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# Migraine Features in Patients with Recurrent Benign Paroxysmal Positional Vertigo

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## Abstract

**Objectives:** To identify migraine features present in a cohort of patients with recurrent benign paroxysmal positional vertigo (BPPV).

**Methods:** Patients presenting with recurrent BPPV were surveyed. Recurrent BPPV was defined as 3 episodes or greater in 6 months prior to presentation, with resolution of symptoms after Epley maneuver. Current or past migraine headache (MH) diagnosis was made according to the International Headache Society guidelines.

**Results:** Fifty-eight patients with recurrent BPPV with a mean age of 53.8±17.4 years were included. Half (29 patients) fulfilled criteria for MH and half (29 patients) did not meet the criteria for MH (non-MH). No statistically significant difference was found in a majority of migraine-related symptoms between the MH and non-MH cohorts with recurrent BPPV. History of migraine medication usage ($P$=0.008), presence of a weekly headache ($P$=0.01), and duration of dizziness after positional vertigo ($P$=0.01) were the only variables that were different on multivariate analysis between the MH and non-MH cohorts.

**Conclusions:** Half of recurrent BPPV patients suffer from migraine headaches. The other half presented with migraine-related symptoms, but do not meet criteria for MH. The high comorbidity of MH in our recurrent BPPV cohort as well as the absence of a statistically significant difference in a majority of migraine-related features among patients who did and did not fulfill criteria for MH may suggest that BPPV has a relationship with migraine. Recurrent BPPV may potentially be a manifestation of migraine on the inner ear, which we term otologic migraine.

### Keywords

Migraine; Benign positional vertigo; Migraine-related symptoms; Recurrent benign paroxysmal positional vertigo; Otologic migraine

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**Conflicts of Interest:** None

## Introduction

Benign paroxysmal positional vertigo (BPPV) is a clinical syndrome characterized by brief episodes of vertigo and nystagmus triggered by movement of the head in relation to gravity.[1] BPPV is the most common vestibular disorder with a reported lifetime prevalence of 2.4%, accounting for 50% of all causes of dizziness in adults.[2,3] BPPV has a high rate of recurrence, with an estimated recurrence rate of 23% to 29% within 1 year of treatment with canalith repositioning maneuvers.[4] The pathophysiology of BPPV involves displacement of otoconia, which are composed of calcium carbonate crystals, from otolith macula beds into the semicircular canals. Changes in head position cause otoconia to move towards the more dependent portions of the semicircular canal, leading to endolymph flow. This resulting flow of endolymph deflects the gelatinous cupula that sits atop the cristae, leading to excitation/inhibition of vestibular afferent nerves.[5] Pathologic excitation/inhibition of the vestibular nerve may lead to symptoms of lightheadedness, postural instability, nonspecific dizziness, and nausea. Although the pathophysiology of BPPV is somewhat well understood, the etiology for otoconia displacement is unknown in a majority of cases.

Migraine headache (MH) is a complex neurologic disorder affecting 18% of women and 6% of men worldwide.[6] It is classically characterized by severe headache, although the presence of a headache is not a requirement for diagnosis.[7] MH can be accompanied by an aura, which can present as a variety of reversible visual, sensory, and/or motor symptoms. Recent studies have begun to address the epidemiologic relationship between BPPV and MH, with outcomes revealing that patients with BPPV are twice as likely to suffer from MH.[9] Additionally, MH and BPPV are known to have overlapping features of vertigo with head motion, sometimes making it difficult to distinguish between the two disorders. Finally, benign paroxysmal vertigo of childhood has been found to be a migraine precursor.[10]

In our practice, we have found that a majority of patients with recurrent BPPV presented with features of MH, many of whom did not meet the full International Headache Society (IHS) criteria for MH. Therefore, the high comorbidity and similarity in symptomatology between MH and BPPV may suggest a pathologic association between the two diseases. In this study, we compare the prevalence of migraine features in a cohort of patients with recurrent BPPV who meet IHS criteria for MH to a cohort of patients with recurrent BPPV who do not meet criteria for MH to determine whether a difference between the cohorts exists.

## Methods

Following Institutional Review Board approval, patients presenting to a tertiary care academic center's neurotology clinic from February 2018 to June 2019 with a chief complaint of recurrent dizziness were instructed to complete detailed questionnaires on dizziness and headache. Patients who met criteria for recurrent BPPV, which was defined as 3 or more episodes of vertigo in the 6 months prior to presentation where there was resolution of each episode after canalith repositioning maneuver, were included in our study. BPPV was diagnosed according to the International Classification of Vestibular Disorders (ICVD) guidelines.[5] Patients without definite recurrent BPPV based on clinical evaluation

were excluded from the study. The questionnaires were used to evaluate whether patients experienced migraine, according to the guidelines set forth by the IHS.[7] The 28-item questionnaire also included a comprehensive list of questions regarding migraine-related symptoms and clinical features that have been described in the literature.

The statistical analysis was performed in two steps. First, comparison of subgroups was performed via univariate analysis of survey data, which included independent sample *t*-test and chi-square or Fisher's exact tests for comparing numerical and categorical variables, respectively. Second, multivariate analysis was performed on variables with *P* values less than 0.05 using linear regression to account for potential confounders. The software program SPSS 23.0 (SPSS Inc., Chicago, IL, USA) was used to perform the statistical analysis.

## Results

A total of 77 patients were diagnosed with recurrent BPPV and were screened for inclusion in our study. Of the 77 patients, 58 completed the questionnaires satisfactorily and were included for further analysis. Twenty-nine patients (50%) fulfilled the criteria for migraine headache (MH) with or without aura, and 29 patients (50%) comprised the recurrent BPPV without MH (non-MH cohort). There was a statistically significant difference in age between the MH (47 ± 18 years) and non-MH (61 ± 14 years) cohorts ($P = 0.002$). There was not a significant difference in gender between the two cohorts ($P = 0.76$); however, there was a predominance of females in both cohorts (76% with MH *vs.* 72% non-MH). The non-MH cohort experienced a higher proportion of daily vertigo during an episode compared to the MH cohort (69% *vs.* 34%, $P = 0.01$). Additionally, the patients in the non-MH group experienced a shorter duration of dizziness symptoms after the paroxysmal positional vertigo compared to the MH cohort (5 ± 13 min *vs.* 19 ± 25 min, $P = 0.03$).

On univariate analysis, there was no statistically significant difference in the prevalence of a variety of migraine-related symptoms between the two cohorts (Table 1). Compared to those without MH, patients with MH had a higher prevalence of several migraine-related symptoms including headache accompanying their dizziness (86% *vs.* 41%, $P = 0.007$), weekly headaches (45% *vs.* 14%, $P = 0.009$), neck stiffness (79% *vs.* 55%, $P = 0.01$), sound sensitivity (41% *vs.* 10%, $P = 0.005$), weather sensitivity (41% *vs.* 3%, $P < 0.001$) and history of migraine medication usage (72% *vs.* 14%, $P < 0.001$). Multivariate linear regression was performed on all variables with a significant *P* value ($P < 0.05$) after univariate analyses. History of migraine medication usage ($P = 0.008$), weekly headache ($P = 0.01$), and dizziness duration after the acute paroxysmal positional vertigo ($P = 0.01$) were the only variables that remained significant after multivariate linear regression (Table 2). All other variables were insignificant following secondary analysis.

## Discussion

In this study, we found that 50% of the 58 patients with recurrent BPPV fulfilled IHS criteria for MH, which is significantly higher than the prevalence of MH in the general population (15.3%).[11] While all patients in the non-MH cohort experienced headache or symptoms associated with migraine, we found no statistically significant difference in a majority of

migraine symptoms and clinical features compared to those who fulfilled IHS criteria for MH. The non-MH cohort experienced a higher proportion of daily vertigo during a BPPV episode compared to MH cohort (69% *vs.* 34%). We attribute this finding to the nature of IHS criteria not including vertiginous symptoms as part of the MH diagnostic criteria. Although strict IHS diagnostic criteria were not met, patients experienced a significant number of migraine features not present on the list of IHS criteria for migraine headache.

After multivariate linear regression analysis, only dizziness duration after vertigo, weekly headache, and history of migraine medication usage were significantly different between the two cohorts. One might expect to find a difference in history of migraine medication usage between the cohorts since those with more severe and classic migraine headache symptoms are more likely to receive a prescription for migraine medication. The gender distribution for all patients presenting with recurrent BPPV was similar to that of idiopathic BPPV found in the literature (2F:1M).[12] There was no statistically significant difference in gender between the cohorts, with both showing a predominance of females at a ratio 3.2F:1M in the MH cohort and 2.6F:1M in the non-MH cohort. This further demonstrates a demographic similarity among the cohorts. The absence of a statistical difference in a majority of migraine symptoms experienced by both cohorts may indicate an association between recurrent BPPV and migraine in general.

Although there is a general consensus regarding the pathophysiology of BPPV involving free floating otoconia in the semicircular canals, the etiology for otoconia detachment is only partially understood. Otolith displacement from the utricular macule is known to occur as a result of damage to the inner ear by head trauma or secondary to inner ear diseases such as Meniere's disease, labyrinthitis, and vestibular neuritis.[13,14] However, the majority of cases of BPPV are idiopathic.[15] One of the proposed mechanisms for idiopathic BPPV involves vasospasm of the labyrinthine arteries, whereby ischemic damage to the inner ear leads to release of otoconia from macular beds.[3] Additionally, fluid extravasation in the cochlea has been found to occur as a result of trigeminal nerve stimulation.[16] This fluid extravasation could theoretically cause the separation of otoconia from the otolith organs.

Atypical migraine symptoms can vary, ranging from episodic vestibular symptoms to sensory and motor dysfunction.[7] Vertigo is a well-documented manifestation of MH in the literature, with studies suggesting that patients are two to three times more likely to suffer from vertigo when compared to a headache-free control group.[8,17] MH may be accompanied by an aura, which can involve a variety of sensory symptoms, some of which include photophobia, phonophobia, and vertigo.[18] The aura is theorized to be caused by cortical spreading depression leading to the release of neuropeptides, such as substance P, neurokinin A, and calcitonin gene related peptide, which cause sensitization and activation of the trigeminal vascular system.[19–21] Altered central processing and cortical spreading depression can lead to vestibular and para-vestibular symptoms, such as motion sickness, imbalance, and nausea.[22] The pathophysiology of migraine-related cochleovestibular symptoms is thought to involve trigeminal nerve activation and resultant changes to the posterior cerebral circulation leading to a change in vascular supply to the inner ear as well as neurogenic inflammation.[22] We term these various cochleovestibular symptoms as "otologic migraine", which can range from purely cochlear to purely vestibular

symptoms or a combination thereof. Recurrent BPPV likely falls under the otologic migraine umbrella.

There is epidemiologic evidence suggesting an association between migraine and BPPV. In one study, the odds ratio for BPPV in individuals with migraine was found to be 7.5 (95% confidence interval: 3.9–14.2) over age- and sex-matched controls.[2] Another study found that patients with idiopathic BPPV were three times more likely to suffer from MH compared with BPPV secondary to surgery or head trauma.[23] Ogun *et al.* found that 33.3% of BPPV patients report headache or migraine symptoms immediately prior to the onset of BPPV symptoms.[24] Our study contributes to the growing body of literature describing this association by demonstrating a high prevalence of MH in a cohort of recurrent BPPV. In addition, we found that the patients who did not fulfill the IHS criteria for MH in the recurrent BPPV cohort had very similar migraine-related features as those who fulfilled IHS criteria. The similarity in prevalence of migraine features, in combination with the epidemiologic evidence previously discussed, raises the possibility that recurrent BPPV may have a migraine etiology. Theoretically, it is possible that a migraine attack can cause fluid extravasation within the vestibule, leading to separation of otoconia and BPPV episodes.

Recent studies have drawn similar parallels between MH and various vestibular disorders and have had subsequent success in treating these patients with migraine prophylactic therapy. For example, migraine prophylactic therapy has been successfully shown to treat persistent post-stapedotomy vertigo, Meniere's disease, Mal de Debarquement syndrome, and sudden sensorineural hearing loss.[25–28] We believe that migraine prevention should be considered as a treatment option for patients suffering from recurrent BPPV to reduce the recurrence of symptoms prior to considering surgical therapy. The current treatment for BPPV is limited to the canalith repositioning procedure (CRP), also known as the Epley, Semont, and Lempert maneuvers.[29] Despite its success in relieving vertigo, there is a high 1-year rate of recurrence (23%−29%) after CRP.[4] If recurrent BPPV is indeed a manifestation of migraine, patients may experience reduced episodes with the implementation of preventative migraine treatment protocol that may include lifestyle, or diet modifications as well as supplements or other medications known to be useful for migraine prophylaxis. Awareness of a pathologic association between recurrent BPPV and migraine would allow clinicians to better identify triggers in patients presenting with recurrent BPPV, thereby improving management and overall quality of life.

Our study is limited by the size of the patient cohort, as it was performed at a single tertiary neurotology clinic, and by the retrospective nature of the survey analysis. Some of the questions on the survey require recall by the patient which could potentially introduce recall bias, as patients with more severe migraine-related symptoms are more likely to recall events. A larger prospective study is needed to better elucidate this relationship.

## Conclusion

We found that half of the patients with recurrent BPPV fulfilled IHS criteria for migraine headache and the other half of the patients had many similar features of migraine despite not fulfilling the IHS criteria. The high prevalence of MH in our BPPV cohort, as well

as high prevalence of migraine features among BPPV patients who did and did not fulfill IHS criteria for MH, may suggest a pathologic association between recurrent BPPV and MH. BPPV may be a part of the larger otologic migraine umbrella which includes cochlear, vestibular, or cochleovestibular symptoms.

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**Table 1.**

Comparison of migraine-related features in survey responders with recurrent benign paroxysmal positional vertigo

| Feature | MH cohort (N=29) | Non-MH cohort (N=29) | *P* value |
|---|---|---|---|
| Motion sickness | 18 (62%) | 14 (48%) | 0.28 |
| Head/brain fog | 14 (48%) | 9 (31%) | 0.18 |
| Accompanying headache with dizziness | 25 (86%) | 12 (41%) | 0.007* |
| Daily headaches | 5 (17%) | 3 (10%) | 0.45 |
| Weekly headache | 13 (45%) | 4 (14%) | 0.009* |
| Monthly headache | 8 (28%) | 4 (14%) | 0.20 |
| Headache duration (hour) | 9.3±10.1 | 9.8±18.9 | 0.92 |
| Headache side<br>Right<br>Left<br>Bilateral | <br>1 (3%)<br>6 (21%)<br>11 (38%) | <br>2 (7%)<br>0 (0%)<br>3 (10%) | 0.07 |
| Headache location<br>Frontal<br>Temporal<br>Occipital<br>All over | <br>4 (14%)<br>2 (7%)<br>5 (17%)<br>14 (48%) | <br>2 (7%)<br>1 (3%)<br>5 (17%)<br>4 (14%) | 0.52 |
| Neck stiffness | 23 (79%) | 16 (55%) | 0.015* |
| Neck stiffness side<br>Right<br>Left<br>Bilateral | <br>3 (10%)<br>3 (10%)<br>17 (59%) | <br>1 (3%)<br>3 (10%)<br>11 (38%) | 0.73 |
| Otalgia/ear pain | 15 (52%) | 10 (34%) | 0.12 |
| Recurrent sinus headaches | 10 (34%) | 7 (24%) | 0.38 |
| Ice cream headaches (brain freeze) | 13 (45%) | 16 (55%) | 0.35 |
| Cold air cause headaches | 10 (34%) | 6 (21%) | 0.19 |
| History of migraine medication usage | 21 (72%) | 4 (14%) | <0.001* |
| Family history of migraine | 11 (38%) | 7 (24%) | 0.29 |
| Family history of Meniere's disease | 2 (7%) | 1 (3%) | 0.51 |
| Family history of motion sickness | 4 (14%) | 4 (14%) | 0.96 |
| Light sensitivity | 14 (48%) | 8 (28%) | 0.07 |
| Sound sensitivity | 12 (41%) | 3 (10%) | 0.005* |
| Smell sensitivity | 6 (21%) | 2 (7%) | 0.11 |
| Weather/pressure change sensitivity | 12 (41%) | 1 (3%) | <0.001* |
| Hearing loss with headaches | 8 (28%) | 5 (17%) | 0.43 |

MH: Migraine headache.

Asterisk denotes a significant *P* value.

**Table 2.**

The results of multivariate analysis to evaluate the differences among two MH and non-MH cohorts of survey responders with recurrent benign paroxysmal positional vertigo

| Factor | *P* value |
|---|---|
| Age | 0.56 |
| Dizziness frequency | 0.84 |
| Perceived period of dizziness after paroxysmal positional vertigo (min) | 0.01* |
| Accompanying headache with dizziness | 0.82 |
| Weekly headache | 0.01* |
| Neck stiffness | 0.47 |
| History of migraine medication usage | < 0.001* |
| Sound sensitivity | 0.58 |
| Weather sensitivity | 0.28 |

MH: Migraine headache.

Asterisk denotes to significant *P* value.