.7
PNS-P, mm	43.62±4.94
MP-H, mm	12.93±6.75
IAS, mm	10.92±3.46

SNA, angle formed between the line SN to point "A"; SNB, angle formed between the line SN to point "B"; ANB, difference between SNA and SNB; PNS-P, length of uvula; MP-H, distance from mandibular plane to hyoid bone; IAS, positive airway space.

previous reports on skeletal morphology in the general Japanese population (26,31).

The results of the MRI parameters are listed in *Table 5*. In the midsagittal plane, the retroglossal pharyngeal area significantly increased after treatment (P=0.007). There were no statistical differences in nasopharyngeal, retropalatal, hypopharyngeal, tongue, soft palate, or epiglottis widths. Although the difference was not statistically significant, the nasopharyngeal and retropalatal areas tended to increase, and the retroglossal pharyngeal area was substantially larger than the pharyngeal morphology before treatment. Furthermore, the hypopharyngeal area tended to be smaller (P=0.071), and the width of the epiglottis tended to increase (P=0.074), although this difference was not statistically significant.

Discussion

The present study revealed several novel and interesting observations concerning the relationship between OSA and HNC patients treated with RT. First, we found that, in untreated patients with HNC, the presence of OSA was high (81.3%), while the severity of OSA showed a wide range (mean AHI 20.8±19.0 events/hr). Second, in RT-treated patients, despite a significant decrease in the BMI

Table 5 MRI findings of pre- and post- treatment in sagittal section

Parameter	Pre-treatment	Post-treatment	P value
Nasopharyngeal area, mm^2	161.05±64.70	198.60±58.85	0.102
Retropalatal pharyngeal area, mm^2	333.66±53.29	345.44±78.58	0.558
Retroglossal pharyngeal area, mm^2	225.80±144.38	274.42±141.20	0.007
Hypopharyngeal area, mm^2	125.65±18.75	113.53±21.50	0.071
Tongue area, mm^2	2,876.86±418.11	2,791.41±312.18	0.201
Soft palate area, mm^2	374.55±72.51	370.47±77.79	0.752
Width of the epiglottis, mm	6.95±1.99	8.03±1.99	0.074

Values are expressed as mean ± SD.

and neck circumference, the presence of OSA increased from 81.0% to 85.7%. Third, patients who underwent RT in MRI imaging, the nasopharyngeal and retropalatal areas tended to have expanded, especially the retroglossal pharyngeal area, which was significantly larger than the pharyngeal morphology before treatment. Furthermore, the hypopharyngeal area tended to be smaller and the width of the epiglottis tended to increase.

The prevalence of OSA in the general middle-aged population has been estimated to be 4% in men and 2% in women (4). Upper airway abnormalities, such as tumors in the head and neck region, are common risk factors for OSA in adults (4,32). OSA can induce significant morbidity and mortality, and has been associated with severe daytime hypersomnolence and cardiovascular complications, including systemic hypertension, cardiac arrhythmias, and automobile accidents (33,34). Among patients complaining of snoring, 2.4 in 1,000 were found to have upper airway tumors, or cysts such as nasopharyngeal cancer in a multi-center research (5). Further, OSA with cancer in the upper airway has been reported to occur in 76% (13 of 17) of patients with cancer in the oral cavity and oropharynx, and in 72% (13 of 18) of patients with nasopharyngeal cancer. This was diagnosed by PSG in pre-treated patients with HNC (6,7). In our study, we found that the prevalence of OSA was high, at 81.25% (26 of 32 patients) in pre-treatment patients with pharyngeal and/or laryngeal cancer, which agrees with previous reports. The identification of OSA prior to treatment for HNC may be an important factor in improving quality of life after cancer therapy.

Our results showed that post-treatment patients with HNC had a much higher incidence of OSA (67%) compared to the normal population of middle-aged adults (2–4%) (4,35). Concerning the prevalence of OSA after

radiation therapy for HNC, Friedman reported that all patients who received radiation therapy for pharyngeal or laryngeal cancer had OSA (35). Huyett found that 16 patients with a history of RT for oropharyngeal or laryngeal cancer completed a home sleep test, and half of the patients had OSA (13). Comparing our results with those of the normal population, we noticed a higher percentage of OSA, as found in previous reports on post-RT patients.

Furthermore, our results suggest that residual OSA may persist despite the disappearance of upper airway tumors after treatment. Excluding our report, only one study has so far specifically addressed HNC with OSA before and after RT in nasopharyngeal carcinoma, which targeted patients with nasopharyngeal cancer (7). In their study, AHI did not change significantly after treatment. These results were consistent with our study, which enrolled patients with cancer in all areas of the pharynx and larynx. We found that AHI did not significantly change after treatment, although it worsened somewhat in 12 of 21 patients (57.1%), and improved slightly in 9 of 21 patients (42.9%).

RT, such as CRT, for advanced carcinoma of the pharynx and larynx can reduce the need for surgical procedures, and is becoming a standard therapy to enable larynx preservation in patients with HNC (9,36). However, the disadvantages of irradiation, such as dry mouth, mucositis with sores, and difficulty in swallowing should be considered (12). Increased BMI and neck circumference have been reported to be important risk factors for OSA in the general population, whereas sleep apnea and hypoxia tend to improve after weight loss (37,38). In contrast to general OSA patients, most of our patients were not obese before HNC treatment (BMI <30 in 96.9%). Furthermore, BMI and neck circumference after treatment were significantly decreased compared to the pre-treatment values. Sore throat due

to RT and nausea due to chemotherapy can both be considered as causes of weight loss. Upper airway narrowing due to pharyngeal edema is also common in HNC patients treated with RT (39,40). Mucosal edema after RT is a major radiation-induced side effect, and is generally represented as a thickened epiglottis on MRI (41). The predominant factor in patients with worsening OSA after RT is assumed to be reduced function and control of the pharyngeal dilator muscle, which may affect upper airway compliance and resistance and predispose individuals to OSA (7,14,16,35). In addition to edema of the upper airway after CRT, xerostomia and dysphagia are known to have adverse effects (39,40). Piccin *et al.* reported that the site of upper airway obstruction after treatment with HNC was the level of the larynx (15). In our study, the MRI findings showed that the width of the epiglottis tended to increase, although not significantly. Furthermore, the area of the upper airway, especially the retroglossal pharyngeal region, which is generally the main site of obstruction in OSA, was significantly larger than that before pre-treatment (27,42). The cause of this significant increase in the area may include weight loss and a decrease in neck circumference. Craniofacial anatomy is another factor associated with OSA. Non-obese patients with OSA have more disadvantageous cephalometric findings related to upper airway obstruction than obese patients (43). Regarding the cephalometric measurements in our patients, our case suggests that adverse cephalometric findings are less likely to be associated with OSA etiology.

Considering the results of this, the reason that 85.7% of residual OSA in post-treatment despite having a wider pharyngeal morphology is considered by dry mouth, dysphagia, and laryngeal dysfunction with irradiation (12,39,40). Consequently, laryngeal function might have decreased, and residual OSA was revealed after treatment.

This study had several limitations. First, bias may have been introduced because of diversity in population heterogeneity, OSA risk factors, different tumor locations, and the pathophysiology of HNC, including T stage and N stage. Variability in radiation and chemotherapy regimens was also a potential confounder. Second, the sample size was small because of the difficulty in obtaining consent for sleep tests, especially PSG, due to physical and mental distress. For this reason, two types of sleep test were conducted. Third, the follow-up period was limited to two months, and the patients were evaluated only in the acute phase after treatment. This should also be considered in the late phase. Finally, the functional site of the obstruction is unclear.

Swallowing videoendoscopy and/or videofluorography are therefore required.

To the best of our knowledge, the present study is the first to show the pathophysiology of OSA with cancer in all areas of the pharynx and larynx, which were evaluated both before and after treatment, including irradiation. However, since the management of OSA after RT is not mentioned in the standard care of the NCCN guidelines, management of OSA may be an important factor in improving the quality of life of patients with HNC. Routine screening for OSA is important to improve the QOL of patients with advanced HNC.

Conclusions

This study found a higher prevalence of OSA both before and after radiation combined therapy for HNC compared to the normal population, even though our patients were not obese. Furthermore, AHI did not change despite a significant decrease in BMI after treatment. MRI revealed no significant narrowing of the airway. Therefore, we suggest that patients with HNC should be assessed for OSA. Early identification and treatment of OSA are important for the comprehensive management of patients with HNC.

Acknowledgments

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://apm.amegroups.com/article/view/10.21037/apm-22-267/rc

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013), and was approved by the Ethics Committee of Juntendo University Faculty of Medicine (# 17-004). Informed consent was obtained from all patients.

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