REVIEW ARTICLE

ANZJSurg.com

Scoping review of head and neck neoplasms presenting with obstructive sleep apnoea: the importance of flexible nasendoscopy

Phillip Moore ,* Felipe Cardemil,†‡ Nathan J. Hayward§ and Samuel Flatman *

*Division of Cancer Surgery, Peter MacCallum Cancer Centre, Melbourne, Victoria, Australia
†Department of Otolaryngology, University of Chile, Santiago, Chile
‡Department of Otolaryngology, Clinica Las Condes, Santiago, Chile and
§Department of Otolaryngology, Monash Health, Melbourne, Victoria, Australia

Key words
head and neck cancer, nasendoscopy, neoplasm, obstructive sleep apnoea.

Correspondence
Dr Phillip Moore, Peter MacCallum Cancer Centre, 305 Grattan Street, Melbourne, VIC 3000, Australia. Email: philljmoore@gmail.com

P. Moore BSc (Hons), MD; **F. Cardemil** MD, PhD; **N. J. Hayward** MBBS, FRACS; **S. Flatman** MBBS, FRACS.

Material included in this manuscript has been accepted for oral presentation at the 2020 Royal Australasian College of Surgeons Annual Surgical Congress.

Accepted for publication 27 May 2020.

doi: 10.1111/ans.16090

Abstract

Background: Obstructive sleep apnoea (OSA) can be caused by neoplasms involving the upper aerodigestive tract. Currently, many of these patients have this diagnosis missed, as most adults diagnosed with OSA do not undergo adequate head and neck examination including flexible nasendoscopy. We performed a review of the literature to shed light on this phenomenon and outline the pathologies and issues surrounding this sub-population of patients diagnosed with OSA.

Methods: A scoping review of the literature was conducted on head and neck neoplasms presenting with OSA. Data were extracted on demographics, clinical presentation, histopathology, treatment and patient outcomes.

Results: Sixty-seven articles were included, describing 79 patients. Mean age was 45.8 years, and 77.2% were male. Symptoms of OSA were present for an average of 29.2 months before a diagnosis of causative neoplasm was made. Forty-two different benign and malignant histopathological entities were reported. At diagnosis, the causative pathology of 100% of patients was visible on head and neck examination including flexible nasendoscopy, while only 53.2% were visible on trans-oral examination. One-third of patients had commenced inappropriate treatment for OSA, including three who had undergone sleep surgical procedures. The majority of patients were treated with surgery alone (72.2%).

Conclusion: Although rare, neoplasms of the upper aerodigestive tract should be considered as a cause of OSA, especially in patients experiencing other symptoms in addition to the typical symptoms of OSA. They should particularly be considered in patients with comparatively lower body mass index or those with worsening OSA without an apparent cause identified.

Introduction

Obstructive sleep apnoea (OSA) is a chronic disease characterized by frequent collapse of the upper airway while asleep, resulting in snoring, apnoeic periods, intermittent hypoxia and recurrent arousals. The worldwide adult prevalence of OSA with associated daytime somnolence is estimated to be 3–7% for males and 2–5% for females.[1] Untreated moderate or severe OSA is a risk factor for hypertension, ischaemic heart disease, cardiac arrhythmias, stroke, type 2 diabetes mellitus[2–4] and major psychiatric illness,[5,6] and can greatly affect the quality of life. When adult patients present with symptoms of OSA, current practice is to investigate with diagnostic polysomnography (PSG) and delineate the severity and associated health risks of OSA. Treatment is tailored to each individual based on clinical risk and symptoms, and may involve a combination of lifestyle measures, oral appliances, continuous positive airway pressure (CPAP) or multilevel airway surgery.

Current international guidelines on the assessment and treatment of patients with OSA do not include recommendations for routine examination with flexible nasendoscopy (FNE).[7] FNE is a quick, cheap and effective procedure to examine the upper airway to the level of the subglottis. It is performed in awake patients in the office without the need for general anaesthetic. FNE is frequently used by otolaryngology head and neck surgeons to identify

generators of airway collapse, planes of collapse and exclude other pathological entities in patients with OSA.

Multiple anatomical sites and subsites that can be affected by neoplasms occurring in the head and neck are identified within internationally accepted guidelines.[8]This includes the nasal cavity and paranasal sinuses, oral cavity, pharynx (nasopharynx, oropharynx and hypopharynx), larynx (supraglottis, glottis and subglottis), major salivary glands and thyroid, with many different benign and malignant pathologies. Neoplasms in any of these locations, or involving the parapharyngeal or retropharyngeal space, can narrow or compromise the upper aerodigestive tract and lead to obstruction, mimicking the symptoms of OSA. Many of these neoplasms cannot be seen on transoral examination, nor are apparent on palpation of the neck (Fig. 1). In particular, these neoplasms may be more difficult to identify on examination in overweight or obese patients in whom OSA is also common.

Given the relative rarity of a neoplasm causing OSA and the infrequency of head and neck examination with FNE in patients with OSA, the diagnosis of a causative neoplasm may be missed. As a result, some patients are commenced on device use without being correctly diagnosed.[9,10] Patients may have tumour diagnosis delayed and resultant disease progression may then limit treatment options or lead to other local problems, such as cranial nerve palsies with subsequent dysphonia, aspiration, dysphagia and airway compromise. In cases of malignant pathology, a delay in diagnosis and treatment may worsen the chance of survival.

While these causative lesions are rare, they are often easily detectable on thorough head and neck examination including FNE. These neoplasms may be surgically removed or otherwise treated, improving or resolving the patient's OSA. In this paper, we review the available literature on head and neck neoplasms presenting with OSA to shed light on this phenomenon, summarize the pathology and clinical course, and give evidence that thorough head and neck examination with FNE is required for selected patients presenting with symptoms of OSA.

Methods

A scoping review of the literature was conducted on head and neck neoplasms presenting with OSA. The keywords 'obstructive sleep apnoea AND tumour' and 'obstructive sleep apnoea AND neoplasm' were entered into the Pubmed online search engine of the MEDLINE database to identify relevant English-language articles published between the years of 1985 and 2019 inclusive. Only articles reporting cases of patients with either malignant or benign head and neck neoplasms who initially presented with OSA were included. Articles describing cases that developed OSA as a result of disease progression or treatment for head and neck neoplasms, and articles describing the incidence of OSA in patients with diagnosed head and neck cancer, were excluded (Fig. 2).

Data collection included assessing the articles identified on initial literature search in piloted forms by one researcher. After exclusions, remaining articles were reviewed and data were extracted on patient demographics, clinical presentation, PSG results, radiological findings, pathology, treatment and reported outcomes. Case reports were included. Absolute and relative frequencies were used to describe the results. Results of studies were combined and frequencies were obtained.

Results

Initial literature search returned 1318 articles. Titles and abstracts of these articles were reviewed for relevance, with 1206 articles excluded. Full text of the remaining 112 articles was then reviewed. After final exclusions, 67 articles remained for inclusion, describing 79 patients (Fig. 2). Of these, 62 were single case reports, four were

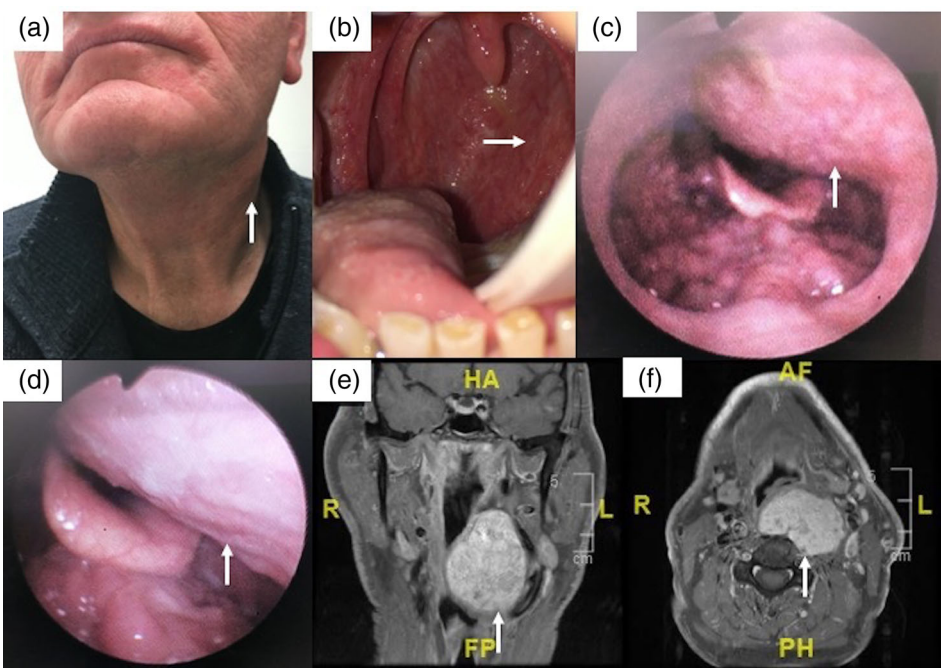

Fig 1. A 61-year-old male with severe obstructive sleep apnoea, treated with continuous positive airway pressure for 6 years before being diagnosed with a large parapharyngeal tumour. Postoperative histopathology showed a low-grade malignant peripheral nerve sheath tumour. (a) Subtle fullness of left upper neck indicated with white arrow. (b) Transoral examination showing left parapharyngeal fullness. (c) View on flexible nasendoscopy (FNE) showing marked retropharyngeal and parapharyngeal mass encroaching on airway. (d) View on FNE with patient reclining from the upright position to 45° demonstrating further obstruction of the airway. (e) Coronal and (f) axial magnetic resonance imaging showing large left parapharyngeal tumour with airway obstruction.

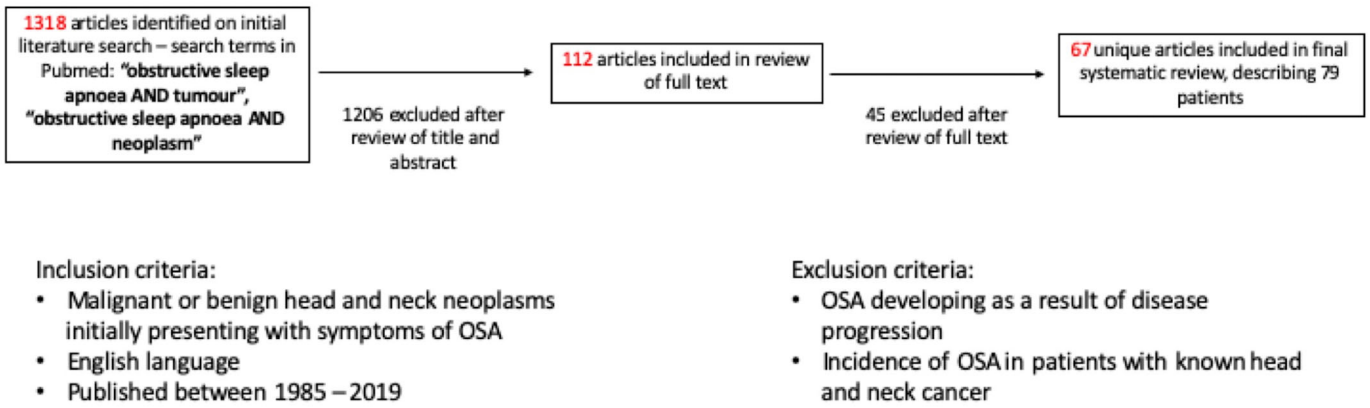

Fig 2. Scoping review methodology, results, inclusion and exclusion criteria. OSA, obstructive sleep apnoea.

case series of two patients each and one was a case series of nine patients. Patient demographics are summarized in Table 1. The weight of three paediatric patients was listed as percentiles: 50th, 20th and fifth percentiles, respectively. A total of 42 different pathologies were described. Fifty-eight patients had benign pathology and 21 had malignant pathology. The pathological and anatomical details are detailed in Tables 2–4.

All patients presented with symptoms of OSA, including nocturnal snoring and choking, restless sleep and daytime somnolence. In 28 patients (34%), these were the only noted symptoms. Other symptoms reported by patients are listed in Table 5. Symptoms were present for a mean of 29.2 months before diagnosis (range 0–240 months).

PSG results were reported in 55 patients. Apnoea-hypopnoea index was reported for 47 patients, with a mean score of 45.4 events/h. Respiratory disturbance index was reported on in six patients, with a mean score of 41.5 events/h. Oxygen desaturation index was reported on in two patients, both of whom scored greater than 31 events/h.

Previous treatment patients had undertaken before diagnosis of the causative neoplasm was reported in 26 patients, with 22 patients using CPAP devices and two using bilevel positive airway pressure (BiPAP) devices. Three patients had undergone sleep surgery procedures – one each of adenotonsillectomy,[11] septoplasty[12] and tracheostomy.[13]

At the time of diagnosis of the causative neoplasm, 42 (53.2%) were visible on trans-oral examination, and 79 (100%) were visible on head and neck examination including FNE.

The majority of included patients had their neoplasms treated surgically, with 57 patients (72.2%) treated with surgery alone.[9–12,14–61] Two patients (2.5%) were treated with both surgery and radiotherapy,[13,62] and one patient (1.3%) treated with each of surgery and chemotherapy[63] and surgery and chemoradiotherapy.[64] Furthermore, three patients (3.8%) declined surgery[65–67] and one patient (1.3%) was not medically fit for surgery.[68] Seven patients (8.9%) were treated with chemotherapy alone,[24,69–72] four patients (5%) were treated with radiotherapy alone,[73–75] and one patient (1.3%) was treated with chemoradiotherapy.[24] The treatment of two patients (2.5%) was not reported.[76,77] Objective or subjective post-treatment OSA outcomes were reported in 64 patients (81%). A total of 51 patients had subjective resolution of symptoms after treatment, 10 of which were objectively confirmed on post-treatment PSG. A further 11 patients reported subjective improvement of symptoms, all of whom had objective improvement on post-treatment PSG. Two patients reported subjective improvement but showed no improvement on post-treatment PSG.

Table 1 Patient demographics

Total number of patients	79
Age	Mean 45.8 years (range 0–79 years)
Male	61 (77.2%)
Female	18 (23.4%)
Body mass index	Mean 26.5 kg/m^2 (range 16.9–49.6 kg/m^2)

Discussion

OSA is most commonly caused by a combination of factors, resulting in narrowing of the upper airway during sleep. However, in a minority of patients this upper airway narrowing is caused by treatable neoplasms causing anatomical obstruction, which often go undiagnosed or are only diagnosed after disease progression. In this paper, we conducted the first review of patients who were diagnosed with benign or malignant head and neck neoplasms after first presenting with OSA. In the 79 reported cases, lipomatous tumours of the parapharyngeal and retropharyngeal spaces were the most common pathology. Pleomorphic adenomas arising from the deep lobe of the parotid gland or in the parapharyngeal space were also prevalent, while the most common oropharyngeal pathology reported was lymphoma of the palatine tonsils. Current international guidelines on the assessment and treatment of patients with OSA do not mandate examination with FNE. The causative pathology in 100% of patients in this review was visible on head and neck examination with FNE, while only half (53.2%) were visible on transoral examination alone.

Limitations of this study include inconsistency in reporting across studies. Many did not report PSG results before and after treatment. Furthermore, outcome measures used across studies

Table 2 Histopathological diagnoses of causative lesions divided into benign and malignant pathologies

Pathology	Incidence (%)
Benign	58 (73.4)
Lipoma	15 (18.9)
Simple	13
Fibrolipoma	1
Angiolipoma	1
Pleomorphic adenoma	11 (13.9)
Simple	10
with chondroid metaplasia	1
Cyst	8 (10.1)
Simple	5
Dermoid	1
Epidermoid	1
Thyroglossal	1
Schwannoma	4 (5)
Paraganglioma	3 (3.8)
Solitary fibrous tumour	3 (3.8)
Typical	2
Atypical	1
Neurofibroma	2 (2.5)
Osteochondroma	2 (2.5)
Papilloma	2 (2.5)
Non-secreting pituitary macroadenoma	1 (1.2)
Osteoma	1 (1.2)
Plexiform neurofibroma	1 (1.2)
Angiofibroma	1 (1.2)
Cystic fibroma	1 (1.2)
Encephalocoele	1 (1.2)
Haemangioma	1 (1.2)
Rhabdomyoma	1 (1.2)
Malignant	21 (26.6)
Lymphoma	11 (13.9)
Diffuse large B cell	3
Burkitt	2
Mantle cell	2
Non-anaplastic T-cell	1
Non-Hodgkins	1
Small B-cell lymphocytic	1
Small lymphocytic	1
Sarcoma	3 (3.8)
Liposarcoma	1
Liposarcoma within lipoma	1
Subtype not specified	1
Extramedullary plasmacytoma	2 (2.5)
Melanoma	1 (1.2)
Mucoepidermoid carcinoma	1 (1.2)
Neuroblastoma	1 (1.2)
Pleomorphic adenoma with adenocarcinomatous transformation	1 (1.2)
Squamous cell carcinoma	1 (1.2)

Table 3 Anatomical location of causative lesions

Anatomical location	Incidence (%)
Parapharynx/retropharynx	35 (44.3)
Parapharyngeal space	16
Retropharyngeal space	11
Arising from deep lobe of parotid	6
Arising from vertebra	2
Oropharynx	21 (26.6)
Palatine tonsils	11
Tongue base	4
Lateral oropharyngeal wall	3
Uvula	2
Soft palate	1
Larynx	9 (11.4)
Nasopharynx	5 (6.3)
Nasopharyngeal wall	4
Arising from sella turcica	1
Deep neck space	4 (5)
Arising from carotid body	3
Carotid sheath	1
Oral cavity	3 (3.8)
Sinonasal cavity	2 (2.5)
Arising from anterior skull base	1
Nasal cavity and paranasal sinuses	1

varied between apnoea-hypopnoea index, oxygen desaturation index and respiratory disturbance index. Functional outcome questionnaires were not consistently used and many of the papers reported outcomes in terms of subjective symptomatology rather than objective PSG results. Nonetheless, the reported objective or subjective improvement in OSA after treatment in 78% of patients suggests the neoplastic lesions were the causative factor. Another limitation of this study is that all papers included were case reports or small case series of no more than nine patients, and no large series or studies were identified in the published literature.

The population was predominantly male with a mean body mass index (BMI) of 26.5 kg/m, which is lower than that most commonly seen in patients with moderate or severe OSA. Thus, a higher index of suspicion should arise in these comparatively 'lower-BMI' OSA patients, particularly if CPAP pressures are increasing, other symptoms are appearing, or severity of OSA appears to be worsening despite a lack of apparent cause. Progressive snoring in a previous non-snorer in the absence of weight gain may also be a red flag for potential neoplasia or mass.

Symptoms most commonly associated with OSA include snoring, apnoea, gasping or choking, daytime somnolence, morning headaches and decreased concentration or memory.[78] In the current review, 34% of patients reported these symptoms alone. In the remaining patients, other symptoms were reported, most commonly dysphagia, dysphonia, globus and nasal obstruction. Some of these additional symptoms are not typical of OSA and should raise suspicion of upper aerodigestive tract pathology. These symptoms should be explored in taking a patient history for OSA; with subsequent referral for upper airway examination with FNE considered should they be present.

Symptoms of OSA were present in the reported population for a mean of nearly two and a half years (29.2 months) before a correct diagnosis was made. This highlights a long delay in diagnosis for these patients; we suspect due to a missed opportunity to perform FNE at initial presentation. Often these patients have very subtle examination findings that are readily missed with only cursory head and neck examination (but are more easily diagnosed with FNE) (Fig. 1).

A proportion of tumours identified in this review, such as lipomas, pleomorphic adenomas, low-grade lymphomas, paragangliomas and schwannomas, particularly involving the parapharyngeal or retropharyngeal space, have a slow-growing and often insidious progression. Indeed, some of them are found incidentally on imaging performed for other conditions. But for many of the other pathologies described in this review, a delay in diagnosis with subsequent disease

Table 4 Histopathological diagnoses of causative lesions listed by anatomical location

Anatomical location	Incidence (%)
Parapharynx/retropharynx	35 (44.3)
Lipoma	15
Pleomorphic adenoma	9
Sarcoma	3
Osteochondroma	2
Solitary fibrous tumour	2
Pleomorphic adenoma with adenocarcinomatous transformation	1
Schwannoma	1
Lymphoma	1
Neuroblastoma	1
Oropharynx	21 (26.6)
Lymphoma	9
Schwannoma	3
Cyst	2
Extramedullary plasmacytoma	2
Pleomorphic adenoma	2
Solitary fibrous tumour	1
Mucoepidermoid carcinoma	1
Haemangioma	1
Larynx	9 (11.4)
Cyst	3
Neurofibroma	2
Squamous cell carcinoma	1
Plexiform neurofibroma	1
Rhabdomyoma	1
Angiofibroma	1
Nasopharynx	5 (6.3)
Papilloma	2
Encephalocoele	1
Lymphoma	1
Cyst	1
Deep neck space	4 (5)
Paraganglioma	3
Cystic hygroma	1
Oral cavity	3 (3.8)
Cyst	2
Osteoma	1
Sinonasal cavity	2 (2.5)
Melanoma	1
Non-secreting pituitary macroadenoma	1

progression may limit available treatment options, or increase risk of morbidity and mortality when treatment is undertaken. During this time period, a third (32.9%) of patients commenced inappropriate treatment, including three who underwent inappropriate OSA-related surgical procedures, exposing them to unnecessary morbidity, medical expense and risk.

Table 5 Presenting symptoms of patients listed by prevalence

Presenting symptom	Prevalence (%)
Typical OSA symptoms only (nocturnal snoring, choking, restless sleep, daytime somnolence)	28 (34)
Dysphagia	15 (18.9)
Dysphonia or voice change	10 (12.6)
Globus sensation	7 (8.8)
Nasal obstruction	6 (7.6)
Stridor or noisy breathing	4 (5)
Dyspnoea	3 (3.8)
Palpable or visible mass	3 (3.8)
Anosmia	2 (2.5)
Epistaxis	1 (1.3)
Weight loss	1 (1.3)

Some patients reported more than one presenting symptom. OSA, obstructive sleep apnoea.

The authors wish to highlight a trend that has emerged in contemporary OSA care in the form of the non-physician attended 'Sleep Clinics'. In these clinics, a patient can have an unattended 'take home' PSG which is reported off-site. The reporting physician does not examine the patient, and often has limited clinical information. They may not be alerted to 'red flag' features that might be concerning for a causative upper aerodigestive neoplasm. A patient can be offered CPAP to treat OSA based on these studies; and commence OSA treatment without ever being clinically assessed by a doctor. It is our opinion that any assessment should be vigilant about the possibility of upper aerodigestive neoplasia causing OSA; and thus have a low threshold to refer patients for clinical assessment should concerning features be present.

Although routine FNE will detect a neoplastic lesion in only a small proportion of patients with OSA, it allows a more thorough assessment of anatomical site contribution to obstruction compared with limited oral and anterior rhinoscopy examination alone.

Conclusion

Although rare, neoplasms of the upper aerodigestive tract should be considered as a cause of OSA, especially in patients experiencing other symptoms in addition to the typical symptoms of OSA. They should particularly be considered in patients with comparatively lower BMI or those with worsening OSA without an apparent cause identified. We recommend that patients who present with symptoms of OSA are screened for further symptoms and signs which may indicate upper aerodigestive tract neoplasia, and that referral for FNE and upper airway assessment is added to clinical paradigms for selected patients with OSA.

Conflicts of interest

None declared.

References

1. Punjabi NM. The epidemiology of adult obstructive sleep apnea. *Proc. Am. Thorac. Soc.* 2008; **5**: 136–43.
2. Jun JC, Chopra S, Schwartz AR. Sleep apnoea. *Eur. Respir. Rev.* 2016; **25**: 12–8.
3. Young T, Finn L, Peppard PE *et al*. Sleep disordered breathing and mortality: eighteen-year follow-up of the Wisconsin sleep cohort. *Sleep* 2008; **31**: 1071–8.
4. Marshall NS, Wong KK, Liu PY, Cullen SR, Knuiman MW, Grunstein RR. Sleep apnea as an independent risk factor for all-cause mortality: the Busselton Health Study. *Sleep* 2008; **31**: 1079–85.
5. Stubbs B, Vancampfort D, Veronese N *et al*. The prevalence and predictors of obstructive sleep apnea in major depressive disorder, bipolar disorder and schizophrenia: a systematic review and meta-analysis. *J. Affect. Disord.* 2016; **197**: 259–67.
6. Sutton EL. Psychiatric disorders and sleep issues. *Med. Clin. North Am.* 2014; **98**: 1123–43.

7. Epstein LJ, Kristo D, Strollo PJ Jr *et al*. Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults. *J. Clin. Sleep Med.* 2009; **5**: 263–76.
8. Amin MB, Edge S, Greene F *et al*. *AJCC Cancer Staging Manual*, 8th edn. NY, USA: Springer International Publishing: American Joint Commission on Cancer, 2017.
9. Sorrenti G, Pelligra I, Albertini R, Piccin O. Solitary fibrous tumor of the tongue: an uncommon cause of obstructive sleep apnea. *J. Maxillofac. Oral Surg.* 2018; **17**: 441–3.
10. Mulla O, Agada F, Dawson D, Sood S. Deep lobe parotid pleomorphic adenoma presenting as obstructive sleep apnoea. *BMJ Case Rep.* 2013; **2013**: pii: bcr2013008655.
11. Setabutr D, Perez MR, Truong MT, Senders CW, Rubinstein BK. Neurofibromatosis of the larynx causing stridor and sleep apnea. *Am. J. Otolaryngol.* 2014; **35**: 631–5.
12. Alving J, Hojer-Pedersen E, Schlichting J, Sindrup EH. Obstructive sleep apnea syndrome caused by oral cyst: a case report. *Acta Neurol. Scand.* 1985; **71**: 408–10.
13. Murali R, Douyon P, Omeis I. Large anterior skull base lesions in patients presenting with obstructive sleep apnea. Report of two cases and review of the literature. J. *Neurosurg.* 2004; **101**: 163–6.
14. Pirovino CA, Giger R, Landis BN. Sleep apnea: do not forget to inspect the throat! *Clin. Case Rep.* 2019; **7**: 143–5.
15. Datarkar AN, Deshpande A. Giant parapharyngeal space pleomorphic adenoma of the deep lobe of parotid presenting as obstructive sleep apnoea: a case report & review of the diagnostic and therapeutic approaches. *J. Maxillofac. Oral Surg.* 2015; **14**: 532–7.
16. Wang AY, Wang JT, Levin B, Alam M, Palme CE, Riffat F. Parapharyngeal pleomorphic adenoma as a cause of severe obstructive sleep apnoea. *ANZ J. Surg.* 2014; **84**: 883–4.
17. Casale M, Salvinelli F, Mallio CA *et al*. Upper airway study should always come before any sleep study in OSAS evaluation: a giant parapharyngeal lipoma behind OSAS. *Eur. Rev. Med. Pharmacol. Sci.* 2012; **16**(Suppl. 4): 106–9.
18. Morariu I, Dias A, Curran A. Giant parotid pleomorphic adenoma in parapharyngeal space causing severe obstructive sleep apnoea. *Ir. Med. J.* 2012; **105**: 184–5.
19. Giddings CE, Bray D, Rimmer J, Williamson P. Pleomorphic adenoma and severe obstructive sleep apnoea. *J. Laryngol. Otol.* 2005; **119**: 226–9.
20. Pipolo C, Maccari A, Messina F, Moneghini L, Felisati G. Late diagnosis of a solitary fibrous tumour of the parapharyngeal space in a continuous positive airway pressure-treated patient. *Acta Otorhinolaryngol. Ital.* 2010; **30**: 160–3.
21. Alobid I, Benitez P, Berenguer J, Bernal-Sprekelsen M, Mullol J. Parapharyngeal angiolipoma causing obstructive sleep apnoea syndrome. *Acta Otolaryngol.* 2004; **124**: 210–2.
22. Pellanda A, Zagury S, Pasche P. Parapharyngeal lipoma causing obstructive sleep apnea syndrome. *Otolaryngol. Head Neck Surg.* 2003; **128**: 301–2.
23. Walshe P, Smith D, Coakeley D, Dunne B, Timon C. Sleep apnoea of unusual origin. *J. Laryngol. Otol.* 2002; **116**: 138–9.
24. Zhu SJ, Wang QY, Zhou SH, Bao YY, Wang SQ. Obstructive sleep apnea syndrome caused by uncommon tumors of the upper aerodigestive tract. *Int. J. Clin. Exp. Pathol.* 2014; **7**: 6686–93.
25. Ballesteros F, Jose Sanz J, Maria Guilemany J, Moragas M, Gaspa A, Bernal-Sprekelsen M. Bulky cervical liposarcoma associated with sleep apnea syndrome. *Acta Otolaryngol.* 2006; **126**: 209–13.
26. King M, Gleeson M, Rees J. Obstructive sleep apnoea and tonsillar lymphoma. *Br. Med. J. (Clin. Res. Ed)* 1987; **294**: 1605–6.
27. Tsou YA, Cheng YK, Lin CD, Chang WC, Tsai MH. Small B cell lymphocytic lymphoma presenting as obstructive sleep apnea. *World J. Surg. Oncol.* 2004; **2**: 26.
28. Adams AJ, Patterson AR, Brady G, Whitfield PH. Resolution of obstructive sleep apnoea after resection of a pleomorphic salivary adenoma. *Br. J. Oral Maxillofac. Surg.* 2008; **46**: 53–4.
29. Yilmaz AD, Unlu E, Orbay H, Sensoz O. Giant pleomorphic adenoma of soft palate leading to obstruction of the nasopharyngeal port. *J. Craniofac. Surg.* 2006; **17**: 1001–4.
30. Motomura H, Harada T, Muraoka M, Taniguchi T. Elongated uvula with a pleomorphic adenoma: a rare cause of obstructive sleep apnea syndrome. *Ann. Plast. Surg.* 2000; **45**: 61–3.
31. Li H, Zhou X, Ran Q, Wang L. Parapharyngeal liposarcoma: a case report. *Diagn. Pathol.* 2013; **8**: 42.
32. Sawhney R, Carron MA, Mathog RH. Tongue base schwannoma: report, review, and unique surgical approach. *Am. J. Otolaryngol.* 2008; **29**: 119–22.
33. Iwai K, Tomoda K, Nakai T, Kimura H. A hypopharyngeal lipoma resulting in obstructive sleep apnea. *Intern. Med.* 2015; **54**: 2789–90.
34. Kim JH, Kang JW. Oropharyngeal mass causing obstructive sleep apnea. Osteochondroma. *JAMA Otolaryngol. Head Neck Surg.* 2015; **141**: 393–4.
35. Toader C, Toader M, Stoica A *et al*. Tonsillar lymphoma masquerading as obstructive sleep apnea – pediatric case report. *Rom. J. Morphol. Embryol.* 2016; **57**(2 Suppl.): 885–91.
36. De A, Don DM, Magee W 3rd, Ward SL. Vallecular cyst as a cause of obstructive sleep apnea in an infant. *J. Clin. Sleep Med.* 2013; **9**: 825–6.
37. Piccin O, Sorrenti G. Adult obstructive sleep apnea related to nasopharyngeal obstruction: a case of retropharyngeal lipoma and pathogenetic considerations. *Sleep Breath.* 2007; **11**: 305–7.
38. El-Sayed IH, Eisele DW, Yang TL, Iezza G. Solitary fibrous tumor of the retropharynx causing obstructive sleep apnea. *Am. J. Otolaryngol.* 2006; **27**: 259–62.
39. Picciotti PM, Agostino S, Galla S, Della Marca G, Scarano E. Aryepiglottic fold cyst causing obstructive sleep apnea syndrome. *Sleep Med.* 2006; **7**: 389.
40. Balasundaram A. Hypopharyngeal lipoma causing obstructive sleep apnea: discovery on dental cone-beam CT. *Ear Nose Throat J.* 2013; **92**: E1–4.
41. Chen MF, Fang TJ, Lee LA, Li HY, Wang CJ, Chen IH. Huge supraglottic cyst causing obstructive sleep apnea in an adult. *Otolaryngol. Head Neck Surg.* 2006; **135**: 986–8.
42. Tarsitano A, Marchetti C. Unusual presentation of obstructive sleep apnoea syndrome due to a giant mandible osteoma: case report and literature review. *Acta Otorhinolaryngol. Ital.* 2013; **33**: 63–6.
43. Yoshida T, Matsuda H, Horiuchi C *et al*. Tsukuda M A case of osteochondroma of the atlas causing obstructive sleep apnea syndrome. *Acta Otolaryngol.* 2006; **126**: 445–8.
44. Namyslowski G, Scierski W, Misiolek M, Urbaniec N, Lange D. Huge retropharyngeal lipoma causing obstructive sleep apnea: a case report. *Eur. Arch. Otorhinolaryngol.* 2006; **263**: 738–40.
45. Eloy JA, Carneiro E, Vibhute P, Genden EM, Bederson JB, Som PM. A rare prevertebral ordinary lipoma presenting as obstructive sleep apnea: computed tomographic and magnetic resonance imaging findings. *Arch. Otolaryngol. Head Neck Surg.* 2008; **134**: 1001–3.
46. Herer B, Royand F, Kieffer E, Vincent JP. A case report of an obesity hypoventilation syndrome associated with obstructive sleep apnea due to a carotid body paraganglioma. *Sleep Med.* 2003; **4**: 459–63.
47. Gong W, Wang E, Zhang B, Da J. A retropharyngeal lipoma causing obstructive sleep apnea in a child. *J. Clin. Sleep Med.* 2006; **2**: 328–9.
48. Golz A, Goldenberg D, Netzer A, Westerman ST, Joachims HZ. Epiglottic carcinoma presenting as obstructive sleep apnea. *J. Otolaryngol.* 2001; **30**: 58–9.

49. Sidman J, Wood RE, Poole M, Postma DS. Management of plexiform neurofibroma of the larynx. *Ann. Otol. Rhinol. Laryngol.* 1987; **96** (Pt 1): 53–5.
50. Farboud A, Pratap R, Helquist H, Montgomery P. An unusual cause of obstructive sleep apnoea. *J. Laryngol. Otol.* 2009; **123**: e22.
51. Ruan LX, Zhou SH, Wang SQ. Palatine tonsil schwannoma: correlation between clinicopathology and computed tomography features. *J. Int. Med. Res.* 2008; **36**: 1140–7.
52. Brodsky L, Siddiqui SY, Stanievich JF. Massive oropharyngeal papillomatosis causing obstructive sleep apnea in a child. *Arch. Otolaryngol. Head Neck Surg.* 1987; **113**: 882–4.
53. Wheatley AH, Temple RH, Camilleri AE. Childhood obstructive sleep apnoea syndrome due to nasopharyngeal viral papillomatosis. *J. Laryngol. Otol.* 1997; **111**: 976–7.
54. Aland JW Jr. Retropharyngeal lipoma causing symptoms of obstructive sleep apnea. *Otolaryngol. Head Neck Surg.* 1996; **114**: 628–30.
55. Jung HJ, Kim JW, Lee CH, Chung YJ, Mo JH. A thyroglossal duct cyst causing obstructive sleep apnea in adult. *Clin. Exp. Otorhinolaryngol.* 2013; **6**: 187–90.
56. Thong JF, Pang KP, Siow JK. Haemangioma of the uvula causing loud habitual snoring – a rare entity. *Med. J. Malaysia* 2008; **63**: 408–9.
57. Srinivasan V, Davies JE. Snoring with sleep apnoea: deceptive appearances. *J. R. Soc. Med.* 2000; **93**: 81–2.
58. Steele MH, Nuss DW, Faust BF. Angiofibroma of the larynx: report of a case with clinical and pathologic literature review. *Head Neck* 2002; **24**: 805–9.
59. Kahn A, Blum D, Hoffman A *et al*. Obstructive sleep apnea induced by a parapharyngeal cystic hygroma in an infant. *Sleep* 1985; **8**: 363–6.
60. Matsumoto Y, Yokoi H, Ikeda T, Fujiwara M, Kamma H, Kohno N. Intra-adenoid cyst: a case report with an immunohistochemical study and review of literature. *Clin. Med. Insights Case Rep.* 2015; **8**: 41–5.
61. Goldman JM, Barnes DJ, Pohl DV. Obstructive sleep apnoea due to a dermoid cyst of the floor of the mouth. *Thorax* 1990; **45**: 76.
62. Veitch D, Rogers M, Blanshard J. Parapharyngeal mass presenting with sleep apnoea. *J. Laryngol. Otol.* 1989; **103**: 961–3.
63. Feldman BS, Quan SF. Tonsillar lymphoma as a cause of obstructive sleep apnea. *Sleep Med.* 2002; **3**: 441–2.
64. Mulla O, Agada F, Dawson D, Sood S. Obstructive sleep apnoea and snoring – is examination necessary? *Aust. Fam. Physician* 2011; **40**: 886–8.
65. Abdullah BJ, Liam CK, Kaur H, Mathew KM. Parapharyngeal space lipoma causing sleep apnoea. *Br. J. Radiol.* 1997; **70**: 1063–5.
66. Smadi T, Raza MA, Woodson BT, Franco RA. Obstructive sleep apnea caused by carotid body tumor: case report. *J. Clin. Sleep Med.* 2007; **3**: 517–8.
67. Singh SP, Tomkowicz B, Lai D *et al*. Srinivasan A Functional role of residues corresponding to helical domain II (amino acids 35 to 46) of human immunodeficiency virus type 1 Vpr. *J. Virol.* 2000; **74**: 10650–7.
68. Hockstein NG, Anderson TA, Moonis G, Gustafson KS, Mirza N. Retropharyngeal lipoma causing obstructive sleep apnea: case report including five-year follow-up. *Laryngoscope* 2002; **112**: 1603–5.
69. Zhu X, Li R, Wang P, Li J. Aberrant functional connectivity of the hippocampus in older adults with subthreshold depression. *Psych. J.* 2014; **3**: 245–53.
70. Gomez-Merino E, Arriero JM, Chiner E, Signes-Costa J, Marco J. Obstructive sleep apnea syndrome as first manifestation of pharyngeal non-Hodgkin's lymphoma. *Respiration* 2003; **70**: 107–9.
71. Ganesan AP, Jiang W, Kuo DJ, Bhattacharjee R. Obstructive sleep apnoea as a presenting manifestation of non-Hodgkin lymphoma in a child. *Lancet Oncol.* 2017; **18**: e618.
72. Leon-Astudillo C, Lee GS, Katwa U. An unusual case of noisy breathing in an infant. *J. Clin. Sleep Med.* 2019; **15**: 149–52.
73. Asai N, Ohkuni Y, Kawamura Y, Kaneko N. A case of obstructive sleep apnea syndrome caused by malignant melanoma in the nasal cavity and paranasal sinus. *J. Cancer Res. Ther.* 2013; **9**: 276–7.
74. Byrd RP Jr, Roy TM, Bentz W, Mehta JB. Plasmacytoma as a cause of obstructive sleep apnea. *Chest* 1996; **109**: 1657–9.
75. Metersky ML, Castriotta RJ, Elnaggar A. Obstructive sleep apnea due to a carotid body paraganglioma. *Sleep* 1995; **18**: 53–4.
76. Araz O, Turan A, Yoruk O, Alper F, Akgun M. Laryngocele and epiglottic cyst as rare causes of obstructive sleep apnea. *Sleep Breath.* 2009; **13**: 285–7.
77. Dilek O, Kaya O, Yilmaz C, Soker G, Gulek B, Akin MA. A rare cause of obstructive sleep apnea syndrome: retropharyngeal Lipoma. *Case Rep. Radiol.* 2017; **2017**: 2134362.
78. Semelka M, Wilson J, Floyd R. Diagnosis and treatment of obstructive sleep apnea in adults. *Am. Fam. Physician* 2016; **94**: 355–60.