E-ISSN: 2833-3772 | Volume 3 (2024), Issue 5 | Sep-Oct 2024

The Scientific Journal of Medical Scholar

Publisher: Real-Publishers Limited (Realpub LLC)

30 N Gould St Ste R, Sheridan, WY 82801, USA

Associate-Publisher: SSESD, Egypt

Website: https://realpublishers.us/index.php/sjms/index

The Scientific Journal of Medical Scholar

Available online at Journal Website
https://realpublishers.us/index.php/sjms/index
Subject (Otorhinolaryngology)

Original Article

Benign Paroxysmal Positional Vertigo (BPPV) and Migraine: Is there a relation?

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Article information

Submitted: August 22th, 2024; Accepted: September 18th, 2024; DOI: 10.55675/sjms.v3i4.103

Citation: Shams AI, Elzarea GA, Abbas AI, Ali AE. Benign Paroxysmal Positional Vertigo (BPPV) and Migraine: Is there a relation? SJMS 2024; 3 (5) Sep-Oct: 97-102. DOI: 10.55675/sjms.v3i4.103

ABSTRACT

Background: Migraine is characterized by episodes of moderate-to-severe headache, most often unilateral and generally associated with nausea and increased sensitivity to light and sound. BPPV is the most common cause of peripheral vertigo, accounting for over half of all cases. According to various estimates, a minimum of 20% of patients presenting to the clinic with vertigo have BPPV. This study aimed to elaborate the relation between Benign Paroxysmal Positional Vertigo (BPPV) and Migraine and the prevalence of Migraine in BPPV versus normal subjects.

Patients and Methods: This case-control study was performed at Audio-vestibular unit, ENT Department at Al-Hussein University Hospital, A total of 80 subjects composed of: A- Study group: Forty patients with BPPV, B- Control group: Forty healthy individuals with normal hearing without any balance disorders, vertigo or Migraine. The clinical assessment was performed according to standard techniques (history taking, general clinical, ontological and audiological examinations). The primary outcome was the incidence of migraine in BPPV, while secondary outcome included the associated factors of migraine and BPPV

Results: Migraine was reported among 11 cases in the study group (27.5%) (8 of them have migraine without aura and 3 with aura), compared to none in the control group ($p < 0.05$). No significant difference between the two studied groups regarding age and gender. There is significant association between BPPV and Migraine. Meanwhile, the most common reported type was posterior BPPV (80%) and lateral type was 20%. Female gender was found to be significantly associated with migraine.

Conclusion: The BPPV was associated with increased risk of migraine and both conditions are more presented in females.

Keywords: Benign; Paroxysmal; Positional; Migraine; Vertigo.

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INTRODUCTION

Benign paroxysmal positional vertigo (BPPV) is the commonest peripheral disease of the vestibular system. It is best described as a transient, sudden, gyratory sensation, associated with characteristic nystagmus. Symptoms are induced by sudden positional changes, especially of the head in relation to the gravity. Clinically, BPPV may be of mild severity in the form of mild dizziness, and may be extended to debilitating episodes of nausea, vomiting, and significantly impairs the daily activities [(1)].

Migraine is best described as a sort of complex neurological disorder. It is characterized by headache and other associated symptoms. Interestingly, migraine can be presented without headache in minority of subjects, which described as migraine aura without headache in the international Headache Society classification [(2)].

Another type is the migraine – associated vertigo. It is recognized when vertigo is the chief symptom of the migraine presentation. This type of migraine is now termed "vestibular migraine (VM)" [(3)]

The topic of migraine-Few researchers have investigated the association between migraine and BPPV and showed that migraine and vestibular dysfunction may have potential interactions and associations through several conditions including BPPV or other disorders associated with inner ear dysfunction [(4).]

Accordingly, this study was done to determine the association, if it exists, between BPPV and Migraine.

PATIENTS AND METHODS

This study was designed as a case-control study. It was performed at Audio-vestibular unit, ENT Department at Al-Hussein University Hospital from 1/7/2022 to 1/7/2023. Written consents were taken from all participants. Eighty individuals were selected from the Audiology Unit at Al-Hussein University Hospital. They were composed of two groups, each group composed of 40 individuals. The study group for individuals have BPPV, while control group for healthy individuals, and mostly were patient's relatives.

The inclusion criteria were; age from 20 to 60 years old, both genders were involved. **The exclusion criteria** were: ages below 20 or above 60 years old, patients with past history of chronic suppurative otitis media, patients with previously known congenital anomaly in the external ear and patient with previously diagnosed otosclerosis.

All subjects were submitted to full history taking, especially detailed information about main vestibular manifestations (e.g., Vertigo (onset, course, duration, what increase or decrease, precipitating factors "head or body movement…." , associations, accompanied by loss of consciousness "or not" , headache,...). In addition, detailed information about migraine were collected (e.g., onset, course, duration and frequency of acute attacks, treatment (Responsive or not) and complication (e.g. Migraine-triggered seizures), family history of migraine). The clinical examination was classified into two step, the general examination and otological examination. Furthermore, the audiological assessment compromised pure tone audiometry, speech audiometry and immitancemetry. Additionally, the vestibular evaluation included vestibular effect test.

The pure tone audiometry (PTA) included air conduction hearing threshold level. It was recorded for frequencies between 250-8000 Hz. The second test was bone conduction hearing threshold level, which was recorded at frequencies between 500-4000 Hz. The threshold was registered as the faintest sound that the patient responds to 50% of the time. However, the speech audiometry comprised speech Reception Threshold (SRT) using Arabic spondee words [(5)]**.** In addition to the word Discrimination Scores (WDS) using Arabic phonetically balanced words [(6)]**.** Furthermore, the Immitancemetry included tympanometry, which was performed at different pressure ranging between +200 and - 400 mm H_2O, to assess the middle ear pressure and its compliance. Finally, the acoustic reflex (AR) threshold was performed using pure tones of 500, 1000, 2000 and 4000 Hz.

Vestibular office test was performed as the posture and Gait tests [(7)]**.** These tests comprised tandem gait testing, the tandem Romberg test and Fukuda test. The Tandem gait testing was performed by stepping one foot in front of the other, the "Romberg's test" was performed by the standing of the patient with feet together, arms folded and with eyes open then closed while the observer watches for swaying or movement of the feet to achieve balance. The tandem Romberg test assesses if the patient stands heel to toe rather than with feet together. The Fukuda test was performed by asking the patient to march in place with extended arms straight out at the level of the shoulders. The test was done without vision. At least 50 steps are essential to perform a complete assessment.

The oculomotor examination: First, the eyes were examined for range of movement in different positions. Normally both eyes showed combined movement in the same direction for the same extent. Spontaneous nystagmus denotes movement of the eye without visual or vestibular stimulations. The smooth Pursuit was performed by asking the patient to visually track a slowly moving object, slowly back and forth in a sinusoidal fashion, to a maximum of 30° displacement from the midline while keeping stationary head. The saccades test performed by asking the patient to alternately fixate the examiner's finger after nose without moving the head. The test was held at different position at approximately 15 degrees away from primary position. The gaze-holding test was performed by the instruction of the patient to gaze at a fixed dot in different locations (central, horizontal and vertical positions), for about 15-20 seconds. Finally, the head impulse test (HIT) (head thrust test) consisted of eye movements monitoring as the patient fixates on a stationary object. While the head is rotated to right or left unexpectedly using passive, small amplitude 10–20 degree, and high-acceleration head movement.

The VNG test battery included spontaneous nystagmus, Gaze test, oculomotor tests and Optokinetic test. These tests were performed after confirmation of stoppage of any medications which could affect vestibular function for 48 hours before the examination. **Spontaneous nystagmus** test was performed by asking the patient to sit with upright head and supported back; spontaneous nystagmus was observed in complete absence of any visual fixation. Minimum observation period was 30 seconds. In Gaze test, the patient was asked to fix his vision on the light bar, in an eccentric position of 20 degrees, vertical and horizontal and the eye was kept in position for 20- 30 seconds. Finally, the oculomotor tests included the saccadic and smooth pursuit tests. In these tests, the patient was seated on test chair 1.5 meters from the center of a television (TV). In saccadic test, the patient was asked to follow a moving object that moves back and forth in jumping pattern. Such movements are of 5-30 degrees, unpredicted, start in the horizontal plane then to the vertical plane for 90 seconds. On the other side, in smooth pursuit test, the patient was instructed to follow the moving object that moves back and forth in sinusoidal waveform. Such movements were 20 degrees to right and 20 degrees to left and at various frequencies that ranges between 0.2 – 0.6 Hz. In Optokinetic test, each patient was instructed to follow the multiple visual targets as they move across the light bar. These objects move in the 4 directions for 20 seconds for each direction at a rate 20 degree/second. Normally, nystagmus occurs with its slow phase with the direction of movement. Such nystagmus was evaluated for gain and asymmetry.

The positional tests where subjects were recorded for different changes of the body and head positions. Each two observations are separated by at least 30 seconds between two observations. These positions include supine, supine with head right, supine with head left, right side (right decubitus). Normally, there is no nystagmus in all positions.

The positioning test (Dix-Hallpike maneuver). The patient was on the table in a sitting position. The subject's head was turned to the right (or the left) at 45º and the patients was changed to the supine position with head downward 30º. The patient was left in this position for 30 seconds. If there was no nystagmus, the patient was returned to the sitting position. If nystagmus occurred, it was recorded and the patient retained the sitting position after fading out of nystagmus.

The bithermal Caloric test was performed by placing the patient in the supine position, with opening eyes and the head was elevated 30 degrees. Four irrigations were performed. These included right ear cold, left ear cold, right ear warm and left ear warm (Proper mental tasks were given and nystagmus was recorded)

Diagnosis of migraine was based on the clinical data (e.g., patient history and physical examination", and fulfillment of the International Classification of Headache Disorders criteria for migraine [8].

The primary outcome was the incidence of migraine in BPPV, while secondary outcome included the associated factors of migraine and BPPV.

Statistical analysis: Data were collected, documented and coded before transmitting to the statistical package for social science (version 20) for analysis. The data were expressed by their means ± standard deviation (SD) if the data was numeric and normally distributed. However, if the categorical data were analyzed, the data were presented by relative frequency and percentages. Both groups were compared by student "t" or Chi square test for continuous and categorical data respectively. P value < 0.05 was considered significant.

RESULTS

Migraine was reported among 11 cases in the study group (27.5%) (8 of them have migraine without aura and 3 with aura), compared to none in the control group ($p < 0.05$). Family history of migraine was positive among 12 patients in the study group, compared to none in the control group.

The mean age of the study group was 54.61± 8.29 years, compared to 56.84 ± 9.76 for the control group ($P = 0.274$). In both groups, there were female sex predominance (females represented 57.5% and 65.0% of the study and the control groups respectively ($p = 0.491$). The audiovestibular symptoms in the study group included tinnitus (10 subjects, 5 with migraine and 7 were bilateral), hearing loss in 3 subjects (2 with migraine), phonophobia in 8 subjects (2 with migraine) and otalgia in 1 subject and associated with migraine. By classification of groups, all patients in this group had vertigo.

Table (1) described the results of pure tone audiometry (PTA) threshold in the study and control group. It revealed that, both groups were comparable (no significant differences) at different intensities (250, 500, 1000, 2000, 4000 and 8000 Hz). In addition, the vestibular evaluation of study group individuals revealed that; there is no abnormalities detected in vestibular office tests or V.N.G. except in Dix-Hallpike maneuver as all individuals in study group have BPPV. The 8 individuals in study group have lateral BPPV. The remaining 32 have posterior BPPV, in which 29 due to canalithiasis and 3 due to cupulolithiasis. There is no statistical difference between right and left side as regard BPPV types.

Table (2) showed that there was no significant difference between males and females regarding side and type of BPPV.

Table (3) showed that migraine was higher in females more than males among the study group. In addition, migraine was more presented on the right than the left side and the posterior canal type was the commonest.

Table (1): Mean PTA threshold of the study and control groups.

PTA	Study group (n=40)	Control group (n=40)	test	P
250Hz)Mean ± SD(dB)(	12.25 ± 3.59	11.75 ± 2.94	0.681	0.498
500Hz)Mean ± SD(dB)(	12.8 ± 3.94	12.4 ± 3.77	0.464	0.644
1k Hz)Mean ± SD(dB)(	13.4 ± 4.65	12.43 ± 3.19	1.16	0.252
2k Hz)Mean ± SD(dB)(	14.2 ± 4.5	12.75 ± 3.43	1.62	0.109
4k Hz)Mean ± SD(dB)(	16.8 ± 6.11	13.52 ± 3.81	1.19	0.254
8k Hz)Mean ± SD(dB)(	19.5 ± 5.7	14.67 ± 3.35	1.32	0.175

Table (2): BPPV characteristics in relation to gender in the study group

Variable		Male (n=17)		Female (n=23)		Test	p-value
		N	%	N	%		
Side	Right	12	70.6%	17	73.9%	0.054	0.816
	Left	5	29.4%	6	26.1%		
Type	Posterior Canal	14	82.4%	18	78.3%	0.102	0.749
	Lateral canal	3	17.6%	5	21.7%		

Table (3): Comparison between subjects with and those without migraine in the study group.

		Migraine (n=11)	No Migraine (n=29)	test	P
Gender (n, %)	Male	3 (27.3%)	14 (48.2%)	1.44	0.230
	Female	8 (72.7%)	15 (51.7%)		
Side (n, %)	Right	8 (72.7%)	22 (75.9%)	0.042	0.838
	Left	3 (27.3%)	7 (24.1%)		
Type (n, %)	Posterior Canal	8 (72.7%)	24(82.8%)	0.502	0.479
	Lateral Canal	3 (27.3%)	5 (17.2%)		
	Anterior Canal	0 (0.0%)	0 (0.0%)		

DISCUSSION

The results of the current work showed that, the cochlear symptoms was reported for 22 patients. These manifestations included hearing loss (3 patients), tinnitus (10 patients), otalgia (one patient) and phonophobia (8 patients). **Dash *et al.*** [9] reported that, the auditory clinical manifestations are generally considered less than vestibular symptoms in migraine. Another study by **Bayazit *et al.*** [10] also reported that tinnitus was the most frequent auditory symptom. It was seen in 50% of migraine patients.

In spite of the previous cochlear symptoms in the majority of subjects, the current study revealed no significant differences between the study and the control groups regarding peripheral hearing evaluation. Tinnitus was bilateral more than unilateral which agree with **Abdel Rahman *et al.*** [11] and **Nevin *et al.*** [12].

The origin of the tinnitus in cases with migraine is not well known, however, different causes can be responsible for the development of tinnitus. Any insult of the auditory system throughout the pathway extending from the ear to the auditory cortex may be responsible for this condition [9]. Phonophobia is considered as the second auditory symptom as it is recognized in about (20%). Several studies reported that phonophobia associated with migraine [11, 13, 14].

In this study, 1 case presented with otalgia (dull aching pain). Idiopathic Otalgia can be related to migraine referred otalgia mechanisms, as there was a high prevalence of migraine characteristics associated with otalgia. These included headache, migraine-associated symptoms, patterns of triggers and response to treatment of migraine [15]. **Teixido *et al.*** [16] reported that 65% of otalgia without clear cause had migraine.

According to VNG test battery results, all subjects in the study group had positive Dix-Hallpike test "32 subjects (80%) presented with posterior canal BPPV and remaining 8 patients (20%) presented with horizontal (lateral) canal BPPV", which was expected, because the most free-floating endolymph debris tends reach the posterior canal by the effect of gravity, as the canal is the most gravidity- dependent part of the vestibular labyrinth, either in the upright or supine positions. This result agrees with the studies reported that posterior canal BPPV is common more than other canals BPPV [17, 18].

The other VNG test batteries revealed no abnormality detected, which mean that there is no central cause or vestibular hypofunction and it was pure BPPV. The 32 (80%) patients of BPPV in this study had posterior BPPV, the right posterior BPPV patients were 24 patients (75% of 32), while the remaining 8 patients (25% of 32) were left posterior BPPV. The remaining 8 (12.5%) patients had horizontal BPPV. The right horizontal BPPV was reported in 5 patients (62.5% of 8), while the remaining 3 patients (37.5% of 8) were left horizontal BPPV with no difference between right and left side as regard BPPV types. In

addition, there were 29 subjects (72.5%) with tight BPPV and left BPPV was reported among 11subjects, representing 27.5% of BPPV. These results disagree with **Celikbilek *et al*.** [19]. They revealed that among the most included side of BPPV, the right was affected in 26 patients (57.8%) and the left in 19 patients (42.2%), with no significant differences which explained by racial difference.

Another study explain why right BPPV was the most favorable than left BPPV. This study comprised 150 patients with right BPPV and 87 patients with left BPPV. Among the patients, 122 (52%) sleep on right side. Of those, 102 (84%) had right BPPV. On the other side, 82 (34%) habitually sleep on the left side. Of those 53 (65%) had left BPPV. This study stated that favorable sleeping side might govern the affected side if BPPV was occurred [20].

In the current study, BPPV due to canalithiasis, was recorded for 29 patients (90.6%), while cupulithiaisis was counted in 3 patients (9.4%). In agreement with these results, **Soylemez *et al*.** [21] explained by the fact that, cases with canalithiasis of the posterior semicircular canal prevailed as statoconia accumulated preferably in this position by the action of the gravitational force.

As regard gender distribution, there was female to male ratio was 1.35. The results are in line with the systematic review by **Chen *et al*.** [22] where, female to male ratio was 1.5. In addition, **Bhattacharyya *et al*.** [23] reported that the number of patients with BPPV was more often in females with female to male ratio ranged between 1.5 and 2.2 [23]. In addition, **Kim *et al*.** [9] reported comparable results where females experienced more BPPV than males (74.5% versus 25.5%, respectively). Another study showed that in 263 patients, females were 159 and males were 104 [24].

The increased rate of BPPV in females may be attributed to the effect of estrogen. The estrogen receptors are abundant in the inner ear, namely the ampulla and utriculus and affect the role of otoconia 90. It is a protein maintains normal morphology and growth of otoconia. In addition, reduced estrogen levels will disrupt the internal structure, interconnection and attachment of otoconia to the gelatinous matrix [22].

The current study showed that there is an association between BPPV and migraine. This agrees with other several studies [4, 25-30]. The pathophysiologic linking between migraine and BPPV is not well understood. However, the repeated vasospasm may exert an effect on the inner ear microstructure of vascular system. Repeated vasospasm may damage the vestibular cells, with subsequent displacement of otoconia from the macula. In addition, suppression of the microvasculature of the inner ear because of vasospasm may lead to cochlear manifestations (e.g., hearing disturbance and vestibular symptoms). The vascular effect of migraine varies from small-to large-vessel disease [4].

Recurrent vasospasm is also associated with an effect of oxidative stress of endothelial cells. This is a possible pathogenetic mechanism shared by migraine and BPPV. The specific oxidative stress pathways in migraine are not fully understood. However, several reports showed a significant decrease in the activity of superoxide dismutase in migraine. In addition, proinflammatory mediators in BPPV (e.g., interleukins 1β, IL-6, and TNF), were elevated during attacks and reduced after repositioning maneuvers such (e.g., the Epley maneuver). Also, the total antioxidant capacity and levels of paraoxonase (antioxidant parameters) were decreased during a BPPV attack. Thus, oxidative stress and inflammatory processes in the inner ear may be linked to the formation and migration of the otolith. This pathologic link may be increased with migraine [4]. The current study was in disagreement with many of studies which explained because of their small sample size [16, 22, 24, 31, 32].

Migraine has two main types, migraine with and without aura. Distribution of migraine types in this study was 72.7% without aura, 27.2% with aura. This agreed with previous studies that reported that migraine without is more common than with aura [33, 34].

In this study, there was significant difference between the two studied groups regarding family history of migraine. The migraine was 50% more common among first degree relatives in the study of **Lafreniere *et al*.** [35] and 70% in another study done by **Murdin** [36]. Positive family history in Migraineurs is 72.72%. This findings support the heredofamilial predisposition of migraine. Furthermore, the association between migraine and female gender was in agreement with other studies which explained in terms of hormonal changes associated with the reproductive cycle [29, 37, 38].

In conclusion, the auditory and vestibular symptoms are associated with migraine with no peripheral hearing loss. The BPPV was associated with increased risk of migraine and both conditions are more presented in females than males mostly due to hormonal effects. However, the small number of patients included in this study is a limiting step against globalization of results. However, we could recommend the audio-vestibular assessment for all patients with migraine as BPPV could be considered as a co-morbidity with migraine. Long term and large scale studies are warranted to confirm the association and severity of BPPV in migraine and explain the possible pathophysiological mechanisms.

Financial and non-financial activities and relations of interest: None.

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E-ISSN: 2833-3772 | Volume 3 (2024), Issue 5 | Sep-Oct 2024

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