The Journal of International Advanced Otology

J Int Adv Otol 2021; 17(4): 353–360 • DOI: 10.5152/iao.2021.9434

Review

Repositioning Chairs in the Diagnosis and Treatment of Benign Paroxysmal Positional Vertigo – A Systematic Review

Serkan Abdulovski, Mads Klokker

Copenhagen Hearing and Balance Center, Department of Otorhinolaryngology Head and Neck Surgery and Audiology, Rigshospitalet Copenhagen University Hospital, Copenhagen, Denmark

ORCID IDs of the authors: S.A. 0000-0001-7351-5476; M.K. 0000-0002-4230-4251

Cite this article as: Abdulovski S, Klokker M. Repositioning chairs in the diagnosis and treatment of benign paroxysmal positional vertigo - A systematic review. *J Int Adv Otol.* 2021; 17(4): 353-360.

Multi-axial repositioning chairs such as the TRV chair and the Epley Omniax Rotator (EO) are newer alternatives in the treatment of complex and recurrent cases of the common peripheral vertigo disorder, benign paroxysmal positional vertigo (BPPV). The objective of this systematic review is to collect and synthesize current knowledge on the clinical characteristics of repositioning chairs for treatment of BPPV. A systematic search of the PubMed and EmBase databases was conducted and data regarding clinical characteristics were extracted from both retrospective and prospective studies, and a qualitative synthesis was made. Of 36 unique publications, 9 studies were considered eligible, containing data from 3383 subjects. No randomized controlled trials were found. The included studies were found to have a high risk of bias and the overall quality of evidence was low. The type of referred patients and follow-up periods varied. Recurrence rates varied between 11% and 27.9%. Incidence of rarer types of BPPV was higher in the included studies than previous estimates. The rate of symptom relief was high, and clinical outcomes were similar between posterior canal BPPV (p-BPPV) and non-P BPPV. The included studies show repositioning chairs to be a safe and effective treatment for BPPV, especially for rarer forms and in patients unable to perform manual treatment. However, data from randomized controlled trials are needed to compare with conventional methods to examine their efficacy, to determine indications for treatment, and to decide whether they should be used as first-line treatment.

KEYWORDS: Dizziness, imbalance, TRV, Epley Omniax

INTRODUCTION

Benign paroxysmal positional vertigo (BPPV) is the most common vestibular disorder across all ages, and accounts for 14-42% of vertigo cases.[1,2] The disease has a lifetime prevalence of 2.4%, being twice as high in women compared to men, and a cumulative incidence at 80 years of around 10%. The highest incidence is found between 50 and 70 years of age, although BPPV occurs across all age groups.[3] BPPV is characterized by short transient episodes of vertigo associated with head movement. Most cases of BPPV are idiopathic, but several causes of secondary BPPV have been described. These include head trauma (17%), vestibular neuritis (15%), vertebrobasilar ischemia, labyrinthitis, or as a complication of middle ear surgery. Approximately 10% of BPPV cases have shown to be secondary rather than idiopathic.[4]

Presently, there are 2 main models describing the pathology of BPPV, canalolithiasis (CAN) and cupulolithiasis (CUP). The first theory (Brandt's Theory) being that displaced free-floating utricular otoconia in the semicircular canals (most commonly the posterior) cause an endolymphatic current resulting in cupular displacement. The other theory (Schuknecht's Theory) hypothesizes that otoconia become adherent to the cupula, which causes a gravitational pull that in turn causes cupular displacement.[1] The traditional management of BPPV has relied on manual maneuvers for both diagnosis and treatment.

Corresponding author: Mads Klokker, e-mail: klokker@rh.dk

Received: September 11, 2020 • **Accepted:** November 28, 2020

Available online at www.advancedotology.org

Diagnosis of BPPV is made based on clinical characteristics. Because dizziness and vertigo are symptoms of several conditions, one must consider other causes before making the diagnosis of BPPV. In atypical or refractory cases, it is mandatory to perform complete otoneurologic and other examinations in order to rule out central positional vertigo, multiple sclerosis, vestibular migraine, or vascular causes such as vertebrobasilar insufficiency or transient ischemic attacks. In addition, other otologic causes like Meniere's disease, vestibular neuritis, or perilymphatic fistula must be considered. Furthermore, non-neurological and non-otologic causes like side effects of medication, cervicogenic vertigo, postural hypotension, or mental and psychiatric disorders (e.g., anxiety) also have a place in the differential diagnosis.[2]

For posterior canal BPPV (*p*-BPPV), the diagnosis is made using the Dix–Hallpike test (DHP), where a positive test provokes vertigo with a short latency period, along with vertical upward beating nystagmus with a torsional down-beating component.[2] The diagnostic maneuver of choice for horizontal canal BPPV (*h*-BPPV) is the supine roll test, where a positive test provokes horizontal nystagmus of either a geotropic or apogeotropic type (depending on the sub-type of *h*-BPPV). The *h*-BPPV is managed using maneuvers such as the Gufoni or Barbeque maneuver. The efficacy of these maneuvers has been proven in randomized controlled trials.[2,5-7] The *h*-BPPV has previously been estimated to account for 6-10% of cases.[8]

BPPV affecting the anterior semicircular canal (*a*-BPPV) has been controversial and is rarely seen, and *a*-BPPV accounts for up to 1-2% of cases. The clinical characteristics of *a*-BPPV is down-beating nystagmus with a less pronounced torsional component following DHP-testing or straight head-hanging. Treatment options are the Epley Maneuver for the affected contralateral ear (reverse Epley) or other less-used maneuvers (the forward flip, the bend-over). An important differential diagnosis regarding the nystagmus pattern observed in *a*-BPPV is various cerebellar and brainstem lesions, which may present similarly when it comes to the nystagmus observed.[9]

The Epley Maneuver, introduced in 1992 by the pioneer Dr. John Epley, is the main treatment option for *p*-BPPV and has been shown to be a safe and effective option for treatment, in randomized controlled trials.[4] Since *p*-BPPV accounts for around 85-95% of cases, most simple cases can be managed using traditional canalith repositioning positioning (CRP) maneuvers using an examination bed, and also include other conventional methods (Semont's Maneuver, Brandt-Daroff Exercise, etc.).[10]

Issues arise in diagnosis and treatment of BPPV in more complicated cases, like those affecting the horizontal or anterior canal, multiple canals, and in patients where manual repositioning is contraindicated or non-effective. The diagnosis using conventional methods is sometimes inadequate (10-20% of cases) and has shown to be a challenge even for specialists. Treatment outcome has also shown to be negatively impacted by factors such as age, secondary etiology, head trauma, and osteoporosis.[8,11,12] These unmanaged cases can place a large burden on healthcare and society because of the invalidating nature of the condition.[2]

In light of these challenges, alternatives to conventional maneuvers have been developed, centered around multi-axial chairs that allow the patient to be rotated 360° in all planes while strapped up in a sitting position, eliminating neck and back rotation during therapeutic and diagnostic maneuvers. Presently, the 2 main chairs in use are the Epley Omniax Rotator (EO) developed by Dr. Epley, and a chair later developed by Dr. Thomas Richard-Vitton (TRV chair); newer rotation chairs have also been introduced (the Swiss Rotundum and the Chinese VertiChair). Both the TRV and the EO utilize infrared videonystagmography goggles (VNG) for monitoring eye movement simultaneously with rotation. The TRV is manipulated by hand while the EO is remote-controlled.[8,11,13]

The purpose of this review is to give a systematic overview of peer-reviewed publications regarding diagnosed BPPV subtypes, treatment outcomes, recurrences, and number of treatments needed using multi-axial repositioning chairs in the management of both simple and complicated cases of BPPV. Furthermore, the purpose is to reveal indications and contraindications for the use of repositioning chairs, and any adverse effects of treatment if reported.

METHODS

Eligibility Criteria

A number of criteria were set before the systematic search was conducted. These criteria were used for the selection of studies eligible for inclusion in the review.

Type of Studies

Prospective and retrospective studies

Participants

Patients across all age groups diagnosed with BPPV, both simple and refractory/recurrent cases, including patients where manual repositioning was not possible or had been contraindicated

Intervention

BPPV treatment with a multi-axial repositioning chair

Comparisons Sought After

Manual repositioning vs chair repositioning
Chair repositioning vs no treatment
Chair repositioning vs placebo

Primary Outcome

Absence of vertigo symptoms or negative DHP, supine roll, or another diagnostic test

Secondary Outcomes

Adverse effects and/or complications related to treatment

Recurrences

Number of treatments needed

Search Strategy

The PubMed and Embase databases were systematically searched on the date of June 29, 2020, with no restrictions on publication date.

The PubMed search string was: (("Benign Paroxysmal Positional Vertigo"[Mesh]) OR BPPV) AND (TRV OR multi-axial positioning chair OR Epley Omniax OR Biaxial rotational chair OR repositioning chair).

The Embase search string was: (((BPPV or benign paroxysmal positional vertigo) and TRV) or Epley Omniax or Biaxial rotational chair or multi-axial positioning chair or repositioning chair).

Screening for Eligibility

The titles and abstracts found as a result of the search were then screened for eligibility. Duplicates were removed using a reference manager (EndNote). Full texts of relevant records were then retrieved and examined for whether they met the inclusion criteria. Other studies were found using reference lists. Data from unpublished studies were not included in this review.

Data Extraction

The following data were extracted from the included studies:

- Study design
- Number of participants
- Type of repositioning chair (TRV, EO, or others)
- Treatment maneuvers used
- Treatment outcome with regard to relief of symptoms or negative diagnostic test
- Number of treatments necessary for success
- Indications/contraindications
- Types of BPPV diagnosed/treated
- Adverse effects/complications
- Follow-up period
- Recurrence of BPPV

RESULTS

A total of 47 search hits were reduced to 36 records after duplications were removed (Figure 1). Out of these, 13 studies turned out to be within the topic of repositioning chair treatment of BPPV and were selected for full-text review. However, a further 3 studies were excluded due to foreign (non-English) language. One study was excluded because it focused on a non-multi axial chair only suitable for *a*-BPPV and was therefore not deemed relevant for inclusion in the context of this review. A total of 9 studies were considered eligible and included in this review,[8,10,11,13-18] containing data from 3383 subjects (Figure 1). No randomized controlled trials were found as a result of the search. The search was last updated on June 29, 2020.

The setting for all of the included studies were specialized otorhinolaryngology units. Four of them were located in a hospital setting[8,10,16,17] and the rest were conducted in a specialized outpatient clinic.[11,13-15,18] Five of the studies were retrospective, while 4 studies were prospective. One study compared the TRV chair treatment with the manual Epley Maneuver prospectively, with no description of a randomized allocation or blinding (Table 1).

No uniform statement of indications for chair treatment was expressed in the included studies (Table 1). Patients were referred with complaints of positional vertigo and recurrent/refractory BPPV, along with patients where manual repositioning was not possible or because of contraindications when using manual maneuver. One study included subjects who did not experience true vertigo but rather an unsteadiness coupled with positional nystagmus, which turned out to be treatable using the TRV chair.[13]

Three of the included studies used the EO chair and another 3 used the TRV, while 1 study used a combination. In 1 study, the specific chair type was not disclosed. One study used a prototype of the EO multi-axial chair developed by Dr. Epley.[18] For the purpose of this review, the different chair types were regarded as the same when evaluating treatment efficacy, due to the similarity in treatment maneuvers used across the different chair types included. In all studies, diagnosis of BPPV and pinpointing the affected canal was found through diagnostic maneuvers using VNG goggles. The different treatment maneuvers used are listed in Table 1.

No serious adverse effects were reported with treatment using repositioning chairs. Minor adverse effects were reported in 1 study with 12 patients suffering from nausea and sweating while undergoing treatment in the TRV chair, whereas the same side effects were observed in 10 patients undergoing manual CRP.[10] Another study reported claustrophobia in 2 patients, which prevented further treatment.[8] Wang et al. reported 1 incident of treatment refusal due to severe coronary heart disease.[17]

The evaluation of diagnostic tests and treatments were consistent and comparable. However, the numbers of BPPV cases in each study differed much, from 31 to 986. Likewise, the different subtypes of BPPV were varied, from only one sub-type (*p*-BPPV) in 2 studies to a comprehensive enumeration including CAN and CUP in 4 studies. Some studies even included canalith jam and bilateral BPPV (Table 2).

Treatments were mostly considered successful and effective in the absence of positional nystagmus and vertigo during a subsequent diagnostic maneuver. One study reported symptom relief along with a number of patients cured. Symptom relief was accomplished in 91.7-100% of the cases after treatment, with 57% of cases being completely cured. Eleven patients (12%) were lost in the follow-up, which the authors suggest could indicate that the number of completely cured patients was higher than reported.[8]

Three studies reported very high successful treatment rates. Richard-Vitton et al.[13] successfully repositioned all included patients who first presented symptoms with minor positional dizziness or unsteadiness, with positional nystagmus. In another study by Wang et al.[17] treatment was successful in 97.12% of cases, with 2.88% being effective. One study had 97% improvement both subjectively and objectively after 3 treatments using a 360° maneuver.[18] Power et al.[16] reported a slightly lower success rate of 86%, which the authors attributed to high percentage of refractory BPPV (24%), where the patients underwent several manual maneuvers ineffectively before being treated with a repositioning chair. Two studies reported a significantly lower treatment rate of 66.4-68.8%.[14,15]

The only prospective study comparing chair treatment with manual maneuvers reported better treatment outcome with negative DHP after the first week, in the TRV group compared to the manual CRP group (85.2% vs. 72.6% $P < .05$), but could not demonstrate statistically significant difference 4 weeks, 3 months, and 6 months later. The TRV group needed a lower number of treatment sessions for successful repositioning than the manual CRP group.[10]

One study reported a significant difference between *p*-BPPV and non *p*-BPPV (2.4 vs. 3.4 treatments on average, $P = .01$).[15] West et al.[8] found

Table 1. Overview of Studies Included for Review

Author(year)	Sample Size, *N* (Diagnosed With BPPV)	Patient Group/ Indication	Maneuvers Used	Chair Type	Study Design	End Point/Outcome
Tan et al.[10]	165 (165)	Unilateral *p*-BPPV	Repositioning maneuver for *p*-BPPV	TRV	Prospective study	Treatment efficacy of TRV compared to Epley maneuver for *p*-BPPV
West et al.[8]	150 (95)	Refractory BPPV or suspected BPPV	Epley, Semont's, Barbeque, and maneuvers for a-BPPV	TRV and EO	Retrospective study	Treatment of different types of BPPV using the TRV and Epley Omniax chair
Luryi et al.[14]	34 (34)	BPPV in patients unable to undergo manual treatment	Canalith repositioning maneuvers with no further specification	EO	Retrospective study	Treatment efficacy of the Epley Omniax chair used for BPPV in patients unable to undergo manual treatment
Power L. et al.[16]	216 (79)	Recurrent and refractory BPPV, non-posterior canal BPPV, and patients in whom manual repositioning and assessment were contraindicated	Epley, reverse or forward 360° somersault and Barbeque	EO	Retrospective study	Treatment efficacy of Epley Omniax chair for different types of BPPV and patient groups
Nakayama[11]	986 (833)	Patients with complaints of positional vertigo	Canalith repositioning. Backward 360° while 45° to ipsi Side BBQ 360° roll: ipsi for CUP, contra for CAN. Forward 360° while 45° to contra side + mastoid oscillation in some cases	EO	Retrospective study	Diagnosis and treatment of BPPV with EO chair
Richard-Vitton[13]	465 (152)[a]	"Patients who felt unsteadiness but described no true vertigo in the presence of positional nystagmus"	Epley, Semont, "DBM," or Lorin maneuver	TRV	Prospective study	Uncovering a new sub-type of BPPV using the TRV chair
Wang et al.[17]	726 (209)	Patients presenting with vertigo and unsteadiness	Epley, Semont, "DBM," Barbeque, or Lorin maneuver	TRV	Prospective study	Characteristics of BPPV with regard to age and gender, using the TRV chair
Luryi[15]	610 (610)	Patients diagnosed and treated for BPPV using a PRC	Particle repositioning maneuvers with no further specification	Not disclosed	Retrospective study	Diagnosis and treatment of BPPV using a particle repositioning chair
Li[18]	31 (31)	Patients presenting with BPPV	360° maneuver	Multi-axial chair (prototype of "EO")	Prospective study	Subjective and objective improvement outcomes

[a]109 patients were diagnosed with canalolithiasis which was treated with TRV.
TRV, Thomas Richard-Vitton chair; EO, Epley Omniax chair; PRC, particle repositioning chair.

that multi-canal BPPV and horizontal CUP (*h*-CUP) cases required a high number of treatments (7 treatments on average for both types), while no significant difference was found between posterior CAN (*p*-CAN) compared with posterior CUP (*p*-CUP) and horizontal CAN (*h*-CAN). Power et al.[16] also found that multi-canal BPPV required a higher number of treatments compared to single-canal BPPV, and that CUP required a higher number of treatments (4 on average) (Table 3).

No consistency in follow-up periods were observed. In this aspect, the studies varied much. Some studies had a short follow-up of

Table 2. Overview of BPPV Subtypes

Author (Year)	Sample Size, *N* (Diagnosed With BPPV)	*p*-BPPV	*h*-BPPV	*a*-BPPV	Multi-canal BPPV	Other Characteristics
Tan et al.[10]	165 (165)	165 (100%)				
West et al.[8]	150 (95)	Canalolithiasis (*p*-CAN): 43(45.3%), Cupulolithiasis (*p*-CUP): 11(11.6%) 68%[c]	Canalolithiasis (*h*-CAN): 7 (7.4%), Cupulolithiasis (*h*-CUP): 9 (11.6%) 32%[c]	1[a]	25(23.3%)	
Luryi et al.[14]	34 (34)	62%[b]	26.5%	11.7%	14.7%	Bilateral BPPV: 17.6% of all cases
Power L. et al.[16]	216 (79)	*p*-CAN: 67*p*-CUP: 287%	*h*-CAN: 6*h*-CUP: 2 10%	*a*-CAN: 23%	45% (of all cases)	
Nakayama[11]	986 (833)	55364%[b]	8410.1%[b]	192.3%[b]	17721.3%[b]	CAN:705, CUP:93, Canalith jam: 32, Unknown:3
Richard-Vitton[13]	465 (152)	*p*-CAN: 1211%[b]	*h*-CAN: 9789%[b]			
Wang et al.[17]	726 (209)	*p*-CAN: 135 *p*:CUP: 564.81%	*h*-CAN: 52*h*-CUP: 1129.17%	a-CUP:136.02%	7 (of all cases)	
Luryi[15]	610(610)	81%	12.6%	6.7%	6.6% (of all cases)	Bilateral BPPV: 32.3% of all cases
Li[18]	31(31)	100%				Bilateral BPPV: 12% of all cases

[a]One case of anterior canalolithiasis was found along with *p*-CAN.
[b]Percentages were calculated by the author.
[c]All cases affecting the reported canal, including those with multi-canal affection.
p-BPPV, posterior-BPPV; *h*-BPPV, horizontal-BPPVl; *a*-BPPV, anterior-BPPV; CAN, canalolithiasis; CUP, cupulolithiasis; neg, negative.

3-14 days, while others had up to 6 months, and a single study with a follow-up of 6 years for some patients (Table 3).

Three studies reported a low relapse rate of 11-13%.[8,14,16] Luryi et al. reported a relapse rate of 27.3-27.9%.[15] West et al. found no statistically significant difference in recurrences between the different BPPV groups.[8]

DISCUSSION

The reviewed studies support that non-*p*-BPPV, multi-canal BPPV, and CUP are more difficult to manage, requiring significantly more treatments than *p*-CAN, even when using repositioning chairs.[8,15,16] It is also suggested that *p*-CAN can be managed with similar outcomes using manual CRP.[10] Despite requiring a higher number of treatments, the treatment outcomes for non *p*-BPPV using repositioning chairs are favorable and similar to those with *p*-BPPV.[15]

Two studies segregated with lower treatment efficacy in general across all groups. For 1 of the studies, this can be explained by low sample size ($n = 34$) or a high number of cases of non *p*-BPPV (38.2%) and multi-canal involvement (14.7%).[14] Another study had a non *p*-BPPV group of 19%, and 7% of subjects also suffered from Meniere's disease, which could have contributed to the low success rate.[15] A lower rate of symptom relief was found in the group of patients with multi-canal affection. (91.7%) [8] This was also the case in another study where the only group that did not see significant improvement in all patients after 4 or more sessions was the multi-canal BPPV group.[11]

In particular, non *p*-BPPV seems to be overlooked and improperly managed, even by neurologists or otorhinolaryngologists. Furthermore, due to the invalidating nature of the disease, combined with the psychosocial and economic impact along with risks such as falling in the elderly, cases of BPPV have proved to be a challenge in primary care, with regard to diagnosis and proper and effective treatment.[8,15,19] The reviewed studies provide evidence that the use of repositioning chairs along with VNG monitoring provides a valuable tool for both an accurate diagnosis and effective treatment. Only 1 of the included studies used both the TRV and the EO or a combination of both. The authors of this study speculated that the unique ability of the TRV chair to use shocks for manipulating otoliths could be a more effective way to deal with CUP and jammed otolith particles. Randomized controlled trials comparing the 2 chairs is desirable to provide an insight in this matter.[8]

From the distribution of BPPV types summarized in Table 2, it is shown that not all of the included studies distinguish between CUP or CAN and other BPPV subtypes, and only specify the affected semicircular canal (SC) of the subjects. When examining the numbers of cases with BPPV affecting the horizontal SC (HSC), 3 studies reported incidences of 26.5%, 29%, and 32%,[8,14,17] while 1 study reported as much as 89% of cases having affection of the HSC. It should be noted that subjects in this study presented unusual clinical characteristics with no true vertigo, and therefore could have been selected.[13] Other studies have previously indicated that 6-10% of BPPV affects the HSC.[8] This difference could also be due to the patients being referred to chair treatment for refractory BPPV, or it could be due to higher sensitivity in the diagnosis made with chairs with better VNG monitoring.

Table 3. Treatment Characteristics and Results

Author (year)	Sample size, *N* (Diagnosed WITH BPPV) [Treated Using PRC]	Treatment Outcome		Follow-Up Period	Number of Treatments/ Sessions Needed	Recurrences	Adverse effects or Complications
Tan et al. (2014) [10]	165 (165) [81]	TRV group: Neg. DHP: 1 w: 85.2%, 4 w: 92.6% , 1 m: 95.1% , 6 m: 97.5%		1 week, 4 weeks, 3 months, 6 months	Maneuvers: 4 w: 1.20 ± 0.46 3 m: 1.31 ± 0.68 6 m: 1.38 ± 0.75	Yes, but no data disclosed	Yes (nausea and sweating, $n = 12$)
West et al. (2015) [8]	150 (95) [95]	Symptom relief: *p*-CAN[a]: 97.1%, *p*-CUP: 100%, *h*-CAN: 100%, *h*-CUP: 100%, Multi-canal: 91.7%	Complete resolution: 57%, Symptom reduction: 28%, 3% not cured, 12% lost to follow-up	6 months	Treatments: *p*-CAN: 2 *p*-CUP: 3 *h*-CAN: 2 *h*-CUP: 7 Multi-canal: 7 (Mean)	*p*-CAN: 5 *p*-CUP: 1 *h*-CAN: 0 *h*-CUP: 1 Multi-canal: 4 (12%)	Yes (claustrophobia, $n = 2$)
Luryi et al. (2018) [14]	34 [34]	Symptom relief + neg. diagnostic test: 68% of all cases		6 days to 6 years	Treatment visits: 1-6 (median:1) Maneuvers: 1-18(mean 2.4)	3 (13% of previously resolved BPPV)	No
Power et al. (2019) [16]	216 (79) [79]	Neg. Diagnostic test: 86% of all cases 9% declined further treatment 5% lost to follow-up		7-14 days	Maneuvers: p-CAN: 2 h-CAN: 2 a-CAN: 2 Multi-canal: 4.25 Bilateral p-CAN: 3.28 CUP: 4	9 (11%) over 2 years	no
Nakayama (2005) [11]	986 (833) [833]	Absence of positional nystagmus and vertigo at follow-up: p-BPPV: 100% a-BPPV: 100% h-BPPV: 100% Multi-canal: 92.1%	CAN: 100% CUP: 92.5% Canalith jam: 87.5%	-	1-3 sessions	-	no
Richard-Vitton (2011) [13]	465 (152) [109]	Neg. Diagnostic test and relief of unsteadiness 100%		3 days	1.6 maneuvers on average	-	no
Wang et al. (2014) [17]	726 (209) [209]	Neg. diagnostic test + no vertigo or nystagmus (success): 97.12% Effective: 2.88%		1 week	1 or 2 sessions	-	no
Luryi (2018) [15]	610 (610) [610]	Symptom relief + neg. Diagnostic test: p-BPPV: 68.8% non p-BPPV: 66.4% $P \geq .05$		No specific follow-up periods were reported	Treatment visits: p-BPPV: 2.4 non p-BPPV: 3.4 (mean) $P = .01$	p-BPPV: 27.9%, non p-BPPV: 27.3% $P \geq .05$	no
Li (2006) [18]	31 (31)	Subjective improvement: First session: 90%, second session: 93%, third session: 97%	Objective improvement: first session: 71%, second session: 90%, third session: 97%	2 weeks	1-3 sessions		no

[a]Conventional Epley was used in p-CAN cases along with chair treatment.
p-BPPV, posterior-BPPV; *h*-BPPV, horizontal-BPPVl; *a*-BPPV, anterior-BPPV; CAN, canalolithiasis; CUP, cupulolithiasis; neg, negative; PRC, particle repositioning chair.

The same argument can be applied to explain the higher incidence of multi-canal affections.[8]

One of the aims of this review was also to examine the indications for treatment in a repositioning chair, as very different indications for chair treatment currently exist.[14] It seems that the indications for repositioning chairs varied in the included studies. Specifically, 2 studies reported indication of treatment due to inability of successful manual CRP with cervical or lumbar spine disease. Co-morbidities can be a primary indication for chair treatment.[14,16] Likewise, patients with refractory BPPV also showed to benefit from being referred to treatment in repositioning chairs, which therefore is a viable indication.[8,15,16]

Since BPPV is a common condition and maybe even under-diagnosed, the number of people suffering from atypical subtypes is also a sizable number of the population. Taking into consideration that the affected population is primarily among adults and especially the elderly, leading to sick leave, discomfort, worry, and several medical consultations, an argument could be made for using repositioning chairs in first-line treatment for BPPV.[2,3,8] The use of repositioning chairs with positional vertigo as primary indication could lead to a quicker diagnosis and better outcomes, especially considering its effectiveness for refractory or complicated cases of BPPV. However, prospective data are needed, especially studies comparing chair treatment to manual maneuvers such as the Gufoni maneuver, which has proven effective for the management of *h*-BPPV.[20]

Almost no adverse effects were reported in the reviewed studies. Prospective data are needed to uncover cases of otoliths moving from the originally affected canal into another as a complication of treatment, and the safety of treatment for patients with recent cardiovascular events needs to be elucidated. Also, the importance of possible contraindications like claustrophobia, brain aneurysms, or recent cardiovascular events need to be elucidated in detail.

Data regarding recurrences were sparse and heterogenous due to differences in follow-up periods. Recurrence rates for BPPV have previously been reported to be 27%, with 50% of recurrences happening within 6 months of treatment.[21] BPPV cases secondary to head trauma or associated to Meniere's disease or vestibular neuritis are more prone to relapse than idiopathic cases.[1,8,22] Three of the included studies reported a lower recurrence rate of 11-13%, but in 1 of these with a follow-up period of 6 months, it was concluded that a longer follow-up period might have revealed more recurrences.[8,14,16] One of the included studies revealed a higher recurrence of approximately 28%, which can be attributed to recurrences being recorded more than 4 years after treatment was started.[15] More data are needed to accurately assess the recurrence rates after chair treatment. Others have demonstrated that BPPV may also resolve spontaneously in 39 days for *p*-BPPV and 16 days for *h*-BPPV on average, which could account for the similar long-term outcomes between the CRP and TRV group, as seen in one of the included studies.[10,23]

Future studies on this subject should also shed light on the issue of the right setup for treatment in regard to the kind of personnel responsible for treatment, for instance, an otolaryngologist compared to specially trained nurses or other healthcare staff.

The limitations of this review primarily relate to the on the low quality of evidence in the reviewed studies. The studies were either retrospective or prospective without a blinded setup or control group, causing a risk of bias. Moreover, 1 of the included retrospective studies treated *p*-CAN both with manual CRP and repositioning chairs, without randomization which also makes the efficacy of the intervention uncertain.[8]

One prospective study had a comparison intervention, but no description of randomization was reported and the difference between sample sizes for the primary and comparison intervention groups was not explained.[10] These 2 aspects pose a large risk of selection bias. The data in the included studies in this review were heterogenous and sometimes incomplete, in some cases because the studies had different endpoints. We trust that new studies with prospective randomized design will be published in the future, which is highly desired.

CONCLUSIONS

Repositioning chairs like EO and TRV can be valuable tools for treatment of BPPV, especially rare subtypes of BPPV. However, published peer/reviewed studies at present are generally inconclusive regarding indications, recurrences, and treatment outcome. A higher level of evidence is desirable to emphasize whether repositioning chairs should be reserved for recurrent/refractory cases or be used as first-line treatment. Presently, the lack of randomized controlled trials does not allow for direct comparison of treatment efficacy with manual CRP.

Peer Review: Externally peer-reviewed.

Author Contributions: Concept- S.A., M.K.; Design - S.A., M.K.; Supervision – M.K.; Data Collection and/or Processing - S.A., M.K.; Analysis and/or Interpretation - S.A., M.K.; Literature Review - S.A., M.K.; Writing – S.A.; Critical Review – M.K.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Instrum RS, Parnes LS. Benign paroxysmal positional vertigo. *Adv Otorhinolaryngol*. 2019;82:67-76. [CrossRef]
2. Bhattacharyya N, Gubbels SP, Schwartz SR, et al. Clinical practice guideline: benign paroxysmal positional vertigo (update). *Otolaryngol Head Neck Surg*. 2017;156(3_suppl):S1-S47. [CrossRef]
3. von Brevern M, Radtke A, Lezius F, et al. Epidemiology of benign paroxysmal positional vertigo: a population based study. *J Neurol Neurosurg Psychiatry*. 2007;78(7):710-715. [CrossRef]
4. Hilton MP, Pinder DK. The Epley (canalith repositioning) manoeuvre for benign paroxysmal positional vertigo. *Cochrane Database Syst Rev*. 2014;(12):CD003162. [CrossRef]
5. Kim JS, Oh SY, Lee SH et al. Randomized clinical trial for geotropic horizontal canal benign paroxysmal positional vertigo. *Neurology*. 2012;79(7):700-707. [CrossRef]

6. Kim JS, Oh SY, Lee SH et al. Randomized clinical trial for apogeotropic horizontal canal benign paroxysmal positional vertigo. *Neurology*. 2012;78(3):159-166. [CrossRef]
7. Mandalà M, Pepponi E, Santoro GP et al. Double-blind randomized trial on the efficacy of the Gufoni maneuver for treatment of lateral canal BPPV. *Laryngoscope*. 2013;123(7):1782-1786. [CrossRef]
8. West N, Hansen S, Møller MN, Bloch SL, Klokker M. Repositioning chairs in benign paroxysmal positional vertigo: implications and clinical outcome. *Eur Arch Otorhinolaryngol*. 2016;273(3):573-580. [CrossRef]
9. Anagnostou E, Kouzi I, Spengos K. Diagnosis and treatment of anterior-canal benign paroxysmal positional vertigo: a systematic review. *J Clin Neurol*. 2015;11(3):262-267. [CrossRef]
10. Tan J, Yu D, Feng Y et al. Comparative study of the efficacy of the canalith repositioning procedure versus the vertigo treatment and rehabilitation chair. *Acta Oto-Laryngol*. 2014;134(7):704-708. [CrossRef]
11. Nakayama M, Epley JM. BPPV and variants: improved treatment results with automated, nystagmus-based repositioning. *Otolaryngol Head Neck Surg*. 2005;133(1):107-112. [CrossRef]
12. Babac S, Djeric D, Petrovic-Lazic M, Arsovic N, Mikic A. Why do treatment failure and recurrences of benign paroxysmal positional vertigo occur? *Otol Neurotol*. 2014;35(6):1105-1110. [CrossRef]
13. Richard-Vitton T, Viirre E. Unsteadiness and drunkenness sensations as a new sub-type of BPPV. *Rev Laryngol Otol Rhinol (Bord)*. 2011;132(2):75-80.
14. Luryi AL, Lawrence J, LaRouere M et al. Treatment of patients With benign paroxysmal positional vertigo and severe immobility using the particle repositioning chair: A retrospective cohort study. *Ann Otol Rhinol Laryngol*. 2018;127(6):390-394. [CrossRef]
15. Luryi AL, Wright D, Lawrence J et al. Analysis of non-posterior canal benign paroxysmal positional vertigo in patients treated using the particle repositioning chair: A large, single-institution series. *Am J Otolaryngol*. 2018;39(3):313-316. [CrossRef]
16. Power L, Murray K, Szmulewicz D. Early experience with a multi-axial, whole body positioning system in the treatment of Benign Paroxysmal Positional Vertigo (BPPV). *J Clin Neurosci*. 2019;61:186-188. [CrossRef]
17. Wang J, Chi FL, Jia XH, Tian L, Richard-Vitton T. Does benign paroxysmal positional vertigo explain age and gender variation in patients with vertigo by mechanical assistance maneuvers? *Neurol Sci*. 2014;35(11):1731-1736. [CrossRef]
18. Li JC, Epley J. The 360-degree maneuver for treatment of benign positional vertigo. *Otol Neurotol*. 2006;27(1):71-77. [CrossRef]
19. von Brevern M, Lezius F, Tiel-Wilck K, Radtke A, Lempert T. Benign paroxysmal positional vertigo: current status of medical management. *Otolaryngol Head Neck Surg*. 2004;130(3):381-382. [CrossRef]
20. Fu W, Han J, Chang N et al. Immediate efficacy of Gufoni maneuver for horizontal canal benign paroxysmal positional vertigo (HC-BPPV): a meta-analysis. *Auris Nasus Larynx*. 2020;47(1):48-54. [CrossRef]
21. Pérez P, Franco V, Cuesta P et al. Recurrence of benign paroxysmal positional vertigo. *Otol Neurotol*. 2012;33(3):437-443. [CrossRef]
22. Kutlubaev MA, Xu Y, Hornibrook J. Benign paroxysmal positional vertigo in Meniere's disease: systematic review and meta-analysis of frequency and clinical characteristics. *J Neurol*. 2021;268(5):1608-1614. [CrossRef]
23. Imai T, Ito M, Takeda N et al. Natural course of the remission of vertigo in patients with benign paroxysmal positional vertigo. *Neurology*. 2005;64(5):920-921. [CrossRef]