EUROMEDITERRANEAN BIOMEDICAL JOURNAL
2019,14 (16) 070–072
(*FORMERLY: CAPSULA EBURNEA*)

Original article

ASSOCIATION BETWEEN OBSTRUCTIVE APNEA SYNDROME DURING SLEEP AND DAMAGES TO ANTERIOR LABYRINTH: OUR EXPERIENCE.

Donatella Marchese, Salvatore Gallina, Riccardo Speciale, Domenico Michele Modica

Department of Biomedicine and Clinical Neuroscience, Otorlaryngology Section, University of Palermo

ARTICLE INFO

Article history:
Received 12 February 2019
Revised 13 March 2019
Accepted 04 May 2019

Keywords:
OSAS, Hearing Loss, Cochlea, Epworth Sleepiness Scale.

ABSTRACT

The obstructive sleep apnea syndrome is a chronic condition characterized by frequent episodes of collapse of the upper airways during sleep. It can be considered a multisystem disease. Among the districts involved, even the auditory system was seen to be concerned.
It was enrolled a population of 20 patients after polysomnographic diagnosis of OSAS (Apnea Hypopnea Index > 10) and a control group of 28 healthy persons (Apnea Hypopnea Index < 5). Each patient has been subjected to Pure Tone Audiometry, Tympanometry, study of Acoustic Reflex, Otoacoustic Emissions and Auditory Brainstem Response. Moreover they were submitted to endoscopy of upper airway with Muller Maneuver and Epworth Sleepiness Scale (ESS).
The values of ESS was 13.5 in OSAS group and 5.4 in control group. The tone audiometry is worse in all frequencies analyzed in OSAS patients, but within the normal range for both groups analyzed by 250 to 1000 Hertz. Otoacoustic emissions show a reduced reproducibility and a lower signal / noise ratio in OSAS group ($P < 0.01$).

1. Introduction

The obstructive sleep apnea syndrome (OSAS) is a sleep disorder caused by an excessive narrowing of pharyngeal airway that also collapses during inspiration, resulting in increased negative intrathoracic pressure, which in turn exacerbates the conditions (1). The consequences of upper airways collapses is the reduction of blood oxygenation; for this reason OSAS is considered a systemic disease and in the last decades attention to persistent snoring, particularly when associated with apnea syndrome, has increased hugely (2). These obstructive respiratory events are typically associated with cortical arousals and micro-desaturation which entail a fragmentation of sleep and an increase in the activity of the sympathetic SNA (3). The prevalence of the disease is settled at about 3-7% and there are many factors that predispose to this disorder, such as age, male gender, obesity, family history, menopausal, craniofacial abnormalities, and voluptuary habits such as cigarette smoke and the alcohol abuse (4).
OSAS can be considered a multisystem disease because poor oxygenation of the body at night, determines important repercussions on the whole organism. Among the districts involved, even the auditory system was seen to be concerned (5).

2. Material and methods

Objective of the study is to evaluate the otoneurological complications in OSAS patients paying close attention to hearing loss. Indeed, nocturnal apneas have been associated with the onset of sensorineural deafness. The pathophysiological mechanisms underlying this association seem to depend first of all by the depletion of oxygen during the cochlear apneic events, from the adverse effects on the vasculature of the cochlea through micro inflammatory events and subsequent vascular remodeling, as well as the acoustic trauma associated with snoring (6). In order to assess the possible impact of this syndrome, increasing exponentially in today's world population due to poor eating habits and behavioral health, we used a prospective case-control.
The study population was enrolled at the Otorhinolaryngology Unit of the University Hospital of Palermo in the period between October 2017 and October 2018, for nocturnal respiratory disorders. We collected all subjects documented an Apnea Hypopnea Index (AHI) > 10 at polysomnography. The control group, is made up of a same population by sex, age and habits luxuries with an AHI <5. To complete the examination of sleep disorder, all patients were interviewed by the Epworth Sleepiness Scale (ESS) (7). The auditory pathway has been studied by Pure Tone Audiometry, Otoacoustic Emissions and Auditory Brainstem Response (ABR) for an objective evaluation of any hearing loss.

Corresponding author: Donatella Marchese, *marchesedonatella@hotmail.com*
DOI: 10.3269/1970-5492.2019.14.16
 ISSN: 2279-7165 - Available on-line at www.embj.org

All data were subsequently included in a dataset and analyzed with EpiInfo ver.3.5.167. The population was selected on the basis of the following exclusion criteria: age <18 years, prior deafness, taking vasoactive drugs or influence on lung function, middle ear disease and / or internal ear malformation exterior, systemic diseases with suspected involvement of auditory function (diabetes mellitus, arterial hypertension not negotiable, hypercholesterolemia), noise exposure, use of ototoxic drugs. On the basis of the exclusion criteria, 48 patients were examined: 20 patients were enrolled in OSAS group (AHI> 10), and 28 in the control group (AHI <5).

All subjects underwent standard ear, nose and throat (ENT) visit, endoscopy of upper airway associated with Muller Maneuver (8), classified by NOH according Neighbors and Mira (9).The study protocol has been fully explained to patients and was picked up a written informed consent for each. The study was approved by the Commission of Human Research and Ethics of the University Hospital of Palermo, number 9 of 2017.

3. Results

The average age of the study population was 43.5 (20-67 years), 45.5 (22-63) in OSAS group and 43.5 (20-67) in the control one. In OSAS group there are 17 males and 3 females, in the control group 21 males and 7 females. The evaluation of sleepiness was carried out based on the ESS, given in writing to the entire population and completed by patients at their first access to the ENT' s department. According to the classification criteria in use (normal value: 0-9; moderate sleepiness: 11-15; severe sleepiness: >16) the ESS average values of OSAS group was 13.5, in the control group was 5.4 *(p-value* <0.01). At endoscopy of upper airway it has been studied the collapse pattern of the upper airways by performing the Muller Maneuver according to the classification of Vicini and Mira (Table 2).

OSAS group	ESS in OSAS group	Muller's maneuver in OSAS group	Control group	ESS in the control group	Muller's maneuver in the control group
PT1	18	N2O3APH2T	PT1	6	N0O1APH1T
PT2	11	N3O4APH2T	PT2	10	N2O1APH0
PT3	13	N2O4APH3T	PT3	3	N0O1APH1T
PT4	11	N3O3APH1AP	PT4	5	N1O2APH0
PT5	14	N2O3APH2T	PT5	4	N2O1APH0
PT6	14	N2O4APH3T	PT6	4	N1O1APH1T
PT7	13	N2O3APH2T	PT7	8	N0O1APH0
PT8	12	N3O3APH1AP	PT8	2	N1O1APH1T
PT9	13	N2O3APH2T	PT9	10	N1O2APH1T
PT10	10	N2O3APH3T	PT10	9	N1O1APH0
PT11	12	N3O3APH3T	PT11	7	N1O2APH1T
PT12	10	N3O3APH4T	PT12	7	N2O1APH1T
PT13	12	N3O3APH2T	PT13	5	N2O1APH0
PT14	18	N3O3APH3T	PT14	3	N0O1APH1T
PT15	20	N3O3APH3T	PT15	4	N1O1APH0
PT16	15	N3O4APH2T	PT16	8	N1O1APH2T
PT17	11	N3O4APH3T	PT17	2	N1O1APH2T
PT18	17	N3O4APH3T	PT18	9	N2O1APH0
PT19	12	N3O4APH2T	PT19	5	N1O1APH2T
PT20	15	N2O4APH3T	PT20	5	N1O1APH0
	-		PT21	8	N1O2APH1T
	-		PT22	6	N0O1APH0
	-		PT23	6	N0O1APH1T
	-		PT24	3	N1O1APH0
	-		PT25	2	N1O2APH1T
	-		PT26	5	N0O1APH0
	-		PT27	3	N1O1APH1T
	-		PT28	2	N0O1APH1T

Table 1. Results of Epworth Sleepiness Scale and Muller's maneuver in OSAS patients (PT) and control groups.

The results of audiograms are reported in Table23. At the tympanometry we found all type "A" tympanograms suggesting normal function. No one recorded the absence of the stapedial reflex.

Frequency (Hz)	250	500	1000	2000	4000	8000
OSAS group	18.25	19	17.75	26.75	37	41
Control group	14.10	14.46	15	19.10	21.96	24.46
p-value	*>0.05*	*>0.05*	*>0.05*	*<0.01*	*<0.001*	*<0.001*

Table 2. Auditory threshold in patients with OSAS and in the control group.

Regarding otoacoustic emissions, the results of the signal / noise ratio (S / N ratio) are shown in Table 3, respectively for the two groups in question, and are significantly lower in OSAS group.

Frequency (Hz)	1000	1500	2000	3000	4000
OSAS group	6.35 ± 4.70	9.85 ± 5.00	9.74 ± 6.15	4.63 ± 4.25	2.25 ± 4.53
Control group	10.3 ± 6.45	12.25 ± 7.25	13.67 ± 4.85	9.33 ± 5.09	6.7 ± 7.21
p-value	*<0.05*	*<0.01*	*<0.01*	*<0.001*	*<0.001*

Table 3. The graph of positive RV obtained by RT-q PCR Thermocycler in patients with OSAS and in the control group..

The results of auditory evoked potential (ABR), demonstrate a dependent and significant increased latency of the wave, and low reproducibility of the tracks (Table 4).

dB NHL	Wave I	Wave III	Wave V	The IPL-III	IPL III-V	IPL IV
OSAS group	1.73	4.02	5.9	2.3	2.06	4.36
Control group	1.45	3.49	5.6	1.85	1.78	3.9
p-value	*<0.05*	*<0.05*	*<0.01*	*>0.05*	*<0.01*	*<0.01*

Table 4. Wave of ABR latency and IPLs in patients with OSAS and in the control group.

4. Discussion and conclusions

In recent years numerous studies have been performed on people suffering from obstructive sleep apnea, as well as the rise in the global landscape, many are the implications of this syndrome. Literature data show that the mechanisms implicated are represented by oxidative stress, central hypoxia, peripheral hypoxia (labyrinthine and cochlear), damage from noise and sleep deprivation. The cyclic recurrence of hypoxia - reoxygenation that characterizes the syndrome, is associated with the production of free radicals, as well as coronary ischemia - reperfusion. The intermittent hypoxia involves mitochondrial dysfunction, activation of enzyme cascades (xanthine oxidase, NADPH), leukocyte activation, and endothelial cells, the production of oxidizing agents and the upregulation of the inflammatory cascade, all this involves platelet activation and the endothelial damage (10). In addition hypoxia causes a brain-vascular insufficiency, acute hemodynamic changes, reduced cerebral blood flow during episodes of apnea and ischemic injury to the inner ear. The inner ear is more sensitive to hypoxia than the cortex and the nuclei, since its vascularization is terminal and have not available any collateral circulation making it very vulnerable to pressure changes and the hypoxia. The damage extends to the cells throughout the cochlea, but it is greater in the basal turn of the cochlea, where high frequencies are encoded (theory of tonotopicity) (11).

In the case of OSAS patients, the damage would depend on the impact of vasospasm, thrombosis, embolism, hypercoagulable (12). Hearing loss related to high frequencies, is justified also by chronic exposure to noise from snoring. Noise-induced hearing loss in snorers and their bed partners was demonstrated by Sardesai (13) in his study employing audiograms and otoacoustic emission.

Our Unit has been working for years on the territory took on the OSAS problem, both from a diagnostically and therapeutically view. In the last two years, we have chosen to explore one of the aspects pertaining to the apneic subject: the otoneurological complications of anterior compartment, in a word, hearing loss.

The selection of patients was carried out on the basis of the results of polysomnography, but subsequently all patients were assessed to define the presence of a peripheral pattern collapse, by performing the Muller Maneuver to endoscopy. The patients of OSAS group prove to have a positivity to maneuver with variable pattern collapse, in contrast to the control group, in which few patients have a dynamic narrowing of the upper airways, but without any clinical significance. To quantify the sleepiness of the population, it was administered the Epworth Sleepiness Scale which shows a positivity in OSAS population compared to controls, whose average value stays within normal values. As for the audiological results, ours are consisted with those reported in the literature, indeed, the tone audiometry is worse in all frequencies analyzed in OSAS patients, but within the normal range for both groups analyzed by 250 to 1000 Hz. A statistically significant difference, however, appeared in OSAS group compared to controls in the context of acute frequencies *(P* <.01), which as already mentioned are the first to be damaged by a hypoxic damage as well as from damage from acoustic trauma related to snoring. Casale et al. (10) show in their study that the damage of the hair cells is extended to the entire cochlea, but it is more important on the basal turn of the cochlea, where the higher frequencies are encoded. Ekin in his study found that patients with OSAS did not have hearing loss at 4000 Hz and other low or high frequencies, but the damage occured at extended high frequencies(14). Regarding the data obtained from the analysis of otoacoustic emissions, they show a reduced reproducibility and a lower signal / noise ratio (S / N ratio) in OSAS group *(P* <.01). This shows that there is a real hearing loss and cochlear cells are damaged by nocturnal hypoxia blood generated during apneic episodes. Kotterba investigated acoustic evoked potentials in 20 patients with severe OSAS, demonstrating prolongation regarding wave latency I and IV interpeak latency (15). Muchnik et al. recorded ABR in 79 OSAS patients and compared them to a control group: a significant prolongation of latency were demontrated in OSAS group (16). In our study the I wave of OSAS group is out of range with a difference statistically significant compared with control group such as a lack of reproducibility of all the waves in OSAS group. It demonstrates a modified pattern of transmission of retrocochlear information.

5. Conclusions

Based on our observations and literature data, we conclude that OSAS causes otoneurologic damage: the peripheral district is more vulnerable than central one to the mechanisms described above. At cochlear level, moreover, the most affected frequencies are those acute, for their distribution at the cochlea and for their sensitivity to noise damage.

The hearing loss, therefore, can be a sign of an OSAS unrecognized and such data must be put into correlation with a more thorough investigation of sleep-disordered breathing whenever a hearing impaired patient without apparent cause comes to our observation. In addition, all patients with sleep apnea syndrome should be screen to evaluate auditory function.

References

1. Patton JT. Gallina S, Dispenza F, Kulamarva G, Ballacchino A, Speciale R. Uvulopalatopharyngoplasty with tonsillectomy in the treatment of severe OSAS. B-ENT. 2009;5:245-50
2. Marchese D, Modica DM, Cancemi S, Speciale R, Gallina S. Anterior palatoplasty: effectiveness for treatment of simple snoring and mild OSAS. EuroMediterranean Biomedical Journal. 2017;12 (12):57-60.
3. Caples SM, Gami AS, Somers VK. Obstructive sleep apnea. Ann Intern Med. 2005; 142:187-97.
4. Punjabi NM. The epidemiology of Adult Obstructive Sleep Apnea. Proc Am Thorac Soc. 2008;5:136-143.
5. Martines F, Ballacchino A, Sireci F, et al. Audiologic profile of OSA and snoring simple patients: the effect of chronic nocturnal intermittent hypoxia on auditory function. Eur Arch Otorhinolaryngol. 2016;273:1419-24.
6. Gallina S, Dispenza F, Kulamarva G, Riggio F, Speciale R. Obstructive sleep apnea syndrome (OSAS): effects on the vestibular system. Acta Otorhinolaryngologica Italica. 2010;30:281-4.
7. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. Sleep. 1991;14:540-5.
8. Borowiecki B, Pollak CP, Weitzman ED, Rakoff S, Imperato J. Fibro-optic study of pharyngeal airway during sleep in patients with hypersomnia obstructive sleep-apnea syndrome. Laryngoscope. 1978;88:1310-3.
9. Vicini C, De Vito A, Benazzo M, et al. The nose oropharynx and larynx hypopharynx (NOHL) classification: a new system of standardized diagnostic examination for OSAHS patients. Eur Arch Otorhinolaryngol. 2012;269:1297-300.
10. Casale M, Vesperini E, Potena M, et al. Is obstructive sleep apnea syndrome with risk factors for auditory pathway?. Sleep Breath. 2012;16:413-7.
11. Sha SH, Taylor R, Forge A, Schacht J. Differential vulnerability of basal and apical hair cells is based on intrinsic susceptibility to free radicals. Hear Res. 2001;155:1-8.
12. Chung S, Yoon IY, Lee CH, Kim JW. The association of nocturnal hypoxemia with arterial stiffness and endothelial dysfunction in male patients with obstructive sleep apnea syndrome. Respiration. 2010;79:363-9.
13. Sardesai MG, Tan AK, Fitzpatrick M. Noise-induced hearing loss in snorers and their bed partners. J Otolaryngol. 2003;32:141-5.
14. Ekin S, Turan M, Arısoy A, et al.. Is there a relationship between obstructive sleep apnea (OSA) and hearing loss?. Med Sci Monit. 2016;22:3124-8.
15. Kotterba S, Rasche K. Acoustic evoked potentials (AEP) in obstructive sleep apnea syndrome. Pneumologie. 1996;50:924-6.
16. Muchnik C, Rubel Y, Zohar Y, Hildesheimer M. Auditory brainstem responses in obstructive sleep apnea patients. J Basic Clin Physiol Pharmacol. 1995;6:139-148.