Eur Arch Otorhinolaryngol (2001) 258 : 492–495

MISCELLANEOUS

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Evaluation of clinical parameters in patients with obstructive sleep apnea and possible correlation with the severity of the disease

Received: 2 November 2000 / Accepted: 15 May 2001

Abstract Obstructive sleep apnea (OSA) is a complex disease whose etiology is multifactorial and incompletely understood. This article focuses on upper airway anatomy evaluation and the standardization of different physical findings in patients with OSA and on the possible correlation of these physical findings with the severity of the disease. All patients underwent a physical examination and polysomnography. The physical examination included tonsil size, modified Mallampati grade, neck circumference, lateral clinical craniofacial assessment and body mass index (BMI). The study group consisted of 85 patients. A statistically significant correlation between tonsil size and BMI and with the respiratory disturbance index (RDI) was detected ($P = 0.004$ and 0.03 respectively). Also patients with a craniofacial anomaly have a higher RDI level than the patients without this anomaly ($P = 0.03$). This study has identified some standardized physical findings for predicting the severity of OSA. We aim to benefit from these findings in the selection of a rational treatment modality selection for patients with OSA.

Keywords Polysomnography · Obstructive sleep apnea · Clinical evaluation

Introduction

Sleep-related breathing disorders (SRBD) form a complex group of diseases whose etiology is not well understood. Irrespective of the neurogenic, muscular or anatomic etiology, these diseases are characterized by obstruction of the upper respiratory airways during sleep. Meticulous, detailed and systematic examination of this anatomic region is mandatory. Since the introduction of uvulopalatopharyngoplasty in 1981 by Fujita et al. [3] and of laser-assisted uvuloplasty in 1990 by Kamami [9], otorhinolaryngologists have been increasingly concerned about the treatment of the clinical conditions leading to SRBD. The term SRBD covers a broad spectrum from simple snoring to the hypoventilation syndromes. Obstructive sleep apnea syndrome (OSA) and upper airway resistance syndrome occupy a place between these two syndromes. Snoring as the common finding in SRBD may present as simple snoring but it may also be a clinical finding in OSA. Although the conversion of the disease from one stage to another is still a matter of discussion it is currently accepted that this disorder represents a continuum [4].

OSA, the best understood disease of this group, affects 2–4% of middle-aged adults [10]. On the other hand, reliable information about the real incidence of upper airway resistance syndrome is still not available, because it is a recently defined disorder with some diagnostic difficulties. Because of the significantly increased risk of morbidity and mortality, patients with OSA must be treated vigorously. The survival period and life quality may be enhanced by therapy [17]. As OSA is a frequent disease that requires appropriate treatment it must be diagnosed in patients at risk. Characteristic diagnostic clinical symptoms are severe snoring, cessation of breathing during sleep, nocturnal awakening and sleepiness in the morning, as well as daytime somnolence. However, because the different complaints addressed do not exhibit high sensitivity and specificity, evaluation of a clinical symptom alone does not permit the diagnosis of OSA [8].

The second diagnostic step is examination of the upper airways, which is best performed by otorhinolaryngologists. In addition to the standard oropharyngeal examination to reveal the location of the obstruction, endoscopic evaluation of the hypopharynx, larynx and nasal cavity is followed by the Müller maneuver. The lack of standardization for evaluating the physical findings is a major prob-

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lem. The classification of the upper airways described by Fujita et al. [3] and the Müller maneuver do not suffice for the diagnosis of OSA, nor for predicting the therapeutic outcome, so the search for new approaches continues [12].

Based on the method described by Mallampati for predicting difficult intubations, which evaluates the relationship between the position of the tongue and the oral cavity, a new classification for the evaluation of the upper airways in patients with OSA was proposed [2]. For this classification, the “modified Mallampati index” (MMPI), the relationship of the tongue to the hard and soft palate is evaluated with the tongue kept in the oral cavity, on the assumption that this position represents the neutral physiological one during sleep. Although in patients with OSA the relationship of tonsillar size to the oropharynx has been evaluated in many studies, different results have been obtained due to the different classifications used [5].

Moreover, on the basis of the studies already performed, the body mass index (BMI) has been found to be the most important physical parameter for the prediction of OSA [1]. On the other hand, a high BMI does not necessarily predict the presence of OSA [6]. The neck circumference measured independently from the BMI is also thought to be a very important parameter for the diagnosis of OSA. Objective craniofacial analysis is also essential in patients with suspected OSA. In particular lateral facial examination should be based on the Frankfort line; the maxillomandibular relation and the facial profile should also be assessed. It should be emphasized that in addition to the anatomic and pathologic assessment, lateral facial evaluation is of paramount importance for planning the therapeutic measures [5].

Radiology and magnetic resonance imaging contribute considerably to the anatomic and pathologic evaluation of the disease. However they prove to be insufficient in the diagnosis and prediction of the therapeutic outcome [16]. Thus, polysomnography after history and clinical examination is accepted as the standard method for the diagnosis, staging and therapy of OSA [15].

For a better understanding of the physiopathology of this disorder, we attempted to evaluate the relationship between various physical examination findings and polysomnographic parameters in patients attending our clinic with the diagnosis of OSA. The clinical evaluation comprised tonsillar size, MMPI scores, BMI, neck circumference and lateral craniofacial assessment. Concomitant evaluation of standardized physical findings in patients with OSA was attempted in order to investigate their presumptive sole and cumulative effects on the severity of the disorder and to plan the appropriate therapeutic approach.

Materials and methods

Eighty-five patients presenting with clinical symptoms of SRBD were evaluated prospectively in the Department of Otorhinolaryngology, University of Istanbul, between October 1999 and June 2000. The study group consisted of 63 males (74%) and 22 females (26%), with ages ranging from 9 to 65 years (median 51, mean 48 years).The patients were asked to attend the study with their partners, if available. General medical evaluation, medical history, Epworth sleepiness scale and sleep habits were investigated. The sleep study questionnaire covered snoring, apneic episodes during sleep, morning headache, memory impairment, restless sleep, feeling of choking during sleep, enuresis, impotence, daytime somnolence, nervousness, personality changes, anxiety, depression, loss of libido, and the severity of these complaints.

Polysomnographic investigations were undertaken if the major symptoms of OSA (snoring, severe daytime somnolence, restless sleep, feeling of choking during sleep or apnea episodes observed by the partner) or obstructive pathologic changes were present on physical examination.

Nocturnal polysomnography in the sleep laboratory routinely consisted of EEG, EOG, submental and tibialis anterior EMG, oral–nasal airflow measurement, plethysmography and oxygen saturation by pulse oximetry. “Apnea” was defined as the cessation of airflow through the nostrils and oral cavity for at least 10 s. “Hypopnea” was defined as the reduction of airflow during sleep by at least 50% for 10 s or more, with a decrease in oxygen saturation, thus as superficial breathing. The apneic index is the number of apneic episodes during 1 h of sleep. Individuals with an apneic–hypopneic index (RDI) greater than 5 were defined as having OSA. An RDI of 5–20 indicated mild OSA, 21–40 moderate OSA and over 40 severe OSA. For evaluation of the oral cavity, the MMPI was performed. The patients were asked to open the mouth wide with the tongue left in its normal place of rest. Oropharyngeal crowding was graded as follows:

- Grade 1: tonsils, pillars and soft palate visible;
- Grade 2: uvula, pillars visible;
- Grade 3: only part of the soft palate visible;
- Grade 4: only the hard palate visible.

Tonsils were evaluated as follows:

- Grade 0: no tonsillar tissue visible
- Grade 1: tonsils in the tonsillar fossa and hardly visible;
- Grade 2: tonsils in the tonsillar fossa and clearly visible;
- Grade 3: tonsillar tissue protruding into the oropharynx;
- Grade 4: tonsils obstructing the oropharyngeal aperture.

The weight and height of the patients were recorded routinely and the BMI was calculated using the formula BMI = weight (kg)/height (m^2). Measurement of the neck circumference was based on a horizontal line at the level of the cricoid cartilage. The clinical craniofacial evaluation was performed on the basis of the horizontal Frankfort line. In ideal mid-face facial assessment, the nasion and subnasion should be in the same vertical line. If the subnasion is posterior to the line, maxillary retrusion may be present. To assess the mandible, a vertical line is dropped from the vermilion border of the lower lip. If the pogonion is more than 2 mm behind this line, mandibular retrognathism may be present.

The MMPI, tonsillar scores, neck circumference and craniofacial anomalies, as well as the correlation between BMI and RDI, were assessed using the Pearson correlation test. The results in individuals with and without cranifacial anomalies were assessed by the Mann-Witney U-test. The MMPI, tonsil scores and craniofacial anomalies as well as the independent contributions of BMI to the RDI were determined by univariate variance analysis ($P < 0.05$ statistically significant). All data analyses were computed using SPSS 9.0.

Results

OSA was detected in all patients in whom nocturnal polysomnography indicated the presence of one of the major OSA symptoms. Thirty-six patients (43%) presented with mild, 24 (28%) with moderate and 25 (29%) with severe OSA. The RDI ranged from 5 to 126, with a mean value of 32. Mean Epworth sleepiness scale value was 10 (1–18), mean BMI 29 (16–48), mean MMPI 3 (1–4), mean

Table 1 Correlation of tonsil size grading with apnea–hypopnea index (*RDI* respiratory disorder index)

	Patients (*n*)	RDI
Grade 1	38	22.06 (5–84)
Grade 2	31	43.53 (5–126)
Grade 3	9	24.75 (14–49)
Grade 4	7	50.5 (36–65)

Table 2 Correlation of clinical predictors with apnea–hypopnea index (RDI). *MMPI* modified Mallampati index, *BMI* body mass index, *CFA* craniofacial anomaly analysis

Variables	Correlation with RDI
Tonsil size*	$P = 0.004$
MMPI* grade	$P = 0.49$
Neck circumference*	$P = 0.14$
BMI*	$P = 0.03$
CFA anomaly (+)/CFA anomaly (–) **	$P = 0.03$

*Pearson correlation test, **Mann-Whitney U test was used ($P < 0.05$ considered statistically significant)

neck circumference 32 cm (28–47 cm). On clinical facial evaluation, seven patients (9%) were assessed as retrognathic.

There was a statistically significant correlation between tonsil size (Table 1), BMI and RDI. The correlation between tonsillar score and RDI was 0.32 ($P = 0.004$), that between BMI and RDI was 0.23 ($P = 0.03$). No correlation was observed between parameters such as age, sex, Epworth sleeping scale, neck circumference, or MMPI with RDI and the severity of OSA (Table 2). Comparison of the RDI in patients without craniofacial anomalies with that of patients with such anomalies revealed that the latter exhibited significantly higher values of RDI ($P = 0.03$).

Table 2 shows the results of the univariate variance analysis of tonsillar scores, which exhibit a statistically significant correlation ($P = 0.004$) with the severity of the disease. Here there is a significant difference between the tonsillar scores in patients with stage 1 OSA (RDI < 20) and those in patients with stage 2 OSA (RDI>20) ($P = 0.002$).

Discussion

Although the multifactorial etiology of OSA is not yet well understood, the anatomic evaluation of the upper airways in these patients still remains the essential examination. The results of examining the upper airways by different methods and the presence of OSA have been discussed in many studies of this subject [13]. In the present study we aimed to evaluate the correlation between these anatomic parameters in patients with OSA and the severity of the disease. Although it is generally accepted that tonsillar hypertrophy leads to obstruction of the airways, the correlation with the severity of the disease has not been assessed in detail until now. If on patient evaluation the obstruction is found to be retropalatal, RDI and tonsillar size may help in deciding on the surgical method. In general, uvulopalatopharyngoplasty is the method of choice in patients with an RDI greater than 20 or with tonsillar hypertrophy. Laser-assisted uvuloplasty is indicated in patients with prominent posterior pillars and a widened uvula [14]. There are reports indicating that in patients with tonsillar hypertrophy simple tonsillectomy may suffice for the treatment [11]. In our study we found a strong correlation between tonsillar size and the severity of OSA ($P = 0.004$). The difference between stage 1 (RDI < 20) and stage 2 (RDI > 20) is even more significant. In 27 of the 31 OSA patients with a grade 2 tonsillar score, moderate or severe OSA disease was detected. These findings suggest that in patients with OSA and a tonsillar score of grade 2 and higher, tonsillectomy in addition to palatal surgery might be beneficial if a retropalatal obstruction is present. The current generally accepted selection criteria for laser-assisted uvuloplasty are an oxygen saturation level not below the minimum value of 85% and an RDI of < 20. So the above findings may support the second criterion.

In several studies, the correlation between BMI, neck circumference and OSA severity has been assessed. OSA is reported to be present in 30% of patients with a neck circumference of 43 cm (males) or 38 cm (females) [7]. In our study, however, no correlation was found between increasing neck circumference and severity of OSA. For a BMI higher than 28 kg/m^2 in males and 27 kg/m^2 in females, OSA is reported to occur with an incidence of approximately 30%. In our study, a positive correlation was found between BMI and severity of OSA ($P = 0.003$). Thus, similar results to those in former reports were obtained.

There are numerous reports assessing the correlation between OSA severity and the anatomic anomalies as detected by cephalometry. Such cephalometric analysis, however, is not applied frequently because of difficulties in assessment, and it is of little help in the diagnosis and selection of the surgical method in patients without prominent craniofacial anomalies. Statistical analysis of data obtained by simple clinical examination shows that patients with maxillar or mandibular displacement present with higher RDI values than patients without displacement ($P = 0.03$). It is generally accepted that retrognathism, the most frequent anomaly, causes upper airway obstruction through dorsal displacement of the tongue and pharyngeal soft tissues, especially when patients are lying down. In retrognathic patients, corrective surgery appears to be more acceptable than palatal intervention. In these patients meticulous postoperative follow-up is essential.

Taking into consideration that OSA patients are at increased risk of difficult intubation, we modified the MMPI for assessing these patients. In contrast to the studies reporting that an increased size and intraoral location of the tongue leads to upper airway obstruction during sleep and might be a predictor for OSA diagnosis, we could not detect a correlation between RDI and MMPI in OSA patients.

Currently, polysomnography is regarded as the most valuable standard method for the diagnosis of OSA. Physical examination, on the other hand, is a matter of discussion. The OSA predictors currently accepted everywhere are snoring, cessation of breathing during sleep as reported by the partner, and daytime somnolence. We detected one of these major symptoms in our patients with a diagnosis of OSA.

The only physical parameter so far reported to be relevant in the diagnosis of OSA is the BMI. In the present study it was our goal to develop a standardized assessment model for the evaluation of upper airway findings that possibly contribute to the pathogenesis and severity of OSA, as well as for detecting the correct anatomic region for surgery with a beneficial outcome. We consider tonsillar size to be the most important predictor, among others, of the severity of OSA. For this reason, in patients with tonsillar hypertrophy palatal surgery alone might not suffice. Additional tonsillectomy could prove a more rational way of treating these patients.

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