

# The Relation of Night-Hypoxia with Otolith Dysfunction in patient suffering from Sleep Apnea

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## ABSTRACT

**Objective:** To evaluate the relation of night hypoxia with the otolith dysfunction in patients suffering from sleep apnea.

**Study design:** Prospective study

**Place and duration of study:** Department of ENT Head & Neck Surgery, Bolan Medical College, Quetta from 1<sup>st</sup> April 2023 to 30<sup>th</sup> September 2023.

**Methodology:** Sixty patients attended cardiorespiratory polysomnography (PSG) with sleep apnea and age group of 24 to 75 years were enrolled. All the cases were assessed for various sleep parameters including Apnea hypopnea Index, horizontal Video Head Impulse Test Results (vHIT) as well as the Vestibular function was assessed using video head impulse test of horizontal evaluating semicircular canal function and cervical vestibular evoked myogenic potentials (cVEMPs) and ocular vestibular evoked myogenic potentials (oVEMPs) to measure otolith function cVEMP and ocular VEMPs (oVEMP). Head and eye movement was assessed using a high-speed infrared camera at 250 Hz. The vestibular-ocular reflex (VOR) was also assessed. All these parameters were used for evaluating the relation of night hypoxia with otolith dysfunction in patients with sleep apnea. All the information, including the demographic details, BMI as well as clinical history was noted.

**Results:** There was a significant majority of males (76.6%). The apnea hypopnea index was calculated, and it was observed that 21 (40%) were in the index range of  $\geq 30$  showing severity level. There were higher cases of diabetes in  $AHI 15 \geq x < 30$  while more patients with hypertension (n=12) were identified to have more severe levels of AHI such as  $>30$ . A strong association was found between AHI, vHIT with diabetes and hypertension especially in cases where  $AHI \geq 30$ . The frequency of hypertension was highest in cases with AHI greater or equal to 30. Diabetes was minimally present in control cases wherein the OSA was not presented with an AHI level  $<5$ . In this context the descriptive indices, there were more cases of diabetes and hypertension with pathological VEMP. There was no significant association found between the sleep parameters and vestibular functions.

**Conclusion:** There was no significant association between vestibular function and sleep apnea, although otolith dysfunction was significantly presented in cases of obstructive sleep apnea and hypertension.

**Keywords:** Night hypoxia, Otolith dysfunction, Sleep apnea, Relation.

## INTRODUCTION

Obstructive sleep apnea (OSA) has been considered as a major risk of cardio and cerebrovascular events as well endocrine related disease.<sup>1</sup> In cases of pulmonary-arterial hypertension the night hypoxia association is also reported among various geological populations, however the underlying cause of this link is not properly understood. It may be considered that the shift of fluid during the night from legs to the upper pulmonary tract results in pulmonary obstruction and night hypoxia.<sup>2</sup> In addition to this, the OSA is reported as a common sleep-related disorder with a prevalence of 6-13% in various adult populations all over the globe.<sup>3,4</sup>

The main features of OSA are obstruction of upper respiratory tract due to the reduction in oxygen flow as mentioned above during the night sleeping time. These alterations in oxygen flow are mainly generated during the slow-wave sleep with rapid orbital movement during the sleep. Consequently, these causes repetitive arousals which results in the restless sleep with reduced performance during the daytime.<sup>5</sup> The OSA pathogenicity is related to respiratory distress involving inflammatory cascade as well as oxidative distress resulting in the inflammatory cascade activation, dysfunction of vascular endothelial system.<sup>6,7</sup>

The damage of vasa-nervorum cause oxygen saturation insufficiency and neuronal-injury affecting several physiological-reflex circuits.<sup>8</sup> There are various stages of hypoxia wherein the hypoxia in the initial stages can be controlled however the persistent hypoxia results in the trigger of neuropathy [9]. Night hypoxia can affect peripheral as well as sensory nervous system.<sup>10</sup> It has been observed that night hypoxia is related to otolith dysfunction. The otolith dysfunction means one or more problems with the otolith organs such as the saccule and utricle. Researchers have demonstrated that cervical VEMPs (cVEMPs) showed decreased otolith functioning in patients with critical OSA

in comparison to healthy individuals.<sup>11</sup> The present study was generated to understand the association of night hypoxia with otolith dysfunction in patients suffering from sleep apnea. The results of this study highlighted important facts which facilitated patients' management and treatment on timely basis.

## MATERIALS AND METHODS

This prospective study design a total of 60 patients with age 24 to 75 years were enrolled from the sleep at Department of ENT Head & Neck Surgery, Bolan Medical College, Quetta from 1<sup>st</sup> April 2023 to 30<sup>th</sup> September 2023. The sample size of the patients was determined by using WHO based sample size calculation method wherein 95% confidence of interval and 80% power of test was applied with 5% margin of error. All the patients included in the study were diagnosed on the basis of polysomnography (PSG) for the suspicion of sleep breathing disorders and were attended overnight for the assessment of PSG as well as vestibular function tests. Those patients who are suffering from other psychological disorders, or were blind or having neck muscle motion problems, vestibular disorders, or any comorbidity which results in sleep apnea were excluded from the study. The analysis of Polysomnography was done through the Graef and Somt'e PSG head boxes while using the Profusion software version 3.0 (Compumedics, Australia). The evaluation of the polysomnography was performed through the available updated procedures based on the American-Academy of Sleep Medicine. The analysis comprised apneahypopnea index (AHI), average oxygen-saturation ( $\text{O}_2$ ), minimal oxygen saturation (min $\text{O}_2$ ), 3% and 4% oxygen-desaturation indicators (ODI 3/4%), and oxygen saturation  $<90\%$  at sleep time. Obstructive sleep apnea was determined at the cutoff of 5/h where it was considered mild upto 14/h, however a value above it and until 29/h was considered as moderate while  $>29/h$  was taken as severe. The vestibular function tests included the horizontal vHIT as well as the cVEMP and ocular VEMPs (oVEMP). Head and eye movement was assessed using a high-speed infrared camera at 250 Hz. The vestibular-ocular reflex

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(VOR) was evaluated through horizontal-head impulses with a target head velocity was 100-to 200-/s 5- and 15-amplitude from the center to the lateral position. The calculations of the VOR gain were made through the eye to head velocity ratio at 40, 60, and 80 ms respectively. Refixation saccades analysis was conducted and cVEMP testing, was performed after securing a supine position with horizontal elevated head 30-(500 Hz, 100 dB SPL tone burst, repetition rate of 4/s delivered monaurally). The Electromyography analysis was recorded. All the information, including the demographic details, BMI as well as clinical history was noted. The data was statistically analyzed using SPSS version 26.

**RESULTS**

Majority of the cases 56.6% (n=34) within the late middle age (45-55) years while 12 patients were <45 years and 14 were >55 years of age. There was a significant majority of males (76.6%) in the study as compared to females. Most of the cases were overweight with a median value of 28.7 kg/m<sup>2</sup> (Table 1).

The apnea hypopnea index was calculated, and it was observed that 21 (40%) were in the index range of ≥ 30 showing severity level. There were 12 patients which had the mild level of apnea hypopnea index and therefore were not presenting OSA and were considered as controls (Fig. 1).

The anthropometric details of the patients were correlated with the Apnea Hypopnea Index and it was observed that no significant difference within age and gender of cases with mild AHI or normal controls than those with severity of the case. A similar pattern was observed for the BMI variable within various groups of AHI (Table 2).

There were higher cases of diabetes in AHI 15 ≥ x <30 while more patients with hypertension were identified to have more severe levels of AHI such as >30. It was observed that an increasing trend of hypertension and diabetes was presented with the increase in the severity level of apnea hypopnea index (Fig 2).

Table 1: Demographic information of the patients (n=60)

Variable	No.	%
<b>Gender</b>		
Male	46	76.6
Female	14	23.3
<b>Age (Years)</b>		
Mean age	55.65±10.5	
Median	54.5	
<b>BMI (kg/m<sup>2</sup>)</b>		
Mean	29.5±4.4	
Median	28.7	

Table 2: The association of AHI with Gender, Age and BMI

Variable	X <5 (n=12)	5≥ x <15 (n=13)	15≥ x <30 (n=16)	≥30 (n=19)
Males	8 (66.6%)	8 (61.5%)	13 (81.25%)	18 (94.7%)
Females	4 (33.3%)	5 (38.4%)	3 (18.75%)	1 (5.3%)
Age Mean±SD	50.3±11.5	51.08 ±12.5	54.5 ±10.1	56.8 ±11.1
Range	36-75	24-65	36-74	30-74
BMI Mean±SD	27.8 ±3.2	27.9 ±4.5	29.8 ± 3.1	30.1 ±3.9
Range	22.8-35.5	20.7-40.9	23.7-38.6	21.5-35.5

Table 3: Results of vHIT Testing in the Cohort

vHIT Testing	Healthy	OSA	AHI > 30	OSA and AHT
Pathologic vHIT right	2	10	6	4
Pathologic vHIT left	1	8	4	4
Pathologic vHIT both sides	1	8	4	4

A strong association was found between AHI, vHIT with diabetes and hypertension especially in cases where AHI ≥30. The frequency of hypertension was highest in cases with AHI greater or equal to 30. Diabetes was minimally present in control cases wherein the OSA was not presented with an AHI level <5. The Video Head Impulse Test Results (vHIT) was not able to be performed on 13 patients due to technical reasoning. There were highest number of patients with OSA and pathological vHIT impulses were delivered on right side followed by patients with AHI >30. No significant difference in the cohort results of vHIT at left or both sides with OSA, AHI and OSA and AHT was presented in the

study. Total 22 patients has pathological reduction on right side with 6 cases having AHI greater than 30 (Table 3).

The detection was possible only in limited number of patients where in it was determined that altogether no significant variance was observed within the VEMP results in patients which were with or without OSA. VEMP was performed to analyze otolith functions. In this context the descriptive indices, there were more cases of diabetes and hypertension with pathological VEMP. There was no significant association found between the sleep parameters and vestibular functions (Table 4).

Table 4: Results of VEMP Testing in the Cohort

Variable	Healthy	OSA	AHI			OSA & AHT	OSA & DHM
			5≥ x <15 (n=13)	15≥ x <30 (n=16)	≥30 (n=19)		
No cVEMP response right	2	13	5	6	10	5	1
No cVEMP response left	1	11	2	5	8	6	3
No oVEMP response right	3	14	3	7	9	6	1
No oVEMP response left	2	10	1	4	2	5	4
No VEMP response at all	4	6	2	5	1	1	1

Fig. 1: The number of patients vs apnea hypopnea index

Fig. 2: Comparison of diabetes with hypertension

**DISCUSSION**

Obstructive sleep apnea is a sleep disorder featured by the reduction in oxygen saturation during the night resulting in sleep apnea, restlessness, and trauma. Due to the repetitive cycles of hypoxia and reoxygenation there is a high risk of neuronal loss and

psychotic events in patients suffering from sleep apnea.<sup>11,12</sup> Night hypoxia therefore can result in sensory dysfunction.<sup>12</sup>

However, the present study results showed no significant linkage between vestibular functioning and sleep and respiratory parameters specifically in cases where OSA was compared within those with normal AHI and severe AHI. There were indications of association between otolith impaired function in OSA patients than with no OSA development specifically in cases where the comorbidity of hypertension was presented.<sup>13,14</sup>

The identification of pathological structures was performed in the current research as VHIT and VEMPs were also conducted presenting the otolith end organs might have been affected due to night desaturation of oxygen. Similar results were also elaborated in other studies with a detail presentation of otolith impairment involved in cases with sleep apnea. These results were in coordination with the present study results.<sup>15,16</sup>

The current study showed that delayed VEMP response was presented in cases of OSA. This might be due to the neural damage of vestibular nerves causing impaired VEMP response in cases of OSA. The association between delayed VEMP response with impaired vestibular nerve function has been demonstrated in previous studies correlating to current study research work.<sup>17-19</sup> The present study highlighted the fact that otolith dysfunction has a significant association with OSA presence. Hypertension was also closely associated with OSA presence.<sup>20,21</sup>

## CONCLUSION

There was no significant association between vestibular function and sleep apnea, although otolith dysfunction was significantly presented in cases of OSA and hypertension.

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