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Effect of different maneuvers of repositioning on benign paroxysmal vertigo: a network meta-analysis

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Abstract

Background The effect of different maneuver repositioning on benign paroxysmal vertigo was explored by network meta-analysis.

Methods The PubMed, Embase, Cochrane library, and web of science databases were searched for randomized controlled studies on the effect of manipulative repositioning on benign paroxysmal vertigo from database creation to September 1, 2024, Bayesian network meta-analysis, R4.4.1 was used for data analysis.

Results Twenty-two articles ($n=2507$) were included in this study, and the results of network meta-analysis suggested the following odds ratios (OR) relative to the control group (UT): Epley maneuver (EM) vs UT [OR = 7.9, 95% CI (3.21, 23.31)]; Gufoni maneuver (GFM) vs UT [OR = 5.1, 95% CI (1.25, 21.45)]; Gans Repositioning Maneuvers (GRM) vs UT [OR = 11, 95% CI (1.65, 83.85)]; Modified Epley maneuver (MEM) vs UT [OR = 9.83, 95% CI (1.55, 64.06)]; Semont's maneuver (SM) vs UT [OR = 6.1, 95% CI (1.97, 18.46)]. The largest surface area under the cumulative ranking curve was for GRM (71.5%), followed by MEM (68%) and SEM (67.8%), and the worst was for UT (5.7%).

Conclusion Based on our current findings, GRM, MEM and SEM are effective for BBPV symptoms, but due to the existence of study limitations, more high quality multicenter large sample randomized controlled studies are needed to testify to our conclusions.

Keywords Maneuvers, Benign paroxysmal vertigo, Network meta-analysis

Introduction

Benign Paroxysmal Positional Vertigo (BPPV), commonly known as "ear stone disease," is characterized by paroxysmal and recurrent vertigo triggered by changes in head position or body posture [1]. This condition is the most common peripheral vestibular disorder which is typically accompanied by nystagmus and autonomic symptoms. It presents with hearing loss, tinnitus, or neurological symptoms and signs, occurring periodically with episodes ranging from hours to years [2, 3]. Intervals between episodes are unpredictable and can span one to several years, with some cases remaining dormant for 10 to 20 years [4]. BPPV can affect individuals at any age but is most prevalent among those aged 50 to 70 years. Posterior canal BPPV is the most common subtype, accounting for 85–90% of cases, with a slightly higher incidence on the right side [5]. Horizontal canal BPPV accounts for 5–10% of cases, and anterior canal BPPV is rare, comprising about 2% [6]. The condition can resolve spontaneously but is prone to recurrence, with a recurrence

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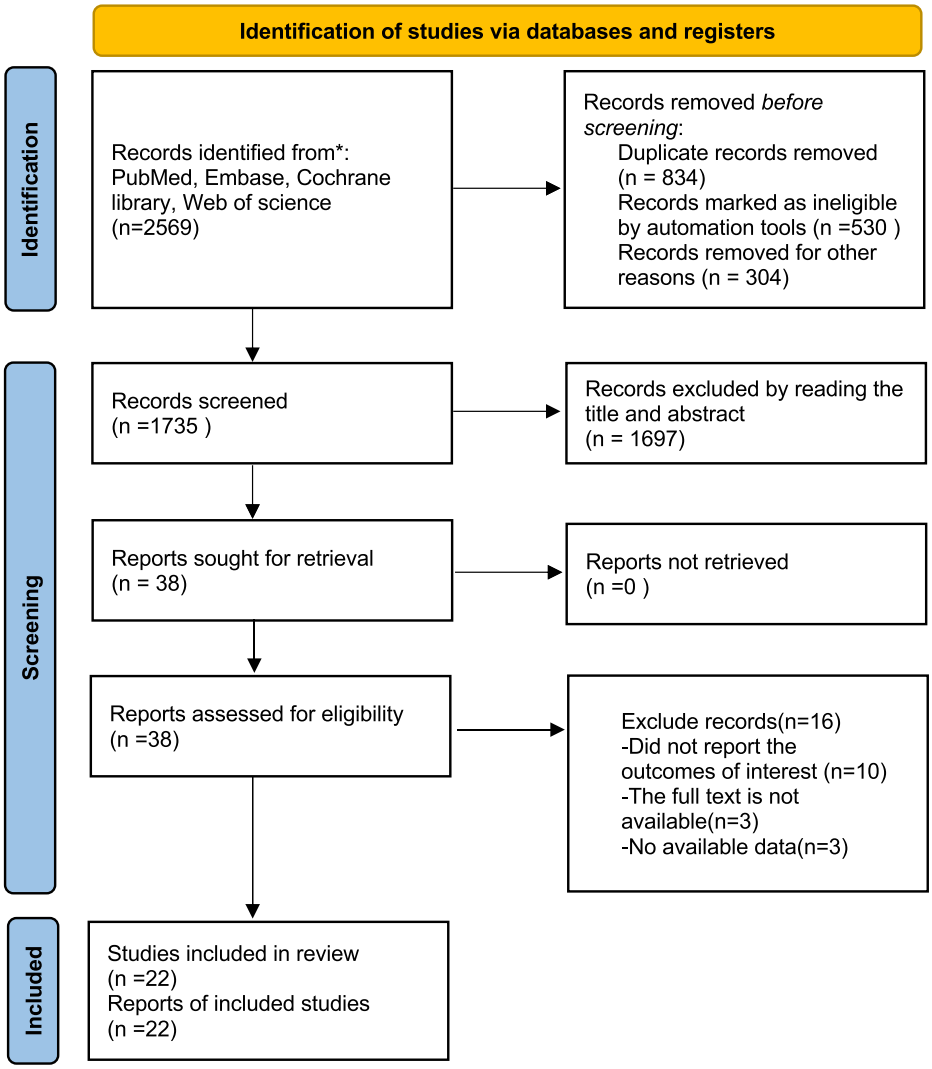
rate of 20–30% and a 10-year recurrence rate of 50% [7, 8]. Research by von Brevern et al [9]. indicates that the incidence in females is approximately twice that of males. Independent risk factors for BPPV include hyperlipidemia, hypertension, migraine, and metabolic diseases such as type II diabetes, osteoporosis, gout, and vitamin D deficiency [10, 11]. Abnormal serum calcium metabolism leading to reduced bone density and osteoporosis may result in changes in otolith composition, causing otoliths to detach more easily from the utricular macula. Conditions such as tracheal intubation, head trauma, age-related degenerative changes, and diabetes can lead to vascular abnormalities in the small vessels supplying the inner ear, thereby impairing the peripheral vestibular system's ability to maintain balance [12].

Among the various treatment methods for BPPV, repositioning maneuvers are widely considered the most effective. These maneuvers involve specific head and body movements designed to relocate the dislodged otoliths back to the utricle, thus relieving the stimulation



*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers).

**If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools.

Fig. 1 Literature search flow chart

of the semicircular canal receptors. Commonly used repositioning maneuvers include the Epley maneuver, the Semont maneuver, and the Barbecue roll maneuver. While these methods have demonstrated efficacy in clinical practice, the relative effectiveness of each maneuver remains a topic of debate due to individual patient differences and the complex pathophysiology of BPPV [13, 14]. The Epley maneuver, one of the earliest and most widely applied repositioning techniques, is typically used for posterior canal BPPV. This method involves a series of head and body rotations to move the otoliths out of the posterior canal [15]. Studies have shown that the Epley maneuver effectively alleviates symptoms in the short term, though its long-term efficacy requires further investigation [16, 17]. The Semont maneuver, on the other hand, is a rapid and straightforward technique that achieves otolith repositioning through quick changes in body position. While effective for posterior canal BPPV, the rapid movements involved may cause discomfort or nausea in some patients [17]. The Barbecue roll maneuver, primarily used for horizontal canal BPPV, involves a sequence of rotational movements to expel the otoliths

Table 1 Literature characteristics table

Study	Year	Country	Sample size	Gender(M/F)	Mena age	Outcomes
Ahmmed	2018	Rangpur	EM:28 UT:28	23/33	EM:50 UT:51.2	F1
Ashfaq	2015	Pakistan	SM:35 UT:35	34/36	SM:53.2 UT:53.4	F1
Ballve	2019	Spain	EM:66 UT:68	32/102	EM:50.5 UT:54	F1
Bruintjes	2014	Netherlands	EM:22 UT:22	18/26	EM:55.7 UT:62.5	F1; F2
Celis	2022	Mexico	BD:9 SM:9 EM:9 UT:7	9/25	BD:59.66 SM:64.66 EM:58.77 UT:55.28	F1
Chen	2012	China	SM:65 UT:63	42/86	SM:53.55 UT:52.35	F1
Chen	2023	China	MEM:33 UT:32	19/46	MEM:57.09 UT:51.59	F1
Choi	2020	South Korea	EM:29 BD:33	16/46	EM:65.8 BD:64.2	F1
Dawood	2023	Iraq	EM:30 UT:30	37/23	EM:50 UT:50	F1
Dhiman	2023	India	EM:118 GRM:116	92/142	EM:118 GRM:116	F1
Gan	2021	China	EM:77 MEM:78	89/66	EM:57.85 MEM:57.26	F1; F2
Imai	2023	Japan	EM:90 rDHt:90	50/130	EM:90 rDHt:90	F1
Kim	2012	Korea	BRM:56 GFM:64 UT:60	61/107	BRM:61.5 GFM:63.3 UT:57.8	F1
Kim	2017	Korea	GFM:70 UT:72	48/94	GFM:62 UT:61.44	F1
Kulthaveesup	2023	Thailand	EM:32 SEM:32	48/16	EM:60.16 SEM:58.78	F1
Lee	2014	Korea	EM:36 SM:32 UT:31	22/81	EM:57.3 SM:56.9 UT:56.8	F1
Li	2017	China	LM:56 EM:57	72/41	LM:50.1 EM:54.1	F1
Mandal	2013	Italy	GFM:37 UT:35	23/49	GFM:60.4 UT:55.8	F1
Saeedi	2019	Iran	EM:21 UT:22	25/18	M:48.19 UT:45.63	F1
Saberi	2017	Iran	GRM:30 EM:30	15/45	GRM:46.9 EM:46.6	F1
Sinsamutpadung	2021	Thailand	SM:40 EM:40	23/57	SM:61.73 EM:60.43	F1
Strupp	2023	Germany	SM:98 EM:97	70/125	SM:64.4 EM:60.9	F1

EM Epley maneuver, *UT* Usual treatment, *SM* Semont's maneuver, *BD* Brandt-Daroff, *GRM* Gans Repositioning Maneuvers, *rDHt* repeated Dix–Hallpike test, *BRM* Barbecue rotation maneuver, *GFM* Gufoni maneuver, *SEM* Self-Epley

from the canal. Despite its simplicity, the effectiveness of this method varies depending on the type of BPPV [18], To comprehensively evaluate the efficacy of different repositioning maneuvers for BPPV, network meta-analysis (NMA) has become increasingly utilized in this field of research. NMA allows for the comparison of both directly and indirectly compared treatments, providing more robust evidence for clinical decision-making. The key advantage of NMA lies in its ability to integrate results from multiple studies, reducing bias and uncertainty associated with single studies and thus offering more reliable evidence.

Methods

Literature retrieval

The PubMed, Embase, Cochrane library, and Web of Science databases were searched for randomized controlled studies on the effects of manipulative repositioning on benign paroxysmal vertigo from the time the database was created until September 1, 2024, with the search term Benign Paroxysmal Positional Vertigo; Maneuver, and the specific search strategy is described in Supplementary Material Table S1.

Criteria for inclusion and exclusion

Inclusion criteria: The population included in this study was adults who met the diagnostic criteria for BBPV, and the interventions were Epley maneuver(EM); Usual treatment(UT) containing conventional medications; Semont's maneuver(SM); Brandt-Daroff(BD); Gans Repositioning Maneuvers(GRM); repeated Dix-Hallpike test(rDHt); Barbecue rotation maneuver(BRM); Gufoni maneuver(GFM); Self- Epley (SEM), and the primary outcome metric was remission rate (defined as disappearance of symptoms in BBPV). The main types of studies we included were randomized controlled studies.

Exclusion criteria: duplicates, animal experiments, protocols, conference abstracts, reviews, unavailable full text, articles with no available data.

Data extractions

The two authors (SNN and LMY) rigorously screened the literature based on the predefined inclusion and exclusion criteria. In case of any disagreement, they resolved it through discussion or sought the input of a third party (CW) for consultation and to reach a consensus. The extracted information from the included studies encompassed the following key details: first author, year of publication, country, sample size, gender, mean age, outcome.

Risk of bias assessment

Risk of bias is assessed by following the latest recommendations of the Cochrane Handbook Risk of Bias assessment tool [19], which consists of five main sections: bias arising from randomization, bias from deviations from established interventions, bias from missing outcome data, bias from outcome measures and outcome selective reporting bias. Against the literature, studies were rated as "Low risk of bias", "Some concerns", "High risk of bias ". The results are checked between the two researchers and if there is disagreement, a discussion is held to reach agreement, or a third person is consulted.

Data analysis

We conducted a Bayesian network meta-analysis using R4.3.2 software (R Foundation for Statistical Computing) with a priori fuzzy random effects models for multiple sets of trials. The combined estimates and probabilities of each treatment being the best were obtained by Markov chain Monte Carlo methods [20]. Model convergence was assessed by trajectory plots and Brooks-Gelman-Rubin plots dichotomous classification results were expressed as the posterior odds ratio or and its 95% confidence intervals (CI). We calculated the percentage of area under the cumulative ranking curve (SUCRA) to estimate the probability of optimal intervention. Network diagrams were drawn using STATA 15.0 with a pass-through macro command loaded. For the network diagram, each circle corresponds to a drug and the edges

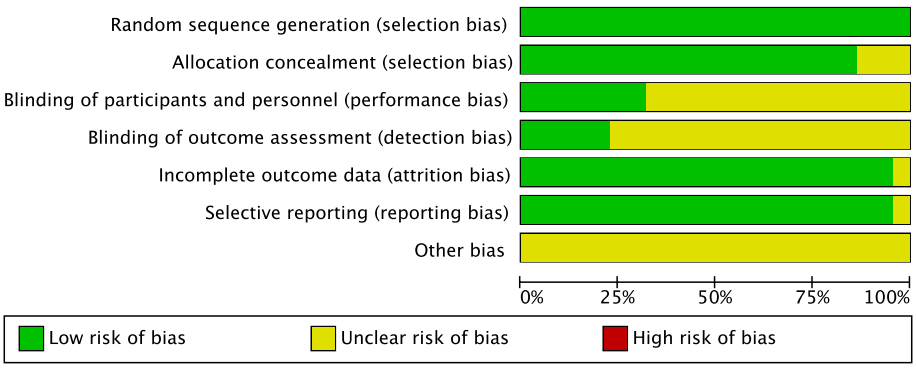


Fig. 2 Risk bias of summary

represent existing comparisons. The size of the circles is proportional to the number of patients included. Cumulative probability plots were drawn using the ggplot2 package.

Result

Literature screening

Figure 1 demonstrates the literature screening process, 2569 articles were retrieved by searching PubMed, Embase, web of science, Cochrane library, and 22 randomized controlled studies [21–42] were finally included by removing duplicates ($n=834$), reading titles and abstracts for removal ($n=1697$), and reading full text for removal ($n=16$).

Basic characteristics and risk of bias

Table 1 shows the basic characteristics of 22 articles ($n=2507$) with interventions containing EM: Epley maneuver; UT: BD: Brandt-Daroff; GRM: Gans Repositioning Maneuvers; rDHt: repeat Dix-Hallpike test; BRM: Barbecue rotation maneuver; GFM: Gufoni maneuver; SEM: Self-Epley. The included studies clearly accounted for the method of randomization used and were therefore evaluated as low risk, but some studies did not account for the blinding method used and were evaluated as unclear, the specific risk of bias is shown in Figs. 2 and 3.

Response rate

Twenty-two articles mentioned the response rate (defined as the disappearance of symptoms in BBPV). The network diagram (Fig. 4) suggests the formation of a closed loop; therefore, a local inconsistency test was used. The test results (Supplementary Materials Figure S1) indicated no statistical differences in the direct comparison, indirect comparison, and network comparison between SM vs BD; UT vs BD; MEM vs EM; SM vs EM; UT vs EM; UT vs MEM; and UT vs SM. The league table (Table 2) shows that EM vs UT [OR=7.9, 95% CI (3.21, 23.31)]; GFM vs UT [OR=5.1, 95% CI (1.25, 21.45)];GRM vs UT [OR=11, 95% CI (1.65, 83.85)]; MEM vs UT [OR=9.83, 95% CI (1.55, 64.06)]; SM vs UT [OR=6.1, 95% CI (1.97, 18.46)]. The surface under the cumulative ranking curve was found to be greatest for GRM (71.5%), followed by MEM (68%), SEM (67.8%), and worst for UT (5.7%) (Fig. 5, Table 3).

Publication bias

We used a funnel plot to evaluate the responds rate publication bias for the study, and the results (Supplementary Material Figure S2) suggest the possibility of a large publication bias.

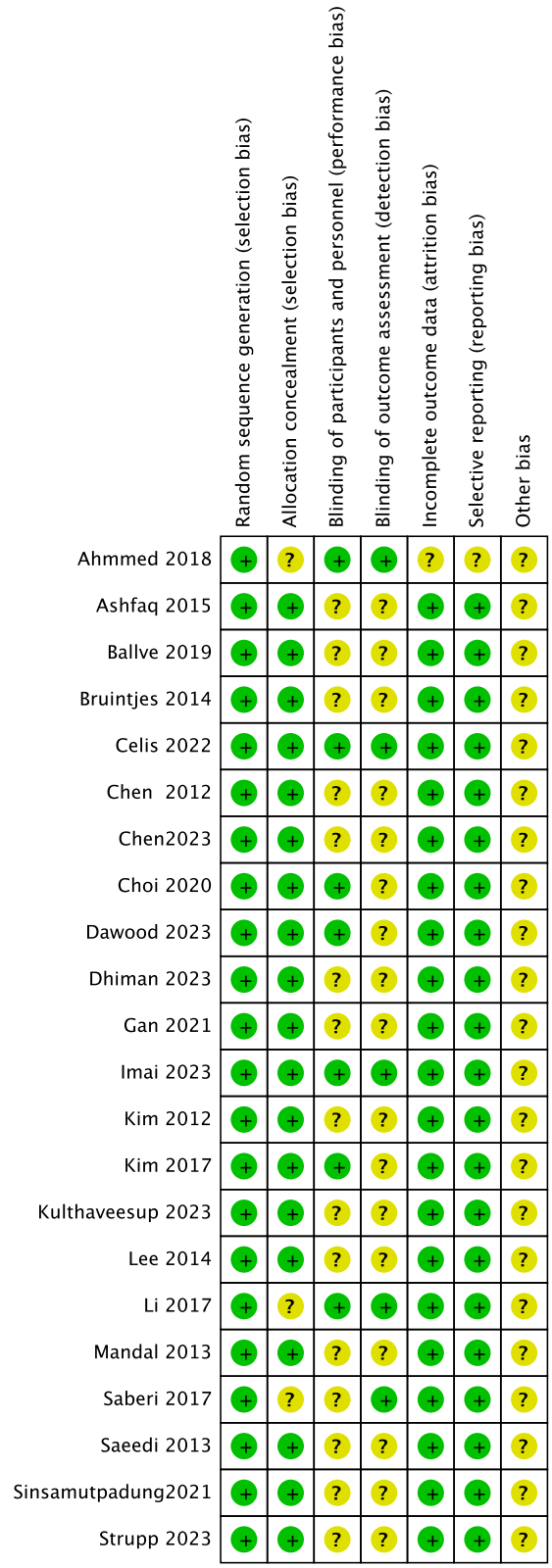


Fig. 3 Risk bias of graph

Discussion

To our knowledge, this is the first time that a network meta-analysis has been used to explore the effects of different maneuvers on BBPV. The results of this study showed that EM, GFM, GRM, MEM, and SM all significantly improved the remission rate compared to the control group (UT). Specifically, GRM showed the greatest effect with an OR of 11 and a 95% confidence interval of (1.65, 83.85), which was significantly higher than the other treatments. These results provide a valuable reference for clinical treatment, suggesting that these treatments can significantly improve the clinical remission of patients, especially GRM, which is further supported by the SUCRA value, indicating that GRM (71.5%) is the most effective treatment option, with an efficacy ranking ahead of the other treatments. This was followed by MEM (68%) and SM (67.8%), which indicated that these three treatments were relatively better in terms of remission rates. Comparatively, UT had the lowest efficacy ranking (5.7%), further confirming its poor therapeutic outcome in this study. Thus, these SUCRA values not only support our conclusions reached through the OR values, but also provide a ranking guide for clinical treatment, helping physicians to choose the best treatment option based on efficacy.

Other findings related to GRM further support the findings of this study, in a study by Robert et al., results one week after a trial combining the Gans maneuver with post-maneuver restrictions showed a recovery rate of 80.2% after one intervention, 95.6% after two interventions, and 99% after three interventions [43]. Francesco Pandipusa et al. described the efficacy of GRM as the most comfortable procedure compared to Semont and Epley repositioning maneuvers [44]. Badawy WM et al. [45] studied the effects of GRM with and without post-maneuver instructions and found no differences; their sample size was very small. This indicates that GRM alone is an effective maneuver therapy without the need for post-maneuver instructions. Alia Saberi et al. [46] conducted a one-week follow-up study on 73 patients to determine the differences between GRM and ERM. As they mentioned in their study results, longer follow-up can be conducted in the future to examine the reversibility or recurrence of vertigo symptoms. Abir Omara et al. [47] compared GRM and EM in terms of postural stability and vertigo, finding both equally effective. GRM is equivalent to EM and can be used as a substitute due to its inclusion of neck extension and rotation. This will help raise awareness of this innovative BPPV treatment procedure. A recent

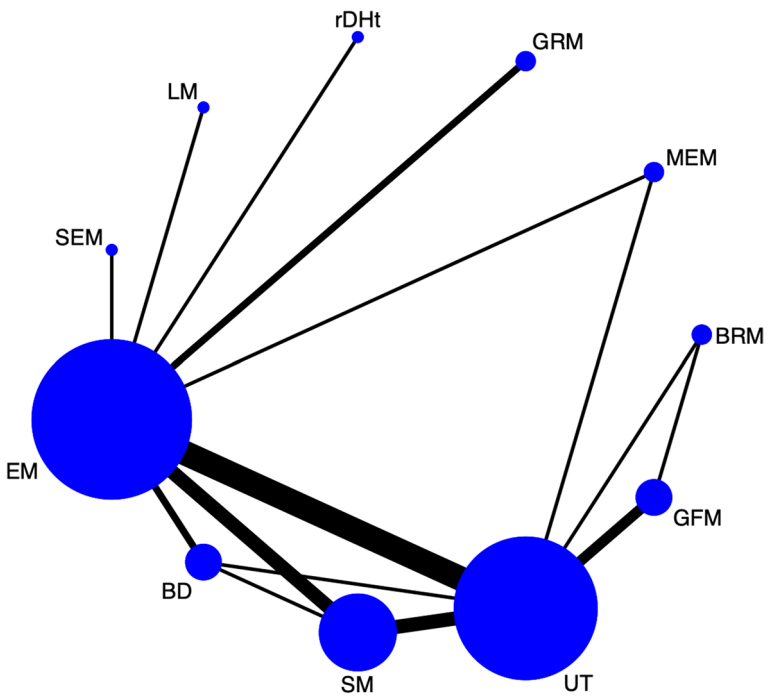


Fig. 4 Network diagram; Each circle represents an intervention (EM: Epley maneuver; UT: Usual treatment; SM: Semont's maneuver; BD: Brandt-Daroff; GRM: Gans Repositioning Maneuvers; rDHt: repeated Dix–Hallpike test; BRM: Barbecue rotation maneuver; GFM: Gufoni maneuver; SEM: Self-Epley)

Table 2 League table

aOR 95%CI										
BD										
0.46 (0.02, 8.56)	BRM									
0.26 (0.04, 1.47)	0.55 (0.05, 5.89)	EM								
0.4 (0.03, 4.15)	0.86 (0.09, 7.74)	1.55 (0.29, 8.79)	GFM							
0.18 (0.01, 2.05)	0.4 (0.02, 7.2)	0.72 (0.13, 3.92)	0.46 (0.04, 4.99)	GRM						
0.39 (0.02, 8.77)	0.85 (0.02, 28.74)	1.53 (0.11, 20.97)	0.99 (0.04, 21.98)	2.14 (0.1, 50.27)	LM					
0.21 (0.02, 2.58)	0.45 (0.02, 8.04)	0.8 (0.13, 5.28)	0.52 (0.05, 5.41)	1.12 (0.1, 14.91)	0.52 (0.02, 13.18)	MEM				
0.28 (0.01, 5.04)	0.61 (0.02, 16.76)	1.1 (0.1, 11.67)	0.71 (0.04, 12.61)	1.53 (0.08, 29.11)	0.71 (0.02, 23.77)	1.36 (0.07, 26.61)	rDHt			
0.18 (0.01, 4.74)	0.39 (0.01, 15.07)	0.7 (0.04, 11.65)	0.45 (0.02, 11.65)	0.98 (0.03, 26.74)	0.45 (0.01, 21.2)	0.86 (0.03, 24.67)	0.64 (0.02, 24.73)	SEM		
0.33 (0.04, 2.37)	0.72 (0.06, 8.66)	1.3 (0.45, 4.18)	0.84 (0.14, 5.22)	1.81 (0.25, 15.33)	0.85 (0.05, 14.74)	1.61 (0.21, 12.96)	1.18 (0.09, 17.46)	1.86 (0.09, 42)	SM	
2.03 (0.28, 13.77)	4.38 (0.48, 40.09)	7.9 (3.21, 21.31)	5.1 (1.25, 21.45)	11 (1.65, 83.85)	5.16 (0.33, 84.18)	9.83 (1.55, 64.06)	7.17 (0.59, 99.21)	11.36 (0.61, 242.15)	6.1 (1.97, 18.46)	UT

EM Epley maneuver, *UT* Usual treatment, *SM* Semont's maneuver, *BD* Brandt-Daroff, *GRM* Gans Repositioning Maneuvers, *rDHt* repeated Dix–Hallpike test, *BRM* Barbecue rotation maneuver, *GFM* Gufoni maneuver, *SEM* Self-Epley

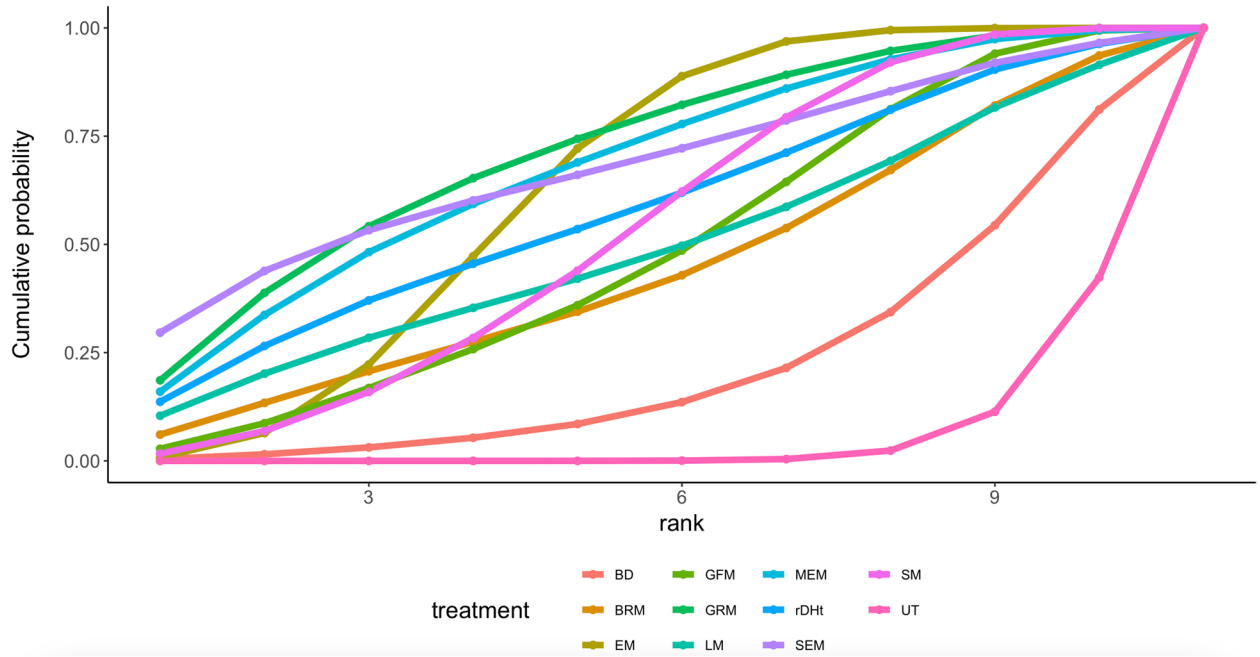


Fig. 5 Cumulative probability ranking; The area under the curve (EM: Epley maneuver; UT: Usual treatment; SM: Semont's maneuver; BD: Brandt-Daroff; GRM: Gans Repositioning Maneuvers; rDHt: repeated Dix–Hallpike test; BRM: Barbecue rotation maneuver; GFM: Gufoni maneuver; SEM: Self-Epley)

systematic review [48] also indicated that the effectiveness of the Gans maneuver in medical research holds significant clinical importance. After implementing this technique, vertigo patients can achieve immediate relief without any supportive treatment, which not only has scientific value but also economic, social, and personal benefits. Moreover, for elderly and postural BPPV patients who experience neck stiffness and discomfort or other conditions, the GRM is equivalent to the Epley maneuver [49]. Therefore, the GRM can replace the Epley maneuver as it involves neck extension and rotation. This will help to raise awareness among the public and practitioners about this innovative BPPV treatment procedure.

EM and other repositioning methods can lead to some patients experiencing residual symptoms such as head dizziness, heaviness, unsteady walking, and neck stiffness after successful repositioning, with a high recurrence rate [4]. Later, a modified Epley maneuver was developed based on these methods, which effectively addressed the issues of residual symptoms and high recurrence rates. Because the modified Epley maneuver involves resting the patient's head on the bed (not in a suspended state), it is relatively easy to position the head, making the maneuver simple, labor-saving, self-treatable, and relatively safe. The SEM method is effective, safe, and easy to perform. After explanations and demonstrations by medical staff and watching repositioning videos, patients and their families usually master this method, allowing for self-repositioning treatment at home in case of recurrence [15]. This reduces over-reliance on medical personnel and alleviates psychological fear and anxiety in patients. The supplementary treatment provided by the SEM method addresses the difficulties faced by patients in remote areas and those with financial constraints, reducing the economic burden and fear of not being able to seek timely medical attention to some extent [50, 51].

Table 3 Sucra rank

Treatment	response rate (%)
BD	22.4
BRM	44.2
EM	63.4
GFM	47.8
GRM	71.5
LM	48.7
MEM	68.0
rDHt	57.7
SEM	67.8
SM	52.9
UT	5.7

EM Epley maneuver, *UT* Usual treatment, *SM* Semont's maneuver, *BD* Brandt-Daroff, *GRM* Gans Repositioning Maneuvers, *rDHt* repeated Dix–Hallpike test, *BRM* Barbecue rotation maneuver, *GFM* Gufoni maneuver, *SEM* Self-Epley

The current study still has the following limitations, first: the frequency of interventions used in this included study, the time is not accounted for, second: for the inclusion of the population included all BBPV, which can lead to a greater heterogeneity in our study, and third: some of the studies have fewer indicators of the observed outcomes.

Conclusion

Based on our current findings, GRM, MEM and SEM are effective for BBPV symptoms, but due to the existence of study limitations, more high quality multicenter large sample randomized controlled studies are needed to testify to our conclusions.

Abbreviations

NMA	Network meta-analysis
EM	Epley maneuver
UT	Usual treatment
SM	Semont's maneuver
BD	Brandt-Daroff
GRM	Gans Repositioning Maneuvers
rDHt	Repeated Dix-Hallpike test
BRM	Barbecue rotation maneuver
GFM	Gufoni maneuver
SEM	Self- Epley

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12883-025-04123-6.

Supplementary Material 1.

Authors' contributions

CW: Conceptualization, methodology, writing—original draft preparation, reviewing and editing. LMY: Conceptualization, methodology, writing—original draft preparation; SNN: Data curation, formal analysis, investigation, software, reviewing and editing.

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No funding was received for this study.

Data availability

The data that supports the findings of this study are available in the supplementary material of this article.

Declarations

Ethics approval and consent to participate

This study did not involve humans or animals and therefore did not need to follow the Declaration of Helsink.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Cole SR, Honaker JA. Benign paroxysmal positional vertigo: Effective diagnosis and treatment. Cleve Clin J Med. 2022;89(11):653–62. https://doi.org/10.3949/ccjm.89a.21057.
2. Imai T, Inohara H. Benign paroxysmal positional vertigo. Auris Nasus Larynx. 2022;49(5):737–47. https://doi.org/10.1016/j.anl.2022.03.012.
3. Koç A. Benign paroxysmal positional vertigo: is it really an otolith disease? J Int Adv Otol. 2022;18(1):62–70. https://doi.org/10.5152/iao.2022.21260.
4. Galluzzi F, Garavello W. Benign paroxysmal positional vertigo in children: a narrative review. J Int Adv Otol. 2022;18(2):177–82. https://doi.org/10.5152/iao.2022.20087.
5. von Brevern M, Bertholon P, Brandt T, et al. Benign paroxysmal positional vertigo: Diagnostic criteria Consensus document of the Committee for the Classification of Vestibular Disorders of the Bárány Society. Acta Otorrinolaringol Esp (Engl Ed). Nov-Dec 2017;68(6):349–360. Vértigo posicional paroxístico benigno: criterios diagnósticos. Documento de consenso del Comité para la Clasificación de los Trastornos Vestibulares de la Bárány Society. https://doi.org/10.1016/j.otorri.2017.02.007
6. Gurberg J, Tomczak KK, Brodsky JR. Benign paroxysmal vertigo of childhood. Handb Clin Neurol. 2023;198:229–40. https://doi.org/10.1016/b978-0-12-823356-6.00004-4.
7. Kwon E, Jeong HS, Jeong SH, Kim HJ, Kim JS. Central paroxysmal positional nystagmus mimicking posterior canal benign paroxysmal positional vertigo in pontine infarction: a case report and literature review. J Neurol. 2024;271(6):3672–7. https://doi.org/10.1007/s00415-024-12346-9.
8. Madrigal J, Manzari L, Figueroa JJ, Castillo-Bustamante M. Understanding Benign Paroxysmal Positional Vertigo (BPPV) and Its Impact on Quality of Life: A Systematic Review. Cureus. 2024;16(6):e63039. https://doi.org/10.7759/cureus.63039.
9. 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):710–5. https://doi.org/10.1136/jnnp.2006.100420.
10. Chen J, Zhang S, Cui K, Liu C. Risk factors for benign paroxysmal positional vertigo recurrence: a systematic review and meta-analysis. J Neurol. 2021;268(11):4117–27. https://doi.org/10.1007/s00415-020-10175-0.
11. Ke Y, Ma X, Jing Y, Diao T, Yu L. Risk factors for residual dizziness in patients with benign paroxysmal positional vertigo after successful repositioning: a systematic review and meta-analysis. Eur Arch Otorhinolaryngol. 2022;279(7):3237–56. https://doi.org/10.1007/s00405-022-07288-9.
12. Sfakianaki I, Binos P, Karkos P, Dimas GG, Psillas G. Risk Factors for Recurrence of Benign Paroxysmal Positional Vertigo. A Clinical Review. J Clin Med. Sep 24 2021;10(19)https://doi.org/10.3390/jcm10194372
13. Hilton MP, Pinder DK. The Epley (canalith repositioning) manoeuvre for benign paroxysmal positional vertigo. Cochrane Database Syst Rev. 2014;2014(12):Cd003162. https://doi.org/10.1002/14651858.CD003162.pub3.
14. Mandalà M, Salerni L, Nuti D. Benign positional paroxysmal vertigo treatment: a practical update. Curr Treat Options Neurol. 2019;21(12):66. https://doi.org/10.1007/s11940-019-0606-x.
15. Khoujah D, Naples JG, Silva L, et al. Epley maneuver for benign paroxysmal positional vertigo: Evidence synthesis for guidelines for reasonable and appropriate care in the emergency department. Acad Emerg Med. 2023;https://doi.org/10.1111/acem.14739
16. Bulğurcu S, Baz E, Güleryüz S, Erkul E, Çekin E. Effect of applying head-shaking maneuver before Epley maneuver in BPPV. Braz J Otorhinolaryngol Nov-Dec. 2022;88(6):932–6. https://doi.org/10.1016/j.bjorl.2020.12.015.
17. Uz U, Uz D, Akdal G, Çelik O. Efficacy of epley maneuver on quality of life of elderly patients with subjective BPPV. J Int Adv Otol. 2019;15(3):420–4. https://doi.org/10.5152/iao.2019.6483.
18. Helminski JO, Zee DS, Janssen I, Hain TC. Effectiveness of particle repositioning maneuvers in the treatment of benign paroxysmal positional vertigo: a systematic review. Phys Ther. 2010;90(5):663–78. https://doi.org/10.2522/ptj.20090071.
19. Higgins JPT SJ, Page MJ, et al. Revised Cochrane risk of bias tool for randomized trials (RoB 2.0). Available at: https://wwwriskofbiasinfo/welcome/rob-2-0-tool/archive-rob-2-0-2016. 20 October 2016;
20. Jansen JP, Crawford B, Bergman G, Stam W. Bayesian meta-analysis of multiple treatment comparisons: an introduction to mixed treatment comparisons. Value Health Sep-Oct. 2008;11(5):956–64. https://doi.org/10.1111/j.1524-4733.2008.00347.x.

21. Ahmmed SU, Hossain MZ, Uddin MN, Rabbani SMG, Alman A. Effectiveness of the epleys maneuver for treatment of benign paroxysmal positional vertigo. Bangladesh J Otorhinolaryngol. 2018;24(1):3–7.
22. Ashfaq K, Ahmad M, Khan M. Comparison between Semonts maneuvere and beta histine in the treatment of benign paroxysmal positional vertigo. Int J Scientific Study. 2015;3(4):98–102. https://doi.org/10.17354/ijss/2015/315.
23. Ballvé JL, Carrillo-Muñoz R, Rando-Matos Y, et al. Effectiveness of the Epley manoeuvre in posterior canal benign paroxysmal positional vertigo: a randomised clinical trial in primary care. Br J Gen Pract. 2019;69(678):e52–60. https://doi.org/10.3399/bjgp18X700253.
24. Bruintjes TD, Companjen J, van der Zaag-Loonen HJ, van Benthem PP. A randomised sham-controlled trial to assess the long-term effect of the Epley manoeuvre for treatment of posterior canal benign paroxysmal positional vertigo. Clin Otolaryngol. 2014;39(1):39-44. https://doi.org/10.1111/coa.12217
25. Celis-Aguilar E, Mayoral-Flores HO, Torrontegui-Zazueta LA, Medina-Cabrera CA, León-Leyva IC, Dehesa-López E. Effectiveness of Brandt Daroff, Semont and Epley maneuvers in the treatment of Benign Paroxysmal Positional Vertigo: A randomized controlled clinical Trial. Indian J Otolaryngol Head Neck Surg. 2022;74(3):314–21. https://doi.org/10.1007/s12070-021-02516-w.
26. Chen X, Mao J, Ye H, et al. The effectiveness of the modified Epley maneuver for the treatment of posterior semicircular canal benign paroxysmal positional vertigo. Front Neurol. 2023;14:1328896. https://doi.org/10.3389/fneur.2023.1328896.
27. Chen Y, Zhuang J, Zhang L, et al. Short-term efficacy of Semont maneuver for benign paroxysmal positional vertigo: a double-blind randomized trial. Otol Neurotol. 2012;33(7):1127–30. https://doi.org/10.1097/MAO.0b013e31826352ca.
28. Choi SY, Cho JW, Choi JH, Oh EH, Choi KD. Effect of the epley maneuver and brandt-daroff exercise on benign paroxysmal positional vertigo involving the posterior semicircular canal cupulolithiasis: a randomized clinical trial. Front Neurol. 2020;11:603541. https://doi.org/10.3389/fneur.2020.603541.
29. Dawood MR. The Epley Maneuver versus Betahistine in Treatment of Benign Paroxysmal Positional Vertigo. Indian J Otol. 2023;29(4):255–8. https://doi.org/10.4103/indianjotol.indianjotol_90_23.
30. Dhiman NR, Joshi D, Gyanpuri V, Pathak A, Kumar A. Comparison between Epley and Gans repositioning maneuvers for posterior canal BPPV: A randomized controlled trial. Ann Indian Acad Neurol Jul-Aug. 2023;26(4):537–42. https://doi.org/10.4103/aian.aian_12_23.
31. Gan Z, Zhou S, Yang H, et al. Self-treatment of posterior canal benign paroxysmal positional vertigo: A preliminary study. Front Med (Lausanne). 2021;8:654637. https://doi.org/10.3389/fmed.2021.654637.
32. Imai T, Uno A, Yamato A, et al. Comparison of the efficacy of the Epley maneuver and repeated Dix-Hallpike tests for eliminating positional nystagmus: A multicenter randomized study. Front Neurol. 2023;14:1095041. https://doi.org/10.3389/fneur.2023.1095041.
33. Kim HA, Park SW, Kim J, et al. Efficacy of mastoid oscillation and the Gufoni maneuver for treating apogeotropic horizontal benign positional vertigo: a randomized controlled study. J Neurol. 2017;264(5):848–55. https://doi.org/10.1007/s00415-017-8422-2.
34. Kim JS, Oh SY, Lee SH, et al. Randomized clinical trial for geotropic horizontal canal benign paroxysmal positional vertigo. Neurology. 2012;79(7):700–7. https://doi.org/10.1212/WNL.0b013e3182648b8b.
35. Kulthaveesup A, Bunnag K. Comparison of outcomes of the Epley and self-Epley maneuvers in PC-BPPV: A randomized controlled trial. Am J Otolaryngol Nov-Dec. 2023;44(6):103995. https://doi.org/10.1016/j.amjoto.2023.103995.
36. Lee JD, Shim DB, Park HJ, et al. A multicenter randomized double-blind study: comparison of the Epley, Semont, and sham maneuvers for the treatment of posterior canal benign paroxysmal positional vertigo. Audiol Neurootol. 2014;19(5):336–41. https://doi.org/10.1159/000365438.
37. Li J, Tian S, Zou S. Efficacy of the Li maneuver in treating posterior canal benign paroxysmal positional vertigo. Acta Otolaryngol. 2017;137(6):588–92. https://doi.org/10.1080/00016489.2016.1258731.
38. 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):1782–6. https://doi.org/10.1002/lary.23918.
39. Saeedi M, Khosravi MH, Bayatpoor ME. Comparing the effects of epley maneuver and cinnarizine on benign positional paroxysmal vertigo; a randomized clinical trial. Galen Med J. 2019;8:e866. https://doi.org/10.31661/gmj.v8i0.866.
40. Sinsamutpadung C, Kulthaveesup A. Comparison of outcomes of the Epley and Semont maneuvers in posterior canal BPPV: A randomized controlled trial. Laryngoscope Investig Otolaryngol. 2021;6(4):866–71. https://doi.org/10.1002/lio2.619.
41. Strupp M, Mandala M, Vinck AS, et al. The Semont-plus maneuver or the epley maneuver in posterior canal benign paroxysmal positional vertigo: a randomized clinical study. JAMA Neurol. 2023;80(8):798–804. https://doi.org/10.1001/jamaneurol.2023.1408.
42. Saberi A, Nemati S, Sabnan S, Mollahoseini F, Kazemnejad E. A safe-repositioning maneuver for the management of benign paroxysmal positional vertigo: gans vs. Epley maneuver; a randomized comparative clinical trial. Eur Arch Otorhinolaryngol. 2017;274(8):2973–9. https://doi.org/10.1007/s00405-016-4235-7.
43. Roberts RA, Gans RE, Montaudo RL. Efficacy of a new treatment maneuver for posterior canal benign paroxysmal positional vertigo. J Am Acad Audiol. 2006;17(8):598–604. https://doi.org/10.3766/jaaa.17.8.6.
44. Aranda-Moreno C, Jáuregui-Renaud K. Epley and Semont maneuvers in the treatment of bening paroxymal postural vertigo. Gac Med Mex. 2000;136(5):433–9 (Las maniobras de Epley y de Semont en el tratamiento del vértigo postural paroxístico benigno).
45. Badawy WM, Gad El-Mawla EK, Chedid AE, Mustafa AH. Effect of a hybrid maneuver in treating posterior canal benign paroxysmal positional vertigo. J Am Acad Audiol. 2015;26(2):138–44. https://doi.org/10.3766/jaaa.26.2.4.
46. Califano L. "A safe-repositioning maneuver for the management of benign paroxysmal positional vertigo: Gans vs. Epley maneuver; a randomized comparative clinical trial": something else about Gans maneuver. Eur Arch Otorhinolaryngol. 2017;274(8):3259–60. https://doi.org/10.1007/s00405-016-4406-6.
47. Blatt PJ, Georgakakis GA, Herdman SJ, Clendaniel RA, Tusa RJ. The effect of the canalith repositioning maneuver on resolving postural instability in patients with benign paroxysmal positional vertigo. Am J Otol. 2000;21(3):356–63. https://doi.org/10.1016/s0196-0709(00)80045-9.
48. Joshi D, Gyanpuri V, Pathak A, Chaurasia RN, Singh V, Dhiman NR. Epley maneuver versus Gans Repositioning maneuver in treating posterior Canal BPPV and Familial Incidence of BPPV: Protocol for a randomized controlled trial. Indian J Otolaryngol Head Neck Surg. 2022;74(4):608–13. https://doi.org/10.1007/s12070-021-02762-y.
49. Joshi D, Gyanpuri V, Pathak A, et al. Gans repositioning maneuver for the posterior canal BPPV patients: systematic review and meta-analysis. Eur Arch Otorhinolaryngol. 2022;279(9):4241–6. https://doi.org/10.1007/s00405-022-07396-6.
50. Omron R. Peripheral Vertigo. Emerg Med Clin North Am. 2019;37(1):11–28. https://doi.org/10.1016/j.emc.2018.09.004.
51. Stahl MC, Otteson T. Systematic review on vestibular symptoms in patients with enlarged vestibular aqueducts. Laryngoscope. 2022;132(4):873–80. https://doi.org/10.1002/lary.29819.

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