Residual dizziness after successful repositioning maneuver for idiopathic benign paroxysmal positional vertigo: a review

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Abstract

The benign paroxysmal positional vertigo (BPPV) is a vestibular disorder cause of vertigo. The BPPV may be corrected mechanically by repositioning maneuvers but even after successful maneuvers, some patients report residual dizziness for a certain period afterward. Early recognition and treatment might decrease the incidence of residual dizziness in patients with BPPV, especially in those patients with psychiatric comorbidities and in the elderly, lowering the risk of falling. Many pathogenetic hypotheses for residual dizziness are under debate.

The purpose of this review was to identify, evaluate and review recent researches about possible causal factors involved in residual dizziness and the implications on clinical practice. A literature search was performed using different databases such as Pubmed and Scopus. The following search terms were used: *residual dizziness, otolithic membrane and BPPV*. The search found a total of 1192 titles, which were reduced to 963 after a procedure of de-duplication of the found titles. The research was then restricted to an interval of time comprised between 2000 and 2016 for a total of 800 titles. Among these titles, only those including the terms *benign paroxysmal positional vertigo* were considered eligible for this review. Only publications in English language were taken into consideration and we excluded those with not available abstract. Finally, 90 abstracts were obtained and critically evaluated by two different Authors, and additional studies were identified by hand searching from the references of artiche of interest. Only 53 were included in this work.

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Introduction

Benign paroxysmal positional vertigo (BPPV) is the most common type of vestibular disorder with a lifetime prevalence estimated at 2.4% in the general population.[1] Among patients admitted to specialized dizziness clinic, 20-30% are diagnosed with BPPV.[2] This vestibular disorder is characterized by short repeated episodes of intense vertigo triggered by special head position changes, and often accompanied by nausea and vomiting.[3] Moreover BPPV disorder is suspected to be caused by small otoconial particles floating freely in the semicircular canals.[4] About 90% of BPPV episodes are idiopatic[1] and involve the posterior semicircular canal, as shown by diagnostic provocation maneuvers, such as the Dix-Hallpike and the Pagnini-McClure tests.[5,6] The BPPV can occur at any age, but incidence increases with advancing age.[7,8] Possible etiological factors have been proposed to be head trauma, vestibular neuritis and vascular disorders.[9-11] Appropriate canalith repositioning procedures (CRPs) can provide rapid and long-lasting relief of symptoms in BPPV patients.[12-16] Although the CRPs are usually very effective in improving vertigo, some patients report for a certain period afterward, imbalance without positional vertigo named *residual dizziness* (RD). The purpose of this study was review the recent discoveries about possible causal factors involved in RD after successful repositioning maneuvers in patients with

idiopathic BPPV and the clinical implications of these findings.

Materials and Methods

A literature review was performed using different databases such as Pubmed and Scopus. The search strings used were *residual AND dizziness*; *residual AND Symptoms AND after AND canalith AND repositioning AND procedures*; *otolithic AND dysfunction AND after AND bppv*. The Medical Subject Headings (MeSH) used for the research were *BPPV*, adding the terms *residual AND dizziness*, and *OTOLITHIC MEMBRANE* adding *bppv*. The search found a total of 1192 titles, which was reduced to 963 after a procedure of de-duplication of the found titles. The research was then restricted to an interval of time comprised between 2000 and 2016 for a total of 800 titles. Among these titles, only those including the terms *benign paroxysmal positional vertigo* were considered eligible for this review. We considered only publications in English language and excluded those with no available abstract. Finally, 90 abstracts were obtained and critically evaluated by two different Authors and additional studies were identified by hand searching from the references of article of interest. Only 57 were included in this work (Figure 1).

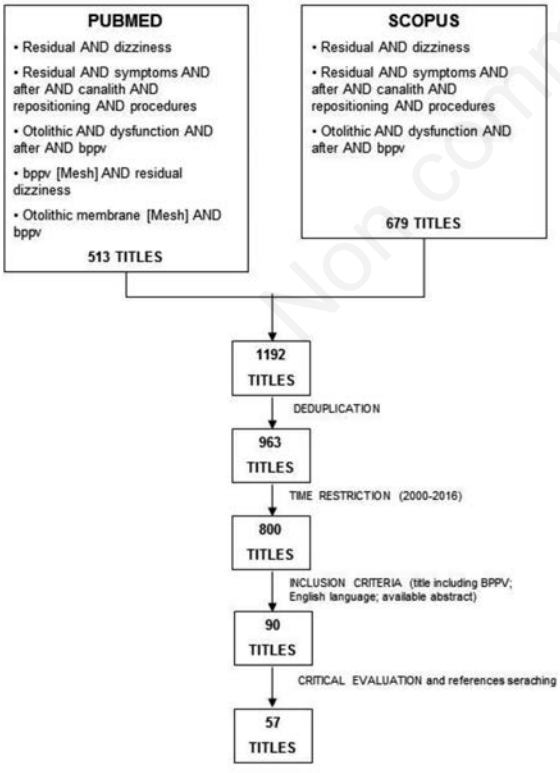

Figure 1. Search strategy flow chart.

Results

Demographics, clinical features and co-morbidities

BPPV is undoubtedly the balance disorder with the most brilliant response to therapy; nevertheless a prolonged imbalance is reported by several patients after successful repositioning maneuvers. This imbalance is often described as a sensation of lightheadedness or dizziness in absence of vertigo or nystagmus, or short lasting unsteadiness occurring during head movements, standing, or walking.[17] The overall prevalence of RD is ranged from 31 to 61%.[17-20] As well the duration of RD can range from a few days to several weeks.[17-20] Moreover, at the diagnosis, RD seems not to be related with involved canal, gender, number of repositioning maneuvers or severity of nystagmus,[17-20] and the main causal factor seems to be linked to the duration of vertigo before successful repositioning maneuvers.[17,20,21] There is no agreement about the correlation between RD and duration of BPPV[18] as well on the incidence of RD in migraineurs[20] generally the mean age of patients affected by BPPV and migraine is lower than a control group of not migraineurs.[22,23] RD after BPPV episode is a common condition among the elderly.[24,25] In a sample study, 36.6% of patients older than 65 experimented RD, this percentage increased in patients older than 72, showing a mean duration of 13±7.5 days and an incidence of RD that was probably related to the duration of the symptoms.[26] RD displayed a significant link with anxiety disorders, indeed subjects with high anxiety showed more durable and disabling dizziness even after the resolution of the acute vertigo in absence of otolithic or vestibular dysfunction.[26,27] Anxiety has been demonstrated to play an additional role in dizziness, which may be considered in some cases a somatoform disorder arising from stressful events.[28,29] Some Authors focused on the high rate to get both dizziness and anxiety in the elderly[26,30] Dizziness in the elderly has adverse psychological and social effects due to the decrease of performances in daily living activities and the increase of fear or risk of falling.[31] A recent study confirmed a significant association with older age and anxiety, in particular with higher DHI questionnaire score in emotional domain, which appears to be the most important predictor factor for the occurrence of RD.[32] Concurrent chronic diseases including hypertension, diabetes mellitus, heart disease, and hyperlipidemia were not significantly correlated with RD.[17]

Pathogenetic theories

Several theories have been proposed to explain the presence of RD after successful maneuvers but the real cause is still under debate. Since BPPV is considered a macular disorder, a utricular dysfunction is theorizable as a causal factor for RD. A simple method to detect otolith function of utricular origin is represented by determining subjective visual vertical (SVV).[33] In the literature there are many contradictory results on SVV in patients with BPPV. In a past study, Bohmer and Rickenmann (1995) examining 19 patients with untreated BPPV, found only in one patient, the

SVV outside the normal range of ±2°, tilting toward the affected ear.[34] Similarly, Von Brevern *et al*. (2006) did not see any differences in SVV perception between group of patients and controls.[35] Conversely, other Authors have reported alteration in utricular function in the course of BPPV. Gall *et al*. (1999), found deviations of the SVV in 14 of 16 patients with acute BPPV compared with a control group, but it was not reported whether SVV shifted toward the affected ear.[36] Some Authors reported variations in SVV values immediately after CRP.[37,38] Although these works highlighted an otolithic dysfunction in BPPV, it is not mentioned any correlation between such outcomes and RD after CRP. For instance, Faralli *et al*. (2016) observed only subclinical modifications of SVV perception in patients with more recent onset of BPPV. These alterations appeared to be rapidly reversible and in these cases the otolith dysfunction could explain only brief dizziness after CRP, but not delayed RD after one week.[21] In 2006 Von Brevern *et al*. demonstrated that a documented otolith dysfunction in patients affected by idiopathic BPPV might account for transient mild imbalance experienced after the resolution of the acute vertigo. In their study the otolith function of patients was tested 1 week and 1 month after successful treatment and compared with 24 healthy subjects. The pure otolith response was assessed by the analysis of the *otolith-ocular reflex* (OOR) considered a more precise way to assess the otolith functional state in comparison with the SVV, since the semicircular canals and proprioception might contribute to the perception of verticality. The main result of this study was the decrement, few days after treatment, of the OOR amplitude in patients with idiopathic bilateral BPPV. Surprisingly, the reflex gain remained lower on the affected side even after the second test performed 1 month later. This study provided evidence that idiopathic BPPV was associated with utricular dysfunction of unknown origin, possibly due to a deficit of the matrix that embeds the otoconia on the macula, that could be the cause of the durable imbalance after resolution of canalolithiasis.[35] Yetiser *et al*. (2014), focused their attention on the duration of BPPV symptoms and on their recurrence in the genesis of RD. Analyzing vestibular evoked myogenic potentials (VEMPs) in BPPV patients, they found a significantly long p1 latency, directly correlated with a long period between the onset of symptoms and diagnosis that was more evident in cases of recurrent BPPV. This might be explained by a degeneration of neural elements with a consequent altered interaction with otolithic and canalicular receptors, responsible for the developing of RD.[39] Inukai *et al*. (2014), studied the otolithic function via the analysis of posturographic data, that is the analysis of the body sway determined by vestibule-spinal reflex. In this regard, the Authors confirmed the role of the utricular dysfunction, as they found a major enveloped sway area in patients complaining RD after CRPs. Since it is accepted that BPPV is the consequence of a disturbance of the otolithic macula, and that Epley maneuver cures the canal, not the otolith organs, they affirmed that RD would be the consequence of an otolithic impairment, even though the posturographic tasks do not detect isolated otolith function, but account for a more complex system involved in the postural control.[40] Faralli *et al*. (2016), partly contradicted the hypothesis that otolith dysfunction is the main cause of RD in idiopathic BPPV. Investigating a potential correlation between post-repositioning RD, utricular dysfunction (assessed by SVV) and time of duration of BPPV, they observed that RD is inversely correlated with the deviation of SVV measured a week after efficacious physical therapy and directly correlated with the duration of BPPV symptoms. They suggested that RD would not be affected by utricular involvement as long as it is assumed that SVV deviation indicates a utricular dysfunction. According to Faralli *et al*. point of view, the genesis of RD could reside in the inability of the vestibular system to readapt quickly to a new functional state: in detail the persistence of debris in the semicircular canal could alter the tonic discharge from the affected labyrinth and could induce a new central adaptation rebalancing the vestibular nuclei activity, in order to minimize the peripheral asymmetry. This new equilibrium tends to stabilize the perturbation produced by the otoconia that is free to float in the semicircular canals. After successful maneuvers, the brain adapted to the new condition is unable to quickly readjust to the old pattern and this could be the cause of RD.[21] Inagaki *et al*. (2006), indicated that the movement of otoconia, returning to the utricle, was the cause of RD after the CRPs. In an experimental setting using isolated bullfrog utricle and posterior semicircular canal, it has been measured the compound action potentials (CAPs) in response to sinusoidal rotation after removing or repositioning otoconia on the macula. It has been recognized that the otoconia could play a crucial role as acceleration transducers. This otoconial effect on the sensory cells, as testified by CAP changes, could justify the vertigo or dizziness after physical therapy.[41] These findings were confirmed by Prokopakis *et al*. (2007) theorizing that early occurrence of RD (within 48-72 h after CRPs) might be caused by the new position acquired by the otoconial mass after the otoconial detachment. Following the CRPs, the debris re-attaches to the otolithic membrane of the utricle changing otolith pressure. This new signal leads to an altered stimulation of the sensory epithelium of the utricle, provoking dizziness. Therefore, RD occurring after physical therapy of BPPV would be caused by otoconia return to the utricular macula.[42] In 2009 Celebisoy *et al*. conducted different posturographic tasks investigating both static and dynamic balance abilities in patients affected by posterior canal (PC) and horizontal canal (HC) BPPV compared with controls.[43] They found that patients with PC BPPV had impaired static balance control after the elimination of the visual and proprioceptive inputs, moreover PC BPPV was significantly improved after CRM. This finding was not detected in HC BPPV patients. For this reason, the altered postural control cannot be justified by the otolith dysfunction caused by unequal loads of the macula present in both PC and HC BPPV. According to Di Girolamo *et al*. (2000), the RD after the CRM could be ascribed to the persistence of a small amount of residual debris into the semicircular canal insufficient to provoke cupular deflection leading to

nystagmus, or alternatively to a paresis of ampullar receptors or to vestibular re-adaptation after a peripheral vestibular disorder.[44] Another explanation could be that recurrence of BPPV episodes may account for an instability of vestibular function which could alter the body scheme and the postural control.[43] Yet, Stambolieva *et al*. (2006) provided an integrated theory to explain RD after repositioning maneuvers: analyzing the results of static and dynamic posturography and correlating them with the different duration of BPPV. They postulated the presence of a pathology involving both the semicircular canal and otolith. In the acute phase of BPPV the presence of otoconia alters the canal dynamics and the sensibility of the motion-sensing receptors, as well as the otolith function is altered because of the unequal loading of the macula. These findings determined a peculiar posturographic pattern. The Authors suggested that, although clearing the canal, the physical treatment of BPPV, is not able to treat the macular damage generating an acute sensory conflict between the vestibular system and vision, which probably diminishes after removing the otoconia via the CRPs. After the Epley maneuver, nystagmus was no longer present but some kind of postural instability remains. The different degree of restoration of postural stability 1 week after the treatment of BPPV-PSC patients with a shorter or longer disease was explained by the stimulation of other sensory subsystems, which promoted adaptation mechanisms, leading to a new postural equilibrium.[45] This mechanism would be weaker in the elderly due to minor brain plasticity, as demonstrated by Lanca *et al*. (2013) founding an initial postural improvement after CRPs which tended to get worse after 12 months.[46] Kim *et al*. (2014), aimed to investigate the relationship between RD and potential autonomic dysfunction, since there were increasing evidences from animal models that vestibular system plays a role in cardiovascular regulation during movements and postural changes.[47] They found a greater level of orthostatic hypotension in patients complaining RD after successful physical treatment and suggested a sympathoneural dysfunction in absence of cardio-vagal parasympathetic abnormalities. In particular, otolithic structures had the main role in the genesis of vestibular sympathetic reflex (VSR) [47] and the RD could be explained in two ways: firstly, BPPV could not only be a disorder of the semicircular canals, but also a disorder of the otolith, which sense orientation in space. Otolith dysfunction itself might account for transient mild dizziness because of the imbalance generated by unequal weight distribution on the macule of the two utricles.[35,36] Secondly, mild positional dizziness could be produced by a small amount of residual debris not sufficient to generate overt nystagmus at the maneuvers. Presumably, a utricular dysfunction due to unequal weight distribution of the two utricles on the macule, or the persistence of debris in the affected canal, might interfere with normal cardiovascular response *via* VSR required to maintain stable blood pressure (BP) during postural changes. It has been speculated that the contribution of the VSR to maintain stable BP during postural changes might be compromised in patients with BPPV who feel RD despite successful treatment. Indeed, in patients with RD, the baroflex-mediated sympathoneural response might be diminished.[48]

Role of medications

Is still controversial the efficacy of the pharmacological therapy in preventing RD. The most used molecule is Betahistine dihydrochloride, which showed pleiotropic actions due to its affinity for histamine receptors as partial agonist for H1 receptors and antagonist for H3 receptors. Histamine takes an important role in the peripheral vestibular system regulating the sensory coding. It increases the activity of the afferent neurons of semicircular canals and regulates the intracellular Ca+ concentration in the vestibular periphery; it reduces the functional asymmetry of vestibular organs, improves the microcirculation of the labyrinth dilating blood vessels and relieves pressure from endolymphatic fluid. Centrally Betahistine enhances histamine synthesis in tubero-mammilary nuclei and its release within the vestibular nuclei. In addition it regulates alertness *via* cerebral H1 receptors.[49] These actions can facilitate the recovery ameliorating the quality of life of patients suffering from BPPV.[50] In support of this theory, Guneri and Kustatun (2012) found that 48 mg of Betahistine daily, in addition to Epley maneuver, gave more effective results than Epley maneuver alone or combined with placebo in improving symptoms in 4 different scales of vertigo symptoms evaluation.[51] On the other hand, Acar *et al*. (2015) sustained that betahistine did not produce any alleviation of RD after some days of treatment. In a randomized controlled clinical trial they divided into four groups the patients affected by BPPV and complaining RD after successful maneuvers: one group did not receive medication and the other groups received betahistine, trimetazidine or gingko biloba, respectively. They found no significant differences in the premedication DHI scores of patients with RD among the four groups (P>0.005). After 3 and 5 days of treatment, the mean DHI scores of the groups receiving medications did not differ significantly from the mean DHI score of the control group (P>0.005), suggesting that betahistine, trimetazidine, and gingko biloba extract did not alleviate RD after successful repositioning maneuvers.[52]

In another study, Deng *et al*. (2014) aimed to investigate the effects of Danhong injections for preventing and relieving RD. 20 mL of Danhong contains 750 g of crude medication of *S. miltiorrhiza* and 250 g of crude medication of *F. carthami*, showing synergistic effects as antioxidant and on the vasodilator activity. For these effects Danhong is usually used as traditional Chinese remedy effective in improving cervical vertigo and posterior circulation ischemic vertigo, since the oxidative stress could be the pathological basis of most vestibular damage. On the basis of these evidences, Deng *et al.* using a randomized double-blinded study, demonstrated that in patients with BPPV, the intravenous administration of Danhong (0.33 ml/kg per day for 5 days) enhanced the recovery from RD after successful repositioning treatment (RD assessed with a RD survey and DHI).[50]

Moreover, Kim *et al*. (2014) investigated the role of vestibular suppressant, analyzing the effect of dimenhydri-

nate in relieving RD after successful maneuvers. In a randomized controlled trial, they compared the presence of lightheadedness or mild headache (the most common symptoms after CRPs) in 3 groups treated with no medication, placebo or 50 mg dimenhydrinate per day, respectively. Even if the DHI scores (total and for each subscale) did not show a substantial difference, they found that the residual symptoms where significantly lower in the medication group, suggesting that this type of medication could be helpful in preventing RD.[53]

Yet, in 2012 Jung *et al*. suggested, in treating RD, the use of anxiolytics, like a low dose of etizolam. The rationale for the use of anxiolitics was the similarity of post-CRPs dizziness with anxiety, typical of some patients especially for the unpredictability of BPPV recurrence. This study showed a resolution in the total DHI score and in particular in the functional and emotional subscales which reflected an impact in the patient social and emotional life. The administration of anxiolytics allowed a faster and more comfortable return to daily life.[54] However since in this study was never conducted a comparison with a placebo control group, the Authors suggested that is not possible to generalize these results and there is no consensus in the habitual use of anxiolytics in clinical practice.[55]

Evaluation of residual dizziness: role of questionnaires

The most common questionnaire, used to assess and quantify the presence of vertigo related and imbalance symptoms, is DHI. Introduced for the first time by Jacobson and Newman in 1990, the questionnaire is a self-assessment inventory formed by 25 items divided into three sub domains of impact on daily life (functional, emotional and physical), with a total score ranging from 0 to 100 on the basis of symptoms frequency.[56] In patients affected by BPPV, the score generally showed a substantial decrement just after successful maneuvers, but never reaching the level of healthy controls.[57] In particular, the emotional domain showed the lower decrease, this would be related to a great anxiety level due to the intrinsic unpredictability of the BPPV itself. For some Authors this would be even more effective in older patients, in whom the fear of falling plays an important role in the genesis of BPPV-related anxiety. In these patients, DHI was a limited tool to assess the real functional performances on daily life, so other scales as the *activities balance scale*, the *vestibular disorders activities of daily living scale* should be associated in order to have a complete evaluation. Another limit in using DHI is that it does not include specific questions about lightheadness or mild headache often complained by patients after the clinical resolution of BPPV.[53]

Another tool used to assess and evaluate the presence of RD is the visuo-analogic scale (VAS), already recognized and validate by the literature, as a useful instrument to graduate pain. VAS provides consistent results detecting different aspects related to vertigo, such as the effect of therapeutic maneuvers, or the role of post-maneuver delay, and finally the VAS score is related with the patient's perceived wellness. Furthermore, VAS has the advantage to distinguish dizziness from vertigo, with reliable results in evaluating specifically RD. For its form, VAS is an *adapted day-to-day evaluation of the symptoms* which the patient can regularly fill-in during the follow-up period in order to optimize the therapeutic strategy. In conclusion, VAS assessment has consistent advantages: it is rapid and easy to use and it overcomes cultural and language barriers, providing a simple tool for dizziness assessment.[57]

Discussion and Conclusions

Even after successful repositioning maneuvers, some patients report imbalance without positional vertigo for a certain period afterward. RD is described by patients in different way: continuous or intermittent lightheadedness, intermittent unsteadiness or both types of dizziness. This review confirms that RD is a common condition in patients with BPPV, but also difficult to define from a quantitative and qualitative point of view. The variability in the rate and duration of RD depends on different inclusion criteria and sample size. In particular, the socio-demographic data and the lack of a commonly accepted definition of RD can play a role in it. The causal factors of RD are still unclear but several possible explanations have been proposed recently: i) the persistence of debris in the canal, insufficient to provoke cupular deflection, thus leading to nystagmus; ii) a utricular dysfunction accompanying BPPV or an undiagnosed coexisting vestibular disorder may be the causal factors; iii) an incomplete central adaptation after CRP. The duration of vertigo before CRP can lead to a delayed central adaptation; iv) sympathoneural deregulation may be a possible cause when the symptoms of RD are similar to those of autonomic dysfunction.

As previously reported our group demonstrated that RD may be linked to incomplete central adaptation and confirmed the association between RD and the duration of vertigo before CRPs. We also focused our attention on early otolith dysfunction and emotional factors. Our results show that different causal factors, as emerging from recent literature, can play a role in the genesis of RD acting singularly or synergistically. Early recognition of BPPV and its prompt treatment will reduce the incidence of residual dizziness, especially in those patients with psychiatric co-morbidities and in the elderly to reduce the risk of falls.

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