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**International Publications**

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# Benign Paroxysmal Positional Vertigo

## The Case for Renaming It Peripheral Paroxysmal Positional Vertigo

[Michael Strupp](#) , [Anita Bhandari](#) , [Thomas Brandt](#), [Michael G. Halmagyi](#), [Ji-Soo Kim](#) , [Herman Kingma](#), [Michael von Brevern](#) , [Susan L. Whitney](#), [Biru Zhang](#) , [Francisco Zuma e Maia](#), [David S. Zee](#) , and [Michael C. Schubert](#) | [AUTHORS INFO & AFFILIATIONS](#)

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### Abstract

This paper focuses on the justification for changing the terminology of the most frequent peripheral vestibular disorder, called benign paroxysmal positional vertigo (BPPV). Below, we argue that continued use of “benign” is a misnomer because many patients are adversely affected by BPPV. In addition, the term squanders its critical, distinguishing cause by omitting “peripheral.” Instead, we support changing the nomenclature from BPPV to peripheral paroxysmal positional vertigo ([PPP], or [3 PV]).



## OPEN ACCESS

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# Editorial: Improving understanding and treatment of peripheral positional vertigo (PPV)

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## KEYWORDS

Dix Hallpike test, Epley, nystagmus, otoconia, positional vertigo, vestibular

## Editorial on the Research Topic

### Improving understanding and treatment of peripheral positional vertigo (PPV)

Peripheral paroxysmal positional vertigo (PPPV)—a term preferred over benign paroxysmal positional vertigo (BPPV)—is the most common peripheral vestibular disorder encountered in clinical practice, yet its evaluation continues to reveal considerable variability across patient groups, testing conditions, and pathophysiological contexts (Alolayet and Murdin). This Research Topic covers a broad range of aspects of this highly relevant disease, including the influence of comorbidities on PPPV.

A systemic review by Alolayet and Murdin examines how metabolic, cardiovascular, psychological, and otologic comorbidities interact with PPPV and its treatment. Co-morbidities such as low Vitamin D levels, head trauma, migraine, several inner ear diseases (1), hypertension, and high cholesterol, are often associated with the lower success rate of repositioning maneuvers. Recognizing these associations is important for the prognosis, intensity of treatment and thereby also consultation of such patients. Clinical complexity may arise from patient-specific factors like age. Li et al. study depicted that elderly patients with presence of atypical symptoms of PPPV experience delays in diagnosis compared with younger individuals. Their findings describe how comorbidities may conceal the classical positional triggers of PPPV in aging populations. In fact, it is now advocated by The World Falls Guidelines: all older adults (>60 years) with objective or subjective balance problems, irrespective of symptomatic complaint, should have positional testing to examine for PPPV (2).

A retrospective study conducted by Lu et al., showed that timing of clinical assessment of BPPV appeared to be a key component of diagnostic variability. Their study demonstrated that positional tests yield a significantly higher rate of positive diagnostic findings in the morning compared with the afternoon. This is theoretically logical because it is assumed that the crystals form an agglomerate overnight while resting which has a higher impact on endolymphatic flow than single crystals (3). Clinicians should therefore consider the timing of testing during the day, particularly in patients with fluctuating symptoms.

# Therapeutic Management of Vestibular Disorders During Pregnancy: A Narrative and Evidence-Based Review

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## Abstract

Vestibular disorders such as vestibular migraine (VM), benign paroxysmal positional vertigo (BPPV), Ménière's disease (MD), persistent postural-perceptual dizziness (PPPD), and vestibular neuritis (VN) are not uncommon among women of reproductive age and may occur or worsen during pregnancy. However, the management of these disorders during gestation is complicated by physiological changes, the limited safety data on many medications, and ethical constraints in clinical research involving pregnant individuals. This review focuses on the therapeutic strategies employed in managing vestibular disorders during pregnancy, highlighting pharmacological and non-pharmacological interventions, evidence-based approaches, current limitations, and areas requiring further research. Emphasis is placed on safety profiles, individualized care, and interdisciplinary collaboration to optimize maternal health while minimizing fetal risk.

**Categories:** Neurology, Obstetrics/Gynecology, Otolaryngology

**Keywords:** dizziness diagnosis, pregnancy, vestibular assessment, vestibular disorders, vestibular testing

## Introduction And Background

Vestibular disorders are a significant source of morbidity among women of reproductive age, often affecting balance, spatial orientation, and quality of life [1]. Among the most prevalent of these disorders are vestibular migraine (VM), benign paroxysmal positional vertigo (BPPV), Ménière's disease (MD), persistent postural-perceptual dizziness (PPPD), vestibular neuritis (VN), and bilateral vestibulopathy (BVP) [2]. Vestibular disorders in pregnant women have a global prevalence of approximately 32 per 100,000 individuals [3]. While each of these conditions presents with distinct pathophysiological mechanisms and clinical profiles, they share a common challenge when occurring during pregnancy: the need to manage disabling symptoms in a setting where pharmacologic options are limited, diagnostic clarity may be impaired, and maternal-fetal safety must be paramount [3].

Pregnancy induces profound physiological changes—from hormonal shifts and vascular adaptations to biomechanical alterations—that can directly or indirectly affect vestibular function [4]. During advanced pregnancy, women may be at higher risk for falling during ambulation in the dark [5]. Elevated levels of estrogen and progesterone modulate neurotransmission, endolymphatic fluid dynamics, and vascular reactivity within the inner ear [6]. Simultaneously, changes in blood pressure regulation, blood volume expansion, and altered proprioception may enhance susceptibility to vertigo or dizziness, particularly in patients with underlying vestibular pathology [7]. However, these same physiological transitions may also confound clinical assessment, as many of the symptoms of vestibular disorders—such as nausea, lightheadedness, or unsteadiness—overlap with normal gestational phenomena, especially during the first and third trimesters [8].

Despite their prevalence and potential severity, vestibular disorders in pregnancy remain underrecognized and undertreated [9]. The exclusion of pregnant individuals from randomized clinical trials and longitudinal vestibular research has led to a significant gap in evidence-based management strategies tailored to this population [10]. Most current recommendations are extrapolated from non-pregnant cohorts or derived from limited observational studies, case reports, or pharmacovigilance registries [11]. Furthermore, therapeutic hesitancy is common among clinicians due to the teratogenic potential of several vestibular-active medications and the ethical complexities inherent in balancing maternal symptom relief with fetal risk mitigation [11]. This narrative review explores the therapeutic and rehabilitative management of vestibular disorders during pregnancy, with an emphasis on practical considerations for clinical care. It discusses both pharmacological and non-pharmacological strategies, taking into account the specific challenges that arise in each trimester.



# Proposal of a standardized testing protocol for BPPV: Using 3D simulations for insights into movement of otoliths during positional tests

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## Abstract

**Background** Benign Paroxysmal Positional Vertigo (BPPV) is a common vestibular disorder caused by displaced otolith debris in the inner ear. This study explored the order effect related to the sequence of performing different diagnostic positional maneuvers.

**Methods** 3D simulations of the Supine Roll Test (SRT), Dix-Hallpike maneuver (DHM), and Deep head hanging tests, performed in the standardized prescribed way, were used to study various types of horizontal, posterior, and anterior canal BPPV. The simulations allowed visualization of the movement of the otolith debris and the resulting nystagmus patterns. The results of the sequence of tests and the starting side of the tests (from left or right) were observed.

**Results** Simulations of the SRT on horizontal canal BPPV (hc-BPPV) showed different patterns of nystagmus: direction changing, direction fixed, and unilateral (only elicited in one position) nystagmus. These patterns depended on the position of the debris within the horizontal canal and the side from which the SRT began. Simulations of the DHM showed that the test procedure could displace debris in the horizontal canal. The SRT, however, caused no movement of debris in the vertical canals. The deep head hanging test could displace debris in all canals.

**Conclusion** An order effect can occur when performing diagnostic maneuvers for BPPV. The maneuvers can displace debris in the semicircular canals into new positions that may influence the findings in subsequent maneuvers and confound interpretation. A standardized testing protocol, starting with the SRT first, can decrease the order effect and simplify the interpretation of test results and in turn improve diagnostic accuracy and outcomes in the management of BPPV.

**Keywords** BPPV · Supine Roll Test · Maneuvers · Dix Hallpike · Simulations

## Introduction

Benign Paroxysmal Positional Vertigo (BPPV) is a common condition caused by the displacement of otolith debris from the utricle into the semicircular canals [1]. The movement of otolith debris within the canal causes recurrent episodes of vertigo with a change of head position. The diagnosis of BPPV depends on identifying the affected canal based on the pattern of nystagmus elicited on positional tests [2].

Diagnostic positional tests work on the premise of moving the head in spatial planes aligning with the plane of the tested canal. Thus, it is assumed that the Supine Roll test (SRT) works in the plane of both horizontal canals, Dix Hallpike maneuver (DHM) in the plane of the ipsilateral posterior and contralateral anterior canal, and the deep head hanging test in the summed plane of the vertical canals [3,

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## Case Report

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# Hyperventilation Induced Nystagmus: An Unusual Sign of Unruptured Intracranial Aneurysm

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## Abstract

Intracranial aneurysms (IA) often remain asymptomatic until rupture, with vertigo as a potential overlooked symptom. This report highlights the role of videonystagmography (VNG) in detecting eye movement abnormalities, leading to the diagnosis of an unruptured IA. A 62-year-old male presented with a three-year history of vertigo, unilateral tinnitus, and progressive hearing loss, alongside a past diagnosis of trigeminal neuralgia. Neuro-otological evaluation revealed hyperventilation-induced nystagmus (HVIN) on VNG and abnormal sway on Unterberger testing with craniocorpography (CCG). Subsequent MRI identified a basilar artery aneurysm, successfully treated with coiling. The patient's condition improved significantly over three months. This case emphasizes the importance of early detection through neuro-otological assessment, particularly VNG, in diagnosing and managing unruptured aneurysms.

**Keywords:** Hyperventilation induced nystagmus, Intracranial aneurysms, Vertigo, Videonystagmography



# Telemedicine: Inter-Method Agreement Between In-Person Consultations and Video Recordings When Diagnosing Benign Paroxysmal Positional Vertigo

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**Objective:** To investigate the inter-method agreement between in-person consultations and video recordings when diagnosing BPPV. **Methods:** Two experienced vestibular clinicians (clinician A and B) evaluated patients for the presence and type of BPPV, using the TRV chair (Interacoustics, Middlefart, DK), at a tertiary referral center. During these in-person consultations, diagnostic maneuvers and eye movements were recorded, and a diagnosis was made. Both clinicians independently evaluated their cases again, during two video review sessions (Video Review 1 and Video Review 2). These sessions were conducted one month apart. Both clinicians were blinded to patient information and medical history during the analysis and did not have access to sound recordings. They were asked to provide a new diagnosis, based on the videos alone. Inter-method and intra-observer agreement for BPPV diagnoses between in-person consultations and video reviews were assessed using the percentage of agreement and Cohen's kappa. An independent analysis of all patients' eye movements was conducted to identify patterns that might have influenced agreement between in-person consultation diagnoses and the two video reviews by clinicians. **Results:** During the in-person consultations, each clinician evaluated 100 patients. Clinician A diagnosed BPPV in 40% of the cases, while clinician B diagnosed it in 19% of the cases. Considering the inter-method agreement, clinician A agreed on 81% (95% CI (73, 89)) and 77% (95% CI (69, 85)) of the cases with associated kappa coefficients of 0.67 (95% CI (0.55, 0.79)) and 0.63 (95% CI (0.51, 0.75)) between in-person consultations and Video Reviews 1 and 2, respectively. For clinician B, the percentages of agreement were, respectively, 86% (95% CI (79, 93)) and 84% (95% CI (77, 91)), with corresponding kappa coefficients of 0.55 (95% CI (0.36, 0.74)) and 0.51 (95% CI (0.32, 0.70)). As for the intra-observer agreement, clinician A achieved an intra-observer agreement of 84% (95% CI (77, 91)) with kappa = 0.74 (95% CI (0.63, 0.85)), while clinician B achieved a slightly higher intra-observer agreement of 90% (95% CI (84, 96)) with kappa = 0.67 (95% CI (0.51, 0.83)). Descriptive analysis of the eye movement revealed that both clinicians showed high diagnostic consistency for "no BPPV" in cases without provoked nystagmus (78/86, 91%) even when spontaneous nystagmus was present, and for posterior canal BPPV (37/78, 47%) when characteristic nystagmus was observed. However, disagreement was noted for horizontal canal BPPV (15 cases) and in scenarios with subjective BPPV (2 cases) or purely vertical nystagmus (11/31 cases, 35%). **Conclusions:** This study showed the feasibility of using video recordings when diagnosing BPPV. It demonstrates that BPPV might be reliably diagnosed in a telemedicine setting. However, careful consideration must be given to certain factors during the protocol's design to improve the diagnostic process.

# Co-occurrence of Otologic Disorders and Benign Paroxysmal Positional Vertigo: A Systematic Review and Meta-Analysis

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**Objectives.** This systematic review was performed to investigate the co-occurrence of otologic disorders and benign paroxysmal positional vertigo (BPPV).

**Methods.** Searches were conducted in PubMed and Web of Science. The review included all original English-language studies—ranging from full-text clinical trials to case reports—enrolling participants aged  $\geq 18$  years. Articles were classified into two groups: group 1 comprised studies reporting otologic disorders in patients diagnosed with BPPV; group 2 comprised studies reporting instances of BPPV among patients with otologic disorders. The frequency of each condition was analyzed using descriptive statistics. Meta-analyses were performed using a random-effects model to estimate overall prevalence in both groups.

**Results.** The initial search yielded 3,407 records, of which 68 articles were included in the analysis. In group 1 (19 studies), 11.4% of patients with BPPV (932/8,157) had co-occurring otologic disorders. Sudden sensorineural hearing loss (present in 11.9% of patients in relevant included studies) and acute unilateral vestibulopathy/vestibular neuritis (5.0%) were most frequently reported. Meta-analysis produced pooled prevalence rates of 11.8% (95% CI, 3.1%–35.7%) for sudden sensorineural hearing loss and 6.5% (95% CI, 3.7%–11.2%) for acute unilateral vestibulopathy/vestibular neuritis. In group 2 (49 studies), 9.7% of patients with otologic disorders (1,106/11,457) experienced concurrent BPPV, with Menière's disease exhibiting the highest rate of concurrence (10.2%). Meta-analyses showed pooled prevalence rates of 10.4% (95% CI, 6.2%–16.8%) for acute unilateral vestibulopathy/vestibular neuritis and 9.1% (95% CI, 4%–19.1%) for Menière's disease.

**Conclusion.** The co-occurrence of otologic disorders and BPPV is prevalent. These findings underscore the need for mutual clinical screening and may inform understanding of the etiologies underlying BPPV.

**Keywords.** Vertigo, Benign Paroxysmal Positional; Ear Diseases; Hearing Loss, Sudden; Vestibular Neuritis; Meniere Disease

Editorial | January 10, 2024

## Meniere Disease

### Deciphering Vestibular Tests to Aid in Diagnosis

Anita Bhandari, MS (ENT) | Authors Info & Affiliations  
April 2024 issue | 14 (2) | <https://doi.org/10.1212/CPJ.0000000000200257>

#### Abstract

Meniere disease (MD) is an uncommon cause of vertigo with unilateral hearing loss. The unpredictable nature of vertigo episodes makes the fear of vertigo as debilitating for sufferers as the actual attacks. At present, the diagnosis is based on history of spells of dizziness, aural fullness, fluctuating unilateral hearing loss with tinnitus, and the characteristic audiologic findings<sup>1</sup> while other guidelines require histopathologic confirmation of endolymphatic hydrops for a diagnosis of “certain” MD.<sup>2</sup>

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doi: 10.1002/ccr3.9529. eCollection 2024 Nov.

# Benign paroxysmal positional vertigo: A case report in which four wrongs made a right

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## Abstract

Repositioning maneuvers for benign paroxysmal positional vertigo (BPPV) designed to induce otoconial movement in one canal can trigger and sometimes unwittingly treat BPPV in other canals. Patients with BPPV are best managed by precisely diagnosing the canal variant and using correctly performed, standardized testing and treatment maneuvers.

**Keywords:** BPPV; Epley maneuver; lateral canal; positional nystagmus; positional vertigo.

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## Diagnostic Delay in Pediatric Vestibular Disorders

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### Abstract

Background: Vertigo and dizziness in children can be multi-factorial. Vestibular function tests allow an improved differential diagnosis and treatment. Delay in diagnosis of the diverse etiologies causing dizziness can adversely affect the health of children and is a matter of concern for their families. This study analyzes the delay in diagnosis and the importance of establishing a diagnosis with detailed history and neuro-otological evaluation.

Original Article

# Large Variability of Head Angulation During the Epley Maneuver: Use of a Head-Mounted Guidance System with Visual Feedback to Improve Outcomes

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**BACKGROUND:** The aim of this study was to show the variability in head angulation during the canalolith repositioning maneuvers to treat benign paroxysmal positional vertigo and to describe a head-mounted benign paroxysmal positional vertigo guidance system to measure the head orientation.

**METHODS:** A guidance system for benign paroxysmal positional vertigo was developed by NeuroEquilibrium Diagnostic Systems to measure head orientation and provide visual feedback and instructions to examiners during various maneuvers for benign paroxysmal positional vertigo. Twenty-five experienced examiners and 25 healthy volunteers (aged 21-35 years) were recruited. Each examiner applied the Epley maneuver twice in 1 volunteer: without and with the use visual feedback from a guidance system. Head orientation in both procedures was measured and compared.

**RESULTS:** The trained examiners demonstrated a large variability in head orientation during the Epley maneuver, which was reduced by using the benign paroxysmal positional vertigo guidance system. There was a variability of 39-65° in head orientation measured without the guidance system. The use of the guidance system reduced the variation range to a sixfold decrease in variability.

**CONCLUSION:** There is a large variability in head orientation when performing repositioning maneuvers, which could compromise the efficacy of benign paroxysmal positional vertigo treatment. Treatment for benign paroxysmal positional vertigo can be optimized by reducing this variability with a benign paroxysmal positional vertigo guidance system. It might also be a useful tool for teaching.

**KEYWORDS:** BPPV, Epley maneuver, guidance system, head angulation

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# Benign Paroxysmal Positional Vertigo: A Lesson in Clinical Reasoning

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## Key Clinical Message

Repositioning maneuvers for benign paroxysmal positional vertigo (BPPV) designed to induce otoconial movement in one canal can trigger or treat BPPV in other canals. We suggest for standardized testing protocols to ensure correct diagnosis of BPPV.

MeSH keywords: BPPV;positional vertigo;horizontal canal;positional nystagmus;case report

### Background:

Benign paroxysmal positional vertigo (BPPV) is a common cause of episodic vertigo in which otoconia (calcium carbonate crystals) become detached from their normal location on the macula of the otolith organs.[1] They can then find their way into the semicircular canals (SCC), become free-floating or attached to the cupula, and create abnormal sensations of motion when the position of the head is changed with respect to the pull of gravity. BPPV of the horizontal canal (hcBPPV) is less commonly diagnosed than BPPV of the posterior canal BPPV (pcBPPV), in part because most emergency department and primary care physicians do not attempt to distinguish the canal variants.[2, 3] The supine roll test (SRT) is primarily used to diagnose hcBPPV, while the Dix-Hallpike test is primarily used to diagnose pcBPPV.[4, 5]

BPPV is usually treated with particle repositioning maneuvers that move the otoconia out of the SCC: the Epley or Semont maneuvers for pcBPPV and, for example, the Gufoni, Zuma, or Lempert (barbeque roll) maneuvers for hcBPPV.[4-7] We report here a woman with hcBPPV who came to the emergency department with acute positional vertigo and positional nystagmus and experienced a favorable outcome despite the wrong side and the wrong canal being diagnosed and consequently receiving the wrong treatment maneuver. To explain this seeming paradox, we simulated the movement of otoconia within the labyrinth in a right-sided hcBPPV in response to an Epley treatment maneuver for left-sided pcBPPV. Our simulations suggest that an extended Epley maneuver (i.e., the patient's head being turned beyond the conventional 45° angle to 60° in the second step) caused the otoconia to leave the horizontal SCC, resulting in this patient's successful outcome.

### Case Report:

A 19-year-old woman came to the emergency department around noon because of acute vertigo with unsteadiness and light-headedness triggered by changing her head position. She woke up around 3:00 am with

# A Study to Compare the Effect of Balance Training Exercises on Presbystasis: A Cross-Sectional Study

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## ABSTRACT

### BACKGROUND OF THE STUDY

Presbyastasis is a medical term for age related balance problems. Presby means elders and stasis means balance problem. Presbystasis can be defined as an aging disequilibrium. Elderly people often complain of dizziness and loss of balance. The main sign and symptoms of presbystasis are dizziness, loss of balance, increased fall risk, vertigo, postural instability which progressively increases loss of quality of life. An estimated 13 percent of adults report imbalance between the ages of 65 and 69. For people 85 and older, it increases to 46%. In addition, balance, and gait disorders are associated with an increased risk of falls<sup>13</sup>. The estimated annual fall rate for adults over age 65 is 28%. Balance is important for maintaining postural balance and thus preventing falls.

### PURPOSE OF THE STUDY

The purpose of this study is to observe the comparison of the effect of the rhythmic weight shift exercises and limit of stability exercises on balance and fall risk in patients with presbystasis.

### STUDY DESIGN

A Cross-sectional study.

### METHODOLOGY

Individuals suffering with presbystasis, between the age group 65 to 85 were included in this study. Presbystasis should be confirmed diagnosed by ENT physician with posturography and Craniocorpography done of the patients, showing abnormal sway were considered in this study. Intervention done are Rhythmic weigh shift exercises and Limit of stability exercise protocol. Outcome measures used were FHI scale and TUG test to measure pre-test and post-test scores. Intervention was given for 4 weeks, with 4 sessions per week.

Editorial | Aug 23, 2023

# Prevalence of Horizontal Canal Variant in 3,975 Patients With Benign Paroxysmal Positional Vertigo: A Cross-sectional Study

Rajneesh Bhandari <sup>1</sup>, Anita Bhandari <sup>1</sup>, Yu-Hsiang Hsieh <sup>1</sup>, Jonathan Edlow <sup>1</sup>, Rodney Omron <sup>1</sup>

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## Abstract

### Background and objectives

Current understanding based on older studies is that pc-BPPV is far more common than hc-BPPV. Such studies are limited by small sample sizes, and often the supine roll test for hc-BPPV is not performed. To better estimate the prevalence of hc-BPPV, we studied a large cross-section of patients with VOG-diagnosed BPPV.

### Methods

Using a cross-sectional study of patients with BPPV, we investigated patients referred to NeuroEquilibrium specialty clinics throughout India between January 1, 2021, and December 31, 2021. All patients were evaluated with video oculography (VOG) during positional tests, and all diagnoses were confirmed by a neurotologist and neurologist.

### Results

Of 3,975 patients with VOG-confirmed and specialist-diagnosed BPPV (median age, 51 years; 56.6% women), pc-BPPV accounted for 1,901 (47.8%), hc-BPPV was seen in 1,842 (46.3%), and anterior canal BPPV was found in 28 (0.7%) patients.



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# Modified Interpretations of the Supine Roll Test in Horizontal Canal BPPV Based on Simulations: How the Initial Position of the Debris in the Canal and the Sequence of Testing Affects the Direction of the Nystagmus and the Diagnosis

Anita Bhandari<sup>1\*</sup>, Rajneesh Bhandari<sup>2</sup>, Herman Kingma<sup>3,4,5</sup> and Michael Strupp<sup>6</sup>

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**Background and Objectives:** The aim of this study was to show with three-dimensional simulations how the diagnostic supine roll test (SRT) is affected by the initial position of the debris within the horizontal canal (hc) and study the nystagmus patterns on changing the sequence of testing and its impact on the diagnosis of the side of involvement in hc-BPPV.

**Methods:** A 3D dynamic simulation model was developed and applied based on reconstructed MRI images and fluid dynamics. Each semicircular canal was linked to the respective extraocular muscles to visualize nystagmus generated on stimulation of the canal.

**Results:** The simulations of hc-canalithiasis showed that the nystagmus pattern seen with the SRT is changed by the initial position of the otolith debris within the canal and the sequence of testing. The debris changes position during SRT so that sequential steps do not start at the initial position as previously assumed. The sequence of performing the SRT steps from the right or left side influences the nystagmus pattern generated: bilateral direction-changing, bilateral direction-fixed, and unilateral nystagmus can be seen in different test conditions. The SRT itself may even reposition the debris out of the canal.

# BPPV Simulation: A Powerful Tool to Understand and Optimize the Diagnostics and Treatment of all Possible Variants of BPPV



Anita Bhandari<sup>1\*</sup>, Herman Kingma<sup>2,3,4</sup> and Rajneesh Bhandari<sup>5</sup>

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BPPV is a mechanical disorder caused by the displacement of otolith debris into the semicircular canals. The treatment involves different repositioning maneuvers to bring the debris back into the utricle. This study aims to show how dynamic simulation models based on fluid dynamics and MRI, can help to visualize and understand the movement of the debris within the canals during head movement in 3D as a function of time. The user can define the rotation angle and plane at each step of the maneuver and then the model visualizes the canal and the otoconial movement in 3D. The simulation developed also allows alteration of various parameters like the rotational head acceleration, the duration of each step of the maneuver, the initial position of the otoconial debris in the canal, the size and the number of the particles and fluid dynamics of endolymph. The clod movement is visualized in such a way that it allows a better understanding of the impact and efficacy of various liberation maneuvers and why certain maneuvers might fail when not applied properly in the clinic. The model allows simulation of multi-canal BPPV. In this paper we demonstrate the power of the model applied on the maneuvers of Semont and Yacovino when executed in different ways. The model aims to provide a visual explanation for the need of specific maneuvers for each type of BPPV. The simulator presented here can be used to test the efficacy of existing maneuvers and help in the development of new maneuvers to treat different BPPV variants.

**Keywords:** simulation, 3D, BPPV, maneuver, semont, yacovino, otolith, rotation angle

ORIGINAL ARTICLE

# Three-dimensional simulations of six treatment maneuvers for horizontal canal benign paroxysmal positional vertigo canalithiasis

Anita Bhandari, Rajneesh Bhandari, Herman Kingma, Francisco Zuma e Maia, Michael Strupp

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## Abstract

### Background and purpose

Horizontal canal benign paroxysmal positional vertigo (BPPV) is the second most common variant of BPPV after posterior canal BPPV. Various liberatory maneuvers are recommended for the treatment of horizontal canal BPPV canalithiasis (hc-BPPV-ca). The aim of this study was to show how three-dimensional (3D) dynamic simulation models visualize the movement of the clot of otoconia within the canal for a better understanding of the theoretical efficacy.

### Methods

Based on reconstructed magnetic resonance imaging and fluid dynamics, a 3D dynamic simulation model (as a function of time) was developed and applied. Thereby, six treatment maneuvers for hc-BPPV-ca were simulated: two types of the roll maneuver (the original 270° and the modified 360°) as well as two Gufoni and Zuma maneuvers (for geotropic and apogeotropic nystagmus).

### Results

The simulations showed that the 360° roll maneuver and Zuma maneuver are effective treatment options for hc-BPPV-ca for debris in all locations within the canal. However, the original 270° roll maneuver will not be effective if the clot is in the ampullary arm of the horizontal canal. The Gufoni maneuver for geotropic hc-BPPV-ca is effective, whereas for apogeotropic hc-BPPV-ca there is a risk of treatment failure due to insufficient repositioning of the debris.



# Diagnostic and Therapeutic Maneuvers for Anterior Canal BPPV Canalithiasis: Three-Dimensional Simulations

## OPEN ACCESS

Anita Bhandari<sup>1\*</sup>, Rajneesh Bhandari<sup>2</sup>, Herman Kingma<sup>3,4,5</sup> and Michael Strupp<sup>6</sup>

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**Background and Objectives:** Anterior canal BPPV is a rare BPPV variant. Various diagnostic and therapeutic maneuvers have been described for its management. The aim of this study was to use three-dimensional simulation models to visualize otoconial debris movement within the anterior canal during diagnostic tests and different liberatory maneuvers. This can help to optimize existing treatment maneuvers and help in the development of better management protocols.

**Methods:** Based on reconstructed MRI images and fluid dynamics, a 3D dynamic simulation model (as a function of time) was developed and applied. Simulations of the supine head-hanging test for diagnosis of ac-BPPV were studied. Three repositioning maneuvers were simulated: 1) the Yacovino maneuver and its modifications, 2) the reverse Epley maneuver and 3) the short canal repositioning (CRP) maneuver.

**Results:** The simulation showed that the supine head-hanging test is a good test for diagnosis of ac-BPPV affecting both labyrinths and demonstrated why there is no inversion of nystagmus on sitting up. The Yacovino maneuver was seen to be an effective treatment option for ac-BPPV without having to determine the side involved. However, simulations showed that the classical Yacovino maneuver carried a risk of canal switch to the posterior canal. To overcome this risk, a modified Yacovino maneuver is suggested. The reverse Epley maneuver was not an effective treatment. Short CRP is useful in ac-BPPV treatment; however, it requires determination of side of involvement.



## OPEN Interobserver agreement in BPPV diagnosis using eye movement recordings

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Benign Paroxysmal Positional Vertigo (BPPV) is one of the most prevalent peripheral vestibular disorders seen in specialized dizziness clinics. Despite being a well-understood condition with effective treatment options, BPPV remains associated with significant diagnostic delays and healthcare costs. If proven reliable, telemedicine approaches could help address these challenges by improving diagnostic accessibility and efficiency. To investigate the interobserver agreement in BPPV diagnosis, when using eye movement recordings. Six vestibular medicine specialists (Specialist 1, 2, 3, 4, 5, 6) were recruited to participate in this study. The specialists were asked to evaluate the recordings of 240 patient cases who underwent assessment for BPPV (first assessment). After viewing the recordings of each case, they were required to make a BPPV diagnosis. Five specialists (2, 3, 4, 5, 6) agreed to repeat the procedure twice, to additionally evaluate the intraobserver agreement (second assessment). The proportion of agreement and Cohen's kappa were calculated for both interobserver and intraobserver agreement. Furthermore, agreement with the original diagnoses was evaluated. The interobserver agreement between experts was fair to moderate with a Cohen's kappa value of 0.40 (CI 95% [0.35, 0.45]) and a proportion of agreement of 60% (CI 95% [54, 67]). Specialists 2, 4, and 5 exhibited substantial intraobserver agreement. In contrast, Specialist 3 demonstrated fair intraobserver agreement, while Specialist 6 showed almost perfect intraobserver agreement. Regarding the first assessment, agreement with the original diagnoses ranged from fair to substantial, with kappa values between 0.40 and 0.70, and corresponding percentages between 58 and 78%. Similar results were observed for the second assessment. The interobserver agreement between specialists diagnosing BPPV using eye movement recordings, was fair to moderate. The suboptimal agreement could be related to missing clinical information (e.g. patient history and symptoms during positional maneuvers). Future studies should incorporate this information and reassess interobserver agreement.

**Keywords** Interobserver agreement, BPPV, Telemedicine, Nystagmus, Vertigo

# **Vestibular Paroxysmia with Trigeminal Neuralgia: Simultaneous Occurrence of Two Compression Syndromes: A Rare Case Report**

Annals of Otology and Neurotology

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## **Abstract**

Neurovascular compression syndromes are compression of cranial nerves by blood vessels leading to troublesome symptoms. They mostly occur due to a single vessel loop compression. Here, we report two rare cases with simultaneous fifth and eighth nerve compression by anterior inferior cerebellar artery and superior cerebellar artery loops together.

# Differential Diagnosis of Vertigo in Children

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Ann Otol Neurotol ISO 2019;2:21–26

## Abstract

**Introduction** Vertigo and balance disorders can affect all age groups. It is common to misdiagnose the cause of dizziness in children, which eventually results in the delay of treatment. The purpose of this study was to review the clinical characteristics and neurotological evaluation of vertigo in patients younger than 16 years and assist in making a differential diagnosis for children with vertigo and balance disorders. The differential diagnosis can help determine the correct management strategy to treat vertigo and imbalance in pediatric patients.

**Methods** Children and adolescents presenting with a chief complaint of vertigo or unsteadiness to Vertigo and Ear Clinic, Jaipur, were selected for this study on the basis of clinical history, physical examination, and neurotological evaluation.

**Results** A total of 90 patients with a mean age of 10.67 years were evaluated. The most common cause associated with vertigo or dizziness was found to be vestibular migraine seen in 38 participants of this study. This was followed by unilateral peripheral vestibulopathy in 15 patients, bilateral peripheral vestibulopathy in 11 patients, and central vestibulopathy in 6 patients. Vertigo was also seen to be associated with various other disorders.

**Conclusion** Vertigo in children must be recognized as a definite symptom, which should be taken seriously by the clinician and family. Pediatric vertigo can be due to many etiologies. History and evaluation are the only way to diagnose the etiology and site of lesion. This will prevent misdiagnosis and delay in the treatment, which can ultimately lead to deterioration of the quality of life.

## Keywords

- ☒ pediatric vertigo
- ☒ vestibular disorders
- ☒ clinical characteristics
- ☒ differential diagnosis

## Introduction

Vertigo and dizziness are not uncommon during childhood even though it is often perceived as a disorder of older people. According to a study on Scottish school children, 15% were seen to have at least one episode of dizziness over a period of 1 year.<sup>1</sup> Many other studies show a high prevalence, but it is still an area that needs to be explored further. Approach to vertigo in children is not easy due to the difficulty in eliciting a clear and reliable history and parents often suspecting that the children are making excuses for not going to school, thereby ignoring the symptoms of vertigo. Pediatric vertigo was first described by Harrison in 1962.<sup>2</sup> Our understanding of vestibular disorders, along with better tools of evaluation, has brought about a tremendous change in our approach to

patients with vertigo and balance the disorder since then. After a detailed history, clinical examination and neurotological evaluation, the diagnosis and required form of management become clearly delineated. A child presenting with dizziness is usually examined by a general practitioner or a pediatrician. It is very common to misdiagnose the cause of dizziness in children, which eventually results in the delay of the treatment.<sup>3</sup>

Vertigo in children could be seen due to many reasons. These include trauma, infections, migraine, disorders of the central nervous system (usually cerebellar and brainstem), benign paroxysmal positional vertigo (BPPV), vestibular neuritis due to the viral infections, and psychosomatic disorders.<sup>4</sup> Of these, otitis media and middle ear infection are found to be the most common causes of vestibular disturbances in

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# Early Intratympanic Methylprednisolone in Sudden SNHL: A Frequency-wise Analysis

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**Abstract** Sudden sensorineural hearing loss is a dire medical emergency which must be treated at the earliest to get better long term hearing results. Our study aims to determine the efficacy of intratympanic steroid (Methylprednisolone) on auditory outcomes in patients of sudden sensorineural hearing loss and study the relation between time of onset of hearing loss to start of therapy and frequency-wise recovery of hearing loss. A prospective cohort clinical study with 33 patients with sudden hearing loss of 30 dB or more were treated with the intratympanic injection of methylprednisolone and the effect of the drug was observed. In this study, 33 patients with sudden onset (unilateral or bilateral) of hearing loss were treated with intratympanic methylprednisolone. The duration at which the drug was administered and the age of the participants was taken into consideration. Main outcome measures included audiometry results at low, medium and high hearing loss frequencies. The specific frequency at which the hearing improvement took place was tabulated. It was observed that hearing improved significantly if the steroid is injected within the first 4 days of onset ( $p < 0.05$ ) at all the frequencies. A gain of 15 dB or more was achieved in more than 78% patients after injecting methylprednisolone intratympanically. A statistically significant association was found between recovery rate and frequency of hearing loss with patients showing greater improvement at low

hearing loss frequency in comparison to mid and high frequencies ( $p < 0.05$ ). The drug efficacy does not change with the age of the patient.

**Keywords** Sudden hearing loss · Methylprednisolone · Intratympanic injection · Audiometric gain · Frequency · Onset · Age

## Introduction

Sudden sensorineural hearing loss (SNHL) is a medical emergency which needs to be tackled at the earliest. It is defined as 30 dB or greater shift in bone conduction thresholds in three consecutive frequencies within 72 h or less [1]. Hearing loss, which occurs over more than 3 days is defined as a rapidly progressive hearing loss. In the US alone, 4000 new cases of SNHL occur annually and the incidence is 1 person in 10,000/year [2]. Various treatment modalities have been used in the treatment of SNHL like oral, intravenous and intratympanic steroids, hyperbaric oxygen and vasodilators. In this study, we propose to analyze the efficacy of intratympanic methylprednisolone at different hearing loss frequencies in the treatment of sudden SNHL.

## Plausible Theories in Causing Idiopathic Sudden SNHL

### Infections

Most evidence in the recent literature support the inflammatory processes of the inner ear as the reason for hearing loss with viral diseases likely to be the commonest cause.

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# Novel Digital Tools for Clinical Research

## Vestibular Simulation for Benign Paroxysmal Positional Vertigo

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### KEYWORDS

• BPPV • Vestibular simulation • Otolith dynamics • Computational modeling  
• Nystagmus • Repositioning maneuvers • Precision medicine

### KEY POINTS

- Three-dimensional vestibular simulations visualize otoconial movement within semicircular canals, bridging theoretical concepts and bedside interpretation in benign paroxysmal positional vertigo (BPPV).
- Simulation studies have demonstrated that head orientation, debris position, and testing order can significantly influence positional nystagmus patterns and clinical findings.
- Digital modeling has improved understanding of diagnostically challenging variants of BPPV.
- Simulation-guided analysis has refined repositioning maneuvers and helped in improving the outcomes of maneuvers by modifying them. Inadequate repositioning with maneuvers could be identified.
- Simulations could be used to test the efficacy of future maneuvers.



Video content accompanies this article at <http://www.neurologic.theclinics.com>.

### INTRODUCTION

Benign paroxysmal positional vertigo (BPPV) is one of the most common peripheral vestibular disorders encountered in clinical practice.<sup>1</sup> It is characterized by brief

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## Benign Paroxysmal Positional Vertigo (BPPV)

by Dr. Anita Bhandari

This interactive book on Benign Paroxysmal Positional Vertigo gives a comprehensive description of all aspects of BPPV. Diagnostic characteristics of the various types of BPPV have been illustrated with their VNG videos. Tables and flow charts are used to guide the reader through treatment protocols of all BPPV variants. Animations are used to describe the repositioning maneuvers for ease of understanding. The use of technological advancements in BPPV management like torsion detection, simulations, augmented reality, and computer vision have been described.

<https://www.neuroequilibrium.in/book-page/>

