Annals of Pharmacology and Pharmaceutics

Research Article
Published: 01 Mar, 2017

Importance of Accurate Diagnosis in Benign Paroxysmal Positional Vertigo with Videonstagmography and the Success Rate of the Maneuvers

*Eryaman Esra**

Private Mecidiyekoy Cevre Hospital, Turkey

Abstract

Objectives: The analysis of benign paroxysmal positional vertigo (BPPV) with videonistamography (VNG) is few.

Aim: My aim is to discuss the place of VNG in the accurate diagnosis and treatment of BPPV.

Subjects and Methods: A total of 124 patients diagnosed as BPPV were included in the study (2013-16). Visual images during diagnostic maneuvers were recorded and analyzed by VNG. The European Evaluation of vertigo scale (EEV) was administered before and after the treatment. The R Project for Statistical Computing was used for statistical analyses.

Results: The posterior canals (PC) were involved in 59.7%, the lateral canals (LC) in 26.6% and the anterior canals (AC) in 13.7%. 18.5% were cupulolithiasis, 72.6% were canalithiasis. Among the canalithiasis patients; 64.9% of PCs, 77.8% of the LCs, 93.3% of the ACs were rehabilitated with 1 maneuver, 35% of the PCs, 22.2% of the LCs, 6.7% of the ACs more than 1. Among the cupulolithiasis patients; 100% of the PCs, 81.8% of the LCs, 100% of the ACs were rehabilitated with 1 maneuver, 18.2% of the LCs more than 1 maneuver. The p values of EEV before and after treatment for PCs, LCs and ACs and in total were found meaningful as 2/(10^43) (<0.05), 1.006 / (10^22) (< 0.05) , 1.597/(10^12) (<0.05) and 2.756/(10^75) (< 0.05) .

Conclusion: With VNG we can easily differentiate the nystagmus and the positions of the debris in the exact canal and side. This gives accurate diagnosis and therapy with high success rate.

Keywords: Benign paroxysmal positional vertigo; Vertigo; Videonistagmography; Videofrenzel; Canalithiasis; Cupulolithiasis

OPEN ACCESS

Correspondence:
Eryaman Esra, Ozel Mecidiyekoy Cevre Hastanesi, Cemal Sair sok, No 2, Mecidiyekoy, Istanbul, Turkey, E-mail: esraer@superonline.com

Received Date: *10 Oct 2016*
Accepted Date*: 27 Feb 2017*
Published Date*: 01 Mar 2017*

Citation:
Esra E. Importance of Accurate Diagnosis in Benign Paroxysmal Positional Vertigo with Videonstagmography and the Success Rate of the Maneuvers. Ann Pharmacol Pharm. 2017; 2(4): 1039.

Introduction

Benign paroxysmal positional vertigo (BPPV) is the most common peripheral vestibular disorder, with female and elder (5th and 6th) preponderance [1]. It has a recurring nature with variable periods of remissions. BPPV is first described by Barany, evaluated later in 1952 by Dix and Hallpike, followed by Schnecht and Epley [2-5].

Canalithiasis and cupulolithiasis are the two main theories accepted. Epley has described canalithiasis as the freely floating otoconias in the canals [6]. These otoconias induce endolymphatic flow and cupular deflection by forming aggregated clots due to gravity [1]. This process is seen as latent time followed by vertigo. Then in a period of less than 1 minute, these clots stabilize in a place in the canal, thereby ending vertigo [7,8]. In cupulolithiasis these particles adhere to cupula, making it highly sensitive to gravity. Vertigo starts immediately with the movement and it doesn't get tired as long as the movement continues [7,8].

The most frequent form is posterior canal (PC) BPPV (80% of observed cases), followed by both geotropic and ageotropic lateral canal (LC) BPPV (15%), anterior canal (AC) BPPV [9]. There are some maneuvers for accurate diagnosis of BPPV and all the visual images may be recorded by videonystagmography (VNG) during this period. Dix Hallpike is a gold standard for posterior and anterior canals, however it is not 100% sensitive specially for the silent phases [1]. Supine roll (Pagnini-McClure test) for the lateral canals is mandatory [10]. There are various treatment maneuvers. However some basic ones are used the most. Among the canalith repositioning procedures (CRP), Epley and Barbecue are the widely accepted ones [11,12]. Semont liberation

maneuver removes the particles on the cupula with the speed of the movement and prevents them from falling back [13]. Brandt-Daroff exercises dislocate the debris in a place where the symptoms are not triggered anymore [14,15].

Materials and Methods

A retrospective nonrandomized study was designed and the informed consents were obtained from the patients and the results were discussed. A total of 124 patients ,40 male and 84 female (32.2% male, 67.7% female) diagnosed as BPPV, aged 22 to 92 (mean age 53.1± 7.6) were included in the study between April 2013 and June 2016. Detailed medical history was obtained and all the patients underwent regular ear nose and throat examination and videonystagmography (VNG). Visual images during Dix- Hallpike and supine roll tests were recorded. Distribution of gender, age and affected side was reviewed. Patients were analyzed according to the canal involvement, age, duration of symptoms, duration of nystagmus before and after treatment and recurrence.

VNG (VF405 Fire wire Video Frenzel System from Interacoustics, DK-5610 Assens , Denmark) provided observation and recording of eye movements during user defined all the balance tests. The VF 405 software module was operated from the "Otoacces tm" patient database. It contained external camera in the goggle for recording the video images [16].

The European Evaluation of vertigo scale (EEV) was administered to all the patients before and after the treatment maneuvers and the results were discussed [17].

Dix Hallpike test was used to observe the anterior and posterior canals. In Dix Hallpike, the up-beating, ipsi-tortional, rotational nystagmus with latency and habituation lasting less than 1 minute and with or without reversal in sitting position showed us PC-canalithiasis. The down-beat rotational niystagmus version with the same features showed AC-canalithiasis. Among the CRP maneuvers, Epley maneuver started with a supine Dix Hallpike position with the affected ear undermost. The head was rolled to the unaffected side, waiting a little and turning to side-lying position with the head turned 45 degrees toward the floor. Then, the patient was brought to sitting position. Ipsilateral Epley was performed for the ipsilateral PC-canalithiasis, reverse (contralateral side) Epley for the AC-canalithiasis. In cases of no habituation and no latency period and lasting longer than 1 minute, the PC or AC cupulolithiasis was diagnosed. Semont liberation maneuver was performed with these cases. The patient was seated in upright position, then the head was turned to 45 degrees toward the unaffected side and rapidly thrown to the side-lying position, waiting 1-3 minutes, then to the affected side rapidly thrown again in side-lying position waiting there 1-3 minutes [13,16]. After these procedures, minimization of the physical activities, sleeping with head 45 degrees high, heads not hyper extended, not side -lying on the affected side for 2 days were recommended [18].

Lateral canals were observed with supine roll test [10]. In this test, the head was inclined 30 degrees forward with the body in supine position and then the head was turned to either side. Nystagmus that is ageotropic (about 25%) was considered as cupulolithiasis, that is geotropic (about 75%) was considered as canalithiasis [10]. Barbecue maneuver was performed with geotrophicnystagmus. It may be described as side lying on the affected side waiting 30 sec, then rolling back the head 30 degrees forward on the pillow waiting 30 sec, then side lying on the unaffected side, then rolling onto the stomach over the elbows waiting 30 sec, then side lying again on the affected side 30 sec, then sitting. In ageotrophicnystagmus, opposite Barbecue was tried first. If it hadn't worked, then BrandtDaroff exercises were applied. Basically, starting in an upright, seated position then moving into the lying position on one side with the nose pointed up at about a 45-degree angle, remaining in this position for about 30 seconds (or until the vertigo subsides, whichever is longer), then moving back to the seated position and repeating this on the other side is the summary of this exercise. Multiple repetitions of these exercises at least twice a day was recommended [19].

In case of bilateral pathologies, the therapy was started from the side where the symptoms were dominant. Canalithiasis, cupulolithiasis, canalith jam could occur at the same time, whereby the therapy was designed due to the specialty of the most dominant nystagmus [19,20].

The R Project for Statistical Computing was used for multiple variance analysis of the data (Licensed under the GNU Free DocumentataionLicence, version 1.3 or later, Copyright Infringement Notification, Powered by Media Wiki and Semantic Media Wiki Source Code Java Script License information) was used for statistical analyses.

This study was approved by Bakırkoy Dr. Sadi Konuk Education and Research Hospital Institutional Review Board (project no 2015/146).

Results

Over 246 patients 124 (50.4%) were diagnosed as BPPV in OzelCevre Hospital, Istanbul, Turkey. 124 patients, the PC s were involved in 74 patients (59.7%), the LC s were involved in 33 patients (26.6%), and the AC s were involved in 17 patients (13.7%). Among them 18.5% (23 patients) were cupulololithisis, 72.6% (90 patients) were canalithiasis. Pluricanals and canal changing ones after the maneuvers were not included to the canalithiasis and cupulolithiasis differentiation.

42 of the PC patients (56.8%), 21 of the LC patients (63.6%), 12 of the AC patients (70.6%) were at the left side. Consequently; 32 of the PC patients (43.2%), 12 of the LC patients (36.4%), 5 of the AC patients (29.4%) were at the right side. A dominance of left side with 60.5% rate was elicited in all. The result was not found not to be meaningful with a p value = 0.47626 (<0.95) (or 0.5237 > 0.05) (chi-square test).

Among the PC- BPPV patients 57 (77%) were canalithiasis, 11 (14.9%) were cupulolithiasis. In 37 of the PC-canalithiasis patients, the disease was rehabilitated with 1 Epley maneuver (64.9%), in 20 patients more than 1 Epley maneuvre (35%) with minimum 2, maximum 4 maneuvers (a mean of 2.7). All of the 11 PC- cupulolithiasis patients were rehabilitated with 1 Semont maneuver (100%).4 (5.4%) of the PC-BPPV patients changed canals during and after the maneuver. It was not included in the pure canalithiasis or cupulolithiasais group.1 right PC- canalithiasis changed to ipsilateral AC- canalithiasis, 1 right PC-canalithiasis changed to ipsilateral AC - canalithiasis, 1 left PC-cupulolithiasis changed to ipsilateral PC-canalithiasis,1 left PC-canalithiasis changed to ipsilateral AC-canalithiasis. CRPs were reapplied due to the changes. There were 2 (2.7%) pluricanal PC – BPPVs. The one with right PC canalithiasis and left PC cuplulolithiasis at the same time was treated with Brand Daroff exercises, 14 days after the treatment right PC canalithiasis was observed and was

treated with right Epley maneuver. The other patient had left PC-canalithiasis and right PC- cupulolithiasis together and was cured with Semont maneuver. 7 (9.5%) of the PC-BPPVs, 6 of them being canalithiasis, 1 of them being cupulolithiasis recurred in a period of minimum 15 days , maximum 6 months with an average of 73.3 days . 2 head trauma , 7 vestibular neuritis, 1 vertebrobasilar insufficiency, 1 Meniere 's disease, 1 recurrent vestibulopathy, 1 previous cerebral hemorrhage (13/74)(17.6%) were recorded as patient history. The rest was accepted as idiopathic (61/74) (82.4%).The EEV was found as 8.6 in average (minimum value 7, maximum value 15) before the treatment and 2.1in average (minimum value 1, maximum value 6) after treatment. The result was meaningful with a p value = 2/(10^43) (<0.05) (paired sample T test).

Among the 33 LC BPPV patients 18 (54.5%) were canalithiasis, 11 (33.3%) were cupulolithiasis. In 14 of the LC-canalithiasis patients, the disease was rehabilitated with 1 Barbecue maneuver (77.8%), in 4 patients more than 1 Barbecue maneuver (22.2%) with minimum 2, maximum 3 (a mean of 2.3) maneuvers. Among the LC cupulolithiasis, 9 (81.8%) of them were rehabilitated with 1 maneuver, 2 (18.2%) of them with more than 1 maneuver (opposite Barbecue, Brand Daroff). 2 (6.1%) patients changed canals during the maneuvers. 1 left LC-canalithiasis turned to ipsilateral LC- cupulolithiasis and 1 right LC-canalithiasis turned to ipsilateral LC-cupulolithiasis. CRPs were reapplied due to the changes. There were 2 (6.1%) pluricanal LC-BPPV .The one with left LC canalithiasis and right PC canalithiasis together was treated with left barbecue. The one with bilateral LC canalithiasis showed right dominance and was treated accordingly.2 (6.1%)of the LC- BPPVs , 1 being cupulolithiasis, the other being canalithiasis recurred in a period minimum 10 days , maximum 1 month with an average of 20 days .1 vestibular neuritis, 1 vestibular hydrops, 1 cerebral infarct, 1 migraine were recorded as patient history (4/33) (12.1%).The rest was accepted as idiopathic (29/33) (87.9%). The EEV was found as 11.3 in average (minimum value 7, maximum value 15) before the treatment and 1.76 in average (minimum value 1, maximum value 5) after treatment. The result was meaningful with a p value = 1.006 / (10^22) (< 0.05) (paired sample T test).

Among the 17 AC-BPPV patients 15 (88.2%) were canalithiasis, 1 (5.9%) was cupulolithiasis. In 14 of the AC-canalithiasis patients, the disease was rehabilitated with 1 opposite side Epley maneuver (93.3%), in 1 patient more than 1 opposite side Epley maneuver (%6.7). 1 AC- cupulolithiasis was rehabilitated with the Semont maneuver (100%) .1 (5.9%) right AC-canalithiasis changed to right PC canalithiasis. CRP was reapplied due to the change. 2 (11.8%)of the AC- BPPVs being both of them canalithiasis recurred in a period minimum 15 days , maximum 5 months with an average of 82 days. 1 vertebrobasilar insufficiency and 1 anxiety using antidepressant medication, 1 vestibular neuritis were recorded as patient history (3/17)(17.6%).The rest was accepted as idiopathic (14/17)(82.4%). The EEV was found as 11.4 in average (minimum value 6, maximum value 14) before the treatment and 1.9 in average (minimum value 1, maximum value 4) after the treatment. The result was meaningful with a p value = 1.597/(10^12) (<0.05) (paired sample T test).

In total, the EEV value before the maneuvers were found to be 9.6, decreasing to 2.35 after the maneuvers. The result was meaningful with a p value = 2.756/(10^75) (< 0.05) **.**

Discussion

VNG (VF405 Fire wire Video Frenzel System from Interacoustics, DK-5610 Assens, Denmark) provides observation and recording of eye movements during user defined all the balance tests. The VF405 software module is operated from the "Otoacces tm" patient database. It contains external camera in the goggle for recording the video images. VNG is a precise method for the exact localization of the otoliths [20]. ENG and VNG has been compared in a study, and the results have been found similar, so VNG has been suggested as a valuable method for assessment and discrimination of peripheral and central lesions [21]. I think that VNG is also more practical and easier to assess the characteristics of nystagmus. It is a device much cheaper than ENG and easily installed. Frenzel goggles are important in magnifying and illuminating nystagmus. Once started; one gets used to discriminate the nystagmus. The direction of subtle vertical-beating nystagmus underlying the torsional component is critical in differentiating AC versus PC origin [22]. In this study; all the VNGs are performed by me. Since the patients are tested only by one specialist, the evaluation of the results has become stable and credible.

EEV is a questionnaire assessing the symptoms and allowing physicians to quantitatively evaluate vertigo. The effectiveness of the treatment is measured by EEV. Dizziness handicap inventory and activities balance confidence tests may be used also [17,20]. In our study, the average value of the EEVs before the maneuvers were found to be 9.6, decreasing to 2.35 with a meaningful p value of 2.756/(10^75) (< 0.05) **.**

Females were found to be affected more [23]. My study confirms this as 32.3% male, 67.8% female.

Yetiser has found an increasing incidence at middle age. It may be due to increased awareness of the disease with its maneuvers [23]. My study's mean age was found to be 53.1± 17.6, approving this study.

Right side has found to be affected more , maybe because the habit to sleep on the right side is more popular [23] .On the contrary , in my study I found a dominance of left side as 60.5% in total. However this value was not found to be meaningful statistically. ((0.47626 (<0.95) (or 0.5237 > 0.05)

Korres gave%90 as PC,%8 as LC, 2% as AC among the 122 cases of diagnosed BPPV [24]. According to Jackson, among 260 BPPV patients, AC was found in 21.2%, PC in 66.9%, and L C in 11.9%. Cupulolithiasis was observed in 27.3% of the AC, 6.3% of the PC, and 41.9% of the LC patients [22]. In my hospital, over 246 patients 124 (50.4%) were diagnosed as BPPV. PC s were involved in 74patients (59.7%), the LC s were involved in 33 patients (26.6%), and the ACs were involved in 17 (13.7%) patients. Among them 18.5% were cupulololithisis, 72.6% were canalithiasis.

BPPV is typically unilateral, although sometimes it may be bilateral. It may be for a short time or may continue a lifetime with mild, intermittent symptoms. Lopez – Escamez, showed 20% multiple positional nystagmus, 5 patients presented bilateral posterior canal BPPVs, 2 presented bilateral AC BPPVs. However, 7 individuals showed positional horizontal and vertical side-changing nystagmus that could not be explained by single-canal BPPV [25]. These patients with multiple positional nystagmus showed changing patterns of positional nystagmus at follow-up [25]. In my study; there were 2 (2.7%) pluricanal PC –BPPV s; Right PC canalithiasis and left PC cupulolithiasis together treated with Brand Daroff exercises ending up with right PC canalithiasis after the treatment and successfully fixed with right Epley maneuver. The other patient had left PC-canalithiasis and right PC- cupulolithiasais together cured with Semont maneuver.

There were 2(6.1%) pluricanal, left LC -canalithiasis and right PC -canalithiasis treated with left Barbecue maneuver and 1 bilateral LC –canalithiasis with right dominance. No pluricanal was observed with AC s. I think diagnosing the exact side and the canal by using VNG is important for the cure rate. In my study, the total pluricanal rate was found as 3.2%.

Primary or idiopathic BPPV is the most common seen (50-70%) origin [1]. Etiopathogenesis of secondary BPPV are given as head trauma, vestibular neuritis, Meniere's disease, otitis media, otosclerosis, inner ear surgery [1]. Either hydropic changes, either inflammatory response from viral attack, either diffusion of toxins into the endolymph through round window, either degenerative changes of otosclerosis in the utricule and either dislodgment of the otoliths following trauma may be the physiopathology of BPPV [1]. In people over 50 years old, it may be related to naturel age related degeneration of the otolithic membrane [18]. It may be associated with migraine and ototoxicity and viral diseases as well [18]. In my study, 17.6% of PC, 12.1% of the LC, 17.6% of the AC s and total 16.1% were accepted as secondary, with the most popular history as vestibular neuritis. 83.9% were defined as idiopathic.

Spontaneous resolution is not desirable. Symptoms may be dangerous during daily activities and may mask other otologic or neurologic diseases. However, even the treatment is successful; BPPV recurs in in one third of the patients after 1 year and in half of them after 5 years [18]. In my study, the recurrence rate was found to be 8.9% . The repositioning maneuvers performed first by Epley in 1992 have been later modified to many versions [26]. Parnes and Price-Jones has modified this to particle repositioning maneuver and the success rate has increased to 85-90% [27]. Semont and Lempert have described repositioning maneuvers [28,29].These repositioning maneuvers have been so successful, that canalithiasis has been the basic theory for a period of time. But recently cupulolithiasis is also termed among the pathophysiology of BPPV [30,31]. Semont has described in 1988 a liberation maneuver for cupulolithiasis [28]. According to Brandt, if BPPV is not treated properly, it may last months and months [32]. Generally BPPV is treated with canalith repositioning maneuvers at first [33].

Since most of them are PC, Epley maneuver gives success rate over 80% [18,33]. Karkos and friends have summarized the treatment as one or two Epley maneuvers as first step and Semont liberation as the final step in case of resistance. Brand Daroff exercises are recommended in failure of the maneuvers [34]. With canalith repositioning maneuvers, sometimes stroke may occur due to the compression of the vertebral arteries, the modification of the maneuvers is recommended in these cases [18]. Epley has stated that for the successful treatment of BPPV the true diagnosis of the 3 pathologies; canalithiasis, cupulolithiasis and canlolith jam should be clarified. He suggests repositioning for canalithiasis, liberation for cupulolithiasis [18,33]. In cases where traces of two pathologies are not found, central disinhibiting should be considered and habituation exercises are recommended. In my study, I treated my patients following this principle. In literature, Yetiser and Ince has seen in 33% of the BBPV patients required two or more maneuvers for the relief of symptoms [23]. In my study, in 34 of the PC- patients, the disease is rehabilitated with 1 Epley maneuver (65.4%), in 16 patients more than 1 Epley maneuver (30.8%) with an average of 2.7 maneuvers. All of the 11 PC- cupulolithiasis patients were rehabilitated with 1 Semont maneuver (100%).

Maneuvers for the LC may be Lempert, Gufoni and Vanucci maneuvers [9,29]. In my study, in 13 of the LC-canalithiasis patients, the disease was rehabilitated with 1 Barbecue maneuver (72.2%), in 3 patients more than 1 Barbecue maneuver (16.7%) with an average of 2.3 maneuvers . Among the LC cupulolithiasis 9 (81.8%) of them were rehabilitated with 1 maneuver, 2 (18.2%) of them more than 1 maneuver (opposite barbecue, Brand Daroff). The authors describe 5 cases of a rare form of LC BPPV, defined as "direction-fixed paroxysmal nystagmus LC BPPV". This may have previously been described as the transformation from an ageotropic into a geotropic form. It is characterized by typical BPPV symptoms and diagnosed by the presence of a nsytagmusageotropic on the affected side and geotropic on the healthy side. In the reported cases, this direction-fixed horizontal paroxysmal nystagmus was always seen to be transformed into a typical geotropic form [10]. In the geotropic form the debris free float in the posterior arm of the LC (canalithiasis). In the ageotropic form the debris free float in the anterior arm or attach to the cupula of the ampulla; if we observe transformation from the ageotropic into the geotropic form this suggests us a canalithiasis, otherwise we assume it as a cupulolithiasis [9]. Another atypical form called ageotropic PC BPPV is less frequent (5%).The term "ageotropic" meaning “contra" for the torsional component was first used by Vannuchi and colleagues. Debris in the PC might move towards the ampulla/cupula rather than away. Here, the nystagmus is strongest with the bad ear down, and the torsion is oppositely directed. This nystagmus pattern is very uncommon [9-11]. I have not seen any in my series.LC cupulolithiasis shows a lesser degree of utricular dysfunction compared with other subtypes. Dynamic subjective visual vertical (SVV) values were lowest in LC cupulolithiasais [35].

Maneuvers for AC are the reversed Epley maneuver, since it is the reversed version of the PC [18]. In my study, the disease was rehabilitated with 1 reversed Epley maneuver (92.3%), in 1 patient more than 1 reversed Epley maneuver (7.7%). 1 AC- cupulolithiasis was rehabilitated with the Semont maneuver (100%). If CRPs and liberation maneuvers don't work, Brandt-Daroff exercises may be given. 3 times daily up to 3 weeks [18].The success tax in reducing vertigo is 95%. I have treated 2 BPPV patients (1.6%) with this exercise.

Complications of these maneuvers may be conversion from canalithiasis to cupulolithiasis or vice versa, migration to another canal or canalith jam. The diagnosis should be revised with the provocative tests and treatments should be reorganized due to the actual situation. Mostly, the debris move from the posterior to the lateral canals. Canalith jam may occur when the particles migrate from a wider ampulla to the narrower segment of the canal [36]. A transient burst of nystagmus not correlating to the canal is seen. These particles mostly migrate to the common crus of superior and posterior canals [6,8]. In my study, in 5.7% of the patients, the debris migrated from one canal to another and the treatment maneuvers are reorganized due to the current state. In cases of accurate diagnosis but stubborn symptoms despite the treatments, surgical options such as canal occlusion, singular neurectomy and labyrinthectomy may be considered [33,18]. Resolving without intervention is to "wait and see protocol" [18].

As a result, BPPV is a disease with a treatment of high success rate. In our study, all of our patients were cured. The use of VNG as the diagnostic tool is very important. With VNG we can easily differentiate the nystagmus and diagnose the positions of the debris in the exact canal and exact side. The patients are tested by the same

specialist who is important for interpreting the results. Controlling the patients after CRPs by VNG shows the course of the disease and designs the treatment schema. The number and duration of these maneuvers are important for the success in cure rate of BPPV.

Compliance with Ethical Standars

This study is supported by the Cerve Hospital Research Fund. It is compatible with Helsinki Declaration 2008 principles (36). The conflict of interest is none. Informed consents are obtained from all individual participants included in the study.

References

1. IbekaTS, RogersC. Clinical evaluation of posterior canal benign paroxysmal positional vertigo. Niger Med J. 2012; 53: 94-101.
2. Dix MR, Hallpike CS. The pathology, symptomatology and diagnosis of certain common disorders of the vestibular system. Ann Otol Rhinol Laryngol. 1952; 61: 987–1016.
3. Schuknecht HF. Positional vertigo: Clinical and experimental observations. Trans Am Acad Ophthalmol Otolaryn gol. 1962; 66: 319–332.
4. Schuknecht HF. Cupulolithiasis. Arch Otolaryngol. 1969; 90: 765–78.
5. Gacek RR. Further observations on posterior ampullary nerve transection for positional vertigo. Ann OtolRhinolLaryngol. 1978; 87: 300–305.
6. Epley JM. New dimensions of benign paroxysmal positional vertigo. Otolaryngol Head Neck Surg. 1980; 88: 599-605.
7. Özlüoğlu L, Akkuzu B. Benign paroksizmalpozisyonel vertigo. In: Ardıç FN, ed. Vertigo. İzmir GüvenKitabevi, İzmir. 2005: 201-211.
8. Herdman SJ, RJ Tusa. Assessment and treatment of patients with benign paroxysmal positional vertigo. In: Herdman SJ, ed. Vestibular Rehabilitation, Philadelphia: Davis. 2000: 451-475.
9. Vannucchi P, Pecci R. Pathophysiology of lateral semicircular canal paroxysmal positional vertigo. J Vestib Res. 2010; 20:433-438.
10. Califano L, Melillo S, Mazzone S, Salafia F. Direction-fixed paroxysmal nystagmus lateral canal benign paroxysmal positioning vertigo (BPPV): another form of lateral canalithiasis. Acta Otorhinolaryngol Ital. 2013; 33: 254–260.
11. Epley JM. Benign Paroxysmal Positional Vertigo (Canalithiasis).Diagnosis and non-surgical management. In: Arenberg IK, ed. Dizziness and balance disorders. Amsterdam: Kugler Publishers.1993; 545–549.
12. Epley JM. The canalith repositioning procedure: For treatment of benign paroxysmal positional vertigo. Otolaryngol Head Neck Surg. 1992; 107: 399–404.
13. Honrubia V, Bell TS, Harris MR, Baloh RW, Fisher LM. Quantitative evaluation of dizziness characteristics and impact on quality of life. Am J Otol. 1996; 17:595–602.
14. Koelliker P, Summers RL, Hawkins B. Benign paroxysmal positional vertigo:Diagnosis and treatment in the emergency department–a review of the literature and discussion of canalith-repositioning maneuvers. Ann Emerg Med. 2001; 37: 392-398.
15. Brandt T. Vertigo. Its multisensory syndromes. 2nd ed. Heidelberg, Springer. 1999.
16. VN415-VO425. House of hearing. 2016.
17. Megnigbeto CA, Sauvage JP, Launis R. The European Evaluation of Vertigo (EEV) scale; a clinical validation study. Rev Laryngol Otol Rhinol. 2001; 122: 95-102.
18. Epley JM. The Canalith Repositioning Procedure: For Treatment of Benign Paroxysmal Positional Vertigo. Otolaryngol Head Neck Surg .1992; 3: 399-404.
19. Prokopakis EP, Chimona T, Tsagournisakis M, Christodoulou P, Hirsch BE, Lachanas VA, et al. Benign paroxysmal positional vertigo: 10-year experience in treating 592 patients with canalith repositioning procedure. Laryngoscope. 2005; 115: 1667-1671.
20. Maslovara SI, Vesligaj T, Soldo S. Importance of accurate diagnosis in benign paroxysmal positional vertigo (BPPV) therapy. Med Glas. 2014; 11: 300-306.
21. Jackson LE, Morgan B, Fletcher JC. Anterior canal benign paroxysmal positional vertigo: an underappreciated entity. Otol Neurol. 2007; 28: 218-222
22. Yetiser S, InceD. Demographic Analysis of Benign Paroxysmal Positional Vertigo as a Common Public Health Problem. Ann Med Health Sci Res. 2015; 5: 50–53.
23. Korres S, Balatsouras DG, Kaberos A. Occurrence of semicircular canal involvement in benign paroxysmal positional vertigo. Otol Neurotol. 2002; 23: 926–932.
24. Lopez Escamaz JA, Molina MI, Gamiz M. Multiple positional nystagmus suggests multiple canal involvement in benign paroxysmal vertigo. Acta Otolaryngol. 2005; 125: 954-961.
25. Li JC. Mastoid oscillation: a critical factor for success in canalith repositioning procedure. Otolaryngol Head Neck Surg. 1995; 112: 670-675.
26. Parnes LS, Price-Jones RG. Particle repositioning maneuver for benign paroxysmal positional vertigo. Ann Otol Rhinol Laryngol. 1993; 102: 325-331.
27. Semont A, Freyss G, Vitte E. Curing the BPPV with a liberatory maneuver. Adv Otorhinolaryngol.1988; 42: 290-293.
28. Lempert T, Tiel-Wilck K. A positional maneuver for treatment of horizontal-canal benign positional vertigo. Laryngoscope. 1996; 106: 476-478.
29. Furuya M, Suzuki M, Sato H. Experimental study of speed dependent positional nystagmus in benign paroxysmal positional vertigo. Acta Otolaryngol. 2003; 123: 709- 712.
30. Squires TM, Weidman MS, Hain TC. A mathematical model for top-shelf vertigo:the role of sedimentingotoconia in BPPV. J Biomech. 2004; 37: 1137-1146.
31. Brandt T, Daroff RB. Physical therapy for benign paroxismal positional vertigo. Arch Otolaryngol.1980 ;106: 484-455.
32. SelçukA, Akdoğan Ö, Özcan I. Benign Paroksizmal Pozisyonel Vertigoda Patofizyolojiye Göre Uygun Tedavinin Belirlenmesi KBB-Forum .2008.
33. Karkos PD, Leong SC, Papouliakos SM. Semont\'s maneuver in BPPV: a forgotten technique. Clin Otolaryngol. 2006; 31: 464-465.
34. Lee SK, Kim SJ, Park MS. Otolith organ function according to subtype of benign paroxysmal positional vertigo. Laryngoscope. 2014; 124: 984-988.
35. Hilton M, Pinder D. The Epley maneuver for benign paroxysmal positional vertigo–a systematic review. Clin Otolaryngol Allied Sci. 2002; 27: 440–445.
36. http://www.wma.net/en/30publications/10policies/b3/index.html