Original Article

Positional Obstructive Sleep Apnoea

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ABBRIVATIONS USED IN THIS ARTICLE

OSA = Obstructive Sleep Apnoea

POSA = Positional Obstructive Sleep Apnoea

SDB = Sleep Disordered Breathing

PSG = Polysomnography

AHI = Apnoea-Hypopnoea Index

NSAHI = Non-Supine Apnoea-Hypopnoea Index

SpO_2 = Arterial Oxygen Saturation

ODI = Oxygen Desaturation Index

TST = Total Sleep Time

CPAP = Continuous Positive Airway Pressure

REM = Rapid Eye Movement

RERAs = Respiratory Effort-Related Arousals

Abstract

Background. Obstructive sleep apnoea (OSA) is considered positional (POSA) when sleep disordered breathing (SDB) events occur predominantly in supine position. Scarce data from Indian sub-continent regarding POSA are available.

Methods. Records of patients who underwent two nights of nocturnal polysomnography (PSG) from January 2018 to June 2019 in the Department of Pulmonary Medicine, Government Medical College and Hospital, Chandigarh were evaluated. Patients were diagnosed as POSA if apnoea-hypopnoea index (AHI) was ≥5/h and supine AHI was at least two times higher than non-supine AHI (NSAHI).

Results. Of the 130 patients studied, 100 were diagnosed as OSA; of these 68 PSG studies were analysed. Fourteen of the 68 (20.6%) had POSA. Both groups were similar in age, gender, body mass index (BMI) and quality of sleep. Mean AHI (P=0.001), NSAHI (P<0.001), right AHI (P=0.002), oxygen desaturation index (ODI) (P=0.007), number of subjects with oxygen saturation measured by pulse oximetry (SpO_2) <90% (P=0.032) and <80% (P=0.031) and percentage of total sleep time (TST) with SpO_2 <90% (P=0.031) was significantly lesser in POSA than non-POSA patients. Mean minimum SpO_2 was significantly higher in POSA than non-POSA (P=0.025). Post continuous positive airway pressure (CPAP) trial, though average CPAP pressures differed significantly (P=0.001), resultant AHI and other PSG parameters in the two groups were not statistically different, suggesting adequate response to treatment.

Conclusions. Identification of POSA is a key step for further studies aimed at deciphering wide array of issues which can be associated with this entity.

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Introduction

Obstructive sleep apnea (OSA) is a highly prevalent disorder in the general population, but usually remains undiagnosed, and hence, untreated. A study[1] in a semi-urban Indian population estimated the prevalence OSA to be 13.7%. Complex metabolic and inflammatory derangements associated with the condition lead to increased morbidity and mortality.[2,3] Costs associated with the diagnosis and treatment of the disease are also considerable, and add to the problem.[2] Continuous positive airway pressure (CPAP) is an effective treatment for the disease.[3] It has been shown to be cost-effective in the long run in terms of individual as well as societal benefits.[4,5] A study[6] in India in the past has showed that the overall adherence rate to CPAP was only 30% with the main cause of non-use of CPAP being the inability to buy a CPAP device.

Though the entity named as positional OSA (POSA) has been long identified, with different definitions from time to time, however, it has not received much attention separately.[3,7-9] OSA is considered positional in those patients in whom sleep disordered breathing (SDB) occur predominantly in supine position. It has been hypothesised that POSA is present in about half of the patients suspected to have SDB. The numbers/proportions are even higher in the Asian population.[10-13] It has been noticed that it is more common in patients with mild to moderate OSA.[3,9] Positional therapy, though grossly under-utilised, is gaining attention and is being recommended for the treatment of such POSA patients.[3,9,11] In the era of personalised medicine, identification of POSA as a separate entity may have implications on the disease management and final outcomes.

The present study was planned to identify this sub-group of POSA patients. The polysomnographic profiles between POSA and non-POSA patients were compared and the potential factors which could discriminate this sub-group of POSA patients were analysed. Also its relevance in the Indian setting, as limited data is available, is evaluated in the present study.

Material and Methods

In this retrospective study, departmental database of the patients who underwent full night nocturnal polysomnography (PSG) and CPAP titration, from January 2018, to June, 2019 at Department of Pulmonary Medicine, Government Medical College and Hospital, Chandigarh was evaluated. Patients aged 18–65 years with apnea-hypopnea index (AHI) >5/h diagnosed on full night Level 1 PSG were included. Patients with total sleep time (TST) <4 hours, a supine or non-supine sleep time <30 minutes, those who did not undergo CPAP trial on next day of PSG and those who did not achieve optimal titration on CPAP trial were excluded. An optimal titration was defined as a reduction in respiratory disturbance index (RDI) <5 per hour for at least a 15 minutes duration which included supine rapid eye movement (REM) sleep at the selected pressure that was not continually interrupted by spontaneous arousals or awakenings.[14]

Out of a total of 130 PSGs, 100 were diagnosed with OSA and underwent CPAP titration the following night. Sixty-eight PSGs met the inclusion and exclusion criteria and were finally analysed.

PSG recordings using a digital polygraph system (Somnoscreen TN plus, make: SomnomedicGmbh, Germany) were recorded including electroencephalogram, electrooculogram, electrocardiogram and submental and anterior tibial electromyogram. Nasal airflow was measured by a pressure sensor and arterial oxygen saturation by finger pulse oximetry. Thoraco-abdominal motion was recorded by straps containing piezo-electric transducers. Snoring was recorded through a piezo snoring sensor. Body position was determined by a position sensor that could differentiate between upright, supine, left, right and prone positions and confirmed by a sleep technician. Synchronised digital video recordings were also obtained and reviewed to confirm the body position in cases of any discrepancy.

Patients with an AHI >5/h underwent CPAP titration the following night. During CPAP titration PSG, patients were administered CPAP therapy starting at 4 cmH_2O and was increased by at least 1 cmH_2O with an interval not shorter than 5 min if at least two obstructive apnoeas, three hypopnoeas, five respiratory effort-related arousals (RERAs) or 3 min of loud or unambiguous snoring was observed.[14]

The data were manually reviewed for the analysis. Sleep and respiratory events were scored according to 2012 American Academy of Sleep Medicine guidelines.[15]

Obstructive sleep apnoea was defined as a decrease of airflow of >90% for at least 10 seconds, in the presence of respiratory efforts. Central apnoeas were defined as a decrease of airflow of >90% for at least 10 seconds and no respiratory effort of thorax or abdomen. Hypopneas were defined as a decrease in nasal pressure by ≥30% for at least 10 seconds, associated with either ≥3% desaturations from pre-event baseline or an arousal. The AHI was calculated as the sum of total events (apnoeas and hypopnoeas) per hour of sleep. An AHI of 5-15/h was labelled as mild OSA, AHI of 15-30/h as moderate and AHI of >30/h as severe OSA, as assessed by PSG. Oxygen desaturation index (ODI), considered as ≥3% arterial oxygen desaturations/hour, was

calculated in the same manner based on total number of desaturations divided by sleep time. Snore index was defined as the total number of snores per hour of sleep.[15]

Other calculated variables included the respiratory parameters, total sleep time (TST), sleep efficiency (TST time divided by time in bed), time slept in supine and non-supine positions, and post CPAP titration pressures and variables.

Patients were categorised as having POSA or non-POSA according to criteria suggested by Cartwright, the most commonly used definition for POSA.[7] Patients were diagnosed to have POSA if overall AHI was ≥5/h and the supine AHI was at least two times higher than the non-supine AHI (NSAHI).[7] POSA was sub-typed depending on degree of AHI while in non-supine position as: subtype I (NSAHI <5/h), subtype II (NSAHI ≥5 and <15/h) and subtype III (NSAHI ≥15/h).[16]

Statistical Analysis

Categorical variables are reported as counts and percentages. Group comparisons were made with Chi-Square test/Fisher's Exact test. Continuous data are presented as mean ± standard deviation and range; or median and interquartile range, as appropriate. Normality of quantitative data was checked by measures of Kolmogorov-Smirnov tests of Normality. For skewed data, comparisons for two groups were made by Mann-Whitney test. For normally distributed data, Student's t-test was applied to compare two groups. For non normally distributed data, comparison based on the basis of grades of POSA was made by Kruskall-Wallis test followed by Mann-Whitney test. Right and left sided comparison was done by Wilcoxon Signed rank test. A P-value of <0.05 was considered as significant. Analysis was conducted using IBM Statistical Package for the Social Sciences, USA (SPSS) Statistics for Windows, Version 22.0 (Armonk, NY: IBM Corp.).

Results

Out of 68 OSA patients included in the study, 14 (20.6%) had POSA and 54 were labelled as non-POSA. Both the groups were age- and gender-matched. There was no difference in BMI in the two groups. Both the groups were also matched with respect to quality of sleep as reflected by TST, sleep efficiency, sleep latency and percentage of REM sleep (Table 1).

The mean AHI and NSAHI was significantly less in POSA as compared to non-POSA (P=0.001 and <0.001, respectively). There was no difference between the two groups when number of patients as per different grades of OSA were compared (Table 1).

When the right and left lateral mean AHI was compared between the two groups, it was observed that mean AHI in the right lateral position was significantly less in POSA than non-POSA (P=0.002). Left lateral

Table 1.Various polysomnographic parameters in POSA and non-POSA patients

Parameter	POSA (N=14)	Non-POSA (N=54)	P value
Age (in years)	52.2±14.4	51.5±15.1	0.865
Gender			
Male	8	38	0.346
Female	6	16	
Mean BMI (Kg/m^2)	29.7±2.9	31.3±5.0	0.211
<25	0	3	0.215
25–30	8	18	
>30	6	33	
Sleep efficiency %	79.5±7.6	81.3±11.0	0.214
Sleep latency (in minutes)	12.8±14.7	5.1±5.6	0.268
% REM sleep	30.4±24.7	25.3±19.6	0.564
Total sleep time (in hours)	5.8±0.8	5.9±0.9	0.534
AHI	33. 5±12.6	50.2±23.4	0.001
Mild	2	3	0.408
Moderate	3	8	
Severe	9	43	
Supine AHI	48.6±20.1	51.9±23.2	0.603
Non-supine AHI	18.5±12.2	48.0±25	<0.001
Left AHI	15.3±11.1	30.6±27.8	0.155
Right AHI	19.6±16.7	45.7±33.9	0.002
% Time in supine position	55.9±28.6	57.3±25.5	0.862
% Time in non-supine position	44.1±28.6	42.7±25.5	0.862
% Time in left lateral position	16.1±15.9	17.6±22.8	0.848
% Time in right lateral position	30.7±21.6	26.454±18.3	0.510
ODI	39.4±18.0	56.7±25.5	0.007
Minimum SpO_2 (%)	80.6±6.5	75.0±8.6	0.025
Average SpO_2 (%)	94.2± 2.0	92.7±3.2	0.079
Number of SpO_2 <90%	67.9±120.8	160.6±151.7	0.032
Number of SpO_2 <80%	10.5± 29.3	36.2±71.0	0.031
% of TST with SpO_2 <90%	7.5±15.3	18.1±23.1	0.031
Snore index	144.3±147.2	170.2±176.3	0.585
Snore index supine	101.143±152.96	121.705±155.28	0.514
Snore index left	273.236±303.71	177.404±222.15	0.370
Snore index right	161.686±206.79	182.735±214.93	0.242

mean AHI was also less in POSA but the difference was not statistically significant. However, the mean percentage time in the right and the left lateral position remained similar in POSA and non-POSA group.

Respiratory parameters, such as mean ODI (P=0.007), mean number of SpO_2<90% (P=0.032) and <80% (P=0.031), and mean percentage of time with SpO_2<90% (P=0.031) were significantly less in POSA as compared to non-POSA. Mean minimum SpO_2 and mean average SpO_2 was higher in POSA than non-POSA (P=0.025 and 0.079, respectively). Snore index was less in POSA than non-POSA but the differences were statistically non-significant (Table 1).

When POSA was classified into different sub-types, the number of patients in POSA sub-type I, II, III were 1, 8 and 5, respectively.

Post-CPAP trial, it was seen that AHI improved in both the groups, and the resulting AHI so achieved in the two groups was not statistically different. After this optimal CPAP titration, it was seen that average CPAP pressures differed significantly in both the groups, being 8.7±1.4 cmH_2O in POSA and 11.4±2.4 cmH_2O in non-POSA (P=0.001). The mean values of various other post-CPAP parameters were similar in the two groups (Table 2).

Table 2. Polysomnographic parameters in POSA and non-POSA patients after CPAP titration

Parameter	POSA (N=14)	NON POSA (N=54)	P-value
AHI	5.1±2.4	5.0±2.3	0.940
Supine AHI	9.0±11.4	6.2±3.7	0.638
Non-supine AHI	6.1±2.1	7.0±19.1	0.643
Left AHI	5.4±13.4	4.3±15.8	0.329
Right AHI	3.1±3.5	3.9±6.9	0.435
ODI	11.2±7.7	13.6±10.3	0.549
Minimum SpO_2 (%)	86.3±7.5	85.9±5.7	0.513
Average SpO_2 (%)	96.1±1.1	95.4±1.9	0.293
Number of SpO_2 <90%	2.1±4.1	10.8±23.3	0.178
Average CPAP pressures (cmH_2O)	8.7±1.4	11.4±2.4	0.001

Discussion

Humans are amongst those few mammals who prefer to sleep in supine position.[17] However, this preferential position in some individuals may be a gateway to a wide variety of disorders related to sleep and needs to be avoided.

When this relationship of position with respect to sleep was studied, it was found that out of 68 OSA patients analysed in the study, 14 had POSA (20.6%). Various other studies have reported the prevalence of POSA to range from 9% to 75% amongst OSA patients. Worldwide, the prevalence of POSA has been reported to be even higher in Asian population.[10,11,17-20]

The mean age of POSA and non-POSA groups was almost similar, in contrast with some studies which have shown that POSA is more common in younger patients.[10,18,20-23] This could be because diagnosis at an early age also depends on the awareness and availability of diagnostic modalities, which is better in the western world than our country. Our results are similar to the already available literature, signifying that gender or its associates do not exert any influence.[20,21,23] Similar to previous studies[10,12,18-23], POSA patients had lower BMI in the present study.

The mean AHI was significantly less in POSA than non-POSA patients, suggesting that POSA could represent an earlier stage of SDB, and if not diagnosed and treated, may progress further in severity. Studies in the past have also proposed that if left untreated, patients go through stages from simple positional snoring to positional early stage mild and moderate disease and finally severe OSA (without positional component).[19,24] Previous studies have also reported lower AHI in patients with POSA.[3,10,12,19-21,23] The hypothesis that PSG procedure and the bulky equipment so attached for the same may itself increase the tendency of the patients to sleep in supine position because of associated physical constraint and limitation in movement, and hence, may be responsible in over-estimating the AHI severity has already been refuted.[23] Hence, the results so derived from our study seem to reflect a true picture.

With almost similar sleep times in lateral/non-supine position in the two groups, POSA patients had significantly less AHI when compared with non-POSA patients. Positional therapy, one of the treatments for POSA patients, may not have any role in non-POSA patients, as they have higher AHI in the lateral/non-supine position also. Even when patient's position is changed from supine to non-supine, AHI values remain significantly high.

Difference in respiratory parameters reflect that the severity of the disease is less in POSA group than non-POSA group, and hence, serves as another indicator that POSA may be a precursor of more severe form of disease if left untreated. Preference of POSA patients to sleep in non-supine position could be contributing to less snoring episodes in this group.

Though the sub-classification of POSA was done into various sub-groups, the numbers in each sub-group was quite less to reach at any conclusion. Data worldwide is being generated highlighting the need for such detailed

sub-classification of POSA, so as to facilitate targeted therapies and enhance cost effectiveness in future management strategies.[25,26]

After CPAP, the patient's sleep time in supine position increased in both the groups. This could be due to bulkiness of the CPAP device, as the patients found it difficult to lie in lateral position and because of the relief of AHI in supine position after CPAP, making the patient lie comfortably that way too.

Diagnosis of POSA as a separate entity from the OSA has advantages from the treatment point of view. It has been stated that positional dependency of OSA can influence the outcomes of various treatment modalities, like the use of oral appliances and/or surgery. Mandibular advancement devices (MADs) have shown to yield better results in POSA than non-POSA.[27] Uvulopalatopharyngoplasty (UPPP) has been documented to be the most successful surgery, if patients have POSA.[21]

Comfort and cost of treatment so administered, issues related to adherence to therapy and long term implications on cardiovascular system, metabolic syndrome, insulin resistance etc need to be considered seriously to manage OSA in totality. It has already been widely proposed that CPAP is superior to positional therapy in the treatment of POSA. However, CPAP acceptance is usually poor in OSA patients, especially those with mild OSA where day-time sleepiness is not troublesome. Studies in the past have proposed that some proportion of POSA patients who are receiving positional therapy only may become non-POSA in follow-up PSG's, and hence, need to be closely monitored.[28] There are multiple issues related to long-term compliance and follow-up of the patients who are on positional therapy alone. The problem may increase manifold in patients with co-morbidities. However, the new generation positional therapy devices provide better compliance and a significant proportion of patients tend to benefit.[29,30] These small, easy to wear devices attached to either the neck or the chest, provide a subtle vibrating stimulus that prevents patients from adopting the supine position. The patients can change position without feeling uncomfortable or waking from the sleep. These devices are simple-to-use for patients and clinicians, are reversible and are effective in reducing the AHI during short-term follow-up.[31] Addition of positional therapy to surgery in POSA patients has shown to improve the final outcomes of the treatment.[24] However, the importance of CPAP should never be negated. About one-fifth of the OSA patients had POSA. CPAP is equally effective in both POSA and non-POSA patients. Positional therapy as an initial treatment in addition to life-style changes may be advised once the diagnosis of POSA is confirmed.

Conclusions

Further research for the generation of more evidence on the relevance of POSA in the Indian settings is necessary. In the era of personalised medicine, a holistic approach with identification of POSA as a separate entity will help in framing individually tailored multi-faceted treatment pathways for maximising the final outcomes. Patient participation and preferences as per comfort and affordability are a key to reach at real world effective management strategies.

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