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Benign Positional Paroxysmal Vertigo Treatment: a Practical Update

Marco Mandalà, MD, PhD[*]
Lorenzo Salerni, MD, PhD
Daniele Nuti, MD

Address
[*]Otolaryngology Department, University of Siena, Azienda Ospedaliera Universitaria Senese, V.le Bracci, 11, 53100, Siena, Italy
Email: marcomand@hotmail.com

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Abstract

Purpose of the review To define the best up-to-date practical approach to treat benign paroxysmal positional vertigo (BPPV).
Recent findings Both posterior and horizontal canal BPPV canalith repositioning maneuvers (Semont, Epley, and Gufoni's maneuvers) are level 1 evidence treatment for evidence-based medicine. The choice of maneuver (since their efficacy is comparable) is up to the clinician's preferences, failure of the previous maneuver, or movement restrictions of the patient. Maneuvers for controversial variants, such as anterior canal and apogeotropic posterior canal BPPV, have weaker evidence of efficacy. Despite this, these variants are increasingly diagnosed and treated. Maneuvers also play a role in the differential diagnosis with central vestibular disorders. Chair-assisted treatment may be of help if available while surgical canal plugging should be indicated in selected same-canal, same-side intractable severe BPPV.
Summary The primary evidence-based treatment strategy for BPPV should be physical therapy through maneuvers. Despite the high success rate of liberatory maneuvers, there is a low percentage of subjects who have unsatisfactory outcomes. These patients need to be investigated to identify recurrences, multiple canal involvement, associated comorbidities (migraine, persistent postural perceptual dizziness), or risk factors for recurrences (low vitamin D serum level). Future research should also identify the optimum maneuvers for variants whose diagnosis and treatment are still a matter of some debate.

Introduction

Benign paroxysmal positional vertigo (BPPV) is one of the most prevalent vestibular disorders (2.4%), representing about one-fifth of all referrals due to vertigo or dizziness despite being largely under-diagnosed [1]. Women are affected more than men by about 2:1, and prevalence in the elderly population (over 60 years) may approach 9% [2]. BPPV screening techniques with tailored questionnaires [3] or "smart" devices [4] may increase the accuracy of diagnosis.

Displaced otoconia (canalolithiasis or cupulolithiasis) are thought to cause BPPV by mechanically stimulating the vestibular receptors within the semicircular canals [5••]. Recently, otoconia and otolithic membrane fragments within semicircular canals have been identified during surgery in patients with BPPV [6•]. BPPV may develop after head trauma or inner ear surgery (stapes surgery, cochlear implantation, or when repairing superior canal dehiscence). There is a higher prevalence of BPPV in patients who have migraine or Ménière's disease. Patients with an acute unilateral peripheral vestibulopathy can develop recurrent posterior canal (pc) BPPV in the same ear. Increasing evidence supports an association between low serum vitamin D levels and BPPV [7].

The typical clinical picture is represented by short (seconds to minutes) recurrent episodes of positional vertigo or dizziness provoked by changes in head position with respect to gravity associated with positional nystagmus. Associated symptoms can be unsteadiness and vegetative symptoms (nausea, vomiting, sweating, and tachycardia).

The canal most commonly involved in BPPV is the pc, in around 80% of patients [8]. Lateral canal (hc) BPPV is diagnosed in 15% of patients with all other variants accounting for around 5% [8].

The diagnostic criteria for pc and hcBPPV variants are well defined [9]. However, diagnostic criteria and treatment for anterior canal (ac) BPPV [10], apogeotropic pcBPPV [11], and subjective BPPV without positional nystagmus [12] are still a matter of some debate. Different variants of BPPV and their possible pathogenesis have been hypothesized [5••, 13].

BPPV generally presents spontaneous remissions after days to weeks. Recurrences may develop in around half of BPPV patients.

Level 1 evidence-based treatments exist for BPPV, but are only up-to-date for pc and hcBPPV. These treatments are represented by repositioning maneuvers [14••], and it is very important not to delay treatment of BPPV, or suspected BPPV in variants whose diagnosis and treatment are still a matter of some debate. With any delay, quality of life is greatly affected, the risk of falls is significantly increased, especially in the elderly [15], and differential diagnosis with central vestibular disorders (usually a vestibulocerebellar lesion) can be safely and rapidly accomplished with disappearance or modification of the positional nystagmus after the maneuver. Finally, health care spending on unnecessary laboratory or radiographic testing is reduced.

Physical therapy

Repositioning maneuvers are currently the best evidence-based approach to treat BPPV [9, 14••]. An accurate diagnosis in terms of canal and side affected is of paramount importance and with correct execution of the maneuver.

pcBPPV

pcBPPV with its typical pattern [9] is very rarely due to a central vestibular lesion. Radiographic imaging and additional vestibular testing are not necessary in the absence of additional vestibular/neurological signs and/or symptoms inconsistent with BPPV [14••].

Once the Dix-Hallpike maneuver has correctly shown the side involved, the best therapeutic option during the acute stage for the management of pcBPPV is

physical therapy whose principles are centered on the theory of canalolithiasis [16] https://collections.lib.utah.edu/ark:/87278/s6ng8nbm. Clearing the pc of the floating debris engaged in the lower segment of the long arm, favoring migration to the utricle where otoconia are usually reabsorbed, are the strongholds of physical treatments.

Positional exercises have been proposed first by Brandt and Daroff [17]. Semont's Liberatory Maneuver [18] and Epley's Canalith Repositioning Maneuver [19–21], described in several studies and controlled trials, show good outcomes and efficacy [22]. The treatment chosen often depends upon the practitioner's preference or experience.

Currently, the gold standard treatments for pcBPPV are the Epley and Semont maneuvers. Both of these treatments are classified with Level 1 efficacy based on evidence-based medicine with a success rate close to 90% of cases [14••]. The efficacy of treatment is not affected by the age of patients or pre-existing neurological disorders [23]. It is of paramount importance that the outcome of the physical therapy is assessed on the same day or the day after, to avoid attributing spontaneous remissions to the therapy.

The Liberatory or Modified Semont Maneuver is a simplification of Semont's original treatment [18]. A rapid tilt of 180° in the plane of the pc ejects otoconia from the pc by centrifugal force. For a left pcBPPV, the patient sitting in the upright position is quickly leaned to the affected side with a 45° head rotation to the right and maintaining that position for 1 min. Free floating otoconia gravitate to the lower part of the canal eliciting an ampullofugal flow triggering a typical positional nystagmus after a short latency ("Diagnostic Semont's Maneuver"). The patient is then quickly (within 1.5 s) tilted, without deceleration, into a right side-lying position with nose downwards causing an endolymphatic flow with a rotatory nystagmus beating towards the uppermost right ear ("Liberatory Nystagmus"). Reversal of nystagmus in the last position of Semont's maneuver is a negative prognostic factor for success of the maneuver [24] (Fig. 1).

Speed of rotation is critical for a successful Semont's maneuver, indeed if the maneuver is performed too slowly, it could be ineffective because the debris can fall back into the canal [25].

The Canalith Repositioning Maneuver (CRM) or Modified Epley Maneuver consists of five sequential steps each lasting for 3 min and apt to move the otoconia from the posterior canal to the common crus and then to the vestibule by sequential changing of head position [20]. The mastoid vibrator is not usually used with respect to the original maneuver proposed by Epley [19]. However, mastoid vibration could be useful to remove the so-called canalith jam [26].

The CRM for left pcBPPV starts with the patient on the bed with head rotated 45° to the left (step 1), then the subject is quickly moved into the Dix-Hallpike provoking position with the affected ear downwards (step 2); then the head is slowly rotated by 90° towards the unaffected side causing a further movement of the debris in an ampullofugal stimulus (step 3); the head and trunk continue turning (90°) to the right causing movement of the otoliths towards the exit of the canal (step 4) and finally, the patient is slowly moved into a sitting position (step 5) (Fig. 2). A nystagmus, beating upwards with a torsional component towards the involved ear, is called orthotropic nystagmus (the same as liberatory nystagmus in Semont's maneuver) and should be considered as a marker of

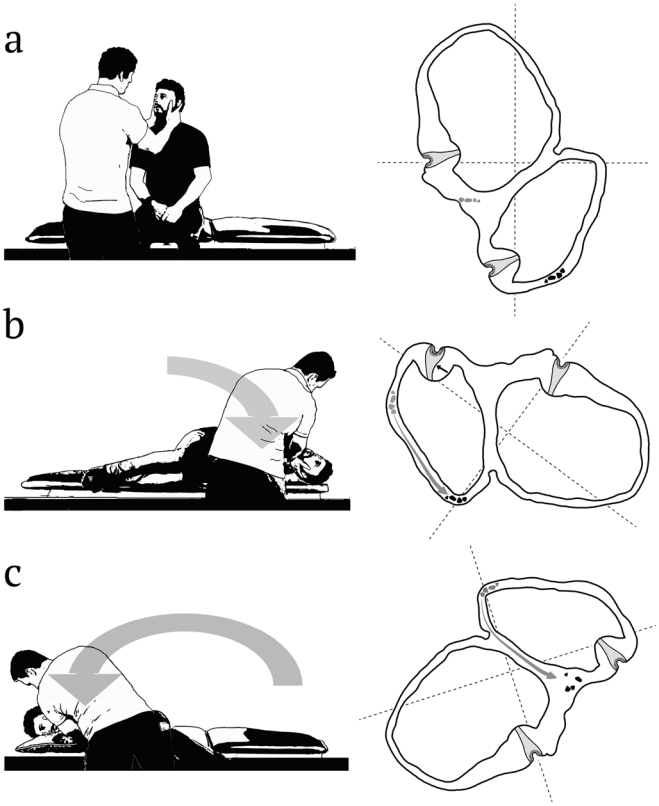

Fig. 1. Semont's maneuver for left pcBPPV. **a** The patient sits on a table in front of the examiner with head rotated 45° to the right side; **b** the patient is moved onto the left shoulder, with the back of the head resting on the table (diagnostic position); **c** after 1 min, the patient is abruptly moved 180° onto the opposite side (right), keeping the head in the same position. In this "liberatory position," after a variable latency—sometimes more than 30 s—another episode of vertigo and excitatory nystagmus should take place. After 1 min, the patient is slowly returned to the sitting position with the head bent slightly forward (not represented in the figure).

a successful maneuver [27], indicating that particles leave the pc moving through the common crus. CRM is preferred to Semont's maneuver in obese patients or when trunk flexibility or neck extension is poor [25].

A shorter variant of Epley's treatment is the so-called Quick Liberatory Rotation, rather similar in the sequence of positions of the head in the horizontal plane as in repositioning procedures, but with a very fast rotation (about 180° in less than 1 s) [28]. A treatment called the "Chair-based Abbreviated Repositioning Maneuver (ChARM)" has recently been proposed to assess the effectiveness of a variation of the Epley maneuver, where the repositioning maneuver is performed on a backed chair in nine steps over 3 min. ChARM does not require an examination on a bed/table and only requires an office setting [29].

In clinical practice, Epley's and Semont's maneuvers are equally efficacious [24] with a recurrence rate of attacks of 10–20% in the first 2 weeks [21] and that usually requires 1–3 repetitions of the same treatment or choosing a different repositioning option.

Sometimes, a canal switch to hcBPPV can occur due to otoconial debris falling into the hc [30], or the patient may develop the benign form of

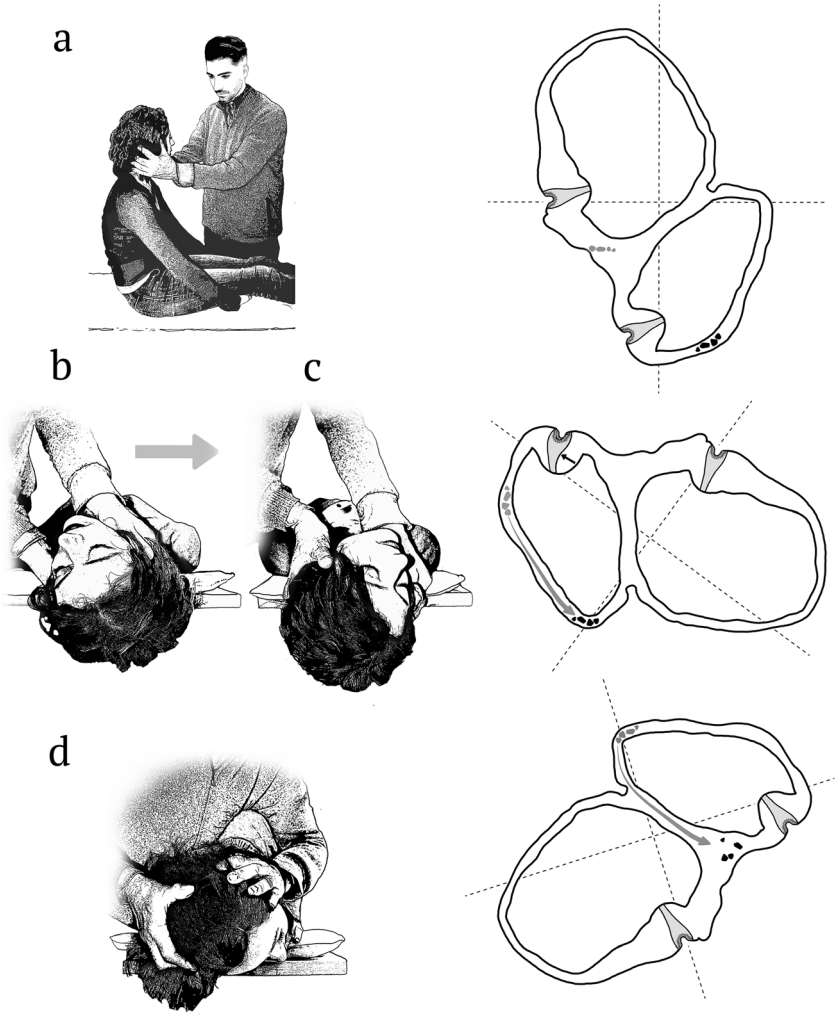

Fig. 2. Epley's maneuver for left pcBPPV. **a** It starts with the patient on the bed with head rotated 45° to the left side. **b** The patient is then moved quickly into the Dix-Hallpike provoking position with the affected ear downwards; **c** then the head is slowly rotated 90° towards the unaffected side causing further movement of the debris for an ampullofugal stimulus; **d** the head and trunk are turned (90°) to the right causing movement of the debris towards the exit of the canal. Finally, the patient is slowly moved into the sitting position (not represented in the figure). The relative orientation of the posterior canal and otoconial movements is displayed in the center of the figure.

positional downbeating nystagmus (either anterior canal BPPV (acBPPV) or apogeotropic pcBPPV) [31]. In these cases, patients should be treated with the appropriate maneuver.

A mild sensation of residual dizziness or intermittent unsteadiness has been described in the days post-treatment [32]. No particular activity restrictions are required after the maneuver [33] although it appears prudent for patients to sit upright for about 15 min after treatment, to walk cautiously, and avoid activities which may increase the risk falling [34].

Brandt-Daroff exercises consist of a repeated sequence (5–10 times/day) of lateral tilts of the head and trunk allowing detachment of otoconia from the cupula or dispersion from the posterior canal [17]. The patient moves rapidly

from the sitting position towards the affected side remaining there for at least 30 s, and then sits up before moving to the opposite head down position for a further 30 s. These exercises seem to be less successful than repositioning maneuvers and cannot be considered to be a first choice treatment [35] but are usually suggested subsequent to liberatory or repositioning maneuvers to prevent recurrences or to treat unresponsive [36] or phobic positional vertigo cases [22].

hcBPPV

Geotropic hcBPPV (https://collections.lib.utah.edu/ark:/87278/s6wx1fd1) and pcBPPV are straightforward diagnoses according to guidelines and do not need any additional investigation [9, 14]. On the other hand, one must distinguish the apogeotropic variant of hcBPPV from a central vestibular disorder (usually a vestibulocerebellar lesion). Recently, the characteristics of horizontal spontaneous and positional nystagmus in peripheral and central disorders have been investigated. The main difference is represented by the greater intensity of nystagmus in the supine versus the sitting position in hcBPPV [37]. Migraine may also present with horizontal direction changing positional nystagmus and vertigo [38].

The two variants of hcBPPV can be distinguished on the basis of the direction of positional nystagmus in the supine head roll maneuver: the more common variant characterized by geotropic nystagmus and the less common presenting apogeotropic nystagmus. hcBPPV may also present with spontaneous horizontal nystagmus while the patient is upright and which reverses direction when moving the head forward or backward ("bow and lean" nystagmus). These findings may help to identify the pathological side when the intensity of the nystagmus in the supine roll test does not change depending upon which ear is down (generally, the nystagmus is most intense when it is beating towards the pathological ear) [39]. Identifying the pathological side appears to be fundamental for correct physical treatment.

Many therapeutic procedures have been proposed for the treatment of hcBPPV since it was described with its geotropic and apogeotropic variants [40–42]. In fact, some of the procedures are just minor modifications of the previous ones. Moreover, since hcBPPV is often a self-limiting disease, the real effectiveness of the physical therapy must be assessed on the same day or the day after, to avoid attributing spontaneous remissions to the therapy.

Geotropic hcBPPV (canalolithiasis)

The first descriptions of treatment for hcBPPV date back to the 1990s, when it was proposed to rotate the patient's body around the longitudinal axis in a supine position, similar to "barbecue rotation" [43]. The patient is rotated towards the healthy ear in 90° steps with the aim of expelling free otoconia from the hc by centrifugal force. The "barbecue rotation" is effective [44] and was validated with a prospective randomized trial [45]. The drawback of this procedure is that it is often uncomfortable, especially in elderly, obese, or motion-restricted patients.

One of the most popular procedures to treat hc canalolithiasis was proposed by Mauro Gufoni in 1998 [46]. Gufoni's maneuver is performed in three steps (Fig. 3):

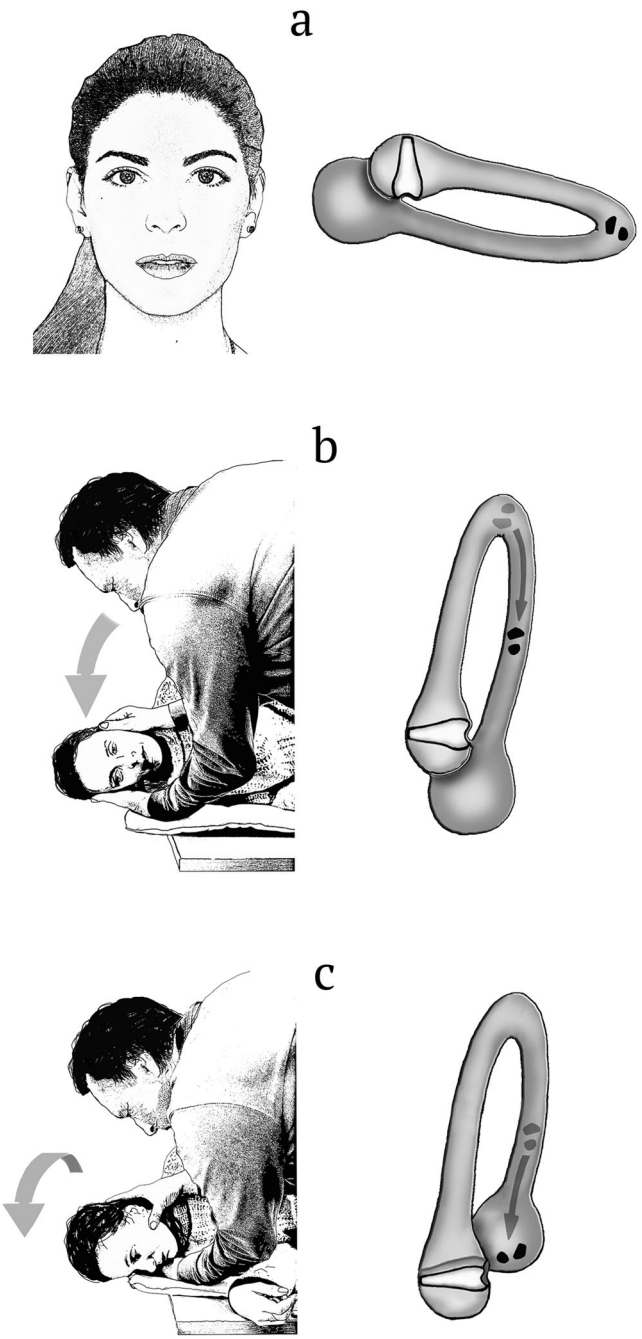

Fig. 3. Gufoni's maneuver for geotropic left hcBPPV. **a** Start from the sitting position (head facing straight forward). **b** The patient is quickly brought laterally to the healthy side (right). **c** After a few seconds, the head is turned about 45° downwards (nose is in contact with the bed). After 1–2 min, the patient is returned to the upright position (not represented in the figure). The maneuver may be repeated three times.

Step 1: from the sitting position (head facing straight forward), the patient is quickly brought laterally towards the healthy side.

Step 2: after a few seconds, the head is turned about 45° downwards (nose is in contact with the bed).

Step 3: after 1–2 min, the patient is returned to the upright position.

The procedure should be repeated three times sequentially. Similar to the Semont maneuver, Gufoni's maneuver should allow the otoconial debris to exit the canal under the centrifugal force created by the rapid deceleration, so a relatively strong deceleration is required as the head contacts the bed. The final position (nose downwards) should favor the exit of the otoconial debris from the canal by gravitation. Figure 3 shows an example of the maneuver for left hcBPPV. Gufoni's treatment is a good option when the patient is moderately tolerant to vertigo and without significant physical impediments (handicap). Its effectiveness was validated with randomized double-blind studies (Level I evidence-based classification) [45, 47].

A good alternative treatment is the Forced Prolonged Position (FPP) devised by Vannucchi et al. in 1997 [48]. FPP is particularly advisable for older patients, obese patients, patients with significant mobility limitations, or patients with severe autonomic symptoms. Once the pathologic side has been identified, the patient is simply instructed to lie in a supine position, then to turn onto the side of the healthy ear and to stay in that position for as long as possible, preferably all night (Fig. 4). In this way, otoconial debris can exit the canal under gravity. The efficacy of FPP is already known [44, 49] and has recently been confirmed in an Italian randomized multicentric study carried out on almost 200 patients (under review).

A proposed further therapeutic option is the Vannucchi-Asprella procedure [49]. Starting from the supine position, the patient's head is quickly rotated towards the unaffected ear. After 30 s, the patient is returned to the sitting position, maintaining the head rotated. Then, the head is slowly returned to the central position and the procedure is repeated up to five times. This procedure is difficult to perform in patients with a "stiff" neck even though this problem can be overcome by also turning the shoulders. Similar to the Vannucchi-Asprella maneuver is the procedure recently proposed by Ichijo [50]. In the supine position, the patient's head is rotated 120° towards the healthy ear (as in Gufoni's maneuver) and then the patient is returned to the sitting position with the chin down. The author believes it is important for the patient to keep the head tilted until going to bed and to sleep in this position. This procedure would seem to be difficult to follow rigorously by patients.

Recently, a new quick maneuver was described for geotropic hcBPPV. In the supine position, the patient is first rolled 90° onto the pathological side then after the nystagmus has disappeared, the patient is abruptly rotated 180° to the contralateral side and kept in that position for 2 min, then the patient is allowed to sit back [51].

Apogeotropic variant of hcBPPV (canalolithiasis, cupulolithiasis)

The apogeotropic variant is characterized by a horizontal positional nystagmus which beats towards the uppermost ear when the supine roll test is performed

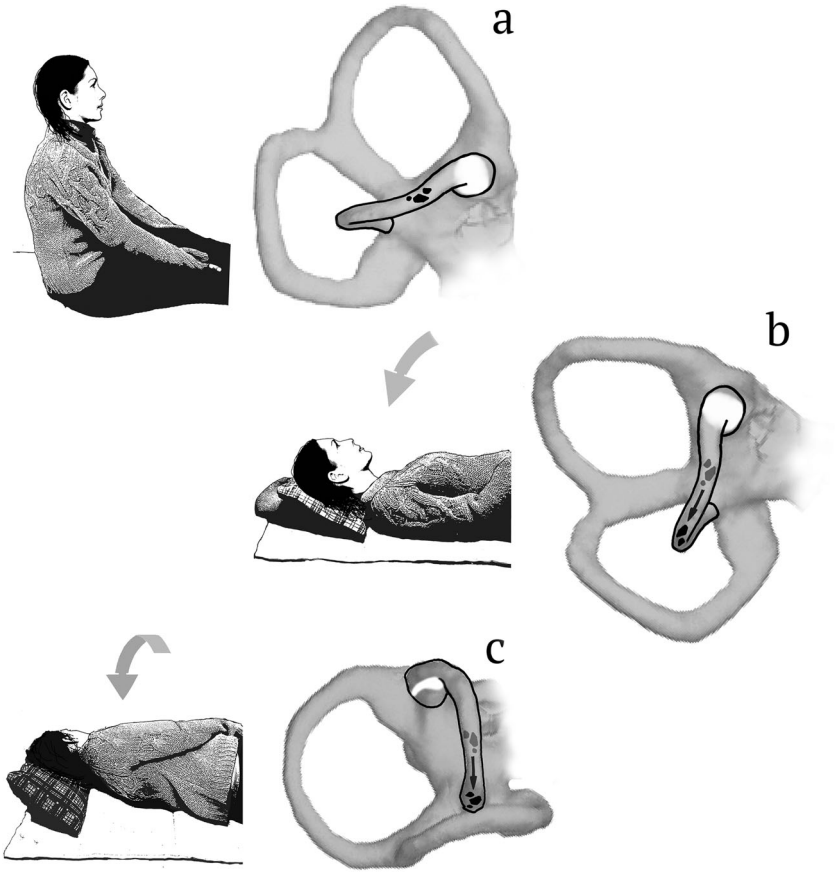

Fig. 4. Forced Prolonged Position for geotropic left hcBPPV. **a** Start from the sitting position (head facing straight forward). **b** The patient lies down in the supine position. **c** The head of the patient is turned 90° to the healthy side (right). This position should be maintained for 12 h. The relative orientation of the posterior canal and otoconial movements is displayed in the center of the figure.

and is most intense towards the affected side, https://collections.lib.utah.edu/ark:/87278/s61p1xt1. Apogeotropic positional nystagmus is usually attributed to cupulolithiasis: when the head is rotated to one side, the cupula is displaced downward because of the mass attached to it. Another hypothesis is that a canalolithiasis can also provoke apogeotropic nystagmus if debris is located anteriorly, close to the ampulla of the hc. In this case, the dislodged otoconia would move in the opposite direction with respect to the geotropic variant.

In patients with the apogeotropic variant, one can try to convert the positional nystagmus into the more treatable geotropic variant, by changing the position of free otoconia in the canal. This can be achieved by performing the Barbecue position, the FPP, or Gufoni's maneuver on the affected side, instead of on the healthy side. Sometimes, it is also possible to convert the apogeotropic variant into the geotropic one with head movements in the sagittal plane [52]. Once the change of nystagmus direction has been verified with diagnostic maneuvers, it is necessary to repeat the treatment on the opposite side (two-step treatment). In fact, sometimes the second step is not necessary because the

patients are already cured. Incidentally, when the conversion from the apogeotropic variant into the geotropic one is easily obtained, the theory of canalolithiasis is much more probable, regardless of the intensity and duration of positional nystagmus.

Good results have been obtained with a one-step treatment using a modified Gufoni's maneuver which is performed on the affected ear and with the patient's head turned 45° upward instead of downward [53]. The most promising new method for treatment of the apogeotropic hcBPPV variant has recently been proposed by Zuma e Maia in 2016 [54•]. From the sitting position, the patient is quickly positioned on the affected side, as in Gufoni's maneuver. Then the head is rotated 90° towards the healthy ear (nose up). After this, the whole body is moved to the supine position and the head is again rolled towards the unaffected side. Finally, the patient's head is tilted slightly forward and the patient returns to the sitting position. Each position should be maintained for 3 min. This technique requires validation.

Recently, a new maneuver has been proposed for apogeotropic hcBPPV. It consists of mastoid vibration of the affected ear with the head turned 135° to the lesion side in the supine position. It seemed to be effective in a preliminary study [55].

Similarly to pcBPPV, both a canal switch (to pcBPPV or acBPPV) and/or post-maneuver dizziness can occur after physical treatment for hcBPPV. The management is the same as for pcBPPV.

Variants whose treatment is a matter of some debate: physical treatment

acBPPV treatment

acBPPV diagnosis can be really challenging both in understanding its mechanism and identifying the affected side. With a presumed canalolithiasis, the Dix-Hallpike and/or deep head-hanging maneuvers elicit a positional downbeat nystagmus often without a torsional component, https://collections.lib.utah.edu/ark:/87278/s6hq7wmw. When the torsional component is absent, it is difficult to define the affected side. Reversal of nystagmus is rarely observed when resuming the sitting position while vertigo is more severe on returning to the upright position than when lying down [31].

Since acBPPV (positional downbeat nystagmus) and apogeotropic hcBPPV must be distinguished from central vestibular disorders, the role of physical treatment is fundamental both for improving vertigo spells and confirming the peripheral origin of the disorder when positional nystagmus disappears or is transformed into typical pcBPPV [56].

Since 1999, many maneuvers have been proposed to treat acBPPV [10, 57]. The reverse Epley/Epley [58] and Yacovino [59] maneuvers are the most widely adopted treatments for acBPPV. An important advantage of Yacovino's maneuver is that it does not require the affected side to be identified. It consists of four steps separated by 30-s intervals: the patient is first moved from the sitting to the supine head-hanging position, then the head is tilted forward, chin to chest, and finally, the patient sits up (Fig. 5).

The outcome of Yacovino's maneuver seems to be affected by the duration of the positional downbeat nystagmus: patients demonstrating

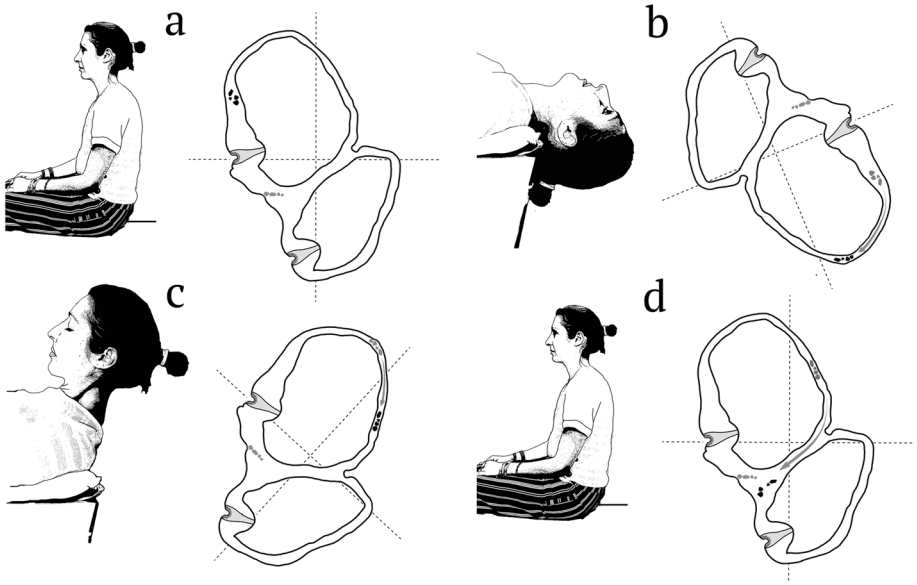

Fig. 5. Yacovino's maneuver for left/right acBPPV. **a** The patient is in the sitting position. **b** The patient is first moved from the sitting to the supine head-hanging position and kept in that position for 30 s. **c** The head is tilted forward, chin-to-chest for another 30 s. **d** Finally, the patient sits up. The relative orientation of the posterior canal and otoconial movements is represented on the right side of the figures.

positional nystagmus lasting for less than 1 min have significantly better outcomes [60].

Despite the fact that there are no controlled studies available on the effectiveness of acBPPV treatment, recent reviews have concluded that acBPPV is an uncommon variant of BPPV and can be treated safely and effectively [10, 61•].

Apogeotropic pcBPPV

This pcBPPV variant has been described recently and the studies support the idea that positional downbeating nystagmus attributed to acBPPV may also arise from otoconia displaced in the long arm of the pc (close to the common crus) [62, 63•]. In these patients, a torsional component of the positional downbeating nystagmus and reversal in the sitting position are often present. Furthermore, more than 40% of patients with a diagnosis of acBPPV had or will develop a typical pcBPPV [31]. Recently, a transient downbeating nystagmus on sitting up has been described just after the Epley maneuver in pcBPPV [64].

Two maneuvers have been proposed to treat apogeotropic pcBPPV: the "demi Semont maneuver" and the "45° forced prolonged position" [11]. The decision on which to choose can be made on the basis of the patient's movement restrictions.

The demi Semont maneuver consists of a contralateral "half Semont" with the head turned 45° to the healthy side. In detail, the patient's head is turned by 45° to the healthy side, then he/she is brought onto that side. The patient should not be moved too rapidly but has a final sharp deceleration (similar to Gufoni's maneuver) to avoid strong ampullopetal endolymphatic flow that would push the debris towards the ampullary arm of the canal. A liberatory

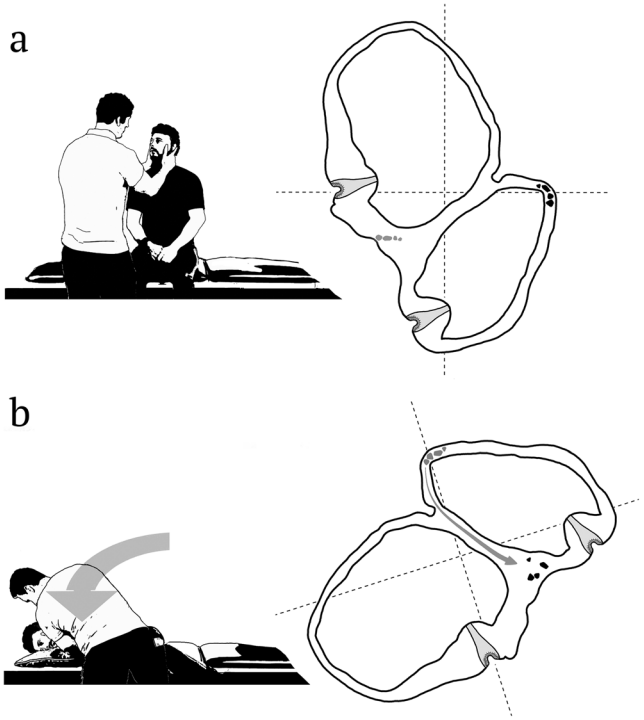

Fig. 6. Demi Semont's maneuver for left apogeotropic pcBPPV. **a** The patient's head is turned 45° to the healthy side (right). **b** The subject is brought onto that side. The patient should not be moved too rapidly but has a final sharp deceleration (similar to Gufoni's maneuver) to avoid strong ampullopetal endolymphatic flow. Finally, after 30 s, the patient is brought back quickly to the sitting position (not represented in the figure). The complete sequence of movements is repeated five times. The relative orientation of the posterior canal and otoconial movements is represented on the right side of the figures.

nystagmus (opposite direction) may be observed in this position. Finally, after 30 s, the patient is brought back quickly to the sitting position. The complete sequence of movements is repeated five times (Fig. 6).

The 45° forced prolonged position can free the canal from debris through gravity: the patient should lie down on the healthy side with head turned 45° downwards. Since it is suggested that the position should be maintained for 8 h, the patient should complete the maneuver at home.

Subjective BPPV

Subjective BPPV meets all of the diagnostic criteria for BPPV apart from the presence of positional nystagmus [65]. This entity is largely debated but it is not unreasonable to suggest that the amount of otoconia may have insufficient mass to trigger nystagmus but can provoke symptoms. The possible treatments are the same as for classic BPPV and seem to be effective [66].

Self-administered physical therapy

Self-administered maneuvers for treating BPPV should not be recommended because recurrences may not arise in the same canal. In a recent study, it was

reported that only 24% of recurrences are from the same side and the same canal [67••].

BPPV: medical treatment

Vestibular suppressant medications (antihistamines and/or benzodiazepines) are not recommended treatments in acute BPPV [14••]. The role of medical therapy is much more important in the case of comorbidities that may have developed before or after BPPV and significantly decrease the quality of life of the patient. Anxiety/depression and residual dizziness are frequent findings in BPPV patients and can affect both maneuver efficacy [68] and long-term disability [69]. Their specific medical treatment may be of importance.

Among conditions that may predispose the patient to detachment of otoconia from the utricular maculae are low serum vitamin D levels and disorders of bone metabolism. These seem to be an emerging risk factor that could easily be treated medically [70, 71••]. Increased recurrences [72] and canalolithiasis rather than cupololithiasis [73] BPPV seem to be related to a low serum level of vitamin D. Comorbidities such as migraine [74] and persistent postural perceptual dizziness [75] should be treated.

Mechanical/motorized chair-assisted treatment

In the case of refractory/multi-canal BPPV or in special cases (severely obese subjects), particle repositioning chairs (sophisticated patient positioning systems) may be adopted [76, 77]. The drawbacks of these mechanical or motorized chairs are represented by the possible anxiety of the subjects (being firmly tied on the chair and moved only passively) and by availability/instrument cost.

Surgical treatment

Intractable severe cases due to persistent BPPV (5–10%) may be treated with surgical plugging of a semicircular canal [78]. These procedures seem to be safe and effective but should only be indicated after a long follow-up and when there are no recurrences in different canals or when both sides are involved [79]. Recently, transtympanic steroid treatment has been proposed for recurrent BPPV [80]. Rare cases when surgical approaches may be advocated are related to intractable BPPV due to pneumolabyrinth after inner ear surgery [81].

Conclusions

Since complete recovery of patients from BPPV should be defined as the absence of positional nystagmus and symptoms during daily life activities [82], the primary evidence-based treatment strategy for BPPV should be physical therapy through maneuvers (Table 1). Despite the high success rate of liberatory maneuvers, there is a low percentage of subjects with unsatisfactory outcomes [83]. These patients need to be investigated to identify recurrences, multiple canal involvement, associated comorbidities (migraine, persistent postural perceptual dizziness), risk factors for recurrences (low vitamin D serum

Table 1. Practical recommendations for BPPV treatment

BPPV variant	Level 1 EBM physical treatment	Other physical treatments	Medication, movement restrictions	Mechanical chairs	Surgical canal plugging
pcBPPV	Semont's maneuver [18] https://collections.lib.utah.edu/ark:/87278/s6614x1v (no movement restrictions) Epley's maneuver [19] https://collections.lib.utah.edu/ark:/87278/s6s79d1w (movement restrictions)		Vestibular suppressant not recommended	In intractable cases or in patient with severe movement restrictions	In intractable and really disabled cases (not multiple canals)
hcBPPV	Gufoni's maneuver [46] https://collections.lib.utah.edu/ark:/87278/s6q55z98 (no movement restrictions)	Barbecue roll [43] https://collections.lib.utah.edu/ark:/87278/s6kd56mc Forced prolonged position [48] (movement restrictions) Zuma's maneuver [54•]	Normalize vitamin D serum level in recurrences Treat comorbidity (PPPD, migraine, etc.)		
acBPPV	/	Jacovino maneuver [59]			
Apogeotropic pcBPPV	/	Demi Semont maneuver [11] 45° forced prolonged position [11]			

pcBPPV posterior canal BPPV, *hcBPPV* lateral canal BPPV, *acBPPV* anterior canal BPPV, *EBM* evidence-based medicine, *PPPD* persistent postural perceptual dizziness

level), or previous inner ear surgery. Furthermore, it is mandatory to obtain the best possible differential diagnosis with central vestibular disorder in intractable cases. In this view, absence or transformation of positional nystagmus after a maneuver seems to be the fastest and most effective treatment option. Chair-assisted treatment may be of help if available, while surgical canal plugging should be indicated in selected same-canal, same-side intractable BPPV [84].

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Compliance with Ethical Standards

Conflict of Interest
Marco Mandalà declares that he has no conflict of interest. Lorenzo Salerni declares that he has no conflict of interest. Daniele Nuti declares that he has no conflict of interest.

Human and Animal Rights and Informed Consent
This article does not contain any studies with human or animal subjects performed by any of the authors.

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- • Of importance
- •• Of major importance

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