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Original Research Article

Cross-sectional study of the factors predisposing to obstructive sleep apnea in the adult population attending ENT outpatient department with snoring in tertiary care center

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ABSTRACT

Background: Obstructive sleep apnea (OSA) is characterized by repetitive upper airway obstruction leading to stimulation of the cardiovascular system, oxygen desaturation, and sleep fragmentation. Overnight polysomnography (PSG) is the standard diagnostic test for Obstructive sleep apnea. The objective of the study was to assess the prevalence and severity of OSA and the factors predisposing to OSA.
Methods: In this cross-sectional study, 98 patients with snoring were subjected to undergo polysomnography. Apnea-hypopnea index (AHI), Oxygen desaturation events per hour, and Lowest oxygen desaturation events per hour were statistically analyzed. The Chi-square test and analysis of variance (ANOVA) test were used and the p value was calculated. Statistical package for the social sciences (SPSS) version 20 was used for statistical analysis.
Results: In our study, the most common age group affected was between 51-60 years. The most common comorbidity found among the patients was hypertension. There was a positive correlation between OSA and neck circumference. The most common type of apnea was obstructive apnea. AHI was found to have a positive correlation with OSA and its severity. There was a significant association between average oxygen desaturation and OSA. There was also a positive correlation between ODI and OSA.
Conclusions: Increasing age, neck circumference, deviated nasal septum, and inferior turbinate hypertrophy had a strong association with OSA. Polysomnography shows the strong association of AHI, and oxygen desaturation events per hour with OSA.

Keywords: Obstructive sleep apnea, Apnoea-hypopnea index, Snoring, Polysomnography, Body mass index, Oxygen desaturation events per hour

INTRODUCTION

Obstructive sleep apnea-hypopnea (OSAH) is a sleep disorder that involves complete cessation or significant decrease in airflow, despite the breathing effort. Obstructive sleep apnea (OSA) is the most common type of sleep-disordered breathing. OSA is characterized by repetitive pharyngeal airway collapse during sleep, which obstructs the airway, causing apnea, and oxygen desaturation.[1]

Snoring is the most common symptom of OSA. A quick and reliable screening test to detect OSA is polysomnography (PSG). The Epworth sleepiness score (ESS) is an important parameter in predicting OSA. Other factors considered are male gender, older age (>50 years), body mass index (≥30), neck circumference (≥43 cm in males and ≥40 cm in females), and history of apnea witnessed by the bedroom partner.

OSA mainly affects obese individuals and it is defined as an apnea-hypopnea index (AHI) of five or more episodes per hour and is associated with daytime somnolence.

Obesity affects the upper airway anatomy because of the deposition of fat and metabolic activity of the adipose tissue.[2]

Soft tissue and bony abnormalities in morphology can cause airway narrowing during the awake state and collapse of the airway and apnea during sleep.

Multivariate analysis revealed that male gender, age, obesity (defined by BMI>30), and waist/hip ratio are significant risk factors for OSAS. Other risk factors include alcohol consumption, active and passive smoking, age, and craniofacial anomalies. Alcohol consumption is associated with worsening the severity of snoring.[3]

There was a high prevalence of OSA in patients with type 2 diabetes. OSA can contribute to atherosclerosis, insulin resistance, atrial fibrillation, and systemic hypertension associated with obesity.[4]

Body-weight reduction is found to improve sleep apnea and obesity treatment must be emphasized, including lifestyle changes, anti-obesity drugs, and bariatric surgery. OSA increases cardiometabolic risks by causing detrimental effects on adipose tissue metabolism.

The ENT causes for OSA are relatively simple and can be treated by safe medical or surgical procedures. We have to examine the patients who attend the sleep clinic with complaints of snoring. Those patients should undergo assessment including clinical history, otorhinolaryngology examination, and PSG.

METHODS

A prospective cross-sectional study was conducted in the Department of ENT at the Southern Railway Headquarters Hospital, Ayanavaram, Chennai (January 2023 to January 2024). 98 participants were included in the study. 50 participants were male and 48 participants were female. The study aimed to assess the prevalence and severity of OSA and to determine the factors associated with OSA using polysomnography. Descriptive analysis for quantitative variables was carried out by mean and standard deviation, and for categorical variables by frequency and proportion. Data was represented using appropriate diagrams like bar diagrams, pie diagrams, and box plots. Mean and standard deviation were calculated for continuous variables, and the percentage was assessed for categorical variables. Ethical committee approval was obtained. The Chi-square and analysis of variance (ANOVA) tests were used, and the p value <0.05 was considered statistically significant. Statistical package for the social sciences (SPSS) version 20 was used for statistical analysis.

Inclusion criteria

Patients attending the ENT OPD with a history of snoring, patients with complaints of excessive daytime somnolence, and patients >18 years were included in the study.

Exclusion criteria

Patients <18 years, patients who are not willing for PSG, patients who have already been treated for OSA, and patients who were not giving consent for the study were excluded.

Methodology

Patients attending the ENT OPD fulfilling the above-mentioned criteria were selected. Complete clinical history including age, and symptoms of OSA like excessive daytime sleepiness and history of smoking and alcohol consumption were asked. History of comorbidities like diabetes, hypertension, coronary artery disease, bronchial asthma, and hypothyroidism were asked. Body mass index (BMI) was calculated. Neck circumference (NC) was measured using a non-elastic tape.

Waist circumference was measured at the level of the umbilicus with the subject in a mid-expiratory position. Hip circumference was recorded at the widest point over the greater trochanters and the waist-to-hip ratio (WHR) was calculated.

The Epworth sleepiness scale (ESS) questionnaire was used to assess the likelihood of an individual dozing off.

ENT examination was conducted with special attention to tonsil size, Mallampati score, Friedman tongue position (FTP), deviated nasal septum (DNS), and turbinate hypertrophy.

An overnight PSG was performed on all of the patients. Electroencephalography, electrooculography, electro-cardiography, chin and tibial electromyography, oral-nasal airflow meter measured by thermocouples and nasal pressure, oxyhemoglobin saturation measured by finger pulse oximeter, chest and abdominal movements measured by respiratory inductive plethysmography, body position, and snoring noise captured by a microphone, were recorded. Digital video recording was performed throughout the night.

We were conducting a level I study for the participants. Embletta X100™ System, Middleton, USA, with the software Somnologica 5.1 version was used for doing the PSG.

The AHI is the number of apnea and hypopnea episodes averaged per hour of sleep. Supine and non-supine AHI were calculated. Average oxygen desaturation (AO2S), lowest oxygen desaturation (LO2S), and oxygen desaturation index (ODI) were calculated. From the PSG, patients were classified as having mild, moderate, and severe OSA.

RESULTS

The most common age group affected was between 51 to 60 years (42%), followed by 61 to 70 years (27%) and 41 to 50 years (15%). 51.02% of the participants were males and 48.97% of the participants were females (48.97%). The p value was <0.05 for increasing age. So there was a positive correlation between OSA and increasing age.

Table 1: Descriptive analysis of age distribution in the study population.

Age (in years)	Female	Male	Total	%
21 to 30	0	1	1	1.02
31 to 40	4	4	8	8.16
41 to 50	6	9	15	15.31
51 to 60	19	23	42	42.86
61 to 70	16	11	27	27.55
71 to 80	2	2	4	4.08
81 to 90	1	0	1	1.02
Total	48	50	98	100

Among the 50 male participants, 4.08% of participants were smokers and 15.31% of participants were alcoholics. Neither of the females smoked nor consumed alcohol.

The most common comorbidity in our study was hypertension (74.49%) followed by diabetes mellitus (36.73%). The p values were 0.214 and 0.226 for hypertension and diabetes respectively. CAD was seen in 34.69% of patients. Patients with bronchial asthma constituted 10.20%, while patients with hypothyroidism constituted 6.12%. There was no statistical significance between OSA and hypertension and there was no significant association between OSA and diabetes.

The most prevalent apnea was obstructive apnea (OA) (73.47%) followed by mixed apnea (10.20%). The p value was <0.05 for obstructive apnea. There was a statistically significant association between obstructive apnea and OSA.

Table 2: Descriptive analysis of comorbidities in the study population.

Comorbidities	Yes	No	Yes (%)	No (%)
DM	36	62	36.73	63.27
HTN	73	25	74.49	25.51
CAD	34	64	34.69	65.31
BA	10	88	10.20	89.80
HT	6	92	6.12	93.88

In our study, 84.69% of patients were obese (BMI>30). Among those obese participants, 31.63% of the participants were in class I, and 25.52% of participants were in class II. The mean BMI was 35.858 and the SD was 5.821. The p value was 0.646. There was no statistical significance between BMI and OSA.

Table 3: Descriptive analysis of BMI in the study population.

BMI	Numbers	%
15-19.9 (underweight)	0	0.00
20-24.9 (normal)	2	2.04
25-29.9 (overweight)	13	13.27
30-34.9 (class I)	31	31.63
35-39.9 (class II)	25	25.51
>40 (class III)	27	27.55
>30 (obese)	83	84.69
Total	98	100.00

In our study, most of the patients had mild OSA (36.73%) followed by participants with no OSA (26.53%). 20.41% of patients had moderate OSA. The p value was <0.05 for AHI. Hence AHI had a significant association with OSA.

Nearly 89.80% of the patients had nasal septal deviation. 62% of the patients had both right and left inferior turbinate hypertrophy. The p values were 0.011 and 0.003 for DNS and inferior turbinate hypertrophy respectively. We found a statistically significant association between OSA and nasal factors (DNS and inferior turbinate hypertrophy).

In our study, 36.73% of the patients had Mallampati grade 3 followed by 33.67% of the patients who had Mallampati grade 2. Most of the patients had FTP grade 4 (36.73%) followed by patients with FTP grade 3 (31.63%). 88.78% of the patients had grade 1 tonsil followed by patients with grade 2 tonsil (9.18%). There was a statistically significant association between OSA and FTP (p value=0.024).

Out of 98 patients, 88.78% of patients were found to have grade 1 tonsils, and 9.18% of patients had grade 2 tonsils. In our study, the mean oxygen desaturation events per hour for severe OSA was 48.09 with an SD of 19.40, and the mean oxygen desaturation events per hour for moderate OSA with an SD of 12.25. There was a significant association between oxygen desaturation events per hour and OSA.

Table 4: Descriptive analysis of the prevalence of apnea in the study population.

Prevalence	Yes (%)	No (%)	Yes	No
Obstructive	73.47	26.53	72	26
Central	7.14	92.86	7	91
Mixed	10.20	89.80	10	88

Among 98 participants, the mean lowest oxygen desaturation events per hour for mild OSA was 77.06 with an SD of 8.62, and the mean lowest oxygen desaturation events per hour for severe OSA was 71.94 with an SD of 8.44. A statistically significant association was found between the lowest O_2 desaturation events per hour and OSA (p value <0.05).

Table 5: Descriptive analysis of nasal factors in the study population.

Nasal factors	Yes (%)	No (%)	Yes	No
Septal deviation	89.80	10.20	88	10
R	41.83	58.16	41	57
L	47.95	52.04	47	51
Right ITH	75.51	24.49	74	24
Left ITH	76.53	23.47	75	23

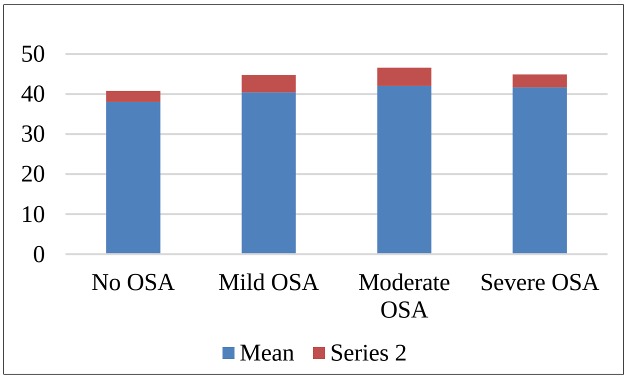

Figure 1: Bar diagram showing the distribution of neck circumference in the study population.

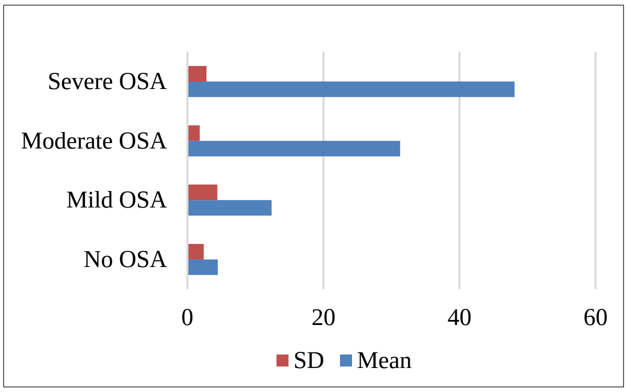

Figure 2: Clustered bar showing the distribution of oxygen desaturation events per hour.

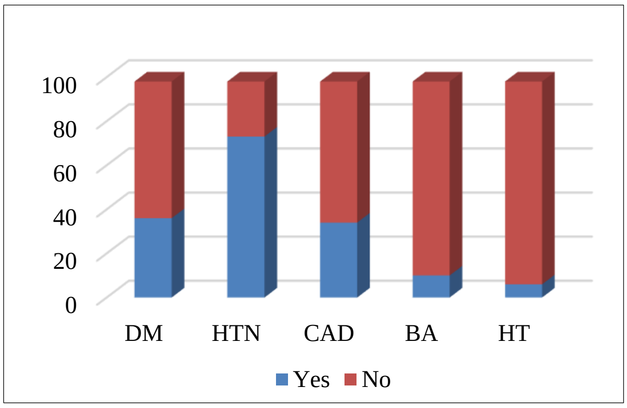

Figure 3: Bar diagram of comorbidities distribution in the study population.

In our study, the mean average oxygen desaturation events per hour were 91.88 for severe OSA and the mean average oxygen desaturation events per hour was 93.46 with an SD of 3.20 and 4.21 respectively. There was a significant association between average oxygen desaturation and OSA (p value <0.05).

There was a positive correlation between AHI and neck circumference (p value=0.0153).

There was a positive correlation between obstructive apnea and AHI (p value <0.001).

There was a positive correlation between obstructive apnea and oxygen desaturation (p value <0.001).

There was a negative correlation between OA and LO2S (p value=0.000157). We also found a negative correlation between OA and AO2S (p value=0.00366).

There was no correlation between: AHI and age, AHI and BMI, AHI and pulse mean, AHI and WHR, AHI and ESS, BMI and ESS, ESS and AO2S, ESS and LO2S, ESS and NC, ESS and ODI, ESS and OA, ESS and WHR, BMI and OA, NC and OA, and OA and WHR.

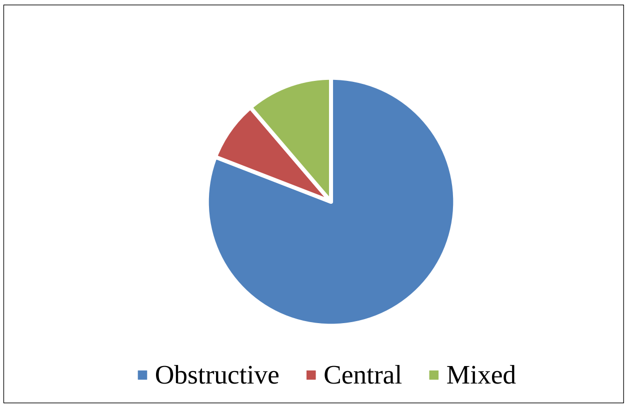

Figure 4: Pie chart showing the distribution of the prevalence of apnea.

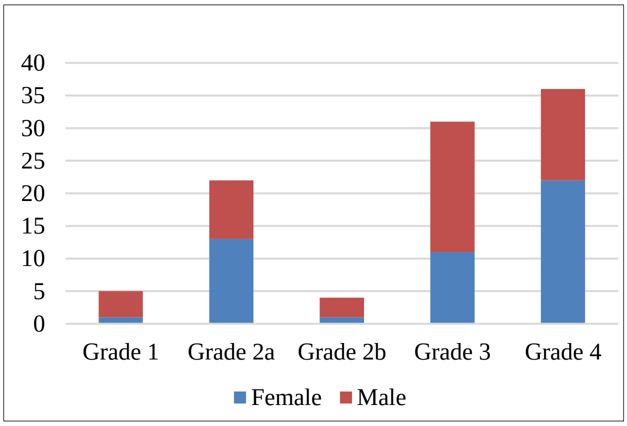

Figure 5: Bar diagram of FTP grading distribution in the study population.

DISCUSSION

A total of 98 patients who presented with snoring were included in the study. Detailed clinical history was obtained. Anthropometric measurements and ENT examinations were done. ESS score was obtained. These patients have undergone PSG. After the results of PSG, 36 patients were categorized as having mild OSA, 20 as moderate OSA, and 16 as severe OSA.

The maximum number of patients was in the age group of 51-60 years (42% of patients) followed by 61-70 years (27% of the patients). A study was conducted by Sharma et al in the Indian population which stated that OSA was found to be twice as common in men, especially in the age group of 40-60 years.[5]

In our study, 91% of female participants had OSA and 56% of male participants had OSA. Among the female participants, 45% had mild OSA, 25% had moderate OSA, and 20% had severe OSA. Among male participants, 28% had mild OSA, 16% had moderate OSA, and 12% had severe OSA. So there was a strong positive correlation between increasing age and OSA.

In our study group, 95% of the patients were non-smokers. Among 50 males, 4.08% of participants were smokers, 15.30% of participants were alcoholics, and 3% of participants were both smokers and alcoholics. Among the patients who smoked, only 25% of participants had severe OSA and 25% of participants had moderate OSA, and among the patients who consumed alcohol, 25% of patients had severe OSA and 75% of patients had moderate OSA.

In a study conducted by Jang et al, the odds ratio was higher in ex-smokers (OR: 1.53, 95% confidence interval) and current smokers (OR: 1.79, 95% confidence interval) when compared to non-smokers. In females higher OR was observed and the risk was found to be similar to non-smokers and pack years. In men, moderate risk was found in ex-smokers (OR: 1.61, 95% CI), and severe risk was present in current smokers (OR: 1.88, 95% CI).[6]

Simou et al did a systematic review and meta-analysis study which showed a 25% increase in the risk of OSA with the increase in alcohol consumption (RR=1.25, 95% confidence interval). However, the meta-analysis has also shown that mean alcohol intake was higher in OSA patients which was two units per week, but this difference was not statistically significant (p=0.41).[7]

The most common comorbidity among the patients studied was hypertension. The majority of the patients had hypertension (74.49%). On comparing the presence of hypertension with the OSA severity, it was found to be statistically not significant (p value=0.117). Amna Bangash conducted a study in 2020, which showed that in developed countries 75% of treatment-resistant hypertensives were found to have OSA.[8]

The second most common comorbidity in our study population was diabetes. 36% of patients were found to have diabetes. However, there was no statistical significance (p value=0.222).

Huh et al carried out a study on 7650 people of the Korean population about the prevalence, associated factors, and comorbidities associated with OSA and found the odds ratio in diabetes mellitus was 1.57 and hypertension was 4.81, obesity was 2.02, and synergistically the odds ratio was 3.88.[9]

Muraki et al conducted a study that showed the increased prevalence of type II diabetes in OSA patients. Diabetes can alter central respiratory control and can promote OSA. OSA can cause hypoxia which is intermittent and this can worsen insulin resistance.[10]

Pamidi et al established a study that showed a robust association between OSA and insulin resistance and the risk of type II diabetes which is independent of obesity. 83% of patients with type II diabetes suffered from unrecognized OSA and severe OSA was independently associated with poor glucose control.[11]

Vasheghani et al researched to establish the association between OSA and coronary artery disease and found that patients with OSA had an increased risk of myocardial infarction and hypertension. They found that the treatment for OSA reduces cardiovascular mortality and improves cardiovascular risk factors like insulin resistance, lipid profile, and blood pressure.[12]

Alkhalil et al did a study that showed that OSA was an independent risk factor for exacerbation of asthma. The common asthmatic features that promote OSAS symptoms are nasal obstruction, a decrease in pharyngeal cross-sectional area, and an increase in upper airway collapsibility. Vascular endothelial growth factor-induced airway angiogenesis, leptin-related airway changes, and OSAS-induced weight gain also may play a common mechanistic role linking both disorders.[13]

Pancholi et al conducted a study to find the prevalence between OSA and hypothyroidism. They found a close relationship between OSA and hypothyroidism, as hypothyroidism has led to the development of OSA. Early diagnosis of OSA in hypothyroidism and treatment of hypothyroidism has reduced the prevalence of OSA.[14]

The BMI of patients was calculated according to World Health Organization (WHO) classification in our study. 84.69% of the patients were obese and 13.27% were overweight. Only 2.04% of patients had their BMI in the normal range. The mean BMI was 35.858 with an SD of 5.821. The p value was 0.646 and hence there is no statistical significance between BMI and OSA.

Salvador et al conducted a study which showed the prevalence of OSA in morbid obesity. It was found to be

80% in males and 50% in females with morbid obesity. Weight reduction brought a dramatic improvement in OSA. 10% weight reduction was found to reduce apnea index by 26%.[15]

Wall et al performed a study in 2012 among people >50 years of age in primary care in the UK and concluded that those people with BMI >40 kg/m^2 were 27.39 times (95% CI: 24.64 to 30.46) more likely to have OSA (p<0.0001).[16]

A systematic review and meta-analysis was conducted by Dong et al, among 3214 participants which elicited that increased BMI was associated with an increased risk of OSA. AHI was found to be higher in obese than in non-obese individuals and the difference was found to be statistically significant in children and adults.[17]

Based on our study, the mean neck circumference was 42.03 cm for moderate OSA and the mean neck circumference for severe OSA was 41.66 cm. The p value was found to be 0.002 and there was a statistical significance between neck circumference and OSA. There was a positive correlation between NC and AHI. Ahbab et al carried out research among 44 patients and reported that the mean BMI and NC were higher in severe OSA patients (p=0.021).[18]

In our study, majority of patients had obstructive apnea. 73.47% of patients had obstructive apnea, 10.20% of the patients had mixed apnea, and 7.14% of patients had central apnea. The p value was <0.05 for obstructive apnea, so there was a positive correlation between obstructive apnea and OSA.

Javeheri et al researched central apnea and found that central apnea occurs when $PaCO_2$ goes below the apneic threshold. Central apnea was characterized by alternating apnea/ hypopnea with hyperpnea. They have adopted a concept of loop gain, to indicate ventilatory instability and susceptibility to central apnea.[19]

Choudhary et al carried out a study that concluded that Nasal obstruction was most commonly caused by turbinate hypertrophy.[20]

In our study, 36% of the patients had Mallampati grade 3 followed by grade 2 in 33% of the patients. Grade 4 was present in 24% of the patients. Among the patients with grade 2 Mallampati, 39% of the patients had moderate OSA and 27% of the patients had severe OSA. We found a negative correlation between the high Mallampati score and OSA severity. However, the p value is 0.003, so there was a statistical significance between Mallampati grading and OSA.

Nuckton et al carried out research among 137 patients to assess the effectiveness of the Mallampati score while assessing the severity of OSA. They found for every point increase in Mallampati score, the odds of having OSA increased more than 2 fold (odds ratio (for 1-point increase) =2.5, 95% confidence interval, 1.2-5.0, p=0.01) and the AHI increased by more than 5 events per hour (coefficient=5.2; 95% confidence interval 0.2-10; (p=0.04).[21]

In our study, 36% of patients had Friedman tongue position grade 4, 31% of patients had FTP grade 3, and 22% of patients had FTP 2a. Among patients with FTP grade 4, 19% of patients were found to have severe OSA. The p value was 0.024. So, there was a statistically significant association between FTP and severity of OSA.

In December 2011, Friedman carried out research on 2513 patients and found that the analysis of the correlation of tongue position with OSA severity showed a correlation of 0.184 (0.049, 0.646, p=0.026) for the Friedman tongue position. They concluded that Friedman's tongue position had a significant association with the severity of OSA.[22]

In our study, 88% of the patients had deviated nasal septum and 75% had enlarged turbinates. Among those patients with septal deviation, 40% of patients had mild OSA, 19% presented with moderate OSA, and 17% with mild OSA had DNS. The p value was 0.023 for septal deviation. There was a statistically significant association between the severity of OSA and the presence of DNS.

Among the patients who presented with inferior turbinate hypertrophy, 62% of the patients had both right and left inferior turbinate hypertrophy.

Magliulo et al conducted a study about nasal pathologies and their association with OSA. Three conditions were thought to be the cause of nasal obstruction. They were anatomical conditions (DNS, enlarged turbinates), chronic rhinosinusitis, and allergic rhinitis.[23]

In our study, 87% of the patients had tonsils grade 1, and 9% had tonsils grade 2. Among 87 patients with tonsil grade 1, 37% had mild OSA, 20% of patients had moderate OSA and 17% of the patients had severe OSA. The p value was 0.772. So, the association between the tonsil size and OSA severity was not statistically significant.

Jara et al published research stating the association between tonsil size and OSA in adults. This cross-sectional study consisted of a cohort (N=83) that were middle-aged (mean age 43±12 years) and were predominantly male (61%), obese (mean BMI 33±7 kg/m^2), and had severe OSA (mean AHI 32±28). They have concluded that palatine tonsil grade was strongly associated with palatine tonsil volume (beta=1.8, 95% confidence interval, p<0.001) and AHI (beta=13.5, 95% confidence interval, p=0.01).[24]

A study was conducted by Singh et al among 51 subjects and found that tonsillar hypertrophy was associated with poor sleep efficiency and REM sleep which was decreased in subjects who were suspected to have OSA.

Oropharyngeal structures were found to affect the architecture of sleep in patients with OSA.[25]

In our study, 36.53% of patients had an AHI score of more than 5 and less than 15, 20.41% of patients had an AHI score between 15 and 30, and 16.33% of patients had an AHI score of more than 30. The p value is <0.05. There was a statistically significant association between the AHI score and the severity of OSA. Tapia et al concluded from his study that the AHI score should be used to show the diagnosis and severity of OSA and evaluate the efficacy of the treatment.[26]

Among 98 participants, the mean ODI for severe OSA was 48.09, the mean ODI for moderate OSA was 31.28, and the p value was <0.05. So we found a statistical significance between ODI and OSA. There was also a positive correlation between ODI and obstructive apnea and the p value was <0.001. Temirbekov et al conducted a study that showed a strong positive correlation between AHI and ODI (p value <0.005).[27]

CONCLUSION

Increasing age, neck circumference, deviated nasal septum, and inferior turbinate hypertrophy could be predisposing factors for OSA. We also have seen that the parameters from PSG like obstructive apnea and oxygen desaturation index, average oxygen desaturation per hour, and lowest oxygen desaturation events per hour were strongly associated with OSA.

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