Original Article

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Split Night versus Full Night Polysomnography in Obstructive Sleep Apnoea Syndrome: A Retrospective Study

Internal Medicine Section

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ABSTRACT

Introduction: Obstructive Sleep Apnoea (OSA) is traditionally evaluated using a diagnostic Polysomnography (PSG) which is then followed by a PSG with Continuous Positive Airway Pressure (CPAP) titration. Split Night PSG (SN-PSG) includes the diagnostic and titration study in a single night. Split Night PSG is a better technique however, the requirements for CPAP titration are too strict.

Aim: To assess the accuracy of different duration of split night compared to a Full Night PSG (FN-PSG) in OSA Syndrome.

Materials and Methods: A retrospective observational study was performed in the Department of Pulmonary Medicine at VMMC and Safdarjung Hospital, from January 2019 to May 2019 at Safdarjung Hospital was done. Apnoea-Hypopnea Index (AHI) was assessed at the 1 hour, 2 hour, 3 hour and 4 hour from analysis of SN-PSG data obtained from FN-PSG. Using the Area Under Receiver Operating Characteristic (AUROC) curve, it was compared to the FN-PSG. Calculations were made to validate the diagnosis by a 2 hour PSG using different AHI cut-off points (5/hour to 15/hour).

Results: Data from 20 PSG recordings was processed. A stronger correlation of FN-AHI was demonstrated with AHI at 2 hour (p-value <0.0001) (r value=0.902). At 2 hours of study, with an AHI cut-off of 5 hour, the sensitivity and specificity was 92.9% and 83.3%, respectively. The Positive Predictive Value (PPV) was 100% and Negative Predictive Value (NPV) was 83.3% (AUROC=0.976; p-value <0.0001). At 2 hours, AHI cut-off of 15 hour, the sensitivity and specificity was 71.4% and 100%, respectively. The PPV was 100% and NPV was 86.7% (AUROC=1.000; p-value <0.0001).

Conclusion: Split-night PSG is effective for diagnosing severe OSA. A lower cut-off of AHI may be used to qualify patients for CPAP titration.

Keywords: Apnoea hypopnea index, Continuous positive airway pressure, Sleep Study, Titration

INTRODUCTION

The OSA is increasingly affecting the general working population and currently affects 26% of this population [1]. It is a major contributor to cardiovascular, cerebrovascular and pulmonary vascular disorders [2,3]. The usual method for evaluation of OSA consisted of two separate overnight in-laboratory polysomnograms. A diagnostic polysomnogram was performed first, and then a polysomnogram with CPAP titration to reduce the episodes of disturbed breathing was performed. This method remains the gold standard PSG practice [4]. This also allows observing breathing and response to CPAP across the full spectrum of sleep states and positions. But as PSG is time consuming and also resource-intensive, we combine diagnostic and CPAP titration into a single night and term it as "Split-Night" PSG (SN-PSG). According to the clinical practice guidelines published by American Academy of Sleep Medicine (AASM), a patient with an AHI of ≥15/hour or AHI≥ 5/hour with symptoms is diagnosed to have OSA [5].

The same guidelines recommend that SN-PSG was acceptable only when AHI was > 40/hour during a minimum of 2 hour of diagnostic PSG, or when AHI was > 20/hour and clinical judgment suggested this more lenient threshold was appropriate [5]. The cut-off of AHI for the SN-PSG is based on early studies [5,6] and needs to be revised, so that split night studies can be done at a lower AHI and shorter time interval of 2 or 3 hour instead of 4 hours. This way we may perform more split night studies and avoid the added expense of two studies (diagnostic and therapeutic).

Previous studies demonstrate that Full Night AHIs (FN-AHI) are comparable to AHIs recorded in the first few hours of sleep [6-8]. There is paucity of similar data assessing the accuracy of SN-PSG in Indian OSA patients. Hence, this study aimed to compare the recorded AHI of FN-PSG with AHI recorded in first few hours of sleep and thus determine the accuracy of SN-PSG over FN-PSG.

MATERIALS AND METHODS

A retrospective observational study was performed in the Department of Pulmonary Medicine at VMMC and Safdarjung Hospital, New Delhi, India, from January 2019 to May 2019. The Institutional Ethical Committee (IEC/VMMC/SJH/project/2019-09/78) was obtained. FN-PSGs was done in 20 patients with suspected Obstructive Sleep Apnoea Syndrome (OSAS).

Inclusion criteria: All full-night diagnostic sleep studies (with a total sleep time of >6 hours and a sleep efficiency of more than 75%) done in the mentioned study period were included in the study.

Exclusion criteria: Sleep studies of less than four hours of duration, sleep studies investigating Central Sleep Apnoea (CSA), Cheyne-Stoke Respiration (CSR), Papanicolaou (PAP) test titration studies, unattended bedside studies, and studies of poor quality were excluded from this study.

The patients underwent overnight, in laboratory, supervised PSG (Alice 6, Respironics, Murrysville, PA, USA). If a patient underwent more than one study, only the first interpretable sleep study was analysed and all subsequent sleep studies were excluded.

Procedure

The scoring was based on the criteria laid down in the AASM manual for the scoring of sleep and associated events [9]. PSG was performed using Alice sleep-ware software. Basic demographic profile of the patients was recorded. Subjects underwent overnight PSG using the standardised protocols and the scores for sleep stages, leg movements and arousals were assessed [10]. Pulse oximetry and nasal pressure cannula were used to assess arterial oxyhaemoglobin saturation and airflow, respectively. To evaluate respiratory effort, thoracoabdominal motions were used (using respiratory inductance plethysmography).

Apnoeas were defined as a cessation of airflow ≥10 seconds, and hypopnoeas were defined by a 30% decline in airflow ≥10 seconds accompanied by an oxyhaemoglobin desaturation ≥4% [9]. The number of apnoeas (central, mixed, or obstructive) plus hypopnoeas per hour of sleep were scored and AHI was calculated accordingly. Respiratory effort-related arousals were scored episodes ≥10 seconds of reduced airflow not meeting criteria for apnoeas or hypopnoeas and terminating with an arousal [9]. The Respiratory Disturbance Index (RDI) was calculated as the number of apnoeas plus hypopnoeas plus respiratory arousals per hour of sleep. All PSGs were performed, graded, and reviewed by registered polysomnographic technologists before being examined by sleep medicine experts. Authors extracted the data from the recorded FN-PSG and separated it at 1 hour, 2 hour, 3 hour and 4 hour from lights off time, and analysed it.

STATISTICAL ANALYSIS

All the data was collected in a predesigned proforma and transferred into an Excel spreadsheet. Parametric data was represented as mean and standard deviations, and categorical data was presented as percentage. The AHI estimated at different times after lights off was corelated with the full night AHI (gold standard). The ability of different time periods to accurately assess the severity of OSAS was assessed by seeing the concordance between the AHI at different time periods. Using an AHI cut-off of 5/hour and 15/hour for diagnosing the presence of OSAS, the ROC curve was made for AHI calculated at 1 hour, 2 hour, 3 hour and 4 hour of PSG compared to a FN-PSG (gold standard). Statistical significance was set at 5% (corresponding to a p-value of <0.05).

RESULTS

The mean age of the subjects was 53±17 years with equal gender distribution (M:F=1:1). The mean AHI recorded was 19.40±21.41/hour. At 1 hour, mean AHI recorded was 13.15±20.03/hour and it had a significant correlation (p-value=0.002) (r-value=0.657). A stronger correlation of FN-AHI was demonstrated with AHI at 2 hour (p-value <0.0001) (r value=0.902) [Table/Fig-1].

At 1 hour, severity was correctly classified in 70%, at 2 hour patients were correctly classified in 75%, and at 4 hour, 85% were correctly classified. Severe Sleep Disordered Breathing (SDB) was correctly classified across all the time points [Table/Fig-2].

	FN-AHI (per hour)	1 hour AHI (per hour)	2 hour AHI (per hour)	3 hour AHI (per hour)	4 hour AHI (per hour)
Mean±SD	19.40± 21.41	13.15± 20.03	14.88± 16.49	18.89± 20.81	20.25± 22.69
Correlation to FN-AHI	1.0	0.657	0.902	0.967	0.968
p-value	-	0.002	<0.0001	<0.0001	<0.0001

[Table/Fig-1]: Correlation between AHI recorded at various time points during the PS and correlation with the full night AHI recordings.
p-value of <0.05 was considered to be significant; Pearson correlation quotient

For an AHI cut-off of 5, the sensitivity and specificity at 1 hour was 71.4% and 83.3%, respectively. At 2 hours of study, with AHI cut-off of 5, the sensitivity and specificity were 92.9% and 83.3%, respectively. For an AHI cut-off of 15, the sensitivity and specificity at 1 hour were 71.4% and 100%, respectively. At 2 hours of study, with AHI cut-off of 15, the sensitivity and specificity were 71.4% and 100%, respectively. This suggests that a 2 hours diagnostic study with a lower cut-off of >15/hour also detects most patients with a FN-AHI of >15/hour [Table/Fig-3].

DISCUSSION

The most important observation noted in our study was that there was a significant correlation between the FN-AHI and the AHI at 1 hour. This correlation grew stronger with AHI at 2, 3 and 4 hours. This was similar to the findings in previous studies [11,12]. Khawaja IS et al., had reported that the 2 hours AHI and 3 hours AHI correlated strongly with the full night AHI [11]. Similarly, Kim DK et al., had reported a significant correlation of AHI between the first two hours and full night of sleep for patients with severe OSA [12].

It was observed that the AHI measured at 1 hour correctly classified the severity in 14 (70%) of the 20 patients. At second hour, AHI measured correctly classified the severity in 15 (75%) of the 20 patients. More patients were correctly classified at later time intervals. What is interesting to note is that at AHI measured at 1 and 2 hour, correctly classified patients with severe SDB. This was in contrast to what was observed in the study done by Nikkonen S et al., [13]. In his study, he suggested that AHI measured at 2 hours over estimated the severity of OSA, as compared to FN-AHI. He also suggested that using 2 hour AHI for classification resulted in more consistent differences in hazard ratios between the OSA severity categories for all mortality types [13]. Since FN-AHI is subjected to changes in the position patient takes while sleeping, it is also suggested that two hour-AHI may have less inter-night variability than FN-AHI. Also, in case of non OSA, mild, and moderate categories, FN-AHI may underestimate the severity of OSA in such patients.

In our study, ROC analysis showed that at 1 hour, AHI cut-off of >5 / hour had a sensitivity and specificity of 71.4% and 83.3%, respectively for the diagnosis of OSA. Also, an AHI >15 cut-off had a sensitivity and specificity of 71.4% and 100%, respectively. Similarly at 2 hours, AHI >5 had a sensitivity and specificity of 92.9% and 83.3%, respectively. Study by Wahba N et al., suggested a lower AHI cut-off of 15 for CPAP titration, as compared to recommendations by AASM [14]. Similar observations were also noted by Khawaja IS et al., and Chou KT et al., [11,15]. Khawaja IS et al., had concluded that the first two or three hours of sleep is of sufficient diagnostic accuracy to rule in OSA at an AHI threshold of 5/hr [11]. Chou KT et al., had similarly concluded that an PSG recording indicating an AHI of ≥30/hr for two hours is sufficient to diagnose severe OSA and CPAP titration can be initiated [15]. The current study is one of the few studies that evaluated AHI >15 for patient eligibility for CPAP titration. An AHI >15 was chosen as many health insurance companies approve of use of

	FN-AHI (Gold Standard)	1 hour AHI (per hour)			2 hour AHI (per hour)			3 hour AHI (per hour)			4 hour AHI (per hour)		
		Total	Correct classification	Incorrect classification	Total	Correct classification	Incorrect classification	Total	Correct classification	Incorrect classification	Total	Correct classification	Incorrect classification
No SDB	6	9	5 (55.55%)	4 (44.44%)	6	5 (83.33%)	1 (16.66%)	8	6 (75%)	2 (25%)	6	5 (83.33%)	1 (16.66%)
Mild SDB	7	6	4 (66.66%)	2 (33.33%)	9	6 (66.66%)	3 (33.33%)	6	5 (83.33%)	1 (16.66%)	7	6 (85.71%)	1 (14.28%)
Moderate SDB	2	2	2 (100%)	0	0	0	0	0	0	0	1	1 (100.00%	0
Severe SDB	5	3	3 (100%)	0	5	4 (80%)	1 (20%)	6	5 (83.33%)	1 (16.66%)	6	5 (83.33%)	1 (16.66%)
Total number of correct classifications			14 (70.00%)			15 (75%)			16 (80%)			17 (85%)	
Total number of incorrect classifications				6 (30%)			5 (25%)			4 (20%)			3 (15%)

[Table/Fig-2]: Classification of severity of AHI at different time intervals.
SDB-Sleep disordered breathing; p-value of <0.05 was considered to be significant

		AHI >5	AHI >15
1 hour AHI	Area	0.887	0.885
	Strain elastography	0.087	0.110
	p-value	0.007	0.006
	Sensitivity	71.4%	71.4%
	Specificity	83.3%	100%
	PPV	90.9%	100%
	NPV	55.6%	86.7%
2 hour AHI	Area	0.976	1.000
	Strain elastography	0.030	0.000
	p-value	0.001	<0.0001
	Sensitivity	92.9%	71.4%
	Specificity	83.3%	100%
	PPV	92.9%	100%
	NPV	83.3%	86.7%
3 hour AHI	Area	0.982	1.000
	Strain elastography	0.024	0.000
	p-value	0.001	<0.0001
	Sensitivity	85.7%	85.7%
	Specificity	100%	100%
	PPV	100%	100%
	NPV	75%	92.9%
4 hour AHI	Area	0.976	1.000
	Strain elastography	0.030	0.000
	p-value	0.001	<0.0001
	Sensitivity	92.9%	100%
	Specificity	83.3%	100%
	PPV	92.9%	100%
	NPV	83.3%	100%

[Table/Fig-3]: ROC Analysis with AHI cut-offs > 5 and > 15 at different time intervals.
SE: Strain elastography; PPV: Positive predictive value; NPV: Negative predictive value
p-value of <0.05 was considered to be significant

CPAP at AHI >15 without any co-morbidities. Moreover, if a 2 hours AHI is accurate in patients with milder OSA (i.e., AHI >5), it would imply that rest of night could be adequately used for CPAP titration attempt rather than needlessly waiting for more diagnostic time or asking patients to come back for a full night CPAP titration attempt. Future studies with larger sample size may validate our findings and may have important economic, convenience and resource utilisation implications for both patients and providers.

Limitation(s)

The limitation of the current study is the retrospective nature of the study and another limitation is the small sample size due to which results cannot be generalised.

CONCLUSION(S)

This study, using the recommendations and criteria given by AASM, examined the full night PSG studies and partial night PSG data obtained over different recording times. We can conclude that a lower cut-off of AHI may be used to qualify patients for CPAP titration. Current AHI threshold of 40 or greater may be too stringent. Also, instead of 4 hours of diagnostic study period, a shorter interval of 2 to 3 hours may be sufficient for determining the AHI and thus switching to CPAP titration may be done sooner. This suggests that SN-PSG may be extended to a broader population of patients suspected to have SDB, and not restricted only to patients with a higher baseline AHI.

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