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Habituation Exercises versus Proprioceptive Training for Dizziness, Vertigo, Balance, and Quality of Life in Benign Paroxysmal Positional Vertigo: A Randomized Clinical Trial

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ABSTRACT

Background: Benign paroxysmal positional vertigo, the most common peripheral vestibular disorder, is caused by displaced otoconia in the semicircular canals, producing brief position-triggered vertigo, nausea, and imbalance that impair postural stability, quality of life, and increase fall risk.

Objective: To compare the habituation exercises and proprioceptive training, each combined with conventional vestibular therapy, against conventional therapy alone, on dizziness, vertigo, balance, and quality of life in chronic benign paroxysmal positional vertigo patients.

Methods: This was a double-blind randomized clinical trial conducted over ten months at the Department of Physical Medicine and Rehabilitation, Ittefaq Hospital, and PSRD, Lahore, Pakistan, following approval from the Research and Ethics Committee of the Riphah International University. Patients with central nervous system involvement, orthopedic conditions limiting proprioceptive tasks (including cervical deficits that could compromise positioning maneuvers), an inability to follow verbal commands, or a history of head injury were excluded. In this trial, 39 patients with Dix-Hallpike-confirmed benign paroxysmal positional vertigo were assigned by coin-toss randomization to three groups of 13: habituation exercises plus conventional therapy (Group A), proprioceptive training plus conventional therapy (Group B), and conventional vestibular therapy alone (Group C). All groups received a weekly Epley repositioning maneuver. The Berg Balance Scale, Dynamic Gait Index, Dizziness Handicap Inventory, Vertigo Visual Analogue Scale, and Activities-specific Balance Confidence Scale were recorded at baseline, three weeks, and six weeks. We assessed within-group change across the three time points with repeated-measures ANOVA and between-group differences at each time point with one-way ANOVA.

Results: All three groups showed statistically significant within-group improvement on every outcome across the three assessment points ($p<0.001$). In between-group comparison at six weeks, proprioceptive training produced significantly greater gains than the other two groups on the Berg Balance Scale, Dizziness Handicap Inventory, Vertigo Visual Analogue Scale, and Activities-specific Balance Confidence Scale ($p<0.05$); Dynamic Gait Index improved in all groups but did not differ significantly between groups ($p>0.05$).

Conclusion: Combining proprioceptive training with the Epley maneuver improves balance, dizziness, vertigo severity, and balance confidence more than habituation exercises or conventional therapy alone in Benign paroxysmal positional vertigo patients, supporting its use as a preferred adjunct in vestibular rehabilitation.

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INTRODUCTION

Vestibular disorders produce vertigo, dizziness, abnormal eye movements, and impaired balance through peripheral or central lesions of the balance system.[1] Peripheral disorders are common in older adults and linked to falls.[2] Benign paroxysmal positional vertigo (BPPV) is the most frequent peripheral vestibular condition, accounting for roughly one-fifth of vestibular presentations and occurring more often in women.[3] It is caused by free-floating otoconial debris in a semicircular canal, most often the posterior canal, and typically presents as brief, position-triggered vertigo with nausea and unsteadiness.[4]

Canalith repositioning procedures such as the Epley maneuver are the primary evidence-based treatment and are effective at clearing otoconial debris from the affected canal.[5,6] Emergency-practice guidance likewise endorses it as the first-line bedside intervention once positional testing confirms BPPV.[7]

However, recurrence is common, and residual imbalance, dizziness, and reduced confidence in daily activities can persist after successful repositioning, lowering quality of life and sustaining fall risk.[8,9] This has motivated adding vestibular rehabilitation therapy (VRT) to repositioning.[10,11] VRT combines gaze-stabilization, habituation, and balance and gait training, and works through central compensation and neuroplastic adaptation rather than mechanical debris clearance.[12,13]

Habituation exercises reduce symptom provocation through repeated, controlled exposure to dizziness-provoking movements, promoting central adaptation.[14] Proprioceptive training instead emphasizes somatosensory and postural strategies, such as single-limb stance, heel-to-toe gait, and graded balance tasks, to strengthen the sensory reweighting underlying stable posture, and has reduced fall risk in other balance-impaired populations.[15,16] The two approaches have rarely been compared directly as adjuncts to repositioning in the same BPPV cohort, as most prior work combined them.[17] This trial therefore compared habituation exercises and proprioceptive training, each added to conventional therapy, with conventional therapy alone in chronic BPPV. We hypothesized that proprioceptive training would improve balance, gait, dizziness handicap, vertigo severity, and balance confidence most.

This trial was therefore designed to compare habituation exercises and proprioceptive training, each added to conventional vestibular therapy, against conventional therapy alone, with respect to balance, dizziness, vertigo severity, and quality of life in patients with chronic BPPV.

METHODS

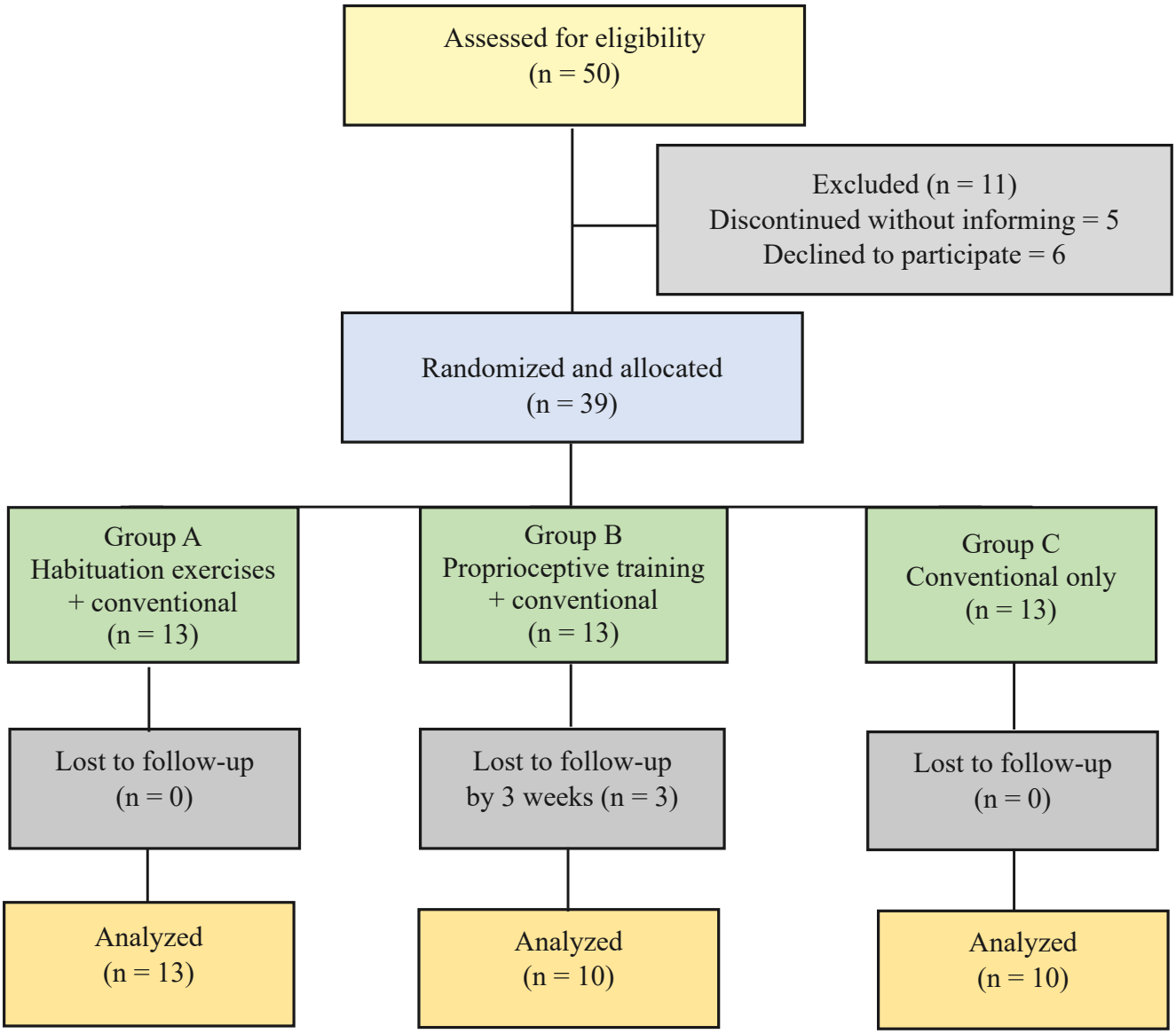
This randomized controlled trial was conducted from 5 June 2022 to 28 February 2023 at the Department of Physical Medicine and Rehabilitation, Ittefaq Hospital, and Pakistan Society for Rehabilitation of Differently Abled (PSRD), Lahore, Pakistan. The protocol was approved by the Research and Ethics Committee of Riphah International University (REC/22/0221) and followed the Declaration of Helsinki. It was registered at ClinicalTrials.gov (NCT05425199) on 15 June 2022, ten days after enrollment began (retrospective registration).

Adults aged 30 to 65 years with chronic BPPV confirmed by a positive Dix-Hallpike test, a Vertigo Visual Analogue Scale (VVAS) score above 1, and a Dizziness Handicap Inventory (DHI) score above 50 were eligible.[18] Patients with central nervous system involvement, orthopedic conditions limiting proprioceptive tasks (including cervical deficits that could compromise positioning maneuvers),[18,19] an inability to follow verbal commands, or a history of head injury were excluded. Eligible patients were recruited by non-probability convenience sampling and gave written informed consent.

Sample size was estimated with EpiTool using balanced outcome data from prior work (mean difference 15.5, pooled standard deviations 15.5 and 10.9), at 95% confidence and 80% power, yielding 12 participants per arm; after accounting for 10% anticipated attrition, the target enrollment was 39 (13 per group). An independent person uninvolved in treatment or assessment allocated participants 1:1:1 by coin toss. Outcome assessors were blinded to allocation; participants and the treating therapist could not be blinded.

All three groups received a standardized 15-minute conventional vestibular treatment session supervised by a physical therapist, consisting of a baseline Dix-Hallpike test and a weekly Epley Canalith repositioning maneuver held through four sequential head and body positions until nystagmus resolved. Group A additionally performed habituation exercises like head turns, nodding, circumductory head circles, and gait with head movement for 30 minutes, three sessions per week for six weeks. Group B additionally performed proprioceptive training, single-leg stance on each side, toe pointing, heel-to-toe walking, and alternating high-knee marching, progressing to eyes-closed performance once mastered for 30 minutes,

Figure 1: CONSORT Diagram



three sessions per week for six weeks. Group C received the conventional treatment only. Balance was assessed with the 14-item Berg Balance Scale (BBS, 0-56) and dynamic balance during gait with the Dynamic Gait Index (DGI, 0-24). Dizziness-related disability was measured with the DHI (0-100), vertigo severity with the VVAS (0-9), and balance confidence during daily activities with the Activities-specific Balance Confidence Scale (ABC, 0-100%), all of which have documented reliability and validity for peripheral vestibular populations.[19] All outcomes were recorded at baseline, after three weeks, and after six weeks of treatment as shown in Figure 1. Data were analyzed in SPSS version 25. Normality was verified with the Shapiro-Wilk test. We assessed within-group change across the three time points with repeated-measures ANOVA and Bonferroni-adjusted pairwise comparisons; we assessed between-group differences at each time point with one-way ANOVA. Statistical significance was set at $p<0.05$.

RESULTS

Thirty-nine patients were enrolled, and 36 completed the six-week protocol (Group A, n=13; Group B, n=10; Group C, n=13); three participants in Group B withdrew, one discontinued without explanation, and two declined to continue. The overall mean age was 52.2±11.8 years, and the sample was predominantly female (19/36, 52.8%). Posterior canal involvement (63.8%) and right-sided BPPV (61.5%) predominated across groups. Table 1 summarizes group demographic characteristics. Box's test of equality of covariance matrices was significant ($p=0.017$); a mixed-model ANOVA was not appropriate, and within-group change was instead evaluated separately for each group using repeated-measures ANOVA.

All five outcome measures improved significantly from baseline to three weeks and from three weeks to six weeks within every group ($p<0.001$ for all pairwise comparisons; Table 2). Between-group comparison

Table 1: Demographic and clinical characteristics

Variables	Categories	Group A	Group B	Group C	Total
		n (%)			
Age (Years)	Mean±SD	51.54 ± 12.19	46.20 ± 9.77	57.54 ± 11.1	52.22 ± 11.78
Gender	Male	4 (30.8)	4 (40)	7 (53.8)	15 (41.7)
	Female	9 (69.2)	6 (60)	6 (46.2)	21 (58.3)
Affected side	Left	4 (30.8)	4 (40)	5 (38.5)	13 (36.1)
	Right	9 (69.2)	6 (60)	8 (61.5)	23 (63.9)
BPPV type	Posterior canal	8 (61.5)	8 (80)	7 (53.8)	23 (63.9)
	Horizontal canal	5 (38.5)	2 (20)	6 (46.2)	13 (36.1)
Socioeconomic status	Upper	2 (15.4)	2 (20)	4 (30.8)	8 (22.2)
	Upper middle	8 (61.5)	6 (60)	6 (46.2)	20 (55.6)
	Lower middle	3 (23.1)	2 (20)	3 (23.1)	8 (22.2)

Table 2: Within-group change in outcome measures at baseline, 3rd and 6th week

Outcome Measures	Time Points	Group A (Habituation)	Group B (Proprioceptive)	Group C (Conventional)	p-value
		(Mean ± SD)			
BBS	Baseline	32.61±5.01	34.00±5.62	30.23±5.66	p<0.001
	3 weeks	37.07±5.12	39.70±5.14	32.76±5.69	
	6 weeks	46.15±4.72	49.00±4.29	38.30±6.25	
DGI	Baseline	13.61±2.75	14.90±3.6	13.30±3.35	p<0.001
	3 weeks	15.76±2.59	17.00±3.23	15.23±3.56	
	6 weeks	19.38±2.02	20.90±2.47	18.69±3.04	
DHI	Baseline	74.30±12.4	71.00±12.72	76.92±12.1	p<0.001
	3 weeks	63.84±12.42	61.60±12.17	69.69±11.77	
	6 weeks	45.07±11.24	38.80±12.37	57.07±11.33	
VVAS	Baseline	7.30±0.81	7.07±0.74	7.53±0.85	p<0.001
	3 weeks	5.85±0.91	6.08±0.79	6.83±0.93	
	6 weeks	3.92±0.79	3.60±0.96	5.67±0.85	
ABC	Baseline	38.92±6.67	41.90±9.37	40.84±8.7	p<0.001
	3 weeks	44.84±6.89	47.00±9.41	44.84±8.33	
	6 weeks	62.30±10.2	68.20±12.03	53.46±8.56	

showed no significant difference among the three groups at baseline for any outcome ($p>0.05$ for all), confirming comparable starting status. By three weeks, significant between-group differences had emerged for BBS ($p=0.013$) and VVAS ($p=0.022$), while DGI, DHI, and ABC did not yet differ significantly. By six weeks, all outcomes except DGI showed significant between-group differences: BBS ($F=13.37$, $p<0.001$), DHI ($F=7.53$, $p=0.002$), VVAS ($F=20.67$, $p<0.001$), and ABC ($F=6.14$, $p=0.005$). Two-sided $p<0.05$ was

Table 3: Between-group comparisons (one-way ANOVA, df = 2, 33)

Outcome	Time points	F	p	ηp²
BBS	Baseline	1.45	.250	.081
	3 weeks	5.00	.013	.233
	6 weeks	13.37	<.001	.448
DGI	Baseline	0.75	.481	.043
	3 weeks	0.92	.410	.053
	6 weeks	2.16	.131	.116
DHI	Baseline	0.65	.530	.038
	3 weeks	1.41	.258	.079
	6 weeks	7.53	.002	.313
VVAS	Baseline	0.97	.390	.055
	3 weeks	4.32	.022	.208
	6 weeks	20.67	<.001	.556
ABC	Baseline	0.39	.678	.023
	3 weeks	0.25	.779	.015
	6 weeks	6.14	.005	.271

Table 4: Post-hoc pairwise comparisons between groups with mean difference, 95% CI, p-values

Outcome (time)	B vs A	B vs C	A vs C
BBS (3 weeks)	2.62 (−3.04, 8.29) p = .754	6.93 (1.26, 12.60) p = .012	4.31 (−0.98, 9.59) p = .143
VVAS (3 weeks)	0.23 (−0.72, 1.17) p = 1.000	−0.76 (−1.70, 0.18) p = .151	−0.98 (−1.86, −0.11) p = .024
BBS (6 weeks)	2.85 (−2.70, 8.39) p = .614	10.69 (5.14, 16.24) p < .001	7.85 (2.67, 13.02) p = .002
DHI (6 weeks)	−6.28 (−18.58, 6.02) p = .621	−18.28 (−30.58, −5.98) p = .002	−12.00 (−23.47, −0.53) p = .038
VVAS (6 weeks)	−0.32 (−1.23, 0.59) p = 1.000	−2.08 (−2.99, −1.17) p < .001	−1.75 (−2.60, −0.91) p < .001
ABC (6 weeks)	5.89 (−4.93, 16.71) p = .537	14.74 (3.92, 25.56) p = .005	8.85 (−1.25, 18.94) p = .102

considered significant. Higher scores indicate better function on BBS, DGI, and ABC; lower scores indicate less handicap or severity on DHI and VVAS, as shown in Table 3. In each case, Group B showed the largest improvement, followed by Group A and then Group C. DGI improved within all groups but did not differ significantly between groups at any time point (p>0.05). Post-hoc pairwise comparisons between groups with mean difference, 95% CI, and p-values are given in Table 4.

DISCUSSION

This trial compared habituation exercises and proprioceptive training, each combined with Epley repositioning, against repositioning alone in patients with chronic BPPV. All three approaches improved balance, dizziness, vertigo, and balance confidence, but proprioceptive training produced the largest gains on every measure except dynamic gait, indicating that somatosensory and postural-strategy training confers additional benefit beyond that achieved by canalith repositioning alone. These findings are consistent with earlier work showing that customized, multicomponent vestibular rehabilitation outperforms repositioning maneuvers or generic vestibular exercise alone on measures of balance and dizziness handicap, even though not every prior study found statistical significance for the exercise-based arm.[20,21,22] Trials comparing the Epley maneuver with alternative repositioning techniques such as the Gans maneuver have reported similarly favorable short-term resolution of posterior-canal and subjective BPPV.[20,23] while the trials contrasting the Epley maneuver with Brandt-Daroff exercises and other combined exercise protocols have likewise reported significant, if variable, improvement in vertigo and balance outcomes.[24] The relative benefit of proprioceptive training seen here is also in line with reports that proprioceptive-focused programs reduce fall risk more effectively than standard vestibular rehabilitation in older adults with balance impairment, supporting the premise that strengthening somatosensory input and postural strategies is a distinct and additive mechanism to central vestibular habituation.[25]

Unlike some earlier reports that found improvement confined to dynamic rather than static balance, this study found significant between-group differences in both the Berg Balance Scale, which captures largely static and functional balance tasks, and gait-related measures did trend upward, although the dynamic gait index difference between groups did not reach significance, plausibly because gait control depends more heavily on central compensation, which develops similarly across all three treatment arms, than on the specific exercise added.[26] The demographic pattern observed, with BPPV more frequent among women in their middle years and from upper-middle-income

backgrounds, mirrors patterns reported in other regional cohorts and may reflect both underlying susceptibility and differential care-seeking behavior.[3,9] Outcome measures for dizziness, vertigo, and balance confidence relied on patient self-report; participants were drawn from a single geographic area. These factors may limit generalizability and the ability to assess recurrence over the longer term.

CONCLUSION

Habituation exercises, proprioceptive training, and conventional vestibular therapy each improved balance, dizziness, vertigo, and quality of life in patients with benign paroxysmal positional vertigo. Proprioceptive training combined with Epley repositioning produced the greatest improvement in static and functional balance, dizziness handicap, vertigo severity, and balance confidence, and warrants consideration as a preferred adjunct to canalith repositioning in vestibular rehabilitation programs for this condition. Dynamic gait improved in all groups, with no significant between-group advantage. Future trials with longer follow-up are needed to determine whether these gains are sustained and whether they reduce BPPV recurrence.

DECLARATIONS

Consent to participate: Written informed consent was obtained from all participants before enrollment.
Ethical Approval: Approval was obtained from the review board of the Riphah International University.
Availability of Data and Materials: Data will be made available upon request. The corresponding author will submit all dataset files.
Competing interests: None
Funding: No funding source involved.
Authors' contributions: All authors have read and approved the final manuscript.
NJ: Conceptualization, methods, investigation.
SA: Supervision, project administration, and validation.
TS: Investigation, data curation, and resources.
RA: Statistical analysis and visualization, validation.

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