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Original Article

Investigation of the relationship between posterior semicircular canal benign paroxysmal positional vertigo and sleep quality

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Abstract

Aim: The aim of this study was to investigate the relationship between posterior semicircular canal benign paroxysmal positional vertigo (P-BPPV) and sleep quality.

Material and Methods: In this prospective study, 35 patients with P-BPPV and 30 healthy volunteers were evaluated. Pittsburgh Sleep Quality Index (PSQI) and Insomnia Severity Index (ISI) were applied to all subjects. Adult Dizziness Handicap Index (ADHI) was applied to the patients with P-BPPV. The PSQI and ISI scores of the P-BPPV patient group and the control group were compared. ADHI scores were compared with PSQI and ISI scores. PSQI and ISI scores of recurrent P-BPPV patients and P-BPPV patients who had their first attack were compared.

Results: The PSQI and ISI scores of the patients with P-BPPV were significantly worse than the control group ($p=0.02$, $p<0.001$, respectively). There was no significant relationship between ADHI scores and PSQI and ISI scores in patients with P-BPPV ($p=0.552$, $p=0.074$, respectively). There was no significant difference between the PSQI and ISI scores of patients with recurrent P-BPPV and patients with non-recurrent P-BPPV ($p=0.060$, $p=0.065$, respectively). There was no significant difference between PSQI and ISI scores of P-BPPV patients who stated that sleep quality was negatively affected after vertigo attack and P-BPPV patients who stated that sleep quality was not affected after vertigo attack ($p=0.405$, $p=0.919$, respectively).

Conclusion: Sleep quality of P-BPPV patients was significantly worse than the healthy volunteers. However, there was no relationship between the degree of disability due to imbalance after a vertigo attack and sleep quality in these patients. Poor sleep quality may cause P-BPPV. Improving sleep quality may reduce the rate of P-BPPV or reduce recurrence rates in P-BPPV patients.

Keywords: Benign paroxysmal positional vertigo; insomnia severity index; pittsburgh sleep quality index; sleep quality; vestibular.

INTRODUCTION

Benign paroxysmal positional vertigo (BPPV) is one of the most common peripheral vestibular diseases in otorhinolaryngology outpatient clinics. BPPV causes dizziness triggered by head movements and lasts for seconds. It is thought that BPPV is formed as a result of displacement of the otoliths located in the macula of the utricule, adhering to the cupula (1) or falling of these otoliths into semisircular canals (2). BPPV can be triggered by trauma, labyrinthitis, stapes surgery, endolymphatic hydrops, advanced age, and osteoporosis. However, in many BPPV patients, the reason for the displacement of otoliths in the macula cannot be found and is considered idiopathic.

Recently, in the cadaver studies to explain the otolithic theory, the lack of a control group has been criticized (3). However, the high success rate of repositioning maneuvers used to treat BPPV reinforces otolithic theory (4-6). However, although the patients' complaints improved with repositioning maneuver, the recurrence rate of BPPV is quite high in these patients. The recurrence rate of BPPV was reported to be 13.5% in the 6-month period after the repositioning maneuver (7). In the longer follow-up, this rate can be up to 50%

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(8). The researchers focused on the daily life of BPPV patients to understand the high recurrence rate of BPPV. Recent studies indicate a relationship between BPPV and sleep position. Many BPPV patients experience their first episodes while getting out of bed in the morning or during sleep (9). It is recommended that patients with BPPV who undergo repositioning maneuver should use position restriction and high pillow, with the thought that the sleep position may cause BPPV. However, many studies have reported that position restriction does not affect recurrence rates of BPPV (10, 11). In addition, there are some uncertainties in the literature regarding the relationship between BPPV and sleep. Wang et al. (12) found that sleep quality of patients with recurrent BPPV was worse than patients with non-recurrent BPPV. They reported that patients with recurrent BPPV have more psychiatric problems and that psychiatric problems may affect sleep (12). However, it is known that sleep disorder can cause vestibular problems (12, 13). In this case, the relationship between sleep and BPPV seems to be much more complicated than it was thought, and the relationship between BPPV and sleep has not been fully elucidated.

The aim of this study was to investigate the relationship between sleep quality and BPPV in patients with BPPV.

MATERIAL and METHODS

In this prospective study, patients admitted to the outpatient clinic of otorhinolaryngology with complaints of vertigo were evaluated. A detailed history and otorhinolaryngologic examinations were performed from all patients. Dix-Hallpike test and supine roll test were performed. The diagnosis of posterior semicircular canal BPPV (P-BPPV) was made in the presence of characteristic nystagmus findings induced by Dix-Hallpike test as described by Bhattacharyya et al. (14). Thirty-five P-BPPV patients (mean age: 47.20±16.04 years, range: 23-78 years) presenting with a history of vertigo attack when they getting out of bed in the morning or during sleep, were included in the study. Patients whose vertigo started in day time were excluded. Patients with otological problems such as otitis media, tympanic membrane perforation, otosclerosis, history of otological surgery, obstructive sleep apnea, neurological disease, and psychiatric disease, abnormal blood counts or peripheral vestibular system problems other than P-BPPV were excluded from the study. In the anamnesis of the P-BPPV patients included in the study, the following questions were asked and their answers were recorded.

1. Have you experienced a similar episode of vertigo in the last year? (Yes or no)
2. Did your complaint of dizziness adversely affect your sleep quality? (Yes or no)
3. To which direction do you sleep more often? (right or left)
4. What is the height of your sleeping pillow? (thin, normal or thick)

Thirty healthy subjects (44.10±11.39 years, range: 24-70 years) who had similar age and sex distribution with P-BPPV patients were included in the study. Pittsburg Sleep Quality Index (PSQI) and Insomnia Severity Index (ISI) were administered to all subjects. Adult Dizziness Handicap Index (ADHI) was applied to patients diagnosed as P-BPPV. PSQI and ISI scores of patients with P-BPPV and control group were compared. PSQI and ISI scores were compared between patients with recurrent P-BPPV episodes and P-BPPV patients who had their first episodes. In P-BPPV patients, the relationship between ADHI and PSQI and ISI was investigated. In addition, PSQI and ISI scores were compared between P-BPPV patients who stated that sleep quality was affected after the vertigo attack and P-BPPV patients who stated that sleep quality was not affected after the vertigo attack. The relationship between head-lying side during sleep preferences and the affected ears was investigated in patients with P-BPPV. Written informed consent was obtained from all participants. Ethics committee approval was received for the study (2018-10/16).

Pittsburgh Sleep Quality Index (PSQI)

PSQI consists of seven sections named as subjective sleep quality (component 1), sleep latency (component 2), sleep duration (component 3), sleep efficiency (component 4), sleep disturbance (component 5), use of sleep medication (component 6) and daytime dysfunction (component 7). Each component is rated from 0 to 3 and the total score can range from 0 to 21. A total score greater than 5 indicates poor sleep quality.

Insomnia Severity Index (ISI)

UTI is used in the clinical evaluation of insomnia to determine the degree of insomnia. As a five-point Likert-type scale, ISI consists of 7 questions. Each item can be scored between 0 and 4. The total score is ranged from 0-28. If the total score is between 0 and 7 points, it shows sleeplessness in the normal range, 8 to 14 points refers to the lower threshold of insomnia. Fifteen to 21 points show moderate insomnia and severe insomnia is between 22 and 28 points.

Adult Dizziness Handicap Index (ADHI)

The scale consists of 25 questions: 9 questions about emotional status, 9 questions about functional status and 7 questions about physical status. Each question is given a score of 0 for no, 2 for sometimes and 4 for yes. The total score is calculated over 100 points. The total score of 0 to 16 is evaluated as 'no handicap', 16-34 as 'mild handicap', 36-52 as 'intermediate handicap' and 54-100 as 'advanced handicap'.

Statistical analysis

SPSS version 21 (SPSS Inc.; Chicago, IL, USA) was used as a statistical method. For descriptive statistics, the mean ± standard deviation was presented when the data was normally distributed, and the median (minimum-maximum) was presented when the data was not normally

distributed. Mann Whitney U test and Chi-square test were used to evaluate age and sex distribution of P-BPPV patient group and control group, respectively. Mann Whitney-U Test was used to compare the PSQI and ISI scores of the P-BPPV patient group and the control group. T-test and Mann Whitney-U test were used to compare the PSQI and ISI scores of recurrent P-BPPV patients and P-BPPV patients who had their first attack, respectively. Pearson correlation test and Spearman correlation test were used to evaluate the relationship between ADHI and PSQI and ISI in P-BPPV patients. Mann Whitney-U Test was used to compare PSQI and UTI scores of P-BPPV patients who stated that sleep quality was impaired after dizziness attack and P-BPPV patients who stated that sleep quality did not change. Chi-square test was used to evaluate the relationship between affected ears and head-lying side direction preferences during sleep of P-BPPV patients. Significance level was accepted as <0.05

RESULTS

There was no significant difference between the P-BPPV patient group and the control group in terms of age and gender distribution (Table 1). In patients diagnosed with P-BPPV, the involved ear was the right side in 23 patients (65.7%) and the left side in 12 patients (34.3%). Totally, 23 of P-BPPV patients (65.7%) had their first episode and other 12 patients (34.3%) had recurrent episodes. The PSQI component 1 score (subjective sleep quality), component 2 (sleep latency) score, component 7 score (daytime dysfunction), total PSQI score and ISI score of the patients with P-BPPV were significantly worse than the control group (Table 2). There was no significant difference in PSQI and ISI scores between patients with recurrent P-BPPV and patients with non-recurrent P-BPPV (Table3).

Table 1. Age and gender distribution of posterior semicircular canal benign paroxysmal positional vertigo (P-BPPV) patient group and control group

	P-BPPV group	Control group	P-value
Age (mean±SD)	47.20±16.04	44.10±11.39	0.635[a]
Sex			0.200b
Male (n)	12	15	
Female (n)	23	15	

[a] Mann Whitney-U test
[b]Chi-square test

The mean ADHI score of patients with P-BPPV was 22.77 ± 6.07. There was no significant relationship between ADHI score and PSQI score and ISI score (p=0.552, p=0.074, respectively). Of 35 patients with P-BPPV, 21 (60%) reported impaired sleep quality after a vertigo attack, and 14 (40%) reported no impairment in sleep quality. There was no significant difference between P-BPPV patients who stated that sleep quality was altered and P-BPPV patients who stated that sleep quality did not change (p=0.405, p=0.919, respectively) in terms of total PSQI score and ISI scores. There was a significant relationship between the lying side of the affected ears and sleep direction preferences of patients with P-BPPV (p: 0.026) (Table 4). Four (11.4%) of the patients with P-BPPV were sleeping on a low pillow, 25 (71.4%) were sleeping on a normal pillow and 6 (17.1%) were sleeping on a high pillow.

Table 2. Pittsburgh Sleep Quality Index (PSQI) and Insomnia Severity Index (ISI) Sscores of posterior semicircular canal benign paroxysmal positional vertigo (P-BPPV) patient group and control group

	P-BPPV group	Control group	P-value
Total PSQI score	5.74 ± 3.06	3 (1-9)	0.002[a]
Subjective sleep quality	1 (0-3)	0 (0-2)	0.002a
Sleep latency	2 (0-3)	1 (0-3)	0.001[a]
Sleep duration	0 (0-2)	1 (0-2)	0.292[a]
Sleep efficiency	0 (0-3)	0 (0-2)	0.488[a]
Sleep disturbance	1 (0-3)	1 (0-2)	0.122[a]
Use of sleep medication	0 (0-0)	0 (0-0)	1.000[a]
Daytime dysfunction	0 (0-3)	0 (0-2)	0.003[a]
ISI score	7 (0 – 19)	1.5 (0 – 9)	<0.001[a]

The mean ± standard deviation was presented when the data was normally distributed, and the median (minimum-maximum) was presented when the data was not normally distributed. [a]Mann Whiney-U test

Table 3. Pittsburgh Sleep Quality Index (PSQI) and Insomnia Severity Index (ISI) scores of recurrent posterior semicircular canal benign paroxysmal positional vertigo (P-BPPV) patient group and P-BPPV patients who had their first episodes (non-recurrent P-BPPV group)

	Recurrent P-BPPV group	Non-recurrent P-BPPV group	P-value
Total PSQI score	7.08±3.02	5.04±2.89	0.060[a]
ISI score	8 (5-18)	4 (0-19)	0.065[b]

The mean ± standard deviation was presented when the data was normally distributed, and the median (minimum-maximum) was presented when the data was not normally distributed. [a]T-test, [b]Mann Whitney-U test.

Table 4. Head-lying side preferences during sleep and the affected ears in patients with posterior semicircular canal benign paroxysmal positional vertigo

Affected ear	Head-lying side preferences		P-value
	Right side	Left side	0.026[a]
Right ear (n)	20	3	
Left ear (n)	6	6	

[a] Chi-square test

DISCUSSION

In this study, PSQI and ISI scores of P-BPPV patients and healthy volunteers were compared. The relationship between ADHI scores and PSQI and ISI scores was evaluated in P-BPPV patients. The PSQI and ISI scores of the patients with P-BPPV were found to be significantly worse than the control group. There was no significant relationship between ADHI scores and PSQI and ISI scores in P-BPPV patients. Also, there was no significant difference between PSQI and ISI scores of P-BPPV patients who stated that sleep quality was affected by dizziness and P-BPPV patients who had no impairment in sleep quality. In the light of these results, it was concluded that poor sleep quality may cause P-BPPV and P-BPPV did not affect sleep quality.

The density of otoliths in the utricle and saccule is higher than the endolymph liquid. Otoliths may move and fall into semicircular canals either idiopathic or due to vibrations, trauma, aging, and inner ear damage. Due to the anatomical structure of the semicircular canals, the otoliths fall into the posterior semicircular canal and less frequently into the horizontal semicircular canal. Recent research has shown a relationship between sleep and BPPV. Sato et al. (15) investigated the relationship between the affected ears of P-BPPV patients and patients with horizontal canal BPPV (H-BPPV) and their preferred sleep direction. Similar to our study, they reported an association between affected ears and lying to bed preferences in patients with P-BPPV. However, they indicated that there was no significant difference between the affected ear and sleep direction preference in H-BPPV patients. Spontaneous improvement in H-BPPV is more frequent and in a short time, so the number of H-BPPV patients presented to the clinics is lower than P-BPPV patients (16). Therefore, we did not include patients with H-BPPV in our study. The relationship between the head-lying side preferences during sleep and the affected ear can be explained by the anatomical location of the utricle and posterior semicircular canals. When the patient is in the supine position, the posterior semicircular canal is located lower than the utricle. Therefore, the otoliths in the utricle may fall into the posterior semicircular canal due to gravity and cause P-BPPV. We also investigated the effect of pillow height on BPPV in our study. However, the majority of the patients stated that they used a pillow with normal height and only 11.4% stated that they used a low pillow. In this case, it can be concluded that the main factor that decreases the otoliths from the utricle is direction preference and there is no relation between the pillow height and P-BPPV. In the literature, BPPV is reported to be more common in the right ear (17). In our study, similar to the literature, 65.7% of the patients had P-BPPV in the right ear. In our study, 74.2% of P-BPPV patients stated that they mostly prefer lying on their right side. This may be one of the reasons why we found more P-BPPV patients lying on the right side while sleeping. It is also known that people lie on their right side more with aging (18).

Although there are some studies investigating the relationship between bed side preferences and BPPV, there are limited studies investigating the sleep quality of patients with BPPV. Wang et al. (12) compared the sleep quality of patients with recurrent BPPV and patients with non-recurrent BPPV with PSQI. They have reported that patients with recurrent BPPV had poorer sleep quality in 5 subgroups on the PSQI scale (shorter sleep duration, prolonged sleep latency, decreased sleep efficiency, daytime dysfunction, and more usage of sleep-aid medications) (12). However, in this study, the relationship between poor sleep quality and BPPV was not fully established (12). It has been reported that BPPV may impair sleep quality by increasing anxiety and depression, or poor sleep quality may cause BPPV (12). In this study, we compared the sleep quality of patients with recurrent P-BPPV, patients with P-BPPV for the first time, and healthy individuals. Patients with P-BPPV had poorer sleep quality in the three subgroups of PSQI (subjective sleep quality, sleep latency, daytime dysfunction) and in ISI than the control group. There was no difference in sleep quality between patients with recurrent BPPV and patients with the first episode of BPPV. We also asked patients whether sleep quality was affected after the vertigo attack in order to better understand the relationship between sleep quality and BPPV, unlike Wang's study. There was no significant difference in PSQI and ISI scores between P-BPPV patients who reported that sleep quality was affected and P-BPPV patients who reported no change in sleep quality. In the light of these results, it can be thought that P-BPPV does not affect sleep quality and poor sleep quality causes P-BPPV. We also evaluated the physical, functional and emotional effects of dizziness in patients with P-BPPV using ADHI. There was no correlation between ADHI scores and PSQI and ISI in P-BPPV patients. This may be another indication that disability following P-BPPV does not affect the sleep quality of patients with P-BPPV, and that the sleep quality of patients with P-BPPV was previously poor. In his study, Ichiojo (19) reported that more than 75% of patients with BPPV had their first episodes during sleep or when they were getting up in the morning. Individuals with poor sleep quality move more during sleep and turn their heads. Inertial force generated when turning the heads of the individuals from one side to the other can cause the otoliths in the underlying ear to fall into the posterior semicircular canal below the utricle and cause P-BPPV. There are also conflicting results in the literature regarding the proposed position restriction after repositioning maneuver in patients with BPPV. In many studies, it was reported that there was a relationship between sleep direction preference and BPPV (15, 20), but position restriction did not prevent recurrent BPPV (10,

11). It is known that position restriction gives individuals some discomfort and inconvenience and therefore affects individuals' social lives and sleep quality (20). The recommended position restriction to prevent recurrence of BPPV may impair the sleep quality of patients. Impaired sleep quality may interfere with the functionality of position restriction recommended to BPPV patients as it may trigger BPPV.

The limitation of our study was that the patients' position preferences when lying to bed were learned verbally from the patients, and no objective tests were used to evaluate the preferred positions

CONCLUSION

Sleep quality of the patients with P-BPPV was significantly worse than the control group. There was a significant relationship between P-BPPV localization (right / left) and lying to bed in the same direction. However, there was no correlation between the severity of dizziness and sleep quality in patients with P-BPPV. In addition, patients who stated that sleep quality was not affected as a result of BPPV had poor sleep quality, as did those who stated that sleep quality was affected. This may explain the relationship between sleep and BPPV and may indicate that poor sleep quality may cause BPPV. Approaches to improve sleep quality in individuals with recurrent BPPV may prevent recurrence of BPPV.

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