

# Association of Night Hypoxia with Otolith Dysfunction patients having Obstructive Sleep Apnea

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## ABSTRACT

**Aim:** To find the association of night hypoxia with otolith dysfunction patients having obstructive sleep apnea.

**Study design:** Prospective study

**Place and duration of study:** Department of ENT and Head & Neck Surgery, Liaquat College of Medicine & Dentistry, Karachi from 1<sup>st</sup> January 2021 to 30<sup>th</sup> September 2021.

**Methodology:** Fifty cases underwent polysomnography (PSG) for diagnostic purposes in context to suspicion of the night hypoxia were enrolled. Analysis for PSG was based on the variables as apnea hypopnea indexing, minimal level of oxygen of saturation, average level of oxygen-saturation, time of sleep as well as 3-4% de-oxygen saturation-indices. The vestibular-function test was performed by including vHIT and cVEMP as well as ocular VEMPs. Head impulses in horizontal method were used for quantitative assessment of the vestibular ocular reflexes.

**Results:** Mean age of the study participants was 50.9±10.9 years. Age and body mass index of the participants were not significantly differed from obstructive sleep patients. Male gender appeared to be prominent in gender distribution. Incidence of hypertension and diabetes especially appeared to be higher in patients who had AHI ≥15.

**Conclusion:** No considerable association was found between sleep apnea and vestibular function.

**Key words:** Sleep apnea, Vestibular functions, Desaturation, Sleepiness

## INTRODUCTION

Obstructive sleep-apnea (OSA) is a well-known sleep related disorder. An adult population majorly suffers from this issue with a percentage of 6-13% effected.<sup>1,2</sup> The condition involves obstruction of the upper respiratory tract while sleeping. Air flow reduces in the conditions of the nocturnal-apnea and hypopnea with rapid movements of the eye with low oxygen causing repetitive arousals.

Consequently, the sleep becomes restless activity instead of providing restoration and comfort. Patients suffering from this disorder are sleepy during the day and could not perform well in their daily routine.<sup>3</sup> OSA had long been considered as a risk factor for causing cardiovascular diseases as well as psychiatry ailments and hypertension<sup>4-6</sup>. Nocturnal hypoxia causes respiratory-distress resulting into activation of inflammatory-cascades, dysfunction of vascular endothelium as well as oxidative-stress and activation of autonomous nervous system<sup>7,8</sup>. Vasa-nervorum gets damaged due to insufficient oxygen supply resulting in loss in the neurons present in the central and peripheral nervous-system. Whole body physiological mechanism can be affected as a reason<sup>9</sup>. The hypoxia which has been temporary caused can be treated but the persistent condition leads into neuropathy<sup>10</sup>.

There has been a limited data available on the effect of night hypoxia on the otolith dysfunction. A study reported high threshold value in pure audiogram tones, reduced otoacoustic-emission and long-term latencies in the brainstem of those patients suffering from severe OSA<sup>11,12</sup>.

The present study was generated to analyze the association of otolith dysfunction with the obstructive sleep-apnea. This was required for better understanding of this condition and improved management strategies for healthier outcomes.

## MATERIALS AND METHODS

The prospective study was conducted at Department of ENT and Head & Neck Surgery, Liaquat College of Medicine & Dentistry, Karachi from 1<sup>st</sup> January 2021 to 30<sup>th</sup> September 2021. An informed written consent was taken from each patient before enrolment in the study. The sample size was calculated by the prevalence of sleep apnea keeping 95% confidence of interval and 7% margin of error. There were 50 total cases enrolled. The study considered inclusion criteria as the

one who underwent polysomnography (PSG) for diagnostic purposes in context to suspicion of the night hypoxia. Vestibular function testing was also performed. PSG-head box comprising of Greal and Somt's was used for this purpose with software-based evaluations. Analysis for PSG was based on the variables as apnea hypopnea indexing, minimal level of oxygen of saturation, average level of oxygen-saturation, time of sleep as well as 3-4% de-oxygen saturation-indices. Patients having vestibular or hearing loss, blind or poor neck motion range were excluded from the study. The vestibular-function test was performed by including vHIT and cVEMP as well as ocular VEMPs. An infrared high-speed camera 250 hertz having a built in accelerometer was applied for measuring head/eye movements. Head impulses in horizontal method were used for quantitative assessment of the vestibular ocular reflexes. Demographic data as well as other clinical information was documented on the well-structured questionnaire. Data was analyzed by using SPSS version 25. The approval of this research was granted by the Institutional Ethical Review Committee.

## RESULTS

Ten participants had no sleep disorder as AHI values of these patients less than five. Mean age of the study participants were 50.9±10.9. Age and BMI of the participants were not significantly differed from OS patients. Male gender appeared to be prominent in gender distribution as there were 40 males and only 10 females in the present study (Table 1).

In present study, strong association of diabetes mellitus and hypertension were found. Incidence of hypertension and diabetes especially appeared to be higher in patients who had AHI ≥15. Frequency of hypertension was highest in OS patients with AHI ≥30. Diabetes was not present in control participants or who were not having OSA (Fig. 1).

The vHIT test was also performed in study participants and the results were physiologically or pathologically assessed. Total 6 cases showed pathological reduction on one side. One patient of pathological vHIT had AHI value even greater than 30. No patient report diabetes mellitus (Table 2). Relation between vestibular functions and sleep parameters were also assessed. No significant association was found between any of the parameter (Table 3).

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Table 1: Gender, age and BMI in association with Apnea Hypopnea Index (AHI) (n=50)

Variable	Total	X<5 (n10)	5≥ x <15 (n=11)	≥15 x <30 (n=13)	≥30 (n=16)
<b>Gender</b>					
Male	40	8	7	11	14
Female	10	2	4	2	2
<b>Age</b>					
Mean±SD	50.9±10.9	51.3±12.3	50.9±12.4	57.6±11.5	57.4±12.1
Median	52.5	45.8	53.4	61	60
Range	23-75	33-67	23-73	37-75	32-75
<b>BMI</b>					
Mean±SD	29.7±4.5	28.85±3.1	27.8±5.5	30.3±3.3	30.4±2.9
Median	29.4	29.5	26.5	30.9	30.8
Range	20.7-41	23-46	20.5-41.7	22.9-38.9	21.7-35.5

Table 2: Comparison of Video head-impulse test

Pathological vHIT	Total	Healthy	OSA	AHI>30	OSA and AHI
Right	6	2	5	1	1
Left	4	1	3	1	1
Right and Left	4	1	3	1	1

Table 3: AHI in cohort VEMP response

VEMP response	Apnea Hypopnea Index %		
	x ≥5	x≥15	x≥30
<b>No cVEMP Response</b>			
Right	31	26	45
Left	32	35	31
<b>No oVEMP Response</b>			
Right	31	38	34
Left	20	30	25

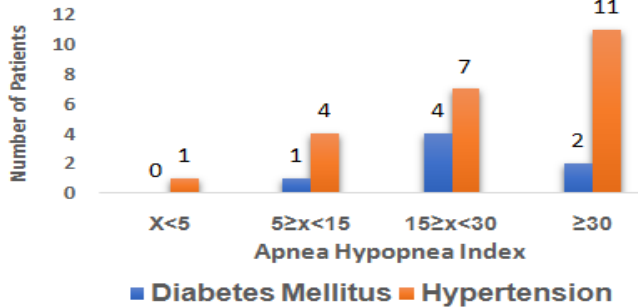


Fig 1: Frequency of hypertension and diabetes mellitus in OSA patients

**DISCUSSION**

Obstructive sleep apnea is a sleep disorder characterized by the collapse of upper respiratory tract in night or during sleep. It is common sleep breathing-disorder and oxygen saturation get dropped. Thus, sleep is no longer considered a restful activity rather a traumatic situation for the patient consequently leading to reduced day time performance, hurdle in regular activities and day-time sleepiness.<sup>3-6</sup> Repetitive re-oxygenation and desaturation can sometimes also cause neuronal lose in peripheral and central nervous system that can effect several physiological reflex circuits<sup>9</sup>. This showed that nocturnal hypoxia can also affect sensory systems and its functions<sup>10</sup>. Therefore, present study was designed to assess the vestibular function in OSA patients<sup>13,14</sup>.

Result of present study showed that higher frequency of impaired otolith function was noted in OSA patients especially in cases who had arterial hypertension. On the other hand, no significant association was found between respiratory parameters and vestibular function in OSA patients. Pathological structures were more precisely analyzed because VEMPs and vHIT both was performed. Otolith end organs appeared to be slightly damaged and affected due to oxygen desaturation whereas semicircular canals showed normal function. Possible explanation of present finding is that neural damage of vestibular nerve might be delayed the VEMP responses<sup>9,10</sup>. Hence, delayed or altered VEMP responses in OSA patients could be happen due to neuronal degeneration<sup>9,15-18</sup>.

Although no significant association was found between sleep apnea and vestibular function, but otolith dysfunction and arterial hypertension appeared to be more closely related with OSA patients. Limited data is available about the mechanism of arterial hypertension and its association with vestibular function<sup>19,20</sup>. Few studies also

suggest that cardiovascular risk factors could also be related with sleep apnea<sup>13-15</sup>.

**CONCLUSION**

Present study highlights that no considerable association was found between sleep apnea and vestibular function. Nevertheless, otolith dysfunction appeared to be more frequent in OSA patients who had hypertension.

**Conflict of interest:** Nil

**REFERENCES**

- Peppard PE, Young T, Barnet JH, Palta M, Hagen EW, Hla KM. Increased prevalence of sleep-disordered breathing in adults. *Am J Epidemiol* 2013;177(9):1006-14.
- Dewan NA, Nieto FJ, Somers VK. Intermittent hypoxemia and OSA: implications for comorbidities. *Chest* 2015;147(1):266-74.
- Mayer G, Arzt M, Braumann B, et al. German S3 guideline non-restorative sleep/sleep disorders. Sleep-related breathing disorders in adults. *Somnologie* 2017;21(4): 290-301.
- Ip MS, Lam B, Ng MM, Lam WK, Tsang KW, Lam KS. Obstructive sleep apnea is independently associated with insulin resistance. *Am J Respir Crit Care Med* 2002;165(5):670-76.
- Lavie P, Herer P, Peled R, et al. Mortality in sleep apnea patients: a multivariate analysis of risk factors. *Sleep* 1995;18(3):149-57.
- Kaskie RE, Graziano B, Ferrarelli F. Schizophrenia and sleep disorders: links, risks, and management challenges. *Nat Sci Sleep* 2017;9:227.
- Budhiraja R, Parthasarathy S, Quan SF. Endothelial dysfunction in obstructive sleep apnea. *J Clin Sleep Med* 2007;3(04):409-15.
- Gozal D, Kheirandish-Gozal L. Cardiovascular morbidity in obstructive sleep apnea: oxidative stress, inflammation, and much more. *Am J Respir Crit Care Med* 2008;177(4):369-75.
- Zhang JH, Fung SJ, Xi M, Sampogna S, Chase MH. Apnea produces neuronal degeneration in the pons and medulla of guinea pigs. *Neurobiol Dis* 2010;40(1):251-64.
- Fanfulla F, Grassi M, Eugenia Taurino A, D'Artavilla Lupo N, Trentin R. The relationship of daytime hypoxemia and nocturnal hypoxia in obstructive sleep apnea syndrome. *Sleep* 2008;31(2): 249-55.
- Sowerby LJ, Rotenberg B, Brine M, George CF, Parnes LS. Sleep apnea, daytime somnolence, and idiopathic dizziness—a novel association. *Laryngoscope* 2010;120(6):1274-8.
- Casale M, Vesperini E, Potenza M, et al. Is obstructive sleep apnea syndrome a risk factor for auditory pathway? *Sleep Breath* 2012;16(2):413-7.
- Goyal M, Johnson J. *Obstructive Sleep Apnea Diagnosis and Management*. Missouri Med 2017; 14(2), 120–24.
- Dempsey JA, Veasey SC, Morgan BJ, O'Donnell CP pathophysiology of sleep apnea. *Physiol Rev* 2010; 90: 47-112.
- Birk R, Dietz M, Sommer JU, Stuck BA, Hörmann K, Rotter N, Schell A. Nightly Hypoxia Does Not Seem to Lead to Otolith Dysfunction in Patients With Obstructive Sleep Apnea. *Ear Nose Throat J* 2021; 100(9): 667-72.
- Pace A, Milani A, Rossetti V, Iannella G, Maniaci A, Cocuzza S, et al. Evaluation of Vestibular Function in Patients Affected by Obstructive Sleep Apnea Performing Functional Head Impulse Test (fHIT). *Nature Sci Sleep* 2022; 14, 475-82.
- Birk R, Dietz M, Sommer JU, Stuck BA, Hörmann K, Rotter N, et al. Nightly Hypoxia Does Not Seem to Lead to Otolith Dysfunction in Patients With Obstructive Sleep Apnea. *Ear Nose Throat J* 2021;100(9):667-72.
- Xu XD, Chen BJ, Sun AR, Zhang Q, Cheng Y, Ren DD, Luo HP. Uneven Effects of Sleep Apnea on Semicircular Canals and Otolithic Organs. *Frontiers Neuro* 2022; 13: 819721-5.
- Zeigelboim BS, Jurkiewicz AL, Klagenberg KF, Alberti A, Palmonari A. Vestibular evaluation in patients with systemic arterial hypertension: a preliminary study. *Int Arch otorhinolaryngol* 2006;10(3):9.
- Ch'avez-Delgado ME, V'azquez-Granados I, Rosales-Cort'es M, Velasco-Rodr'iguez V. Cochleovestibular dysfunction in patients with diabetes mellitus, hypertension, and dyslipidemia. *Acta Otorrinolaringol Esp* 2012;63(2):93-101.