Cardiovascular risk factors and BPPV: a pilot case-control analysis

Original Article

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Abstract

Introduction: Some cardiovascular risk factors have been associated with benign paroxysmal positional vertigo (BPPV), under the hypothesis that they potentiate utricular degeneration; however, the evidence supporting this remains controversial.
Objectives: To evaluate the prevalence of cardiovascular risk factors (CVRF) and their potential impact on the occurrence of BPPV and its variants.
Material and methods: The study included 37 patients consecutively diagnosed with BPPV and 37 age-matched controls. The cases had a mean age of 64,1 ± 11,7 years and included 30 women and 7 men. The relationship between CVRF—including arterial hypertension (HTN), diabetes mellitus (DM), dyslipidemia (DLP), cardiovascular and cerebrovascular disease (CCVD)—and BPPV was evaluated through univariate and multivariate analysis.
Results: A higher prevalence of DM was identified in patients compared to controls ($p < 0.05$), as well as a higher simultaneous presence of all three CVRF in individuals with BPPV ($p < 0.05$). On the other hand, the presence of CVRF did not influence the duration or recurrence of BPPV episodes, nor the affected semicircular canal. The presence of DM was associated with a significantly elevated risk of BPPV (adjusted odds ratio of 9.3; 95% CI 1.5–56.4).
Conclusion: BPPV may be associated with an increased vascular risk in some patients, especially those with diabetes and multiple simultaneous CVRF. Confirmation of this evidence in studies with a larger number of subjects could reinforce early diagnostic measures in at-risk patients. However, most cases of BPPV appear to be idiopathic or caused by other factors not yet confirmed.

Keywords: Benign paroxysmal positional vertigo; Cardiovascular risk factors; Diabetes Mellitus, Type 2; Dizziness.

Introduction

Benign paroxysmal positional vertigo (BPPV) is characterized by episodes of positional vertigo and is the most common cause of peripheral vertigo.[1] BPPV was first described by Bárány in 1921 and later named by Dix and Hallpike in 1952. Its pathophysiology is based on the

displacement of otoconia from the utricular macula;[2] these particles subsequently migrate through the semicircular canals along the plane of head movements, caused by gravity. The resulting endolymph flow deflects the cupula, generating an abnormal electrical impulse relative to the contralateral (healthy) side. This asymmetry in vestibular stimulation produces an episode of vertigo accompanied by nystagmus characteristic of the affected canal (canalithiasis). A second mechanism, cupulolithiasis, can also trigger BPPV; in this process, otolithic particles adhere to the cupula of the semicircular canal, rendering it gravity-sensitive.[3] BPPV is common, with an estimated lifetime prevalence of 2.4% and an estimated 1-year prevalence of 0.6%;[4] extrapolating these figures to the Portuguese population yields more than 60,000 new diagnoses per year in Portugal. Despite the high success rate of canalith repositioning maneuvers[5] and the fact that up to 50% of affected patients may experience spontaneous remission,[6] this disease has a considerable impact on the patients' quality of life and is associated with anxiety and depression.[4,5,7] Moreover, the resulting costs to health systems are high. These include direct costs from unnecessary diagnostic or therapeutic procedures as well as indirect costs stemming from the disabling nature of the symptoms, which lead to lost workdays, reduced working hours, or even cessation of professional activity.[4,6] It is therefore important to assess the potential risk factors that influence the incidence, prognosis, and likelihood of BPPV recurrence in order to mitigate its impact. Among these are cardiovascular risk factors (CVRFs), such as hypertension (HTN), diabetes mellitus (DM), and dyslipidemia. There is a lack of consensus across studies[4,5,8–11] regarding the contribution of these parameters to the clinical course of BPPV. Therefore, this pilot study sought to assess the prevalence of CVRFs and their potential impact on the occurrence of BPPV and its variants.

Materials and methods

We conducted a retrospective case-control study based on the medical records of all patients diagnosed with BPPV at our institution from April 2024 to January 2026. A control group was assembled from the surgical database and electronic medical records of our institution over the same period. The electronic medical records were reviewed to collect the following data: demographics, diagnosis, and cardiovascular comorbidities.

Ethics statement. The Ethics Committee of the Algarve Local Health Unit approved this study (approval no. 023/2026), and the investigation was conducted in accordance with the ethical standards established in the 1964 Declaration of Helsinki and its subsequent amendments. Patient records and information were anonymized before analysis.

Patient group. The medical records of 37 consecutive patients diagnosed with BPPV were retrospectively reviewed. The patients were evaluated in the emergency department and/or at a scheduled outpatient appointment using otolaryngologic and otoneurologic examinations. Patients aged ≥18 years with complete electronic medical records were included. BPPV was diagnosed based on a documented history of positional vertigo and observation of positional nystagmus characteristic of each BPPV variant during appropriate diagnostic maneuvers. Cases were classified according to the affected semicircular canal(s), affected side, and whether the episode was initial or recurrent (based on prior BPPV diagnoses in the medical records). The episode duration (categorized as <2 or ≥2 weeks post-repositioning) was also assessed. Individuals with incomplete medical records and those diagnosed with other causes of vertigo inconsistent with BPPV were excluded.

Control group. Consecutive patients who had undergone surgical procedures at the Outpatient Surgery Unit of our institution's Otolaryngology Department, with no prior diagnosis

of BPPV, were selected. Previous studies have proposed using patients undergoing elective outpatient surgery as a suitable control population for other inner ear diseases (e.g., as controls in a sudden sensorineural hearing loss cohort).[12–15] Preoperative medical histories were obtained for all patients. Control group participants were matched 1:1 for age with patients with BPPV.

For both groups, the presence of the following cardiovascular risk factors was extracted from the medical records:

- HTN
- Dyslipidemia
- DM
- History of stroke
- History of acute myocardial infarction (AMI)

Statistical analysis. Descriptive statistics were used to analyze the demographic and clinical variables. The case and control groups were compared using statistical tests appropriate to each variable type, with a statistical significance level of $P < 0.05$. The data were analyzed using Stata IC 16 software (StataCorp LP, College Station, TX, USA). Continuous variables are expressed as mean ± standard deviation and range, while categorical variables are expressed as frequencies. A contingency table analysis comparing the rates between matched samples was performed using the chi-square test or Fisher exact test, as appropriate. The Student t-test was used to compare the means between the groups. To assess the association between BPPV and the hypothesized risk factors, odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using logistic regression. For all statistical tests, a P-value < 0.05 was considered statistically significant.

Results

The BPPV cohort (n = 37) was predominantly female. Overall, 17 individuals (45.95%) had HTN, 8 individuals (21.62%) had DM, and 14 individuals (37.84%) had dyslipidemia. In this patient group, one patient had a history of stroke, and another had a history of AMI (Table 2). The control group consisted of patients who had undergone septoplasty with or without turbinoplasty (n = 28), isolated turbinoplasty (n = 1), skin lesion excision (n = 3), dacryocystorhinostomy (n = 2), endoscopic sinus surgery for chronic sinusitis (n = 2), and pharyngeal biopsy (n = 1). Twenty patients with BPPV (54.05%) had at least 1 CVRF, 8 patients (21.62%) had at least 2 CVRFs, and 7 patients (18.92%) had all 3 CVRFs concurrently [vs. 1 patient (2.7%) in the control group, $P<0.05$, Figure 1].

A higher incidence of DM was also observed in the BPPV group compared with the control group [n = 8 (10.81%) vs. 2 (2.7%), P = 0.041, Table 2]. Conversely, neither the presence nor the number of CVRFs influenced the BPPV episode duration, recurrence, or the specific semicircular canal involved (Table 1). The presence of DM was associated with a significantly increased risk of BPPV (adjusted odds ratio [aOR], 9.3; 95% CI, 1.5-56.4) in a logistic regression model that included age and the three CVRFs studied (HTN, DM, and dyslipidemia) as independent variables. When sex was added as an independent variable to this model, DM remained associated with a significantly increased risk of BPPV (adjusted odds ratio, 9.5; 95% CI, 1.2–74.3). When the number of CVRFs was considered rather than each factor individually, the presence of all three was associated with an adjusted odds ratio of 138.1 (95% CI, 5.4–3,531.9).

Discussion

This study sought to evaluate a possible relationship between BPPV and CVRFs. Consistent with most prior studies on this disease,[4,8–10,16] our BPPV cohort showed a female predominance, although the female-to-male ratio was somewhat higher than the typically reported 2:1–3:1.[17] Regarding the affected semicircular canals, the posterior canal was the most common (78.38%), which is consistent with the classically reported incidence of the disease.[6]

Methodologically, we chose a 1:1 age-matched design for the BPPV and control groups. This

Table 1
Characteristics of the study population

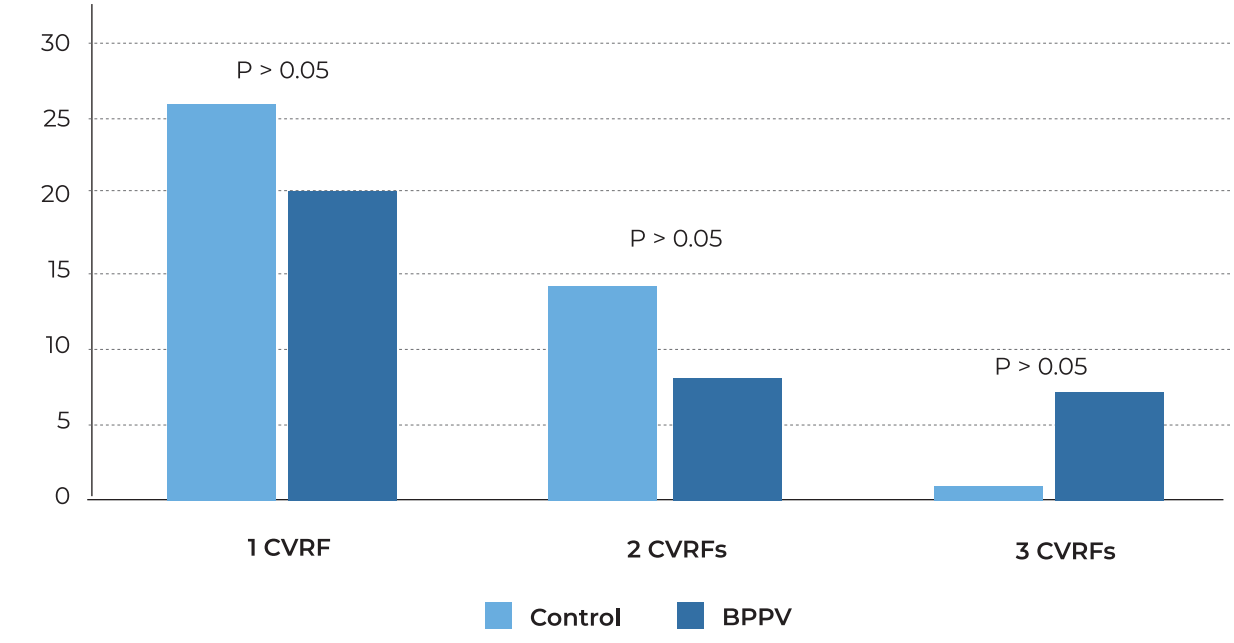
	Control group N (%)	BPPV group N (%)	*P*
Age (mean, min–max)	62,6 (44-86)	64,1 (32-83)	0,579
Sex, No. (%) [M:F]	23 (62,16): 14 (37,84)	7 (18,92):30 (81,08)	**<0,001**
HTN	22 (59,46)	17 (45,95)	0,244
DM	2 (5,41)	8 (21,62)	**0,041**
Dyslipidemia	17 (45,95)	14 (37,84)	0,480
AMI	1 (2,7)	1 (2,7)	1
Stroke	1 (2,7)	1 (2,7)	1
≥1 CVRF	26 (70,27)	20 (54,05)	0,150
≥2 CVRFs	14 (37,84)	8 (21,62)	0,127
≥3 CVRFs	1 (2,7)	7 (18,92)	0,025

Table 2
Distribution of CVRFs by BPPV subgroup

	BPPV subgroup N (%)	HTN N (%)	DM N (%)	Dyslipidemia N (%)
Posterior canal	29 (78,38)	11(37,93)	7(24,14)	12 (41,38)
Lateral canal	4 (10,81)	3 (75)	-	1 (25)
Anterior canal	1 (2,7)	1 (100)	-	-
Multiple canals	6 (16,22)	3 (50)	1 (16,67)	1 (16,67)
Recurrence	6 (16,22)	4 (66,67)	2 (33,33)	3 (50)
Duration >2 weeks*	8 (21,62)	3 (37,50)	1 (12,50)	1 (12,50)

*post-repositioning

Figure 1
Frequency of CVRFs by group



strategy is crucial, as age could introduce significant bias with respect to both vestibular disease and vascular risk.[5]

There is conflicting evidence regarding the association between BPPV and CVRFs. Some studies have associated these factors with a higher incidence[4,17] and recurrence[9,10,16] of BPPV. Von Brevern[4] theorized that the vascular damage caused by HTN and dyslipidemia could cause ischemia in the labyrinthine circulation, thereby facilitating the detachment of otoconia from the otolithic membrane. However, the present study found no statistically significant relationship between HTN or dyslipidemia and BPPV.

DM has also been associated with vestibular degeneration through microangiopathy, in which reduced blood flow causes hypoxia and ultimately leads to the apoptosis and necrosis of vestibular hair cells.[9,18,19] Kumar et al.[18] found that individuals with type 2 DM had lower vestibular evoked myogenic potential (VEMP) amplitudes than age-matched controls. They also reported a higher asymmetry index of cervical VEMPs (cVEMPs) in these individuals compared with controls without DM. Konukseven et al.[19] likewise concluded that VEMP latencies are longer in patients with DM, and they correlated this finding with glycated hemoglobin and fasting blood glucose levels. In the present study, a higher prevalence of DM was found in the BPPV group than that in the control group. Moreover, there was a robust association between DM and BPPV, with an adjusted odds ratio of 9.3. This finding is particularly important, as even after adjusting for variables such as age and sex, DM remained significantly associated with an increased risk of BPPV, corroborating the results of the aforementioned studies. Importantly, however, the confidence interval obtained for this CVRF is wide (95% CI, 1.5–56.4), so this result should be interpreted with caution. Stroke has also been associated with a higher risk of developing BPPV, as demonstrated by Cao.[20] The vestibule is supplied solely by the labyrinthine artery, a collateral branch of the anterior inferior cerebellar artery, which in turn is a branch of the basilar artery. This structure is therefore particularly sensitive to any alteration in the vertebrobasilar circulation, such as those occurring in stroke.[20] Patients with cerebral small-vessel disease are also more likely to develop recurrent BPPV and residual vertigo than patients with BPPV who do not have cerebral small-vessel disease.[21] The present study, however, found no association between BPPV and stroke. A relationship between coronary artery disease and BPPV has also been hypothesized. Comacchio et al.[22] reported a case of acute bilateral vestibulopathy in a patient following an acute myocardial infarction, illustrating the potential susceptibility of the vestibular system to sudden hemodynamic changes. However, a 2025 review article[5] concluded that the association between the two diseases is more consistent for BPPV recurrence than for incidence. The present study found no association between BPPV and AMI.

While DM was the only individual CVRF that this study observed to be independently associated with BPPV, it is worth highlighting that the presence of ≥3 concurrent CVRFs yielded an adjusted OR of 138.1. The confidence interval is wide due to the study's exploratory nature and small sample size, necessitating confirmation in larger cohorts. However, this result suggests a potential association and an increased risk of developing BPPV in patients with multiple cardiovascular comorbidities. The high prevalence of individuals with all three CVRFs in the BPPV group compared with that in the control group (18.92% vs. 2.7%, P = 0.025) reinforces the hypothesis that inner ear homeostasis may be strongly dependent on systemic vascular integrity. BPPV recurrence—defined as the development of a second episode of positional vertigo after a period without residual vertigo—occurs in 20% to 30% of cases.[23] According to several recent studies,[10,16,23] the association between recurrence and CVRFs appears to remain consistent, with HTN, DM, and dyslipidemia identified as independent risk factors for BPPV recurrence. In this study, the presence of

CVRFs did not affect the duration or recurrence of BPPV episodes or the specific semicircular canal involved. This contrast between our results and the prior literature may indicate that BPPV recurrence does not depend exclusively on CVRFs but may also include other factors, such as canal morphology or the success of the initial repositioning maneuver.

However, other authors—such as Singh et al.[8] and Elnasieh et al.[11]—have reported conflicting findings, noting that CVRFs do not increase the risk of BPPV onset or recurrence. This discrepancy in results across studies may stem from the different methodologies used.

This exploratory study has several limitations. Notably, the small sample size (n = 37) restricts statistical power and yields risk estimates with very wide confidence intervals, as observed for the effect of three concurrent CVRFs. Moreover, the small sample size may limit the identification of CVRFs present at low frequencies, such as a history of stroke and AMI. Additionally, the retrospective nature of this study means that data collection relied on the accurate recording of BPPV episodes and their comorbidities, making it vulnerable to incomplete or omitted documentation. For the same reason, reliable collection of anthropometric data for the study population, such as body mass index (BMI) and waist circumference, was not possible. This is an significant limitation of the study, as obesity, together with HTN, dyslipidemia, and insulin resistance, constitutes metabolic syndrome.[24] This systemic proinflammatory condition amplifies endothelial dysfunction and oxidative stress in the terminal microvasculature, including that of the labyrinthine artery. Furthermore, individuals with a high BMI often have limitations in cervical and whole-body mobility, which can compromise the optimal speed and angular range of motion required to correctly perform diagnostic and canalith repositioning maneuvers, potentially influencing the initial treatment success rates and recurrence pattern of the disease.[25] Finally, several factors associated with BPPV incidence and recurrence, such as osteoporosis, vitamin D deficiency, migraine, and psychosocial factors,[4,5,9,23] were not analyzed. Additionally, there was no distinction made between idiopathic and secondary cases of BPPV.

Conclusion

BPPV may be associated with increased vascular risk in some patients, particularly those with DM and other concurrent CVRFs. Confirmation of this finding in larger, possibly multicenter studies could strengthen early diagnostic measures in at-risk patients. However, the majority of BPPV cases remain idiopathic or attributable to other, unidentified factors.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

Data Confidentiality

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

Protection of humans and animals

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the 2013 Helsinki Declaration of the World Medical Association.

Privacy policy, informed consent and Ethics Committee Authorization

The authors declare that they have written consent for the use of photographs of patients in this article.

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Availability of scientific data

There are no datasets available, publicly related to this work.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the author used Gemini to assist with language review. After using this tool/service, the author reviewed and edited the content as necessary and takes full responsibility for the content of the publication.

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