EVALUATION OF VESTIBULAR FUNCTION IN OBSTRUCTIVE SLEEP APNEA SYNDROME PATIENTS

ÉVALUATION DE LA FONCTION VESTIBULAIRE CHEZ LES PATIENTS PRÉSENTANT UN SYNDROME D'APNÉES OBSTRUCTIVES DU SOMMEIL (SAOS)

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ABSTRACT

Purpose: To evaluate vestibular function in patients with obstructive sleep apnoea syndrome (OSAS).
Methods: Our study is cross-sectional, involving patients with obstructive sleep apnoea syndrome. We assessed the obstructive sleep apnoea syndrome by the apnoea–hypopnoea index (AHI) and the Epworth questionnaire. The vestibular function was evaluated using the visual analogue scale, the Dizziness Handicap Inventory (DHI), the clinical examination and the oculomotility tests and the caloric vestibular responses recorded by videonystagmography (VNG).
Results: Twelve women and 7 men were included. The mean age was 53 years old. The mean apnoea–hypopnoea index was 23.7 events per hour [5 - 77.4 AH / H]. Twelve patients complained of balance disorders. Dizziness-related disability, according to the Dizziness Handicap Inventory questionnaire, was considered moderate in four cases and minor in eight cases. At videonystagmoscopy, one patient had spontaneous nystagmus. The head shaking test and the vibrator test revealed nystagmus in 7 and 5 patients respectively. The Halmagyi test was pathological in four cases. The caloric test showed a deficit in 10 cases (including six with moderate to severe obstructive sleep apnoea syndrome) and a significant preponderance in 9 cases (including five with moderate to severe obstructive sleep apnoea syndrome).
Conclusion: Our results, in line with other studies, strongly suggest an alteration of vestibular function in patients with obstructive sleep apnoea syndrome. Recent studies suggest a subjective improvement of imbalance by correct nocturnal breathing disturbances management.
Keywords: Obstructive sleep apnea syndrome, dizziness, imbalance, vestibular function.

RÉSUMÉ

Objectif: Évaluer la fonction vestibulaire chez les patients atteints du syndrome d'apnées obstructives du sommeil (SAOS).
Méthodes: Il s'agit d'une étude transversale incluant des patients présentant un syndrome d'apnées obstructives du sommeil. La sévérité du apnées obstructives du sommeil a été évaluée à l'aide de l'index d'apnées-hypopnées (IAH) et du questionnaire d'Epworth. La fonction vestibulaire a été explorée par une échelle visuelle analogique, le questionnaire Dizziness Handicap Inventory (DHI), l'examen clinique, les tests d'oculomotricité ainsi que l'étude des réponses vestibulaires caloriques enregistrées par vidéonystagmographie (VNG).
Résultats: L'étude a inclus 12 femmes et 7 hommes. L'âge moyen était de 53 ans. L'index d'apnées-hypopnées moyen était de 23,7 événements par heure (extrêmes : 5 à 77,4 événements/h). Douze patients se plaignaient de troubles de l'équilibre. Selon le questionnaire Dizziness Handicap Inventory, l'handicap lié aux vertiges était jugé modéré dans quatre cas et léger dans huit cas.
À la vidéonystagmoscopie, un patient présentait un nystagmus spontané. Les tests du Head Shaking Test et du vibrateur ont révélé un nystagmus chez respectivement 7 et 5 patients. Le test de Halmagyi était pathologique dans quatre cas. L'épreuve calorique a mis en évidence un déficit vestibulaire dans 10 cas (dont six présentant un syndrome d'apnées obstructives du sommeil modéré à sévère) ainsi qu'une prépondérance directionnelle significative dans 9 cas (dont cinq présentant un syndrome d'apnées obstructives du sommeil modéré à sévère).
Conclusion: Nos résultats, en accord avec les données de la littérature, suggèrent fortement l'existence d'une altération de la fonction vestibulaire chez les patients atteints de syndrome d'apnées obstructives du sommeil. Des études récentes indiquent qu'une prise en charge efficace des troubles respiratoires nocturnes pourrait entraîner une amélioration subjective des troubles de l'équilibre.
Mots-clés: Syndrome d'apnées obstructives du sommeil (SAOS), vertiges, troubles de l'équilibre, fonction vestibulaire.

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INTRODUCTION:

Obstructive sleep apnoea syndrome (OSAS) is the most common sleep disorder [1]. Its prevalence is estimated at 6 to 13% of adults [2]. It is caused by repeated episodes of upper airway obstruction during sleep, as either breathing cessation (apnea) or reduction of airflow (hypopnea), resulting in nocturnal hypoxaemia and fragmented sleep [3,4,5]. This condition is associated with an increased risk of hypertension, coronary heart disease, stroke [6] and type 2 diabetes [7]. It has been suggested that OSAS leads to disruption of nocturnal testosterone rhythm [8]. Il also causes cognitive impairment [9] and depression [2].

The balance is maintained by the continuous and effective integration of vestibular, visual and proprioceptive information in the central nervous system to control the effector organs (skeletal muscles of the legs, gait and trunk) [5]. Vestibular dysfunction, which lead to imbalance and dizziness, may be caused by several diseases. It has considerable individual and social effects and may lead to interruption of daily activities, sick leave and avoidance of leaving the house [10].

The cardiovascular problems and neurological disturbances due to OSAS are well known. But, the neurotological consequences and in particular the vestibular system consequences are not so clearly identified and remain unknown. However, its effect is suspected, given the increasingly frequent observation of this association, the more frequent alteration of vestibular explorations in this population [1], or even the balance improvement of these patients after adapted OSAS management [11].

We conducted this study in order to evaluate the vestibular function in patients with OSAS and to find out whether there were any possible effects on the vestibular labyrinth secondary to this sleep disorder.

Material and methods:

We conducted a cross-sectional study, involving adults over the age of 18, suffering from OSAS, as defined by the American Academy of Sleep Medicine [12]. Patients with previous diagnosis of cancer, head trauma, neurological or psychiatric disease, known vestibulopathy such as Meniere's disease, neuritis, benign paroxysmal positional vertigo or major visual or lower limb disease were excluded from the study. A history of alcohol consumption, tobacco use, and illicit drug use was obtained.

OSAS was assessed by whether daytime sleepiness was present and by the apnoea-hypopnoea index (AHI) specified by polygraphy. Daytime sleepiness was assessed according to the validated Arabic version of The Epworth Sleepiness Scale (ESS) [13]: normal [0-8], low [9-12], moderate [13-16] or severe (≥ 17). According to the AHI, OSAS was considered low [5-14], moderate [15-29] or severe ≥ 30 AH /Hour (9).

Vestibular function was evaluated as follows. First, we investigated whether balance disorder was present, then we precised its characteristics and its severity. We used the visual analogue scale by asking the question, "How do you rate your ability to maintain stability over your pre-illness activities? The answer was between: 1 (all time in bed) and 100% (at maximum of capacity). We also used the validated Arabic version of the Dizziness Handicap Inventory (DHI) [14]. The score obtained ranged between 0 and 100: Disability was judged minor between 0 and 30, moderate between 31 and 60 and severe between 61 and 100 [15]. We proceeded in a second time to the vestibular exam including the examination of the oculomotricity, the videonystagmoscopy examination looking for a spontaneous nystagmus or a nystagmus caused by the head shaking test (HST), the vibrator test (100 Hz) and/or the positional maneuvers and the head impulse test (HIT) for the six canals. The third step consisted in the evaluation of eye movement disorders using oculomotility tests and the caloric vestibular responses recorded by videonystagmography (VNG). The oculomotility test evaluation included voluntary saccadic eye movements (latency, maximal velocity, accuracy), smooth-pursuit movements (morphology and gain) and the gain of the optokinetic nystagmus. We also assessed hearing by pure tone audiometry.

RESULTS:

We have collected seven men and 12 women. The mean age of the patients was 53 years (range 38-64 years). Nine patients had no comorbidity, six had hypertension, two had dyslipidemia and two had hypertension, diabetes and dyslipidemia. Two patients had cardiac diseases. The mean value of the body mass index of our study population was 37,7 Kg/m², ranged from 27 to 54.5 kg /m². Two patients were overweight and 14 were obese.

Six patients were active or passive smokers. Two patients reported neither tobacco nor alcohol use, whereas information on tobacco and alcohol consumption was unavailable for the remaining 11 patients.

The OSAS has been evolving for an average of 5 years and 4 months [6 months – 13 years]. Snoring was daily in 14 patients and intermittent in five. It was intense in 10 patients and moderate in nine. Daytime sleepiness was found in 12 patients. AHI value was in the mean of 23,7/h [5 - 77,4/h]. Eight patients had low, five had moderate and six had severe grade OSAS. Twelve patients complained of balance disorders. It was an oscillopsia in six cases and rotatory vertigo in the other six cases. For these patients, OSAS was low in seven, moderate in three, and severe in two cases. According to the ESS, low daytime sleepiness was found in two of these patients and moderate daytime sleepiness in four. The delay between OSAS and dizziness was on average 4 years and 9 months and ranged between 0 and 12 years and a half. According to the DHI questionnaire, the balance

disorders related disability was considered moderate in four cases and minor in eight cases.
All patients had a normal neurological examination, a negative cover test and a normal oculomotricity examination.
At the videonystagmoscopy examination, one patient experienced a horizontal right spontaneous nystagmus inhibited by fixation. The HST revealed nystagmus in six patients. This nystagmus was horizontal right in fve cases and horizontal left in one case.
The vibrator test was positive for five patients in whom the HST was also positive. It revealed a nystagmus with the same characteristics as the HST for all these patients. The HIT was positive in four patients: for the right horizontal canal in one case (in this case the HST and the vibrator test revealed a left horizontal nystagmus) and for the left horizontal canal in three cases (for these three cases the HST test and the vibrator test revealed right horizontal nystagmus).
No patient presented a deviation in both Romberg test and Fukuda Test. Otoscopy was normal for all patients.
Audiological assessment revealed bilateral sensorineural hearing loss in 10 patients with a down-sloping audiometric curve (Table I)
The right caloric reflectivity was normal in all cases. It averaged 35.5 °/s [8.5 - 72.3 °/s]. The left caloric reflectivity was normal in 17 cases. Two patients had left vestibular hyperreflexia. Mean left caloric reflectivity was 40°/s [9.9 - 106.5 ° / s]. Unilateral vestibular hypofunction was objectified in 10 patients, on the right side for seven and on the left for three (Table II). A significant directional preponderance was noted in nine cases (Table III). It was isolated (without hypofunction) in six cases. Caloric vestibular tests demonstrated normal vestibular functions in four patients.
The saccadic eye movement study showed an increased latency (> 200 msec) in 10 cases, slowed velocity in four patients and decreased accuracy (hypometry) in three patients and increased accuracy (hypermetry) in one patient. The curve of smooth-pursuit movements was normal in all cases and the gain was decreased in six cases. Optokinetic reflex gain was decreased in six cases.

Table I: Auditory status of patients

		Left hearing loss		Total
		Low	Moderate	
Right hearing loss	Low	6	0	6
	Moderate	1	2	3
	Severe	1	0	1
Total		8	2	10

Table II: Stratification of vestibular hypofunction with OSAS severity

		Hypofunction interpretation			Total
		No hypofunction <15%	Low hypofunction <30%	Moderate hypofunction <50%	
OSAS grade	Low [5-14]	5	2	2	9
	Moderate [15- 29]	2	3	0	5
	Severe > = 30	3	3	0	6
Total		10	8	2	20

Table III: Stratification of preponderance with OSAS severity

		Preponderance interpretatation			Total
		Not significant <2	Moderate [2-5[	Severe [5-10[	
OSAS grade	Low [5-14]	4	4	0	8
	Moderate [15- 29]	2	2	1	5
	Severe > = 30	4	2	0	6
Total		10	8	1	19

DISCUSSION:

Serious consequences of OSAS are now established. Daytime sleepiness with reduced alertness is responsible for difficulty in driving and performing daily activities, memory and concentration problems, and mood disorders [16]. These disturbances lead to an increase in the risk of road and work accidents as well as an impairment of the quality of life [17]. The recurrent apnoic episode, which is so characteristic of OSAS, results in a continuous reduction in the haemoglobin oxygen saturation. The effects of this chronic hypoxia, during sleep, result in alterations in the normal physiology of several body systems. Severe OSAS increases mortality and cardiovascular morbidity [7,18]. Patients with OSAS have 2 to 4 times higher risk of arrhythmia, 3 times more risk of stroke, and higher mortality related to heart failure and stroke [10].
The effect of OSAS on the vestibular system was suspected in the more frequent prevalence of imbalance and vestibular exploration disturbances in these patients. In our study 13 of 20 patients complained of dizziness or imbalance. According to the DHI questionnaire, the balance disorders related handicap was considered moderate in five cases and minor in eight cases. A Cohort study done in Taiwan, which included 5025 new cases of OSAS and 20100 healthy patients, found that patients with OSAS had 1.7 times higher risk of vertigo. The authors concluded that OSAS was an independent risk factor for vertigo.

The 1-year, 5-year, and 8-year cumulative incidences of vertigo were 1.2%, 5% and 7.4% respectively in patients with OSAS [10]. In an Italian study, four out of 35 patients complained of dizziness or imbalance [19]. In our study vestibular function was assessed in different frequencies. First, the Head Shaking test (for high frequencies: 2 Hz) was pathological in 35% of the cases. Second, the vibrator test (for very high frequencies: 100 Hz) was pathological in 30% of the cases. Third, the caloric test (for very low frequencies: 0,003 Hz) showed an unilateral vestibular hypofunction in 10 cases and a significant preponderance in 10 cases. The caloric test was normal in four cases. The Head impulse test, which explored the six canals, was pathological in four cases. These results suggest the vestibular function alteration in patients with OSAS. In line with our results, Han et al assessing the results of caloric vestibular tests in 77 patients suffering from OSAS demonstrated abnormal findings in 52 patients (67.5%): 16 patients had unilateral vestibular hyporeflexia and 36 patients presented a bilateral vestibular hyporeflexia [20]. Kayabai et al reported that according to caloric test results, six patients with mild OSAS (24%) and 14 patients with moderate-to-severe OSAS (56%) experienced unilateral canal paresis [21]. Micarelli et al performed the video head impulse test (VHIT) in 64 patients (one OSAS group and another control of 32 subjects for each group). OSAS patients demonstrated a lower vestibulo-ocular reflex (VOR) gain value (0.4 in the OSAS group and 1 in healthy subjects). Authors also found that in the OSAS group 57.81% of patients had both covert and overt saccade components and only an overt or covert saccade was observed in 28.12% and 14.06% respectively. These findings constitute a strong argument in favor of vestibular detriments in OSAS subjects.

The consequences of OSAS on different systems, including the vestibular system, are explained by different etiopathogenic mechanisms. Hypoxia can affect postural stability. This has been studied by Degache et al, who showed that exposure to hypobaric hypoxia at an altitude of 1700 and 3000 m could deteriorate the postural control [22]. This association between hypoxia and disturbances of balance has been explained by the alteration of the spindle mediated muscle stretch reflexes, which are considered to be crucial for maintaining the upright human stance [5]. It has also been shown that vestibular nuclei are very sensitive to hypoxia [23]. Moreover, chronic hypoxia affects the central nervous system and induces neural loss by provoking oxidative stress and ischemia [24]. These same alterations have been observed in the peripheral nervous system. The inner ear is particularly sensitive to circulatory alterations as it is supplied by terminal arteries and lacks adequate collateral blood supply [10]. It has also been shown that sleep deprivation reduces levels of alertness and affects postural stability [25].

Authors found that there is an apparent incongruence between the occurrence of subjective symptoms of vestibular dysfunction as opposed to the objective findings of VNG [19]. If the peripheral vestibular system becomes asymmetric due to hypoxic damage, the central vestibular system corrects this disequilibrium and the stability may be restored. As a result, patients with OSAS do not frequently complain of vertigo or balance problems [20].

It has been established that correct management of OSAS improves its consequences [26]. The effect of continuous positive airway pressure on the manifestations of Meniere's disease in patients with concomitant OSAS was evaluated. Authors demonstrated significant improvement in both DHI and audiometric testing following solitary CPAP therapy [27]. Alessandrini et al. studied the effect of 12 months of CPAP treatment, and showed improvement in postural instability and vertigo. Although, VOR gain did not demonstrate such strong behavior. This may require a longer period of treatment [11]

Our study has some limitations that need to be taken into account. First, the sample size is small and doesn't allow us to draw conclusions. Second, the existence of comorbidities in 11 patients, such as diabetes, hypertension and dyslipidemia, whose harmful effect on the inner ear and nervous system is established, prevents attributing the vestibular dysfunctions observed only to the OSAS. Third, the study did not have a control group that consisted of participants without OSAS. Finally, the evaluation of vestibular function should include evaluation of all canals by VHIT which is much more sensitive than the Halmagyi test, as well as otolithic function, by the study of the subjective visual vertical and the study of cervical and ocular vestibular-evoked potentials.

CONCLUSION:

OSAS is a frequent sleep disease that may affect various systems. As already mentioned, some studies were focused on the effect of OSAS on vestibular function and found vestibular alterations. Although the sample size was too limited to draw meaningful conclusions, our results, in line with other studies, strongly suggest an alteration of vestibular function in patients with OSAS. Recent studies suggested a subjective improvement of imbalance by correct nocturnal breathing disturbances management. Physicians should be aware of potential vertigo occurrence following OSAS.

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