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The relation between dizziness and suspected obstructive sleep apnoea

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Abstract

Purpose (1) To determine the prevalence of a high risk of obstructive sleep apnoea (OSA) in patients with dizziness. (2) To assess a relation between the risk of OSA and dizziness-related impairment. (3) To determine whether a high risk of OSA is associated with unexplained dizziness or with hyperventilation/anxiety disorders.

Methods In this cross-sectional study, we included Dutch adult patients with dizziness. Patients suffering from dementia were excluded. We asked patients to complete the Dizziness Handicap Inventory (DHI) and STOP-Bang questionnaire (SBQ). Based on the SBQ, patients were subdivided into groups with a low, intermediate, and high risks of OSA. All patients were subjected to our standard examinations for the workup for dizziness.

Results Among 704 included patients with a mean age of 59 years (± 17 years), 258 (37%) were male. A high risk of OSA was present in 144 (20%) of our patients of whom 120 (83%) were male. Male patients with a high risk of OSA reported an on average 9-point higher score on the DHI than male patients with a low risk of OSA ($p=0.018$). We determined an independent relation between the risk of OSA and dizziness-related impairment. We observed no relation between a high risk of OSA and unexplained dizziness or hyperventilation/anxiety disorders.

Conclusion The prevalence of a high risk of OSA in male patients with dizziness is high and a higher risk of OSA is associated with more dizziness-related impairments. A high risk of OSA is not associated with unexplained dizziness or with hyperventilation/anxiety disorders.

Keywords Obstructive sleep apnoea · Dizziness · DHI · STOP-bang questionnaire

Introduction

In the general population, dizziness is a common complaint with a lifetime prevalence up to 30%. Dizziness is often described as light-headedness or the feeling that one is going to faint, it can cause serious functional impairment and can have a significant impact on health-related quality of life [1–3]. Several factors associated with the occurrence of dizziness were defined in the literature, such as female gender, age, migraine, anxiety, and depression [4–7]. Although it is known that sleep disorders, such as obstructive sleep apnoea (OSA), can cause various psychiatric and physical health problems, a few studies focused on the relationship between obstructive sleep disorders and dizziness [8, 9].

Sowerby et al. concluded that a link between daytime somnolence, idiopathic or unknown dizziness and OSA might exist. Since they only used questionnaires in their assessment, this concerns patients who were suspected to have OSA [8]. Tsai et al. performed a nationwide population-based cohort study to investigate the risk of vertigo in patients with sleep apnoea [9]. They found that OSA was an independent risk factor for vertigo and recommended that physicians should be aware of the occurrence of vertigo in patients with OSA. A recent study of Gallina et al. suggested that OSA may cause dysfunction of the vestibular system due to hypoxic damage [10]. Nakayama et al. investigated whether Continuous Positive Airway Pressure (CPAP) therapy for OSA would improve the management of vertigo and hearing loss in patients with Menière's disease [11]. Their study demonstrated a significant improvement in both DHI scores and audiometric testing following CPAP therapy for OSA.

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A recent systematic review determined that the prevalence of OSA in women varies from 6 to 19%, and in men from 13 to 33% [12]. OSA was defined as ≥ 5 events/hour on the apnoea-hypopnoea index (AHI). This prevalence was only based on studies that objectively measured OSA regardless the presence of complaints.

Although several studies suggest that OSA and dizziness are associated, the prevalence of OSA in patients with dizziness is still unknown. Since there might be a link between OSA and unexplained dizziness, it would be interesting to investigate whether patients with unexplained dizziness suffer more often from OSA than patients with a known cause of dizziness.

The aim of our study was to determine the prevalence of a high risk of OSA in patients with dizziness referred to our tertiary dizziness clinic. Furthermore, we aimed to determine whether there was a relation between a high risk of OSA and dizziness-related impairment, and we aimed to determine whether a high risk of OSA was more often present in patients with unexplained dizziness or hyperventilation/anxiety disorders than in patients with dizziness due to other causes.

Materials and methods

We performed a cross-sectional study in our tertiary dizziness clinic in the Netherlands. From March 2018 until January 2019, we asked all eligible patients to participate by completing two questionnaires. We used the following inclusion criteria: referred to our tertiary dizziness clinic with complaints of dizziness, understanding of the Dutch language, and age 18 years or over. Patients were excluded from participation if they suffered from dementia.

Data collection

We sent all eligible patients the Dizziness Handicap Inventory (DHI) and STOP-Bang questionnaire (SBQ) by mail

to be completed at home prior to their visit to the dizziness clinic. The DHI is a standardised questionnaire to evaluate the level of dizziness-related complaints [13]. It is a 25-item questionnaire with a maximum score of 100 points. To screen for OSA, we used the SBQ [14]. This questionnaire consists of eight polar questions and each question answered with a ‘yes’ adds up one point to the total score (Table 1). The body mass index (BMI) and neck circumference were measured and calculated by a member of our research team when patients visited the dizziness clinic. The outcome was subdivided into three categories based on the total score: a low, intermediate, or high risk of OSA (Fig. 1).

All patients were subjected to our standard examinations for the workup for dizziness, which included routine neuro-otologic examination, otoscopy, videonystagmography, video head-impulse test, pure-tone audiometry, hyperventilation provocation test, postural hypotension test, and the Hospital Anxiety and Depression Scale. After taking the patient’s history and aforementioned examinations, the ENT and neurology consultant, during a joint consultation, attempted to provide each patient with a diagnosis that explained the dizziness.

Data analysis

Patients with incomplete SBQ’s were excluded from analysis. Patients with incomplete DHI questionnaires, without information about a history of OSA and without a known BMI were excluded from the analysis to determine the relation between the risk of OSA and dizziness-related impairment. We analysed whether all excluded patients differed from included patients on gender, age, and BMI. We performed a Student’s *t* test for continuous variables and a Fisher’s exact test for dichotomous variables.

To assess the relation between OSA and the DHI, we first performed the one-way ANOVA test. We compared the mean DHI scores between the three risk groups of OSA and we subsequently used the Bonferroni post hoc correction for multiple comparisons. Second, we determined the

Table 1 STOP-Bang questionnaire

STOP	Questions
Snoring	Do you snore loudly (louder than talking)?
Tired	Do you often feel tired, fatigued or sleepy during daytime?
Observed Apnoea	Has anyone observed you stop breathing during your sleep?
Blood pressure	Do you have or are you being treated for high blood pressure?
BANG	
BMI	BMI > 35 kg/m ²
Age	Age > 50 years
Neck circumference	Females: shirt collar > 41 cm / Males: shirt collar > 43 cm
Gender	Male

BMI body mass index

Fig. 1 Categories of STOP-Bang questionnaire

independent relation between the risk of OSA and the DHI by linear regression analysis. Univariate analyses identified potential confounders (those with an association with both OSA and the DHI with a p value of $p \leq 0.2$) to be included in the multivariate regression analyses. A history of OSA, BMI, gender, and age appeared to be potential candidates. We then performed a multivariate regression analysis. Potential confounders were stepwise added to the model in ascending order of p values. Variables were included in the final model if the regression coefficients of the central determinants (an intermediate risk of OSA and a high risk of OSA) changed by $\geq 10\%$. To assess the relation between the risk of OSA and the diagnoses, we calculated the odds ratios to describe the relation between a high risk of OSA and unexplained dizziness, and dizziness caused by hyperventilation/anxiety disorders and all alternative causes for dizziness. Through all the analyses, a p value of $p < 0.05$ was considered statistically significant. SPSS version 25.0 was used for all analyses.

Ethical approval and informed consent

The study was approved by the clinical research ethical committee of our hospital and performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments up to 2013 [15]. Informed consent was obtained from all individual participants included in the study.

Results

We screened a total of 782 patients. After exclusion of 6 patients because of age ($n = 5$) and language ($n = 1$), we asked 776 eligible patients to participate. Consequently, 48 patients were not included into the study because of refusal to participate ($n = 3$), unsigned informed consents ($n = 38$), or because patients were not diagnosed yet during the end of the study ($n = 7$). Since an additional of 24 patients returned

Table 2 Patient demographics

Variable	Included patients (<i>n</i> = 609)	Excluded patients (<i>n</i> = 167)	<i>P</i> value
Male gender <i>N</i> (%)	258 (37)	54 (32)	0.1
Mean age ($\pm$ SD, min–max)	59 years ($\pm$ 17 years, 18–93 years)	60 years ($\pm$ 16 years, 19–93 years)	0.5
Mean BMI ($\pm$ SD)	26.2 kg/m ² ($\pm$ 4.5 kg/m ²)	26.5 kg/m ² ($\pm$ 5.4 kg/m ²)	0.3

SD standard deviation, BMI body mass index

Table 3 Distribution of patients across the risk categories according to the STOP-Bang questionnaire

	Low risk of OSA	Intermediate risk of OSA	High risk of OSA
Female <i>N</i> (%)	338 (76)	84 (19)	24 (5)
Male <i>N</i> (%)	64 (25)	74 (29)	120 (47)
Total <i>N</i> (%)	402 (57)	158 (22)	144 (21)

OSA obstructive sleep apnoea

an incomplete SBQ (*n* = 18) or did not return the SBQ (*n* = 6), the analyses regarding the prevalence of a high risk of OSA and regarding the relation between a high risk of OSA and diagnoses were based on a total of 704 patients. Among these, 258 (37%) were male. The mean age was 59 years ($\pm$ 17 years) with a minimum age of 18 years and a maximum age of 93 years. The mean BMI was 26.2 kg/m² ($\pm$ 4.5 kg/m²).

Furthermore, the determination of a relation between the risk of OSA and dizziness-related impairment was performed on 609 patients, since 95 patients were excluded because of incomplete DHI questionnaires (*n* = 32), no information about a history of OSA (*n* = 61), or no information

about BMI (*n* = 2). We demonstrated no significant differences in gender, age and BMI between the included patients (*n* = 609) and all excluded patients (*n* = 167) (Table 2).

Prevalence of the risk of OSA

Table 3 shows the prevalence of a low, intermediate, and high risk of OSA. A total of 144 (21%) patients were identified as having a high risk of OSA. Among these, 120 (83%) were male.

Relation between suspected OSA and the DHI scores

The mean total score of the DHI of all patients was 43 points ($\pm$ 20 SD). Figure 2 shows the mean DHI scores categorised by gender and risk group for OSA. The standard deviations of all the individual mean DHI scores varied between 18 and 22 points. When comparing the three risk categories for suspected OSA among the entire group of patients, no differences between groups were found in DHI scores. We found a substantial difference in DHI scores between different OSA categories among male patients, which was not found in females. Post hoc analysis showed a higher score on the DHI in male patients with a high risk of OSA compared

Fig. 2 Mean DHI scores categorised by gender and risk group for OSA. OSA obstructive sleep apnoea, DHI dizziness handicap inventory

to male patients with a low risk of OSA [mean difference: 9 points, 95% CI (1.1–15.5), $p=0.018$]. Male patients with a high risk of OSA scored 7 points higher on the DHI than male patients with an intermediate risk of OSA [95% CI (0–14.1), $p=0.05$].

These results indicate an interaction between gender and risk of OSA for the outcome of the DHI. Along with other variables associated with the risk of OSA and the DHI, such as a history of OSA, BMI, gender, and age, the interaction variable was included in the multivariate analysis (Table 4). After adjusting for these variables, our final model showed a significant independent association between the risk of OSA and the DHI outcome [$B=9.6$, 95% CI (3–16), $p=0.004$, adjusted $R^2=0.03$].

Relation between a high risk of OSA and unexplained dizziness or hyperventilation/anxiety disorders

We calculated the odds ratio for individual diagnostic groups and focused on the group of patients with unexplained dizziness and hyperventilation/anxiety disorders (Table 5). We found no association between a high risk of OSA on one hand and unexplained dizziness or hyperventilation/anxiety disorders on the other hand.

Table 4 Multivariate regression model

Variables	Regression coefficient	95% CI	T test	P value
Constant	40	27.9–52	6.5	<0.001
Intermediate risk of OSA	4.1	–1.7 to 9.9	1.4	0.2
High risk of OSA	9.7	3–16.3	2.9	0.004
A history of OSA	5.9	0.2–11.6	2	0.04
BMI	0.2	–0.2 to 0.5	0.8	0.4
Gender	9.1	–0.7 to 18.8	1.8	0.07
Interaction gender x OSA	–2.2	–7.5 to 3.2	–0.8	0.4
Age	–0.2	–0.2 to –0.03	–2.5	0.01

CI confidence interval, OSA obstructive sleep apnoea, BMI body mass index

Adjusted R^2 of the model: 0.03

Table 5 Association between high-risk OSA and unexplained dizziness; dizziness caused by hyperventilation/anxiety disorders and for all alternative diagnoses

Diagnosis (grouped)	N (%)	High risk of OSA (%)	OR	95% CI	p Value
Unexplained dizziness	88 (13)	21 (24)	1.26	0.74–2.13	0.4
Hyperventilation/anxiety disorders/PPPD	206 (29)	43 (21)	1.04	0.7–1.55	0.86
PH, VM, migraine, VP, VH, VN, MD, BRV	410 (58)	80 (20)	0.99	0.98–1.00	0.25

OSA obstructive sleep apnoea, OR odds ratio, CI confidence interval, PPPD persistent postural-perceptual dizziness, PH postural hypotension, VM vestibular migraine, VP vestibular paroxysmia, VH vestibular hypofunction, VN vestibular neuritis, MD Menière's disease, BRV benign recurrent vertigo

Discussion

In our large prospective observational study, dizzy patients ($n=704$) aged 18 years and older were screened for OSA. Our primary aim was to determine the prevalence of a high risk of OSA in patients with dizziness referred to our tertiary dizziness clinic. Sowerby et al. determined the prevalence of suspected OSA in small groups of patients diagnosed with benign paroxysmal positional vertigo (BPPV) or with idiopathic dizziness and found prevalences of 13% and 41%, respectively. We demonstrated an overall prevalence of a high risk of OSA in 21% of our patients, with a prevalence of 5% in female patients and of 47% in male patients. A recent review of Senaratna et al. [12] also showed a higher prevalence of OSA in males in the general population. They merely included studies that objectively measured OSA using laboratory instruments and they excluded studies based on questionnaires. Since we used the SBQ, our methods are not comparable to Senaratna et al. Nevertheless, our results indeed showed a higher prevalence of a high risk of OSA in males compared with female patients.

Our second aim was to assess the relationship between the risk of OSA and dizziness-related impairment. We observed higher scores up to nine points difference for the DHI in male patients with a high risk of OSA compared to male patients with a low risk or intermediate risk of OSA. On a scale of 100 points, one might discuss whether this is clinically relevant. Some studies regard a difference of three points as clinically relevant [16] and other studies apply a cut-off of 18 points [13]. Such a difference in DHI scores was not observed among the different risk categories for OSA in our female patients. Possible explanations for this gender-related interaction might be that women report higher dizziness-related impairment, higher sleep needs than men, and that the prevalence of insomnia and insufficient sleep is higher in women [17, 18]. The SBQ asks patients about tiredness, and since complaints of sleep deprivation could cause tiredness, this could lead to an overestimation of women with a high risk of OSA. If women with lower risks of OSA actually report lower DHI scores, this would explain the gender-related interaction. However, other studies investigated

gender-specific symptoms of patients with OSA and they concluded that women diagnosed with OSA present atypically, since women were more likely to report insomnia, a lack of energy, and morning headaches instead of the typical OSA complaints, such as snoring and apnoeas [19–21]. This could lead to an underestimation of women with a high risk of OSA. Since this gender difference was not hypothesized a priori, it is a hypothesis-generating result rather than a hypothesis-confirming result. Therefore, the hypothesis generated should be tested in a future, independent cohort before drawing conclusions regarding the gender-specific association between the risk of OSA and complaints of dizziness. By using a multivariate regression model, we demonstrated an independent relation between the risk of OSA and DHI scores. However, only 3% of the variation in DHI scores was explained by the model, which has little clinical relevance.

Finally, we aimed to determine whether a high risk of OSA was more often present in patients with unexplained dizziness or hyperventilation/anxiety disorders than in patients with dizziness due to other causes.

In contrast to Sowerby et al. we found no relation between unexplained dizziness and a high risk of OSA. Since they used different questionnaires to screen for the risk of OSA than we did, our results may not be comparable to their results.

A limitation of our study is the lack of objective results, since we used questionnaires to screen for the risk of OSA and to determine dizziness-related impairment. Both of our questionnaires were translated into Dutch, but only the SBQ was validated for the Dutch language [22]. This validation was performed on healthy people. Since the SBQ was originally developed for surgical patients, it has not been validated for our specific group of dizzy patients. Thereby, the predictive value of the SBQ is somewhat controversial. However, recent studies have evaluated the validity of the SBQ and have compared the predictive value for OSA between the SBQ and other questionnaires, such as the Berlin questionnaire (BQ), and the Epworth Sleepiness Scale (ESS) [23–26]. They found high sensitivity and specificity scores up to 94% and 82%, respectively, and concluded that the SBQ predicted OSA better than other questionnaires. Two studies found a poor predictive performance of the SBQ in certain patient groups and discouraged the use of the SBQ as a screening tool for OSA [27, 28]. However, in our opinion, the other commonly used questionnaires, such as the BQ and ESS, are missing essential information about possible apnoeas, weight, and neck circumference. Because of the lack of this essential information in the other questionnaires and the better predictive value of the SBQ compared to other questionnaires, we decided to work with the widely used SBQ as a quick and simple screening tool for OSA.

Conclusion

We demonstrated a high prevalence of a high risk of OSA in our total group of dizzy patients, specifically in male patients. Furthermore, we observed a relationship between the risk levels of OSA and dizziness-related impairment in male patients: a higher risk of OSA is associated with higher DHI scores. However, the independent relation between the risk of OSA and DHI scores was weak. Future research should focus on objectively measuring the prevalence of OSA among patients with complaints of dizziness and a high risk of OSA by performing polysomnography. Furthermore, it would be valuable to investigate whether treatment for OSA will result in a reduction of dizziness-related impairments and whether these impairments are gender-specific.

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