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DISCOVERY SCIENTIFIC SOCIETY

Benign paroxysmal positional vertigo: an overview of pathophysiology, diagnostic strategies, and therapeutic options

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ABSTRACT

Benign paroxysmal positional vertigo (BPPV) is a vestibular disorder and also the most common cause of peripheral vertigo in patients. Due to its high frequency and recurrent nature, BPPV remains a significant clinical issue, especially in otolaryngology and neurology practice. Clinicians can effectively treat it with non-pharmacological interventions; however, it is often underrecognized and affects patients' quality of life. This article summarizes the key pathophysiological concepts, outlines the most essential positional tests used in diagnosis, and explains how nystagmus patterns guide differentiation between various forms of the disorder, stressing the high success rates of canalith repositioning maneuvers in treatment. Furthermore, the review highlights what is currently known about recurrence, including modifiable factors such as vitamin D deficiency, to encourage proactive management and reassure patients.

Keywords: Benign Paroxysmal Positional Vertigo; BPPV; Vestibular disorders; Repositioning maneuvers; Dix–Hallpike test

1. INTRODUCTION

Benign paroxysmal positional vertigo (BPPV) is the most frequent peripheral vestibular disorder and a common source of vertigo in clinical practice (You et al., 2018; von Brevern et al., 2015). It presents with short-lasting vertigo triggered by changes in position and accompanied by characteristic positional nystagmus. It is often characterized by spontaneous remission and recurrence.

BPPV results from abnormal endolymph movements within the semicircular canal in the inner ear. The most frequently affected structure in BPPV is the posterior semicircular canal, while involvement of the horizontal and anterior canals is less common. It arises mainly through two mechanisms. In canalithiasis, otoconia float freely inside a semicircular canal and disrupt endolymph flow. In cupulolithiasis, otoconia stick to the cupula, making it more sensitive to gravity.

Less common causes, like canalithiasis in other parts of the canals or periampullary canalithiasis, can lead to unusual or hard-to-treat cases (Parnes et al., 2003; You et al., 2018). Knowing the exact cause is important because it allows clinicians to determine the treatment methods and can improve results.

To diagnose BPPV, clinicians usually use positional tests, especially the Dix-Hallpike and supine roll maneuvers. To identify the affected semicircular canal, the doctor has to recognize the induced nystagmus. It should be noted that recent studies do not recommend routine diagnostic imaging in typical cases because it adds little value (You et al., 2018). The main treatment is canalith repositioning maneuvers, such as the Epley, Semont, and barbecue (Gufoni) maneuvers. While these are usually effective, cases involving more than one canal, apogeotropic types, or cupulolithiasis may need repeated or adjusted treatments. Recurrence is common and linked to aging, degenerative changes, and problems with otoconial mineralization. Recent research shows that vitamin D deficiency and osteoporosis are also important risk factors. For some patients, taking supplements and managing bone health may help reduce the risk of BPPV recurrence (Rhim & Kim, 2024; Alolayet & Murdin, 2025).

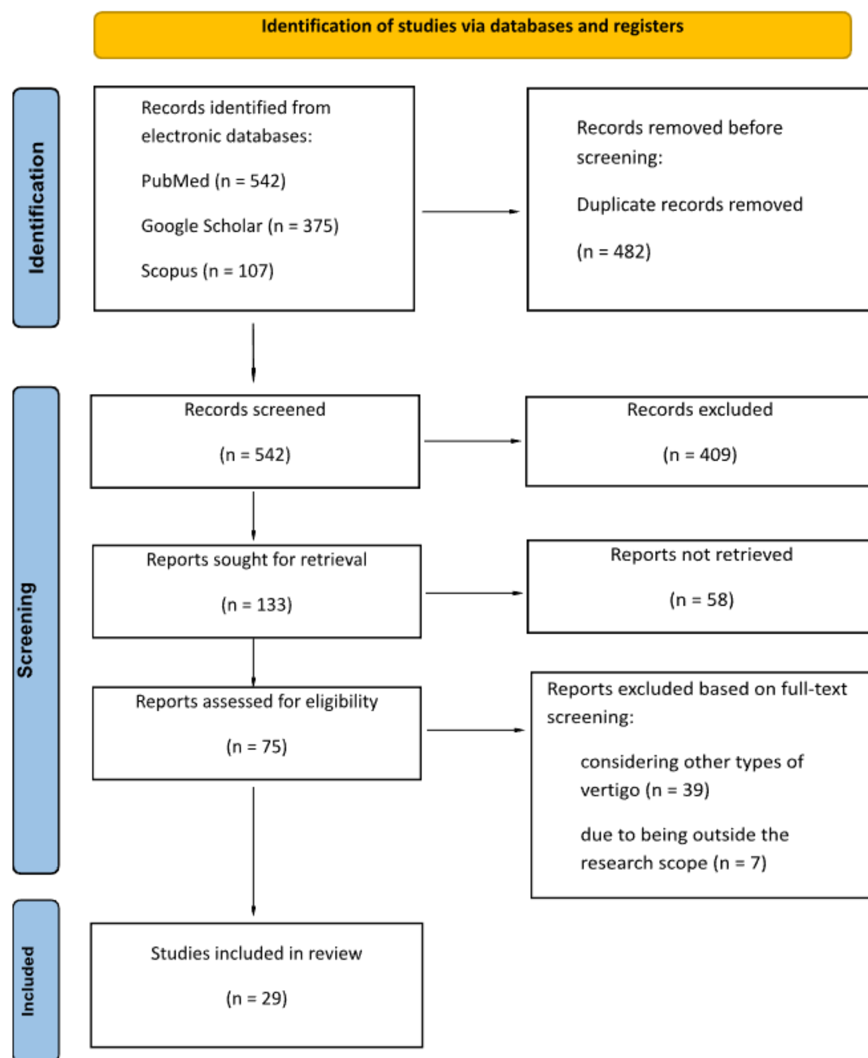

Figure 1. PRISMA flow diagram

2. REVIEW METHODS

We performed a literature review of BPPV, including full-text English-language articles on its causes, diagnosis, treatment, and recurrence. Due to the large number of publications, we had to omit many studies. We excluded all papers that were duplicates, lacked full text, concerned other vertigo types, or were outside our research scope. We searched PubMed/MEDLINE, Scopus, and Google Scholar using relevant terms: benign paroxysmal positional vertigo, BPPV, canalithiasis, cupulolithiasis, Dix-Hallpike, supine roll, and Epley maneuver.

Based on this search, we selected and included 29 full-text articles that met the criteria (Figure 1). From each publication, we extracted information regarding study design, diagnostic methods, BPPV subtype, treatment approach, clinical outcomes, and reported recurrence-related factors. Due to variability across studies, this review synthesized the evidence narratively.

3. RESULTS & DISCUSSION

Clinical Characteristics and Diagnosis

In the studies we reviewed, BPPV was most common in older adults and occurred more often in women. Peña Navarro et al., (2023) found the average patient age was 61 years, with women making up 88% of cases. Van Dam et al., (2021) also found that BPPV patients were older and more often female than those with other types of dizziness. An Italian survey of 2,682 people reported a mean age of about 59 years, and 60.9% were women. The posterior semicircular canal was the most commonly affected, seen in about 90% of cases. Peña Navarro et al., (2023) reported 92% posterior canal involvement, while van Dam et al., (2021) found 89% posterior, 10% horizontal, and 1% anterior canal BPPV. The right side was affected more often, possibly because of sleeping habits. BPPV diagnosis relied on the presence of characteristic positional nystagmus. During positional testing, patients presented a brief delay before developing upbeat, torsional, geotropic nystagmus after performing the Dix-Hallpike maneuver. The supine roll test helped the clinicians to identify horizontal canal types and distinguish between geotropic and apogeotropic patterns.

Efficacy of repositioning maneuvers

Canalith repositioning maneuvers (CRPs) demonstrate high clinical efficacy in the management of BPPV. In posterior canal BPPV, the modified Epley (particle repositioning) maneuver relieved vertigo in ~78–85% of patients with one treatment, rising to >95% after repeated treatments (Table 1). For example, Wang et al., (2019) reported 78.4% symptom resolution one week after a single Epley maneuver (n=264 posterior-canal patients) and 95.8% resolution by one month. A Cochrane meta-analysis of 11 trials (745 patients) likewise confirmed Epley's superiority over sham: initial success was 78.4%. It increased to 95.8% with repeated maneuvers. In addition, a meta-analytic review reported that Epley treatment significantly decreased vertigo symptoms (risk ratio ≈3.14 in primary-care settings and 2.42 in specialty settings) and increased the rate of negative Dix–Hallpike tests (RR≈1.81). Even when performed only once, the particle repositioning maneuver (PRM/modified Epley) reached a 70–85% recovery per session. The Semont liberatory maneuver produced similar results: studies reported response rates of 70–90% (with recurrence ~29%).

Horizontal-canal BPPV also responded well to maneuvers. In Wang et al.'s series, a single barbecue-roll maneuver cured 94.3% of geotropic (canalithiasis) cases and 78.6% of apogeotropic (cupulolithiasis) cases, with all patients (100%) free of symptoms by one month. Multichannel or anterior cases were fewer and required similar principles: in two anterior-canal BPPV cases, success was 50% at one week and 100% by one month. By contrast, multicanal BPPV showed a slower response – only 25% resolved at one week and 75% by one month. In general, these findings show that repositioning maneuvers provided rapid symptom relief in most patients.

Table 1. Effectiveness of Canalith Repositioning Maneuvers in BPPV

Maneuver	Target canal/type of nystagmus	Single-session success (%)	Success after repeated maneuvers / ≈1 month* (%)
Modified Epley	Posterior canal	70-85	> 95
Semont liberatory	Posterior canal	70-90	-
Barbecue roll	Horizontal - geotropic	94,3	100 (by 1 month*)
Barbecue roll	Horizontal - apogeotropic	78,6	100 (by 1 month*)
Anterior-canal repositioning	Anterior canal	50	100 (by 1 month*)
Repositioning for multicanal BPPV	Multicanal involvement	25	75

*Effect observed at 1-month follow-up.

Recurrence

Relapses after initial treatment were standard. According to the literature, the recurrence rate varied from 15% to 50% during the follow-up (Table 2). According to longitudinal estimates, ~26% of patients with BPPV experienced recurrence within 1 year. Over a 5-

year period, this rate increased to over 50%. It is vital to understand that managing risk factors that we can change may reduce recurrence rates. Notably, Schwarz et al., (2022) showed that patients receiving both repositioning maneuvers and vitamin D (for hypovitaminosis) had a markedly lower relapse rate than controls (log-rank p = 0.017). For example, in one trial of vitamin D supplementation, only 31.3% (5/16) of patients had any recurrence after treatment (mean 0.31 relapses per patient), compared with 100% before supplementation. These data indicate that recurrence is common, but dealing with modifiable factors can reduce it.

Risk factors

Studies have identified multiple factors associated with BPPV onset and relapse. For incident BPPV, female sex and inner-ear and bone-metabolism-related factors were significant. Chen et al., (2020) reported that women had modestly higher BPPV odds than men (pooled OR ≈1.18). Several meta-analyses revealed that migraine (OR≈4.40) and recent head trauma (OR≈3.42) notably increased the risk of developing BPPV. Furthermore, osteoporosis (OR≈2.49) and lower serum vitamin D levels are also important predictors. Conversely, neither hypertension (OR≈1.26, p=0.08) nor diabetes (OR≈1.04, p=0.71) was significantly associated with new-onset BPPV. It is worth noting that the factors triggering a first BPPV episode are not necessarily the same as those that cause its recurrence. Cardiovascular and metabolic comorbidities strongly predisposed patients to relapsing BPPV. Madrigal et al., (2024) found that each of the conditions: hypertension (OR=2.05), dyslipidemia (OR=1.84), hypertriglyceridemia (OR=2.11), cerebrovascular disease (OR=1.88), and diagnosed cardiovascular disease (OR=2.31) considerably increased the odds of BPPV relapse. Diabetes (OR=1.73), hyperuricemia (OR=1.86), and thyroid/autoimmune disorders (OR≈1.4–1.9) showed a comparable trend. Taken together, these facts suggest that vascular and metabolic health play a substantial role in recurrence. Crucially, the potential to modify certain risk factors allows for better prevention; in particular, the use of vitamin D supplementation may decrease recurrence frequency. To sum up, the data from the reviewed studies paint a consistent picture of BPPV. It most often afflicts older women with posterior-canal involvement, responds well to canalith repositioning (especially the Epley maneuver), tends to recur in about half of patients, and is associated with identifiable risk factors such as head trauma, migraine, osteoporosis, and cardiovascular/metabolic diseases.

Table 2. Key clinical points of benign paroxysmal positional vertigo (BPPV)

Aspects of research	Summary
Patient profile	Older adults; female predominance
Most involved structure	Posterior semicircular canal (~ 90%)
Assessment	Dix-Hallpike maneuver, supine roll test
Key feature	Canal-specific positional nystagmus
First-line treatment	Canalith repositioning maneuvers (e.g., Epley maneuver, Semont maneuver)
Single-session success rate	~ 70-85 %
Response after repeated maneuvers	> 90 %
Recurrence rate	~ 15–50% during intermediate follow-up
Modifiable risk factors	Vitamin D deficiency; impaired bone health

4. CONCLUSION

BPPV is a common vestibular disorder and a frequent cause of vertigo in clinical practice. It mainly involves women, but it also occurs in men. More often affects middle-aged and the elderly. The disorder usually arises from pathology of the posterior semicircular canal. In diagnosis, clinicians mainly use bedside positional tests, especially the Dix-Hallpike maneuver, and look for characteristic nystagmus patterns. This pattern allows the clinician to determine which canal is affected. Repositioning maneuvers are effective in most cases and usually provide quick symptom relief, although some patients with atypical BPPV may require repeated or modified techniques. Due to its tendency to recur, modifying factors like vitamin D levels and poor bone health may reduce the risk of recurrence.

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Data and materials availability
All data associated with this study will be available based on reasonable request to the corresponding author.

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