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Benign Paroxysmal Positional Vertigo

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Abstract
Benign paroxysmal positional vertigo (BPPV) is the most common cause of vertigo. BPPV is characterized by a sudden spinning sensation along with nystagmus, triggered by specific changes in head position. BPPV most commonly occurs when otoliths are displaced into the posterior semicircular canal; therefore, the Dix–Hallpike test is used to establish the diagnosis, and the Epley maneuver is performed to reposition the otoliths as the main therapy. The prognosis is good, but recurrences and residual dizziness may occur after therapy. This article aims to provide a comprehensive understanding of BPPV, including its definition, epidemiology, etiology, pathophysiology, clinical manifestations, diagnosis, differential diagnosis, management, and prognosis. The writing of this article uses a literature-study method with a narrative approach. BPPV has a lifetime prevalence of 2.4% with an incidence of 10.7–64 cases per 100,000 people per year, is 2–3 times more frequent in women, and peaks in the fifth–sixth decades of life. The most frequent type is PC-BPPV (60–90%). Pathophysiology involves the mechanisms of canalithiasis or cupulolithiasis. The diagnosis is established through the Dix–Hallpike test for PC-BPPV and the supine roll test for LC-BPPV. The main management is the canalith repositioning procedure: the Epley maneuver for PC-BPPV and the Lempert maneuver for LC-BPPV. The prognosis is generally good, with 20–50% of patients recovering spontaneously within 1–3 months; however, a recurrence rate of 40–50% within 5 years and residual dizziness of 29.6–76.9% may occur. BPPV is the most frequent cause of vertigo with relatively simple diagnosis and management, but it is often missed. A comprehensive understanding of BPPV is important for clinicians to diagnose and manage it appropriately in order to prevent complications and improve patients' quality of life.
Keywords: benign paroxysmal positional vertigo, dix-hallpike test, epley maneuver

INTRODUCTION

About 3–6% of patients presenting to the emergency room have dizziness as their main symptom. Dizziness can be broadly classified into two main categories: transient dizziness and dizziness that lasts more than one day. Benign paroxysmal positional vertigo (BPPV) is the most common peripheral vestibular disorder causing transient vertigo and dizziness in the general population. BPPV is characterized by a sudden, transient spinning sensation accompanied by characteristic nystagmus. Symptoms are triggered by changes in head position relative to gravity, and their severity can range from mild to debilitating dizziness that causes nausea, vomiting, and significant interference with daily activities.

Vertigo is defined as an illusory sensation of motion of either the self or the surroundings in the absence of true motion. Positional vertigo is defined as vertigo produced by changes in head position relative to gravity. BPPV is defined as an inner-ear disorder characterized by repeated episodes of positional vertigo. The term "benign" implies that BPPV is not caused by any serious central nervous system (CNS) disorder and has a generally good prognosis for recovery.

Approximately 17–42% of patients with vertigo will eventually be diagnosed with BPPV. BPPV is the most common peripheral vestibular disorder. The lifetime prevalence of BPPV is 2.4%, with an incidence of 10.7–64 cases per 100,000 people per year, and it accounts for about 20–30% of vestibular vertigo. It is 2–3 times more common in women, with an age of onset ranging from 11 to 84 years, and peaks in the fifth and sixth decades of life. The majority of BPPV cases involve a single canal (SC-BPPV) and can be classified into

three types: posterior semicircular canal BPPV (PC-BPPV), lateral semicircular canal BPPV (LC-BPPV), and anterior semicircular canal BPPV (AC-BPPV). Among the three, the most common are PC-BPPV (60–90%) and LC-BPPV (5–30%). BPPV can also involve multiple canals (MC-BPPV).

The pathology of BPPV is based on cupular displacement due to freely moving debris/otoliths in the semicircular canal (canalithiasis) or the attachment of debris/otoliths to the cupula (cupulolithiasis). Various inner-ear pathologies that can result in otoconia detachment appear capable of causing BPPV. In most cases, BPPV is termed primary or idiopathic because of its unclear etiology. Idiopathic BPPV accounts for 50–70% of cases. In secondary BPPV, the most common causes are head trauma (7–17%) and vestibular neuritis (7–15%). Ménière's disease, migraine, and inner-ear surgery have also been shown to be strongly associated with BPPV.

The vestibular system, consisting of the semicircular canals, which are sensitive to rotational movements, and the otolithic organs (saccule and utricle), which are more sensitive to translational movements, plays a crucial role in maintaining visual fixation via the vestibulo-ocular reflex (VOR). This reflex works by providing compensatory eye movements during head movements so that vision remains stable. Disorders of the vestibular system can cause pathological nystagmus and vertigo.

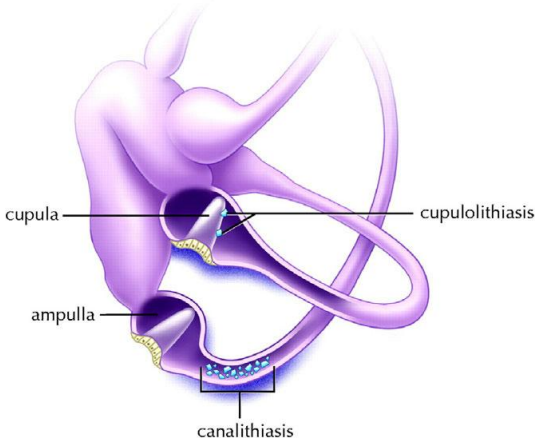

Figure 1. Illustration of cupulolithiasis and canalithiasis (You, Instrum, & Parnes, 2019)

There are two main theories regarding the pathophysiology of BPPV, namely the canalithiasis and cupulolithiasis models. In the cupulolithiasis model, particles adhere to the cupula itself, making it sensitive to gravitational forces and creating alterations in cupular deflection that lead to pathological motion perception. This mechanism may explain a more chronic form of BPPV. In contrast, in the canalithiasis model, symptoms are caused by utricular otoconia particles that fall, become displaced, and move freely in the lumen of the semicircular canal. The abnormal signal occurs when gravity attracts particles within the endolymphatic duct, creating a plunger effect that causes unidirectional cupular displacement. Clinical and pathological studies show that canalithiasis is the predominant subtype.

The occurrence of BPPV is also influenced by several risk factors, one of which is older age. The mean onset of the first episode of BPPV occurs at age >50 years, probably due to fragmentation of otoconia associated with aging. BPPV is also associated with vitamin D

deficiency, which is required for the regulation of calcium transport in the formation and maintenance of the structure and integrity of otoconia. BPPV is frequently associated with Ménière's disease (MD), possibly due to endolymphatic hydrops that induces damage to the utricular and saccular maculae, or because of partial obstruction of the membranous labyrinth. BPPV can also occur due to vestibular neuritis, possibly because inflammation causes utricular macular damage and otolith detachment, or because of thrombus/ischemia of the arteries supplying the semicircular canals and utricle. Secondary BPPV is most often caused by trauma such as traffic accidents, falls, and temporal bone or stapes surgery, which can lead to loss of otoconia. Traumatic BPPV may involve multiple canals and may require repetitive maneuvers.

The prognosis for BPPV is generally good, with approximately 20% of patients experiencing spontaneous recovery within 1 month and up to 50% within 3 months. A single Epley maneuver is often sufficiently effective to relieve BPPV symptoms. However, undiagnosed and untreated BPPV can have significant clinical impacts and reduce quality of life due to an increased risk of falls and decreased ability to perform daily activities. It is estimated that 40–50% of BPPV cases may recur within 5 years after successful therapy. Additionally, residual dizziness may occur in 29.6–76.9% of cases after treatment. The presence of comorbidities such as hypertension and diabetes mellitus can aggravate BPPV and increase the risk of recurrence.

Based on the above description, this article aims to provide a comprehensive understanding of BPPV, covering its definition, epidemiology, etiology, pathophysiology, clinical manifestations, diagnosis, differential diagnosis, treatment, and prognosis, serving as a reference for healthcare practitioners in accurately diagnosing and managing BPPV.

RESEARCH METHOD

This article was written using a literature review method with a narrative approach. A literature review is a research method conducted by collecting, reading, analyzing, and synthesizing relevant literature on a specific topic to obtain a comprehensive understanding of a health problem. Literature sources for this article were obtained from prominent scientific databases, including PubMed, Google Scholar, and ScienceDirect, using the following search keywords: "benign paroxysmal positional vertigo", "BPPV diagnosis", "Dix–Hallpike test", "Epley maneuver", and "canalith repositioning procedure". The inclusion criteria for the literature comprised articles published within the last 10 years (2014–2024), articles written in English or Indonesian, articles with full-text access, and articles relevant to the topic of BPPV covering aspects of epidemiology, etiology, pathophysiology, diagnosis, and management. The literature used consisted of scientific journal articles, clinical practice guidelines, and medical textbooks.

The analysis process employed a narrative synthesis approach, which involved grouping the literature based on discussion themes, comparing findings from various sources, and organizing them into a systematic and comprehensive discussion framework. The collected literature was then critically analyzed to obtain accurate and scientifically accountable information. This article was structured to provide a comprehensive overview of BPPV, including its definition, epidemiology, etiology, pathophysiology, clinical manifestations, diagnosis, differential diagnosis, management, and prognosis. Through this

literature review approach, it is expected that readers can gain a comprehensive and up-to-date understanding of BPPV as the most common cause of vertigo in daily clinical practice.

RESULTS AND DISCUSSION

Clinical Manifestation

The characteristic sign of BPPV appears when the subject's head is positioned in such a way that the plane of the semicircular canal is parallel to the force of gravity, producing nystagmus and vertigo. The duration, frequency, and intensity of symptoms may vary. Persistent autonomic manifestations (nausea, vomiting) or dizziness may also occur (Messina et al., 2017). BPPV usually starts at night, when the patient turns over in bed, or in the morning, when sitting for the first time after a night's rest. This first attack may be severe enough to interfere with activity for 1-2 days, although when lying down at all, vertigo will decrease. The patient may be able to walk, though there might be dizziness. Within hours or days, debris can be dispersed, or spontaneously be released from SCC by movement; and finally, the strongest symptoms disappeared. However, brief episodes of vertigo while moving the head (looking up, bending forward, or turning over in bed) can last longer (You et al., 2019).

Diagnosis

According to the American Academy of Otolaryngology-Head and Neck Surgery Foundation (AAO-HNSF) Clinical Practice Guidelines of BPPV 2017, the PC-BPPV diagnostic criteria are (1) patients reporting a history of recurrent episodes of vertigo with changes in head position relative to gravity, (2) Physical examination fulfills all of the following criteria: • Vertigo associated with torsional (rotatory), upbeating (toward the forehead) nystagmus is provoked by the Dix-Hallpike test. • There is a latency period between the completion of the Dix-Hallpike maneuver and the onset of vertigo and nystagmus. • The provoked vertigo and nystagmus increase and then resolve within 60 seconds from the nystagmus onset. However, when the history matches the BPPV but the Dix-Hallpike test shows horizontal nystagmus or no nystagmus, it is recommended to do a supine roll test to check for LC-BPPV (Bhattacharyya et al., 2017).

While checking the history, it is important to distinguish the chief complaint of vertigo from the usual dizziness such as disequilibrium and pre-syncope. Other differential diagnoses of episodic vertigo should also be excluded. Vertigo patients usually feel the environment is spinning, with episodes of vertigo lasting less than 20-60 seconds, but feelings of imbalance may last longer. BPPV occurs suddenly and is triggered by specific head movements, such as neck extension, forward flexion, or rolling over in bed. Clinicians should also be aware of the symptoms of CNS disorders that resemble BPPV, which are pathologically more serious and require immediate therapy (Bhattacharyya et al., 2017).

Special Tests

To diagnosis PC-BPPV, the characteristics of nystagmus must be confirmed by the Dix-Hallpike maneuver, which is one of the diagnostic criteria. This test has a sensitivity of 79-82% and a specificity of 71-75%, with a low positive predictive value so that a negative Dix-Hallpike test does not rule out the diagnosis of BPPV (Bhattacharyya et al., 2017; Evren et al., 2017).

The Dix-Hallpike test is performed by (i) the patient sitting in bed and turning the head 45° to the right or left (ii) the patient is guided from the sitting position to a supine position, with the head extended 30° (hanging), during which time it is checked for nystagmus. If vertigo and nystagmus occur after some time, the test is considered positive. (iii) The patient is asked to return to a sitting position, and vertigo and nystagmus recur during this process, with the nystagmus in the opposite direction and (iv) the head is turned to the other side and steps 1-3 repeated. The degree of vertigo and the type and intensity of nystagmus were compared to determine the canal and side affected. When there is significant upbeat geotropic-rotational vertigo and nystagmus after a 45˚ right rotation of the head, the condition is considered right PC-BPPV, and when symptoms appear after a 45˚ left rotation, it is considered left PC-BPPV. When it occurs after the head has been turned to either side, it is considered bilateral PC-BPPV (You et al., 2019; Bhattacharyya et al., 2017; Tang & Li, 2017).

LC-BPPV is diagnosed by the supine roll test (Pagnini-McClure maneuver). The patient is positioned supine first with a neutral head position and the face pointed upwards. The head is then rapidly rotated 90˚ to one side, and the eye is observed for nystagmus. After the nystagmus has subsided, the head is returned to a neutral position, and the contralateral direction can be tested in the same way. This test provokes both horizontal channels simultaneously. The affected side is determined by comparing the nystagmus on each side and its direction. In general, horizontal geotropic nystagmus occurs, more severe on the affected side (You et al., 2019; Bhattacharyya et al., 2017).

AC-BPPV is relatively rare. Anatomically, the superior semicircular canal lies in the same plane as the contralateral posterior semicircular canal, thus, the Dix-Hallpike maneuver test can be used. A positive result is the presence of vertigo and downbeat apogeotropic nystagmus with a torsion component towards the painful ear (You et al., 2019; Bhattacharyya et al., 2017).

Laboratory Test and Imaging

In the AAO-HNSF BPPV Clinical Practical Guidelines 2017, it is not recommended to carry out radiographic imaging for patients who have met the BPPV diagnostic criteria without other signs and/or symptoms that require imaging (Bhattacharyya et al., 2017). This is because the imaging results that are usually performed by MRI are not significant enough to identify the etiology of dizziness, also a good physical examination technique is known to be more sensitive than MRI for detecting acute central lesions in patients with acute vestibular symptoms (Cha et al., 2017). Thus MRI is indicated only if the clinical presentation is atypical, if the Dix-Hallpike test reveals faint or unusual nystagmus findings, or if there are additional symptoms other than those caused by BPPV, leading to CNS pathology or otological disturbances (Bhattacharyya et al., 2017; Cha et al., 2017). Routine vestibular testing is also not recommended for patients who have met the diagnostic criteria for BPPV without signs and/or other vestibular symptoms that are incompatible with BPPV. In cases of BPPV with less obvious nystagmus, video-oculographic technology can be used to help better observe nystagmus (Bhattacharyya et al., 2017).

Differential Diagnosis

Several differential diagnoses of BPPV include vestibular neuritis and cerebellar stroke (Johns & Quinn, 2020). Comparison of clinical manifestations and management of these three diseases is presented in Table 1.

Table 1. Comparison of clinical manifestation and guide to BPPV, vestibular neuritis, and cerebellar stroke (Johns & Quinn, 2020)

Clinical manifestation	BPPV	Vestibular Neuritis	Cerebellar Stroke
Vertigo when patient is still	No	Yes	Yes
Patient is able to stand unaided	Yes	Yes	May not be able to
Typical spontaneous and/or gaze-evoked nystagmus	Not present	Unidirectional horizontal/ rotatory Not purely vertical	Various, including bidirectional horizontal/ rotatory; sometimes vertical
Worse when patient moves their head	Yes	Yes	Yes
Other neurologic symptoms or findings	No	No	Often but not always present
New hearing loss	No	No	Can occur
Dix-Hallpike test	Vertical upward and rotatory nystagmus	Do not perform	Do not perform
HINTS plus examination	Do not perform	All 4 findings: • Unidirectional nystagmus • No vertical skew • Abnormal HIT • No hearing loss HINTS plus = peripheral	Any of: • Bidirectional nystagmus • Vertical skew present • Normal HIT • New hearing loss HINTS plus = central
Imaging indicated	No	No	Yes
Primary treatment	Epley Maneuver	Supportive treatment	Treatment for stroke

Note: BPPV = benign paroxysmal positional vertigo, HINTS = head impulse, nystagmus and test of skew, with plus referring to a test of recent hearing loss, HIT = head impulse test

Source: Adapted from Johns & Quinn (2020)

Some other diseases that can cause vertigo are Ménière disease – characterized by recurrent episodes of vertigo, hearing loss, tinnitus, and a feeling of fullness in the ear; Vestibular migraine – characterized by recurrent episodes of vertigo lasting a few minutes to days, at least 50% of episodes develop photophobia, phonophobia, migraine headaches, or visual aura; Labyrinthitis – characterized by symptoms similar to vestibular neuritis but accompanied by hearing loss or tinnitus (Johns & Quinn, 2020).

Treatment

The AAO-HNSF BPPV Clinical Practice Guidelines (2017) recommend management with the canalith repositioning procedure (Bhattacharyya et al., 2017). There are various maneuvers to reposition canaliths in each semicircular canal (Straumann & Brandt, 2020).

For PC-BPPV, the Epley maneuver can be performed by continuing from the last position of the Dix-Hallpike test that provokes vertigo and nystagmus, turning the patient's head 90° to the opposite direction and holding for 20–30 seconds or until the nystagmus disappears. Next, the head is turned an additional 90° in the same direction while the patient rolls onto the side, and the position is maintained for another 20–30 seconds. Then, the patient is brought into a sitting position while keeping the head turned 45° to the side (Bhattacharyya et al., 2017; Straumann & Brandt, 2020). The Semont maneuver can also be performed. The patient sits on the side of the examination bed and turns the head 45° toward the healthy side. The patient is then asked to lie quickly onto the affected side with the head still turned (preferably extended at least 20°) and to maintain this position for 20–120 seconds. Subsequently, the patient is promptly moved to lie on the healthy side, bypassing the sitting position while maintaining the head rotation. If possible, the head should hang downward at least 20°. After 30–120 seconds, the patient returns to an upright sitting position and the head is brought back to neutral (Bhattacharyya et al., 2017; Straumann & Brandt, 2020). This maneuver is considered as effective as the Epley maneuver (Bhattacharyya et al., 2017).

For the geotropic type of LC-BPPV, the Lempert maneuver (barbecue maneuver) can be used. From the supine position, the patient is rolled 270° toward the healthy side in three steps (90° each), with each position maintained for 30–60 seconds. From the final position, the patient may then return to sitting. Some sources suggest rolling the patient more than 270° to enhance maneuver effectiveness, particularly in apogeotropic BPPV (Bhattacharyya et al., 2017; Straumann & Brandt, 2020).

Another maneuver that can be used is the Gufoni maneuver, which has two variations for the geotropic and apogeotropic types. Both begin with the patient sitting upright on the side of the examination bed, then lying down toward the side with less nystagmus on the supine roll test. After 20 seconds, the patient's head is turned 45° upward for the apogeotropic type and downward for the geotropic type. After 1–2 minutes, the patient returns to a sitting position and the head is brought back to neutral (Bhattacharyya et al., 2017; Straumann & Brandt, 2020).

For AC-BPPV, limited research has been conducted to determine the most effective method; however, commonly used approaches include the Epley maneuver (or its modification) and the Yacovino maneuver (Anagnostou et al., 2015).

Patients should also be educated about the impact of BPPV on safety, the potential for recurrence, and the importance of follow-up. Monitoring should be performed within one month after the initial observation or treatment period, with re-evaluation or referral for persistent symptoms suggestive of CNS or peripheral vestibular disorders (Bhattacharyya et al., 2017).

BPPV can also be treated with Brandt-Daroff exercises, which aim to disperse canaliths and increase patients' tolerance to BPPV symptoms. However, this method should not be used as first-line therapy, as its effectiveness is significantly lower than that of the Epley and Semont maneuvers (Pérez-Vázquez & Franco-Gutiérrez, 2017; Gupta et al., 2019).

Routine medical therapy for symptomatic relief of vertigo using vestibular suppressants is not recommended (Bhattacharyya et al., 2017). However, in some cases, residual symptoms in the form of persistent dizziness may occur after the canalith repositioning

maneuver. These symptoms can be managed with betahistine 4 × 6 mg daily or with vestibular rehabilitation (Bhattacharyya et al., 2017; Wu et al., 2019).

For refractory BPPV that does not improve with manual repositioning or medication, singular neurectomy or semicircular canal occlusion surgery may be considered, with careful evaluation of the associated risk of hearing loss (Bhattacharyya et al., 2017; Tang & Li, 2017).

Prognosis

BPPV can recover spontaneously in about 20% of patients within 1 month and up to 50% within 3 months. However, undiagnosed and untreated BPPV will have a significant clinical impact and quality of life due to an increased risk of falling and decreased ability to perform daily activities (Bhattacharyya et al., 2017). One Epley maneuver alone is effective enough to relieve the symptoms of BPPV (Moreno et al., 2019). It is estimated that as many as 40–50% of BPPV can relapse within 5 years after successful therapy (You et al., 2019). There may also be residual dizziness in 29.6–76.9% of cases (Wu et al., 2019). The presence of comorbidities such as hypertension and DM will aggravate BPPV and increase the risk of recurrences (Sreenivas et al., 2019).

CONCLUSION

BPPV is the most common cause of vertigo, with a prevalence of 2.4% and a peak incidence between the ages of 50 and 60 years. The most common type is PC-BPPV. Patients with BPPV typically complain of a sudden spinning sensation triggered by certain changes in head position. The diagnosis of BPPV is confirmed by the Dix-Hallpike test for PC-BPPV and the supine roll test for LC-BPPV. To date, the most effective therapy for BPPV is repositioning of the otoliths within the semicircular canal using the Epley maneuver for PC-BPPV and the Lempert maneuver for LC-BPPV. In general, the prognosis for BPPV is favorable; however, recurrences and persistent symptoms may occur, particularly in the presence of comorbidities. Clinicians are expected to increase awareness of BPPV as the most frequent cause of vertigo, establish an accurate diagnosis using appropriate maneuvers, and provide early canalith repositioning management to prevent complications and improve patients' quality of life. Further research is needed to explore risk factors for recurrence and to evaluate the effectiveness of vestibular rehabilitation therapy in managing residual symptoms following repositioning maneuvers.

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