Vertigo, the illusion of movement of oneself or one’s surroundings in the absence of actual movement, is a common symptom in older adults and, as such, is commonly regarded as an age-related normal or part of the aging process itself, as its incidence increases with age. In neurology and otorhinolaryngology, benign paroxysmal positional vertigo (BPPV) is the most common cause of vertigo. BPPV is a brief, recurrent episode of vertigo caused by changes in head position relative to the direction of gravity. The symptoms of peripheral vestibular disease are vertigo and characteristic nystagmus. The prevalence of undiagnosed BPPV is high due to the fact that many elderlies tolerate vertigo symptoms. According to etiology, it can be subdivided into idiopathic BPPV and secondary BPPV, and according to location, it can be subdivided into posterior semicircular canal BPPV, horizontal semicircular canal BPPV, and anterior semicircular canal BPPV.

Keywords: Benign Paroxysmal Positional Vertigo; Semicircular Canal; Neuronal Injury; Elderly; Degeneration

Epidemiology
Vertigo is the perception of movement of oneself or one’s surroundings in the absence of actual movement. Bárány first described positional vertigo in 1921, defining it as the sensation of rotation caused by changes in head position relative to gravity. Nevertheless, BPPV was proposed in 1952 by Dix and Hallpike and is the most common cause of vertigo in the elderly, with a cumulative lifetime incidence of 10% in the general population (1). Vertigo is a common and debilitating condition among the elderly. Approximately 30% of individuals over the age of 60 and nearly 50% of individuals over the age of 85 suffer from vertigo (2). Vertigo is a significant risk factor for falls in older adults and a remarkable cause of disability in those over 65 (3, 4).

Approximately 5.6 million outpatients in the United States visit a doctor annually with vertigo as the primary complaint, and 17% to 42% of the vertigo patients are eventually diagnosed with BPPV (5). Nearly one-third of 4,294 patients with vertigo from 13 countries and 28-month data were diagnosed with BPPV in a large study (6). The prevalence of undiagnosed
BPPV in the elderly is also quite high.

**Pathogenesis**

BPPV is believed to be caused by the discharge of particulate matter into the semicircular canals (possibly due to debris from ear cone cells). Two fundamental theories can explain the pathophysiology of BPPV: canal calculi and cap calculi (7). The term canalolithiasis refers to the shedding of otolith particles from utricular cysts into the lumen of the semicircular canal. When the position of the head changes relative to the direction of gravity, the otolith particles are displaced relative to the wall of the semicircular canal, resulting in endolymph flow. This causes a displacement of the ampullary crest’s crest cap, resulting in vertigo. Cupulolithiasis refers to the otolith particles on the utricular cysts that fall off and adhere to the crest cap of the ampulla ridge, resulting in changes in the density of the crest cap relative to the endolymph, rendering it sensitive to gravity and causing repeated attacks of transient dizziness (8). In both hypotheses, the initial causative factor is an ear deformity disorder. Ear cone cells are composed of organic and calcium carbonate components. Detachment and fragmentation of cell membranes increases the likelihood of BPPV (9). Other age-related factors that cause alterations in endolymphatic pH or calcium concentration may aggravate these processes (10).

The posterior semicircular canal is the most common site of BPPV (88.4%), followed by the horizontal semicircular canal (6.4%) and the anterior semicircular canal (5.2%). Because the semicircular canals are at the highest point of the labyrinth, they are rarely involved.

**Cause**

BPPV can be broken down into two types: idiopathic BPPV, which is caused by auricular cone detachment for no known reason, and secondary BPPV, which is caused by auricular cone detachment for other reasons. Most people with BPPV had idiopathic BPPV, which means they did not know what caused it (61.9%), and only a few had a specific cause found (11). According to different diagnostic criteria and differences in the patients studied, the most common causes were vestibular/peripheral vertigo (5.4%-42.1%), benign peripheral positional vertigo (4.3%-39.5%), vestibular neuritis (0.6%-42.1%) 24.0%), Meniere’s disease (1.4%-2.7%), cardiovasculars disease (3.8%-56.8%), neurological disease (1.4%-11.4%), and psychogenic vertigo (1.8%-21.6%) (12). People in their later years often have many different diseases and health problems. BPPV can be caused by many diseases, which can lower the quality of life. Some neurological diseases, like tinnitus, hearing loss, and vestibular dysfunction, are often linked to feeling dizzy and having trouble keeping your balance.

Common disorders of the aged, such as hypertension and diabetes, are linked to progressive hearing loss and even sudden-onset sensorineural hearing loss (SSNHL) (13). The connections between diabetes, osteoarthritis, osteoporosis, depression, and BPPV recurrence were evaluated using data from 1,092 BPPV patients at 11 centers in seven countries. 19.8% of patients with BPPV had at least one comorbidity, while 37.4% of patients had two or more comorbidities (14).

The incidence of BPPV was higher in individuals with type 2 diabetes (46%) than in patients with non-metabolic disease (37%), according to a study of 3,933 patients (15). In a multivariate analysis, blood lipids were found to be a risk factor for BPPV, and they hypothesized that the effect of hyperlipidemia on vascular endothelial function may be strongly associated with small dense low-density lipoprotein (sdLDL) (16), and impairment to the inner ear’s vascular endothelial function will result in ischemia of the inner ear, making it simple for otoliths to dislodge and contributing to the development of BPPV (17). Recent research has demonstrated that osteoporosis is one of the risk factors for BPPV, presumably because BPPV is related with an aberrant calcium metabolism (18).

According to a meta-analysis, female gender, hypertension, diabetes, hyperlipidemia, osteoporosis, and vitamin D deficiency were risk factors for BPPV recurrence (19). Furthermore, sleep quality is an independent risk factor for recurrent BPPV (20, 21).

**Diagnosis**

Practical guidelines for the diagnosis and treatment of BPPV was developed that can be used to diagnose and treat BPPV in older patients (22, 23). Patients with vertigo should have a thorough medical history reviewed before receiving a diagnosis. Following a thorough record-keeping of the physical examination and neurological examination, the symptoms and course of the disease, prior surgical history, infection or trauma history, and medication use should all be considered. At this point, the examiner ought to be able to identify the disease’s most likely etiology or at the very least be able to distinguish between peripheral and central vertigo. The Dix-Hallpike test is the gold standard for determining BPPV in the posterior semicircular canal. The patient’s head is 45° below horizontal and the affected ear is 45° rotated when they quickly transition from a sitting to a sleeping posture. The test result was positive if with nystagmus. When the supraocular pole on a Dix-Hallpike examination exhibits vertical torsional nystagmus, anterior semicircular canal BPPV can be detected (the vertical component goes to the inferior pole of the eyeball and the torsional component goes to the ground). Shaking the head while being examined may increase the effectiveness of the Dix-Hallpike test in terms of diagnosis.

The lateral recumbency test is an alternative diagnostic test that involves the following steps (24): place the patient in a starting neutral position, turn the patient’s head rapidly to the right, check for characteristic nystagmus, return the head to a face-up position, and allow the nystagmus all subsided, then a quick turn to the left to check for nystagmus again, which can be used in patients who cannot use the Dix-Holpke method, but is much less sensitive.

Bilateral roll test can diagnose horizontal semicircular canal BPPV and can be judged as horizontal semicircular canalolithiasis and cap lithiasis according to the duration of nystagmus (25). Specific steps: The patient is in a supine position, the head is raised about 30° above the horizontal plane, the head is quickly turned to one side by 90° and the head angle is kept unchanged for 1 min, the patient’s vertigo and nystagmus are recorded, and then the head is turned back. In the middle position, the head angle remained unchanged for 1 min, and then the head...
was quickly turned 90° to the other side, and the head angle was also kept unchanged for 1 min, and the patient's vertigo and nystagmus were recorded again. In cases where postural examination is not possible due to mobility impairment or other reasons, there may be diagnostic and therapeutic issues, and serum middle ear canal protein can be detected in patients. A new method for BPPV detection is proposed, but further research is needed to confirm this reliability of the method.

For patients with a positive history of BPPV and indeterminate postural tests, or for patients with atypical neurological signs and manifestations of BPPV, such as visual impairment, severe headache, or cranial nerve abnormalities, CT or MRI examinations can also be used for preliminary investigation. Many central and peripheral diseases can produce orthostatic nystagmus, which should be differentiated from BPPV. The most common central nervous system diseases that cause orthostatic vertigo include vertebrobasilar ischemia, which are mainly descending nystagmus, vertigo and vomiting (26). When orthostatic vertigo is suggested, but BPPV testing is negative, other etiologies, such as medical factors, should also be considered, including anticonvulsants, antidepressants, anxiolytics, sedatives, hypnotics, strong analgesics, and antiarrhythmics.

Cervical vertigo refers to a delusional movement caused by cervical degenerative disease and vertebral artery compression (27). Its clinical manifestations are similar to BPPV, but its important distinguishing point is persistent vertigo or nystagmus with neck the following body rotates. Intracranial disease can also cause positional vertigo, which is characterized by prolonged vertigo symptoms, sensorineural hearing loss, postural nystagmus that is less fatigued, and ineffectiveness to reduction maneuvers (28).

Treatments
Medical Treatment
Currently routinely used drugs for the treatment of BPPV include vestibular depressants, such as antihistamines, benzodiazepines or anticholinergics, as well as anti-anxiety and antiemetic drugs, but according to the currently published guidelines (22, 23), currently not pharmacological intervention is recommended. However, in patients with severe clinical symptoms, pharmacological intervention may have a short-term rapid control of autonomic symptoms such as nausea or vomiting. Medical therapy may be an alternative treatment in some patients who refuse to perform a positioning procedure due to excessive dizziness, nausea, or anxiety, or when manual reduction is not possible for physical reasons. In the case of drug therapy, physicians should remind patients that adverse drug reactions include falls, urinary retention, and confusion probably happened. Therefore, in the absence of severe vertigo, drug therapy should not be the first-line treatment option for BPPV in older adults. However, betahistine combined with lidocaine has a significant clinical effect on patients with residual dizziness after successful BPPV through canalith repositioning procedure (CRP), which can further improve the prognosis of patients (29).

Reset Therapy
Since the 1980s, manual reduction therapy for BPPV has achieved long-term and effective development. The BPPV maneuver disperses semicircular canal fragments into the cysts, and the altered gravitational sensitivity during head movement no longer affects the vestibulo-ocular reflex. Brandt-Daroff proposed the first reduction method to effectively treat BPPV (30). However, the main advance in the treatment of BPPV was CRP proposed by Epley in 1992 based on the mechanism of duct stones (31). The effectiveness of CRP is widely recognized, and on the basis of a systematic review of all relevant randomized controlled trials, Epley manipulation was reported to be very effective in the treatment of posterior semicircular canal BPPV without any complications.

In a study of 965 patients with BPPV, CRP provided long-term remission of BPPV with an 85% response rate in the first course of treatment (32). The modified Epley method or the modified Semont method can be used for the treatment of BPPV in the posterior semicircular canal. The modified Epley method is to change the position of the head through a certain sequence and sufficient movement, remove the otolith in the posterior semicircular canal, and reset it to the utricle. Specific steps: (i) The patient takes a sitting position on the treatment bed and rotates the head 45° to the affected side; (ii) Quickly lie on the pillow placed on the shoulder, straighten the neck, and place the head on the bed. Keep the side ear facing down for more than 30 sec and observe until the nystagmus disappears; (iii) Maintain the flexion of the head and neck without turning the trunk, turn the head 90° to the healthy side, and hold for about 30 sec; (iv) Turn the head Rotate the body and the trunk to the unaffected side by 90°, lie on the side on the treatment bed, and maintain it for about 30 sec; (v) Keep the head position, slowly sit up with the help of the nursing staff, turn the head back, and lean forward 20°.

The modified Semont’s rule is to move the otolith from the lowest deposition point to the semicircular canal and return to the utricle along it through the inertial action through rapid and large overall movement of the head and limbs to achieve the reset of the otolith (33). Specific steps: (i) The patient takes a sitting position on the treatment bed first, and rotates the head 45° to the unaffected side; (ii) Quickly lies on the side of the affected side, and the area behind the ear touches the bed surface for about 30 sec; (iii) Maintains with the head tilted to the side, sit up with the head and the trunk as a whole, and quickly lie on the side to the unaffected side, so that the forehead of the unaffected side touches the bed surface for about 30 sec; (iv) Then sit up and return to the initial position.

At present, there are two types of horizontal semicircular canal BPPV, one is geotropic nystagmus and the other is dorsal nystagmus. Manipulative repositioning methods for geotropic nystagmus include barbecue roll maneuver (BRM) (34), Vanucchi’s forced long-term position method (35), and Gufoni’s method (36). Manual repositioning methods for dorsal nystagmus include Appiani maneuver (37) and head-shaking maneuver (38). There are various reduction methods for the treatment of anterior semicircular canal BPPV, including reverse Epley maneuver (39), Kim maneuver (40), Rahko maneuver (41) and Yacovino maneuver (42). Studies have reported that Yacovino method for the treatment of anterior semicircular canal BPPV has a recovery rate of 60.0% for the first manual reduction, and a recovery rate of 75.0% in one week (25). However,
because the recurrence rate is significantly higher in the elderly, studies have shown that vitamin D and calcium supplementation can significantly reduce the recurrence rate of BPPV (43), and corresponding education should be carried out to reduce its potential incidence of falls.

Operation Treatment
With the understanding of the pathophysiology of BPPV and the improvement of the reduction operation, the surgical treatment of BPPV is getting less. Of the more than 5,000 people treated at the Balance Center, less than 1% needed to consider surgery, the report noted (44). Surgical treatment of refractory BPPV includes posterior semicircular canal occlusion and simple nerve resection (45). Because surgical complications include sensorineural or conductive hearing loss and vertigo, surgery is not recommended as a priority in patients with BPPV.

Conclusion
BPPV is the most common cause of vertigo in the elderly, and the incidence of BPPV increases with age, mostly idiopathic BPPV. Posterior semicircular canal BPPV is the most common type, usually with paroxysmal vertigo, which is associated with rapid changes in head position, usually lasts from a few seconds to 1 min, and is often accompanied by nausea, but lasts longer than vertigo. many. Dix-Hallpike test is the gold standard for the diagnosis of posterior semicircular canal BPPV. If there is vertical dip and torsional nystagmus, it can be diagnosed as anterior semicircular canal BPPV. The diagnosis of horizontal semicircular canal BPPV requires bilateral roll test. The patient’s medical history should be combined with the identification of central and peripheral diseases that can produce orthostatic nystagmus. With the understanding of the pathophysiology of BPPV and the development of reduction therapy, drug therapy is not recommended for BPPV first, but for patients with severe clinical symptoms, symptoms can be quickly controlled, and surgical treatment of BPPV is becoming less and less common. The effectiveness of reduction therapy has been widely recognized, but the recurrence rate after reduction is high, so reducing the recurrence rate after reduction is the goal of future efforts.

References
1. Dix MR, Hallpike CS. The pathology symptomatology and diagnosis of certain common disorders of the vestibular system. Proc R Soc Med 1952; 45:341-354. DOI: https://doi.org/10.1177/003591575204500604
2. Balatsouras DG, Koukoutsis G, Fassolias A, Moukos A, Apris A. Benign paroxysmal positional vertigo in the elderly: Current insights. Clin Interv Aging 2018; 13:2251-2266. DOI: https://doi.org/10.2147/CIA.S144134
3. Casani AP, Gufoni M, Capobianco S. Current insights into treating vertigo in older adults. Drugs Aging 2021; 38(8):655-670. DOI: https://doi.org/10.1007/s40266-021-00877-z
4. Hawke LJ, Barr CJ, McLoughlin JV. The frequency and impact of undiagnosed benign paroxysmal positional vertigo in outpatients with high falls risk. Age Ageing 2021; 50(6):2025-2030. DOI: https://doi.org/10.1093/ageing/afab122
5. von Brevern M, Radtke A, Lezius F, Feldmann M, Ziese T, Lempert T, Neuhauser H. Epidemiology of benign paroxysmal positional vertigo: A population based study. J Neurol Neurosurg Psychiatry 2007; 78(7):710-715. doi: DOI: https://doi.org/10.1136/jnnp.2006.100420
6. Chen J, Zhang S, Cui K, Liu C. Risk factors for benign paroxysmal positional vertigo recurrence: A systematic review and meta-analysis. J Neurol 2021; 268(11):4117-4127. DOI: https://doi.org/10.1007/s00415-020-10175-0
7. Palmeri R, Kumar A. Benign Paroxysmal Positional Vertigo. [Updated 2022 Jan 3]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. Available at: https://www.ncbi.nlm.nih.gov/books/NBK470308/
8. Lundberg YW, Xu Y, Thiessen KD, Kramer KL. Mechanisms of otoconia and otolith development. Dev Dyn 2015; 244(3):239-253. DOI: https://doi.org/10.1002/dvdy.24195
9. Sfakianaki I, Binos P, Karkos P, Dimas GG, Psillas G. Risk factors for recurrence of benign paroxysmal positional vertigo. A clinical review. J Clin Med 2021; 10(19):4372. DOI: https://doi.org/10.3390/jcm10194372
10. Guerra J, Devesa J. Causes and treatment of idiopathic benign paroxysmal positional vertigo based on endocrinological and other metabolic factors. J Otol 2020; 15(4):155-160. DOI: https://doi.org/10.1016/j.joto.2020.04.001
11. Yetiser S, Ince D. Demographic analysis of benign paroxysmal positional vertigo as a common public health problem. Ann Med Health Sci Res 2015; 5(1):50-53. DOI: https://doi.org/10.4103/2141-9248.149788
12. Baumgartner B, Taylor RS. Peripheral Vertigo. [Updated 2022 Jun 27]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. Available at: https://www.ncbi.nlm.nih.gov/books/NBK430797/
13. Meneses-Barrioviera CL, Bazoni JA, Doi MY, Marchiori LLM. Probable association of hearing loss, hypertension and diabetes mellitus in the elderly. Int Arch Otorhinolaryngol 2018; 22(4):337-341. DOI: https://doi.org/10.1055/s-0037-1606644
14. De Stefano A, Dispenza F, Suarez H, Pe-
rez-Fernandez N, Manrique-Huarte R, Ban JH, Kim MB, Strupp M, Feil K, Oliveira CA, Sampaio AL, Araujo MF, Bahmad F Jr, Ganança MM, Ganança FF, Dorigueto R, Lee H, Kulamarva G, Mathur N, Di Giovanni P, Petrucci AG, Stanisica T, Citraro L, Croce A. A multicenter observational study on the role of comorbidities in the recurrent episodes of benign paroxysmal positional vertigo. Auris Nasus Larynx 2014; 41(1):31-36. DOI: https://doi.org/10.1016/j.anl.2013.07.007. Erratum in: Auris Nasus Larynx 2014; 41(3):325. Kim, Min Beom [corrected to Kim, Min-Beom].

15. D’Silva LJ, Staehler H, Lin J, Sykes KJ, Phadnis MA, McMahon TM, Connolly D, Sabus CH, Whitney SL, Kluding PM. Retrospective data suggests that the higher prevalence of benign paroxysmal positional vertigo in individuals with type 2 diabetes is mediated by hypertension. J Vestib Res 2016; 25(5-6):233-239. DOI: https://doi.org/10.3233/VES-150563

16. Ariyanti R, Bresar B. Dyslipidemia associated with hypertension increases the risks for coronary heart disease: A case-control study in Harapan Kita Hospital, National Cardiovascular Center, Jakarta. J Lipids 2019; 2019:2517013. DOI: https://doi.org/10.1155/2019/2517013

17. Riga M, Bibas A, Xenellis J, Korres S. Inner ear disease and benign paroxysmal positional vertigo: A critical review of incidence, clinical characteristics, and management. Int J Otolaryngol 2011; 2011:709469. DOI: https://doi.org/10.1155/2011/709469

18. Kitahara T, Ito A, Horinaka A, Yohama H, Sakagami M, Ito T, Shiozaki T, Wada Y, Yamanaka T. Idiopathic benign paroxysmal positional vertigo with persistent vertigo/dizziness sensation is associated with latent canal paresis, endolymphatic hydrops, and osteopetrosis. Auris Nasus Larynx 2019; 46(1):27-33. DOI: https://doi.org/10.1016/j.anl.2018.05.010

19. Li S, Wang Z, Liu Y, Cao J, Zheng H, Jing Y, Han L, Ma X, Xia R, Yu L. Risk factors for the recurrence of benign paroxysmal positional vertigo: A systematic review and meta-analysis. Ear Nose Throat J 2022; 101(3):NP112-NP134. DOI: https://doi.org/10.1177/01455998173094362

20. Wang Y, Xia F, Wang W, Hu W. Assessment of sleep quality in benign paroxysmal positional vertigo recurrence. Int J Neurosci 2018; 128(12):1143-1149. DOI: https://doi.org/10.1080/00207454.2018.1486835

21. Iranfar K, Azad S. Relationship between benign paroxysmal positional vertigo (BPPV) and sleep quality. Heliyon 2022; 8(1):e08717. DOI: https://doi.org/10.1016/j.heliyon.2022.e08717

22. Bhattacharyya N, Gubbels SP, Schwartz SR, Edlow JA, El-Kashlan H, Fife T, Holmberg JM, Mahoney K, Hollingsworth DB, Roberts R, Seidman MD, Steiner RW, Do BT, Voelker CC, Waguespack RW, Corrigan MD. Clinical Practice Guideline: Benign Paroxysmal Positional Vertigo (Update). Otolaryngol Head Neck Surg 2017; 156(3 suppl)-S1-S47. DOI: https://doi.org/10.1177/194599816689667

23. Pérez-Vázquez P, Franco-Gutiérrez V, Soto-Varela A, Amor-Dorado JC, Martín-Sanz E, Oliva-Domínguez M, Lopez-Escamazar JA. Practice guidelines for the diagnosis and management of benign paroxysmal positional vertigo Otorhinolaryngology Committee of Spanish Otorhinolaryngology and Head and Neck Surgery Consensus Document. Acta Otorrinolaringol Esp (Engl Ed) 2018; 69(6):345-366. English, Spanish. DOI: https://doi.org/10.1016/j.otorri.2017.05.001

24. Edlow JA, Kerber K. Benign paroxysmal positional vertigo: A practical approach for emergency physicians. Acad Emerg Med 2022; in press. DOI: https://doi.org/10.1111/acem.14558

25. Bhandari A, Bhandari R, Kingma H, Strupp M. 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. Front Neurol 2022; 13:881156. DOI: https://doi.org/10.3389/fneur.2022.881156

26. Claassen DO, Adler CH, Hewitt LA, Gibbons C. Characterization of the symptoms of neurogenic orothostatic hypotension and their impact from a survey of patients and caregivers. BMC Neurol 2018; 18(1):125. DOI: https://doi.org/10.1186/s12883-018-1129-x

27. Kadanka Z Jr, Kadanka Z Sr, Jura R, Bednarik J. Vertigo in patients with degenerative cervical myelopathy. J Clin Med 2021; 10(11):2496. DOI: https://doi.org/10.3390/jcm10112496

28. Dunnaway HM, Welling DB. Intracranial tumors mimicking benign paroxysmal positional vertigo. Otolaryngol Head Neck Surg 1998; 118(4):429-436. DOI: https://doi.org/10.1177/0194599898118004004

29. İnan HC, Kiracı M. An Evaluation of the effects of betahistine and dimenhydrinate on posterior canal benign paroxysmal positional vertigo. Turk Arch Otorhinolaryngol 2019; 57(4):191-196. DOI: https://doi.org/10.5152/tao.2019.4185

30. Pérez-Vázquez P, Franco-Gutiérrez V. Treatment of benign paroxysmal positional vertigo. A clinical review. J Otol 2017; 12(4):165-173. DOI: https://doi.org/10.1016/j.joto.2017.08.004

31. Epley JM. The canalith repositioning procedure: For treatment of benign paroxysmal positional vertigo. Otolaryngol Head Neck Surg 1992;107(3):399-404. DOI: https://doi.org/10.1177/019459989210700310

32. Prokopakis E, Vlastos IM, Tsagournisakis M, Chris-todoulou P, Kawauchi H, Velegakis G. Canalith repositioning procedures among 965 patients with benign paroxysmal positional vertigo. Audiol Neurootol 2013; 18(2):83-90. DOI: https://doi.org/10.1159/000343579

33. Chen Y, Zhuang J, Zhang L, Li Y, Jin Z, Zhao Z, Zhao Y, Zhou H. Short-term efficacy of Semont maneuver for benign paroxysmal positional vertigo: a double-blind randomized trial. Otol Neurotol 2012; 33(7):1127-1130. DOI: https://doi.org/10.1097/MAO.0b013e31826352ca

34. Escher A, Ruffieux C, Maire R. Efficacy of the barbiturate manoeuvre in benign paroxysmal vertigo of the horizontal canal. Eur Arch Otorhinolaryngol 2007; 264(10):1239-1241. DOI:
35. Mandalà M, Califano L, Casani AP, Faralli M, Marcelli V, Neri G, Pecci R, Scasso F, Scotto di Santillo L, Vannucchi P, Giannoni B, Dasgupta S, Bindi I, Salemi L, Nuti D. Double-blind randomized trial on the efficacy of the forced prolonged position for treatment of lateral canal benign paroxysmal positional vertigo. Laryngoscope 2021; 131(4):E1296-E1300. DOI: https://doi.org/10.1002/lary.28981

36. Shi T, Yu L, Yang Y, Wang Y, Shao Y, Wang M, Geng Y, Shi Z, Yin X. The effective clinical outcomes of the Gufoni maneuver used to treat 91 vertigo patients with apogeotropic direction-changing positional nystagmus (apo-DCPN). Medicine (Baltimore) 2018; 97(39):e12363. DOI: https://doi.org/10.1097/MD.0000000000012363

37. Lee DH, Park JY, Kim TH, Shin JE, Kim CH. New therapeutic maneuver for horizontal semicircular canal cupulolithiasis: A prospective randomized trial. J Clin Med 2022; 11:4136. DOI: https://doi.org/10.3390/jcm11144136

38. Bulğurcu S, Baz E, Güleryüz S, Erkul E, Çekin E. Effect of applying head-shaking maneuver before Epley maneuver in BPPV. Braz J Otorhinolaryngol 2021; 2021:S1808-8694(21)00013-6. DOI: https://doi.org/10.1016/j.bjorl.2020.12.015

39. Korres S, Rigas M, Sandris V, Danielides V, Sismanis A. Canalithiasis of the anterior semicircular canal (ASC): Treatment options based on the possible underlying pathogenetic mechanisms. Int J Audiol 2010; 49(8):606-612. DOI: https://doi.org/10.3109/1499201003753490

40. GOT VERTIGO™ Dr. Bell wants to help you get your life back! Last access: October 19, 2022. Available at: https://www.betterbalanceinlife.com/

41. Rahko T. The test and treatment methods of benign paroxysmal positional vertigo and an addition to the management of vertigo due to the superior vestibular canal (BPPV-SC). Clin Otolaryngol Allied Sci 2002; 27(5):392-395. DOI: https://doi.org/10.1046/j.1365-2273.2002.00602.x

42. Yacovino D, Hain T, Gualtieri F. New therapeutic maneuver for anterior canal benign paroxysmal positional vertigo. J Neurol 2009; 256:1851-1855. DOI: https://doi.org/10.1007/s00415-009-5208-1

43. Abdelmaksoud AA, Fahim DFM, Bazeed SES, Alemam MF, Aref ZF. Relation between vitamin D deficiency and benign paroxysmal positional vertigo. Sci Rep 2021; 11(1):16855. DOI: https://doi.org/10.1038/s41598-021-96445-x

44. Agrawal Y, Ward BK, Minor LB. Vestibular dysfunction: prevalence, impact and need for targeted treatment. J Vestib Res 2013; 23(3):113-117. DOI: https://doi.org/10.3233/VES-130498

45. Corvera Behar G, García de la Cruz MA. Surgical treatment for recurrent benign paroxysmal positional vertigo. Int Arch Otorhinolaryngol 2017; 21(2):191-194. DOI: https://doi.org/10.1055/s-0037-1599784

https://doi.org/10.1007/s00405-007-0337-6

Received: July 19, 2022 | Revised: August 18, 2022 | Accepted: August 27, 2022