The Journal of Laryngology & Otology (2008), ***122***, *1295–1298.*

doi:10.1017/S0022215108002168

Main Article

Sleep position and laterality of benign paroxysmal positional vertigo

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Abstract

Objective: The aim of this study was to investigate the frequency of posterior semicircular canal benign paroxysmal positional vertigo in each ear, and to assess the association between the ear affected by benign paroxysmal positional vertigo and the head-lying side during sleep onset. Based on a previous study which used objective methods to prove the preference of the elderly for the right head-lying side during sleep, we hypothesised that a predominance of the same head-lying side in benign paroxysmal positional vertigo patients may affect the pathophysiology of otoconia displacement.

Study design: We conducted a prospective study of out-patients with posterior semicircular canal benign paroxysmal positional vertigo, confirmed by a positive Dix–Hallpike test.

Methods: One hundred and forty-two patients with posterior semicircular canal benign paroxysmal positional vertigo were interviewed about their past medical history, focusing on factors predisposing to benign paroxysmal positional vertigo. All patients included in the study were able to define a predominant, favourite head-lying side, right or left, during sleep onset.

Results: The Dix–Hallpike test was found to be positive on the right side in 82 patients and positive on the left side in 54; six patients were found to be positive bilaterally. During sleep onset, 97 patients habitually laid their head on the right side and the remaining 45 laid their head on the left. The association between the affected ear and the head-lying side during sleep onset was statistically significant ($p < 0.001$).

Conclusions: Our study found a predominance of right-sided benign paroxysmal positional vertigo, a subjective preference amongst patients for a right head-lying position during sleep onset, and an association between the ear affected by benign paroxysmal positional vertigo and the preferred head-lying side during sleep onset. The clinical and therapeutical implications of this observation are discussed.

Key words: Positional Vertigo; Otolithic Membrane; Sleep

Introduction

Benign paroxysmal positional vertigo (BPPV) is the most common vestibular disorder encountered in the neurotology department. The pathophysiology of this clinical entity has been the subject of extended investigation. Numerous clinical observations, and the well established success of canalith repositioning procedures, have indicated that BPPV is the result of vestibular lithiasis. The cupula, which acts as a mechanoreceptor for endolymphatic fluid displacement, is sensitive to the rapid shifts of density which take place when otoconial debris is displaced from the utricle and moves freely in the semicircular canal.[1–4]

However, the factors which cause otoconia to detach from the macula of the utricle still remain obscure, and most cases of BPPV are characterised as idiopathic. Furthermore, and despite the successful application of appropriate canalith repositioning manoeuvres, recurrence may occur unpredictably, ranging from 5 to 50 per cent.[5] Several reports have pointed out an apparently paradoxical predominance of the right posterior semicircular canal in BPPV cases, which cannot be explained by existing theories of the pathophysiology of BPPV.[6–9]

Sleep seems to be involved in the pathophysiology of BPPV, as many patients experience their first attack when arising from bed after waking.[7] De Koninck *et al.* examined the sleep habits of subjects in different age groups, using objective methods (i.e. camera recording), and reported a

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Accepted for publication: 28 January 2008. First published online 3 April 2008.

preponderance of right-sided bed-rest among the age groups considered susceptible to BPPV.[10] Cakir *et al.* and Lopez-Escamez *et al.* reported an association between the side affected by BPPV and patients' preferred sleeping position.[11,12] Lopez-Escamez *et al.* reported the affected canal to be associated with the bed-rest side in 33/45 patients; Cakir *et al.* observed the same association in 43/50 patients.

The aim of the current study was to investigate the statistical correlation between the side affected by BPPV and the preferred side of head-lying during sleep onset, in a larger population ($n = 142$). Moreover, by further analysis of the results and the possible underlying mechanisms, we hoped to add to the understanding of the pathophysiology of BPPV. Furthermore, we discuss the possible applications of such an association in BPPV management and counselling.

Patients and methods

A prospective study was carried out of out-patients with posterior semicircular canal BPPV. Intense vertigo, accompanied by a burst of nystagmus with the typical characteristics of latency, crescendo and transience, was considered necessary to establish a positive Dix–Hallpike test in all patients.[13] The involvement of the posterior semicircular canal was diagnosed by the type of the nystagmus produced during the Dix–Hallpike test. Typically, a lesion of the posterior semicircular canal induces a torsional-vertical eye movement. The torsional component of the nystagmus beats towards the affected and lowermost ear (i.e. counterclockwise during the right Dix–Hallpike test when the right ear is involved, and clockwise during the left Dix–Hallpike test when the left ear is involved), while a vertical upbeating component is superimposed.[14]

A detailed medical history was taken from all patients. Patients with factors predisposing to BPPV, such as head trauma, migraine, hypertension or other heart diseases, diseases of the cervical spine, hearing loss, prolonged bed-rest, and those reporting any medication intake, were excluded from the study. Patients with BPPV of the lateral semicircular canal, a negative Dix–Hallpike test or additional ear diseases were also excluded. All patients were asked about their preferred head-lying side during sleep onset. Patients were included in the study only if they were able to define a predominant, favourite head-lying side during sleep onset. All patients underwent complete clinical, audiological and neuro-otological investigations. The association between the ear affected by BPPV and the preferred head-lying side during sleep onset was evaluated using the chi-square test. Statistical significance was accepted at the $p < 0.05$ level.

In order to examine the hypothesis of a predominance of right posterior semicircular canal BPPV within a larger population, we also reviewed the medical records of out-patients with a diagnosis of posterior semicircular canal BPPV who had been treated over the last six years in three major hospitals.

Results

The medical records review identified 651 patients with a diagnosis of posterior semicircular canal BPPV. The majority of these (364; 56 per cent) had had a positive Dix–Hallpike test on the right side; a minority (242; 37 per cent) had had a positive Dix–Hallpike test on the left. In the remaining 45 (7 per cent) patients, both ears had been involved.

Our prospective study of head-lying position included 142 patients (63 men and 79 women) with posterior semicircular canal BPPV. Their ages ranged from 23 to 86 years, with a mean age of 61.8 ($\pm$10.6) years for men and 59.6 ($\pm$12.0) years for women. The time elapsed from the onset of symptoms until our examination ranged from one day to 15 years, with an average time of 124 days. Eighty-two (57.8 per cent) patients presented a positive Dix–Hallpike test on the right side, 54 (38 per cent) presented a positive Dix–Hallpike test on the left side (giving a right to left Dix–Hallpike test ratio of 1.52:1), and six (4.2 per cent) were found to be positive bilaterally (Table I). At sleep onset, 97 patients were accustomed to laying their head on the right side and 45 on the left side (a right to left head-lying position ratio of 2.15:1).

In the 136 patients who exhibited a unilaterally positive Dix–Hallpike test, the affected ear was associated with the head-lying side on sleep onset in 99 cases (69 on the right and 30 on the left), and was not associated in 37 cases (24 with a right head-lying side and a positive Dix–Hallpike test on the left, and 13 with a left head-lying side and a positive Dix–Hallpike test on the right). The association between the affected ear and the head-lying side during sleep onset was statistically significant ($\chi^2 = 21.94$, two degrees of freedom, $p < 0.001$).

All patients with a positive Dix–Hallpike test were treated with the modified Epley manoeuvre.[15–17] In cases of failure or incomplete remission of the symptoms, a canalith repositioning manoeuvre was repeated five to seven days later. The treatment was considered successful when the patient reported relief from vertigo and the Dix–Hallpike test was negative. Treatment was successful after the first visit in 124 patients (initial success rate of 87.3 per cent). Repetitions of the manoeuvre proved

TABLE I

POSTERIOR SEMICIRCULAR CANAL BPPV: POSITIVE DIX–HALLPIKE TEST SIDE AND HEAD-LYING SIDE

Head-lying side	DHT side (*n*)			Total
	R	L	Bilateral	
R	69	24	4	97
L	13	30	2	45
Total	82	54	6	142

The association between the affected ear and the head-lying side during sleep onset was statistically significant: $\chi^2 = 21.94$, two degrees of freedom, $p < 0.001$. DHT = Dix–Hallpike test; R = right; L = left

https://doi.org/10.1017/S0022215108002168 Published online by Cambridge University Press

successful in another 10 patients, resulting in a total success rate of 94.37 per cent.

Discussion

The aetiology of otoconia displacement remains unknown. Head trauma, advanced age, migraine, prior otological surgery, viral labyrinthitis, Ménière's disease and middle-ear disease have been reported to predispose to secondary BPPV.[4,18–20] Prolonged bed-rest (e.g. after major surgery) or central nervous system disease probably facilitates agglomeration of otoconia.[6,18,21] However, in clinical practice, most cases of BPPV cannot be related to any of the above mentioned predisposing factors, and are thus characterised as idiopathic.

The increased susceptibility of the right posterior semicircular canal to BPPV, supported by our results (right to left Dix–Hallpike test ratio = 1.52:1), is a fairly common observation in the literature.[6–9,22] However, since the above-mentioned probable pathogenetic mechanisms clearly affect both ears equally, an additional explanation must exist for the preponderance of right-sided Dix–Hallpike test positivity.

De Koninck *et al.* have observed a preference for right-sided sleeping, particularly in the age groups susceptible to BPPV.[10] These authors recorded sleep positions on camera and then analysed them using four dimensions: the position of the head, trunk, legs and arms. They reported a significant, progressive, ontogenetic disappearance of prone trunk positions, a significant decrease in left-sided head-lying and a progressive preference, very marked in the elderly, for right-sided positions. Notably, in the 65–80 year age group, the mean percentage of time spent in the right head-lying position increased to 59.9 per cent, while that for the left head-lying position decreased to 18.9 per cent, and that for the upward (supine) head-lying position decreased to 21.2 per cent. A possible explanation was that the right lateral position resulted in a lower sympathetic tone compared with the left lateral position, and was thus beneficial in patients with heart failure or after an infarction without bradycardia.[23] The results of our study seem to verify these findings; we found a right to left head-lying position ratio of 2.15:1, meaning that most patients slept in the right decubitus position.

As most patients suffering from BPPV are of advanced age, a potential factor favouring the occurrence of BPPV on the right side is the preference of the right decubitus position during sleep. In the 99 cases in which the affected ear side coincided with the head-lying side during sleep onset, 69 were on the right. According to the results of the current study, in the 136 patients who exhibited a unilaterally positive Dix–Hallpike test, the association between the affected ear and the head-lying side during sleep onset was statistically significant ($\chi^2 = 21.94$, two degrees of freedom, $p < 0.001$).

The presence of an association between the ear affected by BPPV and the head-lying side during bed-rest seems to be in accordance with existing theories of otoconia displacement. In the recumbent position, the openings of both the ipsilateral posterior and horizontal canals are in the lowermost position. Consequently, during sleep, the otoconial debris displaced from the utricle would seem more likely to gravitate towards and enter into the posterior and the lateral semicircular canal of the lowermost ear. When these canaliths reach a critical mass in the posterior semicircular canal near the ampulla, and the head is moved in the critical provocative direction, the canaliths become free-floating in the endolymph, gravitate as a bolus, and trigger positional nystagmus.[7,12,22,24] The accumulation of a critical mass of otoconia seems to be the key element in relating head-lying side to BPPV laterality. The pressure against the cupula is proportional to otoconium mass and peak cupular volume displacement, and nystagmus seems to increase in a linear fashion with particle size.[25] No cupular volume displacement seems to occur unless the otoconium mass reaches a critical volume, and prolonged head-lying on one side seems to favour the entrance of more otoliths into the semicircular canals of the lowermost ear. Of course, anatomical differences in the orientation of the semicircular canals may facilitate or hinder the entrance of otoconia.

- **The predominance of right-sided benign paroxysmal positional vertigo (BPPV) is a well documented observation**
- **This study reports the association between the ear affected by BPPV and the preferred head-lying side during sleep onset, in a large population, and concludes that the pathophysiology of BPPV may be related to sleeping position laterality**
- **The habitual preference for a right-sided sleeping position may contribute to the gravitation of otoconia into the posterior semicircular canal of the ipsilateral ear**

Thus, if a patient is found to demonstrate an association between the preferred head-lying side and the affected ear, it may be reasonable to advise a change in sleeping habits, at least during sleep onset. In this case, even if the patient reverts to their preferred side during sleep, a reduction in the time during which otoconia can gravitate towards the affected semicircular canal will presumably be beneficial. However, in these patients there is a tendency for the otoconia to detach, and thus the possibility of future involvement of the opposite side cannot be excluded.

A critical aspect of such studies is that patients are able to report their head-lying position only at sleep onset; they may not be aware of any change in their sleep position during the night. De Koninck *et al.* found that their adult subjects more frequently adopted the same postural configuration at bedtime and at sleep onset.[10] Consequently, the head-lying side that the patients report during sleep onset

https://doi.org/10.1017/S0022215108002168 Published online by Cambridge University Press

seems to adequately account for their sleep position during most bed-rest.

Conclusion

Our study confirms: (1) the predominance of right-sided benign paroxysmal positional vertigo (BPPV); (2) the preference of our patients for a right head-lying position on sleep onset; and (3) the association between the ear affected by BPPV and the preferred head-lying side during sleep onset, in a large population. A previous study on the sleep habits of different age groups, using objective methods, reported that the elderly showed a preference for a right-sided position throughout their sleep.[10] Based on these findings, we assume that the laterality of a patient's sleeping position may contribute to the gravitation of otoconia into the posterior semicircular canal of the ipsilateral ear, and the accumulation of a critical mass of otoconial debris capable of inducing an episode of BPPV. Therefore, we hypothesise that it may be useful to advise such patients to change their sleeping habits. Further studies are needed in order to assess the hypothesis that a simple change in head-lying position will prevent the onset of certain types of BPPV.

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Dr M Riga takes responsibility for the integrity of the content of the paper.
Competing interests: None declared