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## Polysomnographic Profile of Hypertensive Patients with Sleep Related Breathing Disorders-An Observational Study

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### ABSTRACT

**Background:** Obstructive Sleep Apnea [OSA] is now well recognised as an independent risk factor for Hypertension. Still there is a paucity of research in identifying the predictors of Hypertension in patients with sleep-related breathing disorders. This study is undertaken in this context to look into the clinical profile of hypertensive patients with OSA and to see how it differed from normotensive patients with OSA.

**Materials and Methods:** A total of 85 subjects were included in the study. Symptoms suggestive of OSA were sought in a structured interview. They were asked to fill up the Epworth sleepiness scale questionnaire in the presence of their partner. Patients were grouped as Hypertensive if they are diagnosed Hypertension based on blood pressure or if they are currently taking antihypertensive medications. The patients who did not belong to the above category were grouped as Normotensives.. A complete physical examination and anthropometry followed by overnight polysomnography (OPS) were done in all patients. Apnea-Hypopnea index of >15 is taken as clinically significant suggestive of moderate to severe OSA. Statistical analysis was done using SPSS statistical software.

**Results:** Average age of hypertensive patients with OSA was at a higher level than that of normotensive patients with OSA.

There was a high proportion of hypertension in patients with clinically significant OSA [AHI>15] compared to those with mild OSA or primary snoring.

**Conclusions:** We may conclude that OSA patients with AHI > 15 have 2.85 times risk of hypertension when compared to patients with mild OSA. Also age is the most meaningful factor in predicting the development of hypertension in these patients with moderate to severe OSA.

**Keywords:** Sleep-related breathing disorders, Obstructive sleep apnea, Hypertension, Epworth sleepiness score, Apnea-Hypopnea index, Desaturation index, Snore index.

## INTRODUCTION

Sleep-related breathing disorders [SBD] have emerged as a major global public health burden. It is characterised by repeated events of ever increasing resistance to airflow in the upper airway. The spectrum of SBD includes primary snoring, Upper airway resistance syndrome, Sleep hypopnea syndrome, Obstructive sleep apnea [OSA] syndrome and obesity hypoventilation syndrome. Of these, obstructive sleep apnea syndrome is the most severe form having considerable impact on individual's health.

Obstructive sleep apnea has been strongly implicated in the initiation and progression of cardiovascular diseases. The interrelation between OSA and Hypertension remains still under explored. There is a high prevalence of hypertension in OSA patients as well as high levels of OSA in hypertensive cohorts. The available evidences now suggest that OSA is casually related to the development of Hypertension as an independent risk factor. It is also observed that 70% of patients with refractory hypertension have underlying sleep related breathing disorder [1]. The normal nocturnal dipping pattern of blood pressure is blunted or lost

in patients with OSA. The current evidence also suggest that treatment of OSA with CPAP results in decrease in 24-hour mean and diastolic pressure and an improvement in nocturnal blood pressure pattern[2]. Interestingly, recent evidence also points towards an inverse relationship that OSA can be aggravated through increase in pharyngeal resistance induced by co-existing hypertension [3]. The exact pathophysiological mechanism contributing the development of Hypertension in OSA patients is unclear but it is postulated that repeated episodes of obstructive apnea result in nocturnal hypoxemia and CO<sub>2</sub> retention which trigger chemoreflex activation resulting in increased peripheral sympathetic activity causing vasoconstriction and surges in arterial blood pressure [4, 5]. These nocturnal metabolic, pressor and reflex responses are carried over to daytime also via mediators like plasma endothelins [6]. Additionally it is also found that OSA is linked to vascular endothelial dysfunction, oxidative stress, vascular remodelling, hypercoagulability and stimulation of rennin angiotensin system resulting in cardiovascular consequences [7, 8, 9,10,11].

The clinical and polysomnographical characteristics of Hypertensive patients with OSA is not well defined. Most of our information is derived from two large community based prospective studies namely Wisconsin Sleep Cohort study (WSCS) and the Sleep Heart Health study (SHHS). WSCS concluded that BP increases linearly with increasing AHI (apnea-hypopnea index) independent of age, gender and BMI. AHI is the traditional polysomnographic index which is used to measure obstructive sleep apnea severity. It is the average number of obstructed breathing events per hour. They found out that for every unit increase in AHI, risk of hypertension increases by 4%. The BMI adjusted OR for having Hypertension was 1.75 and 3.07 for AHI cut off set at 15 and 30 [12]. But an interesting point to be noted was that the study group in Wisconsin Sleep Cohort was aged between 30-60 years. And the study was able to show ample evidence to support the association between OSA and Hypertension in this age group.

Sleep Heart Health Study involved subjects which were older (>40 years) and ethnically more heterogeneous. In this study, the OR for HTN in severe OSA patients was 1.37 compared to Non-OSA group after adjusting BMI, Smoking and alcohol. Strength of association was statistically significant but obviously was lower compared to WSCS. They also found that the level of risk was further lowered in older individuals to the point that there was no association between HTN and OSA of any severity in subjects older than 60 years. So they concluded that there is significant association between OSA and HTN in middle aged individuals while there is a lack of association between OSA

and HTN in elderly. Thus age was a major determining factor in defining the association between OSA and HTN as per this study [13].

The temporal association between OSA and HTN was also studied in a subgroup of patients in these major research works. Longitudinal data from Wisconsin Sleep cohort indicate that baseline SBD [AHI>15] increases the risk of incident hypertension (over 8 years) >2 fold [14]. In contrast, longitudinal data from SHHS showed that the risk of incident HTN is significantly increased with increase in baseline AHI, but after adjusting for BMI, the risk was markedly attenuated and became non significant.

Thus overall, the existing evidences show clear association between OSA and HTN in cross sectional studies but there is insufficient evidence in longitudinal studies to prove a casual relation between the two.

In this context, our study is aimed at looking into the clinical and polysomnographic characteristics of Hypertensive OSA patients and whether it is different from the normotensive OSA Patients. We are also specifically looking into the strength of association between various polysomnographic indices other than AHI like Snore Index and Desaturation Index in an attempt to see whether they can better predict HTN in OSA patients.

## MATERIALS AND METHODS

The study was undertaken in Government Medical College, Calicut, Kerala, India during the period from June 2005 to May 2006. Patients were enrolled into the study as per inclusion and exclusion criteria as described below.

Inclusion criteria: All patients with loud habitual snoring with at least one other additional symptom of OSA like nocturnal awakening, excessive daytime sleepiness, witnessed apneas, nocturnal choking spells, early morning headache and daytime fatigability were enrolled into the study.

Exclusion criteria: Patients were excluded from the study if they did not consent to study or if they could not sleep during the study or if any technical error occurred during the study.

Study design: Patients with loud habitual snoring with or without symptoms of OSA are enrolled into the study. Symptoms suggestive of sleep disordered breathing were noted down through a detailed interview. Excessive daytime sleepiness was objectively assessed using Epworth sleepiness scale. Anthropometric measurements were taken thereafter. Office blood pressure was taken twice using mercury sphygmomanometer and average value was obtained. Patients are grouped as Hypertensive based on Blood Pressure [Systolic BP > 140 mm Hg or Diastolic BP > 90 mm Hg] or if they are taking antihypertensive medications. Overnight Polysomnography was conducted for all patients. The main polysomnographic indices measured included Apnea-Hypopnea Index [AHI], Snore index [SI] and Desaturation index [DI]. AHI is defined as the average number of apnea and hypopnea events taken together in an hour. Snore index is defined as the average snore events in an hour. Average number of desaturation events in an hour is termed as Desaturation index. Statistical analysis were done using SPSS statistical software.

## RESULTS

Total of 85 patients were included in the study after the exclusion procedure. Distribution of the study group based on Age and Sex is given in Table 1. The mean age was 49.52 years in males and 48.32 years in females. Distribution of the study group based on Body Mass Index [BMI] is shown in table 2. Epworth sleepiness score of more than 10 was taken significant for the presence of excessive daytime sleepiness. In our study group, Positive ESS score of more than 10 was shown by 42% as described in table 3. Based on AHI, patients were grouped into those with AHI >15 [Moderate to Severe OSA] and those with AHI < 15 [mild OSA or primary snoring]. Of the total 85 patients, clinically significant OSA [AHI >15] was diagnosed in 55 patients [64%] as shown in table 4. Of the total 85 patients enrolled into the study with symptoms of SDB, 48 patients were found to be hypertensive and 37 patients were found to be normotensive [table 5]. The average age of patients with Hypertension was found to be at a higher level than those with normal blood pressure [52.06 vs. 45.67, t-test p=0.006]. The difference was found to be statistically significant [table 6].

Among the subgroup of patients with moderate to severe OSA [AHI >15], we found a higher proportion of hypertension compared to the group with mild OSA or primary snoring [AHI <15].

**Table 1:** Age distribution according to sex

Sex	N	minimum	maximum	mean	Std.deviation
F	18	28.00	65.00	48.38	11.17
M	67	26.00	76.00	49.52	10.72
total	85	26.00	76.00	49.28	10.76

**Table 2:** Distribution based on BMI

		Sex		
		F	M	total
BMI group	<18.50	0	1	1
	18.50-24.99	3	11	14
	25.00-29.99	2	29	31
	30.00-34.99	5	19	24
	35.00-39.99	4	6	10
	40.00+	4	1	5
total		18	67	85

**Table3.**Distribution based on ESS

ESS	
<10 Number;%	>10 Number%
49 [57.6%]	36 [42.4%]

**Table 4:** Disitribution based on AHI

AHI	
<15 Number;%	>15 Number;%
30 [35.2 %]	55 [64.7 %]

**Table 5:** Means of Age based on HTN

HTN	N	mean	Std.deviation	Std.error mean
No	37	45.67	9.47	1.55
Yes	48	52.06	10.96	1.58

t-test p=0.006

**Table 6:** Distribution based on AHI and HTN

	HTN			
		No	Yes	Total
AHI	<=15	18	12	30
	>15	19	36	55
Total		37	48	85

**Table 7:** Chi-Square test

Pearson Chi-Square : Value = 5.11

Asymp.sig(2-tailed) :0.024

**Table 8: Risk estimate**

		95%confidence interval	
value		lower	upper
Odds Ratio for AHI	2.84	1.13	7.11
For cohort HTN=No	1.73	1.08	2.76
For cohortHTN=Yes	0.611	0.379	0.98
N valid cases	85		

This association was also statistically significant as per the present study [ table 7]. AHI > 15 carries 2.85 times risk for hypertension as per the risk estimate. This is shown in table 8.

Patients with moderate to severe OSA with hypertension and without hypertension were further compared based on age, BMI, ESS and polysomnographic indices namely AHI, SI and DI.

This is shown in table 9 and 10. It is found that the average age of patients with moderate to severe OSA with Hypertension was at a higher level compared to those without hypertension[52.7 vs. 46.2].This observation carried statistical significance [p value =0.027].There was no statistically significant association between the groups based on their BMI, ESS , AHI , Snore index and Desaturation index. Infact, AHI, DI and ESS

were observed to be high in normotensive patients with moderate to severe OSA compared to their hypertensive counterparts as per the present study. The only difference carrying statistical difference was that normotensive patients with moderate to severe OSA was at younger age compared to hypertensive group.

## DISCUSSION

This study included patients with habitual snoring who were referred to our sleep lab for ruling out obstructive sleep apnoea based on their symptom profile. So our patients were having a varying level of upper airway resistance ranging from primary snoring to mild, moderate and Severe OSA.

We have observed that the single most meaningful parameter that was found to be statistically

associated with hypertension in patients with sleep disordered breathing is Age. The mean age of Hypertensive patients was higher compared to normotensives [ 52.06 Vs 45.67 years]. As age advances there increased risk of development of hypertension in patients with sleep disordered breathing. There was no statistically significant difference in AHI between Hypertensive and Normotensive groups implying that age is the strongest predictor of development of hypertension irrespective of the severity of sleep apnea in patients with snoring. Other polysomnographic indices like Snore Index or Desaturation index also do not show any statistically significant association with HTN.

Secondly, we have seen that there was in increased proportion of hypertension in patients with moderate to severe OSA when compared to mild OSA or primary snoring [52% vs 40%].The OR for HTN was found at 2.84 at AHI cut off set at 15. This finding is in concordance with previous studies. Even though found not statistically significant, the

trend analysis revealed an increasing trend for being hypertensive with increase in AHI [p=0.052; not shown].

Among the patients with moderate to severe OSA, age is found to be the meaningful factor for the prediction of hypertension as per the present study. Hypertensive patients were at a higher age when compared to normotensive group. Interestingly Sleep stress parameters like Snore Index and Desaturation index were observed to be higher in normotensive patients than hypertensive groups. This implies that the normotensive group has more snore events, more desaturation events, equally or slightly higher AHI but they have not developed Hypertension since they are at younger age group. Thus we may conclude that even though a high proportion of Hypertension is seen in patients with moderate to severe OSA, the strength of association is not enough to predict the risk of HTN by polysomnographic indices alone.

**Table 9:** comparison of Hypertensive and Normotensive groups among patients with moderate to severe OSA

HTN		Age	BMI	ESS	AHI	SI	DI
No	mean	46.21	29.41	11.32	50.04	119.28	47.27
	N	19	19	19	19	19	19
	Std.deviation	9.36	7.33	5.53	27.17	65.54	29.57
Yes	mean	52.75	29.50	10.36	39.04	111.26	33.54
	N	36	36	36	36	36	36
	Std.deviation	10.51	4.54	4.61	18.95	65.08	24.65
Total	mean	50.49	29.47	10.69	42.84	114.03	38.28
	N	55	55	55	55	55	55
	Std.deviation	10.51	5.59	4.92	22.51	64.74	26.99

Table 10: ANOVA table

		Sum of squares	Df	Mean square	F	Sig
Age*HTN	Between groups	531.83	1	531.83	5.17	0.027
	Within groups (combined)	5443.90	53	102.71		
	Total	5975.74	54			
BMI*HTN	Between groups	0.115	1	0.115	0.004	0.952
	Within groups (combined)	1693.29	53	31.949		
	Total	1693.40	54			
ESS*HTN	Between groups	11.335	1	11.335	0.463	0.499
	Within groups (combined)	1296.41	53	24.461		
	Total	1307.74	54			
AHI*HTN	Between groups	1504.84	1	1504.84	3.082	0.085
	Within groups (combined)	25875.33	53	488.214		
	Total	27380.17	54			
SI*HTN	Between groups	800.408	1	800.40	0.188	0.666
	Within groups (combined)	225592.28	53	4256.458		
	Total	226392.69	54			
DI*HTN	Between groups	2344.305	1	2344.305	3.357	0.073
	Within groups (combined)	37010.76	53	698.316		
	Total	39355.06	54			

## CONCLUSIONS

1. Hypertensive patients with sleep disordered breathing are having a higher age compared to normotensive patients with sleep disordered breathing.
2. There is a high proportion of hypertension among patients with moderate to severe OSA compared to those with mild OSA or primary snoring.
3. AHI greater than 15 carries 2.85 times risk for hypertension in patients with sleep disordered breathing.
4. Among patients with moderate to severe OSA, hypertensives are found to have a higher age compared to normotensives.
5. There was no statistically significant association between Snore Index, Desaturation index and ESS score with Hypertension as per the present study.

6. The strength of association between HTN and OSA is inadequate enough to be predicted by polysomnographic indices alone.

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