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Original Research Article

Role of polysomnography in patients of snoring

Saurav Sachdeva[1]*, Karan Sharma[1], Nirmal Kajal[2]

[1]Department of ENT, [2]Department of TB & Chest, Government Medical College, Amritsar, Punjab, India

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***Correspondence:**
Dr. Saurav Sachdeva,
E-mail: sauravschdv9@gmail.com

ABSTRACT

Background: A useful working definition of snoring is the production of sound by the upper aero digestive tract during sleep. Polysomnography (PSG) is the monitoring of physiological parameters and physiological or pathological events in sleep.
Methods: Fifty patients of either sex, having age >16 years were randomly selected from the ENT OPD based on the pre-determined inclusion and exclusion criteria. Subjective evaluation of snoring was done using Epworth sleepiness Scale. Neck circumference and body mass index were calculated in all patients. Then, complete local ENT examination was done including diagnostic nasal endoscopy. After that, full night polysomnography test of at least 6 hours duration was conducted.
Results: Normal nasal endoscopy was seen in 64% of patients. DNS, DNS with ITH/MTH, ITH/MTH unilateral, ITH/MTH bilateral and nasal polyps were seen in 14%, 12%, 0%, 8% and 4% of patients respectively. Mean apnoea-hypopnoea index (AHI) was 6.58. 48% of the patients in our study had normal AHI (0-4). Mild, moderate and severe AHI was present in 44%, 6% and 2% of the patients respectively.
Conclusions: All cases of snoring must be subjected to thorough clinical examination and nasal endoscopy and thereafter, be evaluated further for presence of sleep apnoea with polysomnography.

Keywords: Polysomnography, Apnoea-hypopnoea index

INTRODUCTION

A useful working definition of snoring is the production of sound by the upper aero digestive tract during sleep. According to the American heritage dictionary of the English language it is ‘‘to breathe during sleep with harsh, snorting noises caused by vibration of the soft palate’’.[1] Naturally occurring or drug-induced sleep is a requirement for its appearance. Snoring is a breathing noise that appears during the inspiratory and sometimes also the expiratory phase of the respiratory cycle.[2] The source of the sound is the pharyngeal segment of the upper airway. Relative atonia of the upper airway dilator muscles during sleep induces narrowing and increased resistance at this level.[3] As a consequence, airflow becomes turbulent and the pharyngeal tissues vibrate as the air passes through. More specifically, snoring is characterized by oscillations of the soft palate, pharyngeal walls, epiglottis and tongue.[4,5]

Snoring is commonly associated with abnormalities of the soft palate or uvula. An overly long or floppy soft palate may vibrate irregularly with airflow. This abnormal vibration makes a sound snoring. Other sources may also contribute to snoring and for this reason, careful and complete evaluation is imperative in order to direct effective treatment. Nasal sources (deviated septum, inferior turbinate hypertrophy, polyps, chronic and allergic nasal congestion), nasopharyngeal sources (enlarged adenoids and nasopharyngeal growths), oral sources (enlarged tongue base, small jaw, enlarged uvula or tonsils) and throat and neck sources (floppy neck soft tissues) may all contribute to snoring and to sleep apnea.

In some cases, snoring may be increased by alcohol consumption late at night (which causes throat to relax and become more floppy). From an epidemiological perspective snoring is a highly prevalent disorder. In an early population-based investigation extending to 5713 people, the prevalence of habitual snoring was found to be 19%, corresponding to 24.1% of the male and 13.8% of the female population.[6] Increased frequency of snoring with age was another finding in this study. Whilst snoring is a ubiquitous phenomenon that is also known to occur in animals, its characteristics cannot easily be defined.[7]

Sleep-disordered breathing (SDB) is characterized by the frequent occurrence of pathological respiratory events, i.e., apnoeas and hypopnoeas. An apnoea is defined as a complete cessation of breathing of at least 10 s. During apnoeas there is no breathing sound. Resumption of breathing is associated with a sequence of snores. The sound quality of these consecutive inter apnoeic snores may vary markedly.[8] With partial collapse of the upper airway, airflow is decreased but not abolished. Corresponding respiratory events that last at least 10 s are called obstructive hypopnoeas. Snoring persists during these events and may show a crescendo pattern of increasing loudness. The number of apnoeas plus hypopnoeas per hour of sleep is the apnoea–hypopnea-index (AHI). The combination of an AHI5 per hour and excessive daytime sleepiness is referred to as the obstructive sleep apnoea (OSA) syndrome.[9] When no apnoeas and hypopnoeas occur during sleep and the individual has no daytime complaints, the vibratory activity of the pharyngeal airway is referred to as 'simple snoring'.[10]

Snoring may have several other side effects. Intense flutter of the upper airway structures may cause vibratory trauma, resulting in early inflammation and permanent damage of the pharyngeal tissues and adjacent vessels.[11-15] To overcome increased upper airway resistance, snorers significantly increase inspiratory muscle effort, as a consequence of which nadir intra thoracic pressures may double or triple.[16,17] Excessive negative intrathoracic pressure increases cardiac afterload by increasing myocardial transmural pressure and may facilitate gastro-esophageal reflux.[18,19]

A potentially large number of anatomical and physiological processes must be integrated into a model of upper airway obstruction during sleep. One model that allows at least some integration is the concept of "balance of forces".[20] The balance of forces model allows an accurate description of how multiple variables alter upper airway size. Airway size is determined by both dilating and collapsing forces. Dilating forces include upper airway muscle tone, mechanical force of upper airway wall structure and positive intraluminal airway pressure. Collapsing forces include tissue mass, tissue adhesive forces and negative intraluminal pressures. The resulting differences in these forces are the distending force, which acts on the wall of the upper airway. When the distending forces increases, the airway size increases; when it decreases, the airway size decreases.

The upper airway is more prone to collapse if there is upper airway narrowing, decreased intraluminal pressure or if either its compliance or the extraluminal pressures are increased. The upper airway dilator muscles are normally activated during inspiration, which reduces intraluminal pressure, and consequently decreases the tendency to upper airway collapse. The upper airway collapses when the force generated by these muscles is exceeded by the negative airway pressure produced by the inspiratory muscle activity. Measurement of the critical pressure (Pcrit) required to collapse the upper airway has been performed in humans undergoing general anaesthesia and complete neuromuscular paralysis.[21] Patients with OSAH had a positive Pcrit, with the airway collapsing at atmospheric pressure, and required positive pressure to relieve the obstruction, whereas normal control subjects required a negative pressure to collapse the upper airway.

The tools to diagnose OSA includes domiciliary single channel (overnight oximetry), domiciliary multichannel (respiratory and oximetry signals) and inhospital full polysonography, which includes measurement of respiratory, oximetry and sleep architecture assessment using EEG, electrooculography (EOG) and electro-myelography (EMG).

Over the past 50 years, technologic advances and scientific progress have permitted huge improvements in the systems used to record sleep. French scientist Henri Pi´eron (1881–1964) with his work entitled "Le probl`eme physiologique du sommeil" published in 1913, is usually regarded as the pioneer of the modern approach to sleep research.

Polysomnography (PSG) is the monitoring of physiological parameters and physiological or pathological events in sleep. Electroencephalographic (EEG) activity in wakefulness and in sleep in humans was initially described in 1928.[22] The earliest overnight sleep studies were performed in the 1930s using a polygraph to record EEG activity and electro-oculograms (EOG) on paper.[23] Major milestones in the history of sleep medicine include the identification of rapid eye movement (REM) sleep in 1953, the description of normal sleep cycles in 1957 dividing sleep into non-REM and REM periods, and the recording of muscle atonia in REM sleep.[24-26] Current PSG techniques are based on the parameters used in the widely accepted standard scoring system for sleep stages outlined by Rechtschaffen and Kales in 1968.[27] The test result of polysomnography is called polysomnogram, also abbreviated as PSG. Polysomnography is useful in the diagnosis, therapy and follow up of sleep related disorders.

METHODS

This study entitled as "A study of role of polysomnography in patients of snoring" was conducted in the Department of ENT, Ram Lal EYE and ENT Hospital in collaboration with Department of Tuberculosis and Chest attached to Government Medical College, Amritsar. This study includes 50 patients of age group >16 years who presented with chief complaint of snoring in our OPD. The study criteria of patients were as follows:

Inclusion criteria

Inclusion criteria were patients of age group >16 years old reporting with:

a) History of snoring
b) History of mouth breathing
c) History of disturbed sleep due to snoring.

Exclusion criteria

Exclusion criteria were central causes of OSA eg. In stroke, in congestive heart failure, parkinson's disease, encephalitis, cheyne-stokes breathing etc; Patients of age group <16 yrs old; Jaw abnormalities; Morbid obesity (BMI>40).

Each case is taken from outpatient Department of ENT and informed consent was obtained. Cases were clinically evaluated by first taking detailed history regarding symptoms, risk factors of snoring and other relevant personal history. Subjective evaluation of snoring was done in all patients using visual analogue scale and Epworth sleepiness scale. Then, complete local ENT examination was done including Diagnostic nasal endoscopy in all patients. Neck circumference and body mass index (BMI) of all patients was calculated. The Mallampatti scoring and grading of tonsil size was done in each patient.

Routine investigations like haemoglobin (Hb), total leucocyte count (TLC), differential leucocyte count (DLC), urine complete examination, blood sugar level, ECG, lipid profile which includes serum cholesterol levels, triglyceride levels, low density lipoprotein (LDL) and very low density lipoprotein (VLDL) were done in all patients. Radiological evaluation of the soft tissue neck and the paranasal sinuses was done wherever indicated.

The complete procedure of polysomnography was explained to each patient and an informed consent was taken. The device used for polysomnography was Somnomedics SOMNOscreen^{TM} plus and the software used was Domino version 2.6.0.

The polysomnography study was started at time, which coincides with the normal sleeping habits of the patient. The following sensors were used : 2 external effort belts (abdomen and thoracic), periodic leg movement sensors on tibialis anterior muscle of each leg, activity sensor on wrist of non-dominant hand, SPO_2 sensor, microphone on neck, flow sensor (thermistor), 2 ECG electrodes, 2 EOG electrodes and EEG electrodes.

Various parameters like apnoea-hypopnoea index (AHI), sleep efficiency and minimum O_2 saturation level etc were obtained from polysomnogram.

Apnoea-hyponoea index (AHI) is calculated by the

$$\frac{\text{Number of apnoea events}}{\text{Number of hours of sleep}}$$

AHI values are categorized as:

- Normal: 0-4
- Mild Sleep Apnoea : 5-14
- Moderate Sleep Apnoea : 15-29
- Severe Sleep Apnoea : 30 or more

Sleep efficiency is calculated by the number of minutes of sleep divided by the number of minutes in bed.

RESULTS

Age distribution

The study comprises of fifty patients with the majority of patients within age group of 31-40 years. The mean age was 40.3 years with the youngest patient being of 20 years male and the eldest was 62 years male.

Gender distribution

The majority of patients in our study were males with 72% and females were 28%.

Demographic distribution

In our study, majority of patients belonged to urban area (70%) while, 30% patients belonged to rural area.

Distribution of presenting complaints

Snoring and mouth breathing were the most common presenting symptoms seen in our study group with 100% presenting with snoring and 64% presenting with mouth breathing. The other symptoms like excessive daytime sleepiness, nasal obstruction, breathing pauses and nasal discharge and post nasal drip were seen in 46%, 32%, 28% and 30% respectively.

Epworth sleepiness scale distribution

Patients in this study has mean Epworth sleepiness scale (ESS) of 11.4. The highest number of patients (66%) has

ESS of 10-15 and 10% patients has ESS of 16-24. The highest value of ESS was 22 and the lowest was 9.

Table 1: Age wise distribution of patients.

Age (years)	No. of patients	Percentage (%)
16-20	1	2.0
21-30	5	10.0
31-40	21	42.0
41-50	19	38.0
>50	4	8.0
Total	50	100.0

Table 2: Gender wise distribution of patients.

Sex	No. of patients	Percentage (%)
Male	36	72.0
Female	14	28.0
Total	50	100.0

Table 3: Distribution of presenting complaints.

Complaints	No. of patients	Percentage (%)
Snoring	50	100.0
Breathing pauses	14	28.0
Excessive daytime sleepiness	23	46.0
Nasal obstruction	16	32.0
Mouth breathing	32	64.0
Nasal discharge and post nasal drip	15	30.0

Table 4: Distribution of body mass index (BMI).

BMI	No. Of patients	Percentage (%)
<20	1	2.0
20-25	7	14.0
26-30	32	64.0
31-35	8	16.0
36-40	2	4.0
Total	50	100.0

Risk factors

In this study, 48% of patients were alcoholic and 26% were smokers.

Body mass index distribution

In this study, mean BMI of studied patients was 27.63 kg/m^2. The highest number of patients (64%) had BMI of 26-30. The lowest BMI in this study was 19.6 kg/m^2 and the highest was 38.1kg/m^2.

Co-morbid conditions

In our study of 50 patients, hypertension was most common associated morbidity (42%) followed by diabetes mellitus and hypothyroidism in 18% and 10% respectively.

Table 5: Distribution of neck circumference.

Neck circumference (cm)	No. of patients	Percentage (%)
<20	1	2.0
20-30	10	20.0
31-40	36	72.0
>40	3	6.0
Total	50	100

Table 6: Distribution of nasal endoscopic findings.

Endoscopic findings	No. of patients	Percentage (%)
Normal	31	62.0
DNS	7	14.0
DNS with MTH/ITH	6	12.0
ITH/MTH U/L	0	0.0
ITH/MTH B/L	4	8.0
Nasal polyps	2	4.0
Total	50	100

Table 7: Distribution of Mallampati scoring.

Class	No. of patients	Percentage (%)
I	9	18.0
Ii	25	50.0
Iii	15	30.0
Iv	1	2.0
Total	50	100

Table 8: Distribution of apnoea-hypopnoea index.

Apnoea-hypopnoea index	No. of patients	Percentage (%)
0-4 (normal)	24	48.0
5-14 (mild)	22	44.0
15-29 (moderate)	3	6.0
>30 (severe)	1	2.0
Total	50	100.0

Table 9: Distribution of sleep efficiency.

Sleep efficiency (%)	No. of patients	Percentage (%)
<85	7	14.0
85-95	38	76.0
>95	5	10.0
Total	50	100

Neck circumference distribution

In this study, mean neck circumference of patients was 33.86 cm with maximum number of patients (72%) having 31-40 cm. The lowest value of neck circumference was 19 cm and the highest 42 cm.

Table 10: Distribution of average oxygen saturation.

Average oxygen saturation (%)	No. of patients	Percentage (%)
<85	3	6.0
>85	47	94.0
Total	50	100

Nasal endoscopy findings

In this study, nasal endoscopic examination was done in all patients. Normal nasal endoscopy was seen in 64% of patients. DNS, DNS with ITH/MTH, ITH/MTH unilateral, ITH/MTH bilateral and nasal polyps were seen in 14%, 12%, 0%, 8% and 4% of patients respectively.

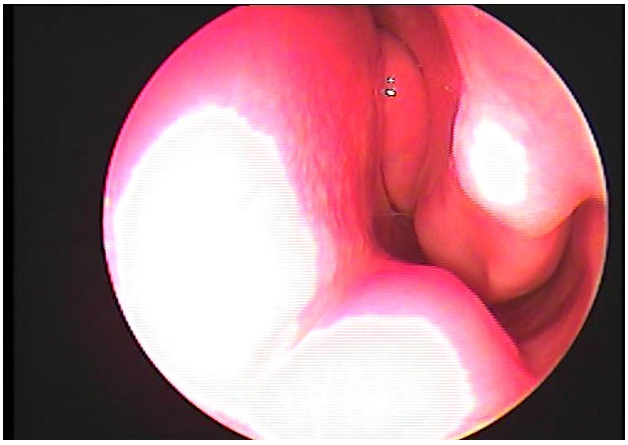

Figure 1: Showing DNS in nasal endoscopy.

Mallampati score distribution

In our study, most common class of Mallampati scoring was class II (50%) followed by class III, I and IV with 30%, 18% and 2% respectively.

Tonsil size grade distribution

In our study, most common grade of tonsil size was grade 1 with 60% followed by grade 2, 0, 3 and 4 with 28%, 8%, 4% and 0% respectively.

Apnoea-hypopnoea index distribution

In this study, mean apnoea-hypopnoea index (AHI) was 6.58. The lowest AHI value was 1 and the highest was 30. 48% of the patients in our study had normal AHI (0-4). Mild, moderate and severe AHI was present in 44%, 6% and 2% of the patients respectively.

Figure 2: Showing patient prepared for polysomnography.

Figure 3: Showing SOMNOSCREEN device.

Sleep efficiency

In our study, mean sleep efficiency was 89.04%. The lowest value of sleep efficiency was 66% and the highest was 97%.

Oxygen saturation level

In our study, mean average oxygen saturation level was 93.06%. 94% of the patients in our study had average oxygen saturation level >85%.

DISCUSSION

Clinical examination of OSA patient requires a detailed history, ideally with the partner present during the consultation. The partner may be able to describe the breath-holding, associated gasping, movement arousal. A physical finding that is particularly relevant is presence of central obesity. Other important examination features include a detailed nasal and oropharyngeal assessment including the Mallampati score, the presence or absence of retrognathia, craniofacial abnormalities and tonsillar hypertrophy. Associated medical conditions such as hypertension, diabetes and hypertriglyceridaemia should always be looked for.

In epidemiological study of snoring from a random survey of 1075 participant, it was estimated that 43.75% of the middle aged (30-69 years) UK population snore and 41.5% of the UK adult population snore. The male to female ratio is approximately 2:1, with 29% of males and 12.5% females snoring. An approximate total 14.9 million adults snore with approximately 10.4 million males and 4.5 million females.[28]

In cross-sectional study to estimate the prevalence and related clinical features of obstructive sleep apnoea–hypopnea (OSAH) in the general population, habitual snoring was found in 35% of the population and breathing pauses in 6%. Both features occurred more frequently in men, showed a trend to increase with age, and were significantly associated with OSAH.[29]

In similar study, consecutive patients with obstructive sleep apnoea-hypopnea syndrome who were evaluated in a public otorhinolaryngology center were studied. Two hundred twenty-three patients (142 men and 81 women) were included (mean age, 48±12 y; body mass index, 29±5 kg/m^2; AHI, 23.8±24.8 events per hour).Sleepiness and nasal obstruction were reported by approximately half of patients, but the most common complaint was snoring.[30] The results of above studies were consistent with our study findings.

Another study aims to investigate the prevalence, profiles, and potential risk factors for snoring and OSAHS and the association between OSAHS and ethnicity was done in Guangxi, China. Urban and rural population-based cluster samples were randomly selected in each of eight counties/cities. All residents aged 14 years or older in the selected clusters were interviewed using a standardized questionnaire. Among 12,742 sampled subjects, 10,819 completed the questionnaire (response rate = 84.9%). Univariate analysis showed that the OSAHS prevalence was significantly higher among the following groups: urban residents, elderly individuals, smokers, drinkers, those with higher body mass index (BMI), those with more years of schooling, those with nasal problems, those whose parents are Han, and those who usually sleep in prone position. However, multiple logistic regression analysis revealed that only urban residency, age, smoking status, drinking status, and BMI were the risk factors for OSAHS.[31]

In another study, a total of 1,035 consecutive Chinese patients with snoring (mean age±SD- 45±15 years, BMI 26.6±4.3 kg/m^2) were examined by overnight polysomnography, and subjective EDS was assessed using the Epworth sleepiness scale (ESS). ESS score progressively increased as the severity of OSAHS aggravated among these patients. Progressive worsening of nocturnal hypoxemia was observed from mild to severe OSAHS patients with a strong correlation with ESS score. The stepwise multiple regression analysis performed to evaluate the correlations of individual clinical and polysomnographic variables with the ESS score revealed that the ESS score significantly correlated with the oxygen desaturation index (ODI), apnoea -hypopnea index (AHI), and body mass index (BMI), and ODI was the strongest determinant of ESS score.[32]

In similar study, when a stepwise multiple regression analysis was performed, neck circumference in men and BMI in women were shown to be the strongest predictors of sleep apnoea which is also seen in our study.[33]

In a two-phase cross-sectional study, the prevalence and related clinical features of obstructive sleep apnoea–hypopnea (OSAH) in the general population were estimated. The first phase, completed by 2,148 subjects (76.9%), included a home survey, blood pressure, and a portable respiratory recording, whereas in the second, subjects with suspected OSAH (n=442) and a subgroup of those with normal results (n=305) were invited to undergo polysomnography (555 accepted). AHI was associated with hypertension after adjusting for age, sex, body mass index, neck circumference, alcohol use, and smoking habit. This study adds evidence for a link between OSAH and hypertension.[29]

Another study investigated the relationship between sleep-disordered breathing and insulin resistance, indicated by fasting serum insulin level and insulin resistance index based on the homeostasis model assessment method (HOMA-IR). A total of 270 consecutive subjects (197 male) who were referred for polysomnography and who did not have known diabetes mellitus were included, and 185 were documented to have OSA defined as an apnoea–hypopnea index (AHI) ≥5. OSA subjects were more insulin resistant, as indicated by higher levels of fasting serum insulin (p=0.001) and HOMA-IR (p<0.001); they were also older and more obese. This association between OSA and insulin resistance was seen in both obese and non-obese subjects. This study findings suggest that OSA is independently associated with insulin resistance, and its role in the atherogenic potential of sleep disordered breathing is worthy of further exploration.[34]

In similar study, the subjects with the nose obstructed awoke more often, had a greater number of changes in sleep stage, had a prolongation of rapid-eye-movement (REM) latency, and spent a greater amount of time in stage I non-REM sleep (light sleep). Acute nasal obstruction caused a statistically significant increase in the number of partial and total obstructive respiratory events (obstructive hypopnea and obstructive apnoea). Sleep apnoea developed in one subject during this study merely on the basis of acute nasal obstruction.[35]

Another study concluded that in patients with allergic rhinitis, obstructive sleep apnoeas are longer and more frequent during a period of symptomatic nasal obstruction than when symptoms are absent. The results support the concept that a high nasal resistance may be a contributing factor in the pathogenesis of obstructive sleep apnoeas in general.[36]

In another study, participants who reported nasal congestion due to allergy were 1.8 times more likely to have moderate to severe sleep-disordered breathing than were those without nasal congestion due to allergy. Men and women with nasal obstruction, especially chronic night time symptoms of rhinitis, are significantly more likely to be habitual snorers, and a proportion also may have frequent episodes of apnoea and hypopnea, indicative of severe sleep-disordered breathing.[37] The results of above studies were consistent with our study.

In similar study, it was observed that on average, for every 1-point increase in the Mallampati score, the odds of having obstructive sleep apnoea (apnoea-hypopnea index ≥5) increased more than 2-fold (odds ratio [per 1-point increase]= 2.5; 95% confidence interval: 1.2-5.0; p=0.01), and the apnoea -hypopnea index increased by more than 5 events per hour (coefficient= 5.2; 95% confidence interval: 0.2-10; p=0.04). These results were independent of more than 30 variables that reflected airway anatomy, body habitus, symptoms, and medical history.[38]

In our study severe AHI (30) was seen in 35 years old female who presented with chief complaints of snoring, breathing pauses and excessive day time sleepiness. Epworth sleepiness scale and body mass index of the patient were 16 and 38.1 kg/m^2 respectively. The neck circumference of the patient was 42 cm. The associated comorbidity was hypothyroidism. On nasal endoscopy inferior turbinate hypertrophy was present bilaterally. The Mallampatti scoring and tonsil size grade of the patient were 1 and 2 respectively. The sleep efficiency, minimum oxygen saturation and average oxygen saturation level were 66%, 74% and 85% respectively.

The lowest value of AHI (1) was seen in 20 years old male who presented with the chief complaint of snoring, Epworth sleepiness scale and body mass index of the patient were 9 and 19.6 kg/m^2 respectively. There was no associated comorbidity. The neck circumference of the patient was 37 cm. On nasal endoscopy nasal polyps were present bilaterally. The Mallampati scoring and tonsil size grade were 1 and 3 respectively. The sleep efficiency, minimum oxygen saturation and average oxygen saturation were 95%, 94% and 98% respectively.

CONCLUSION

All patients of snoring should be evaluated for cause of snoring. As nasal cause has been found to be cause of snoring in a good number of patients, so all patients of snoring must be subjected to complete ENT examination including nasal endoscopy. After that polysomnography should be done as it provides information regarding presence of sleep apnoea, type of sleep apnoea, severity of sleep apnoea, sleep efficiency and O_2 saturation level etc. which are important in management of these patients.

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