Impact of Cawthorne-Cooksey Vestibular Exercises on BBS in PC-BPPV Patients with Residual Dizziness

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Abstract:
Background: Posterior canal Benign paroxysmal positional vertigo (pc-BPPV) is among the most prevalent vestibular disorders, often resulting in dizziness, visual vertigo, and impaired postural control. Even after successful canalith repositioning, many patients continue to experience residual dizziness and balance disturbances, particularly in posterior canal BPPV (pc-BPPV).
Purpose: This study aimed to evaluate the impact of Cawthorne-Cooksey vestibular exercises on balance performance, specifically using the Berg Balance Scale (BBS), in patients with pc--BPPV experiencing residual dizziness.
Design: A pre–post experimental study design was adopted.
Setting: The study was conducted at Marwad Hospital and Research Center, Bikaner, Rajasthan.
Participants: Twelve participants, aged between 20 and 60 years and diagnosed with PC-BPPV based on a positive Dix–Hallpike test, were included regardless of gender.
Intervention: Cawthorne-Cooksey vestibular rehabilitation exercises were administered over a 2-week period to address postural instability associated with residual symptoms in pc-BPPV .
Measurements: Assessments were conducted at baseline and post-intervention using the Visual Vertigo Analog Scale, and Berg Balance Scale (BBS).
Results: Statistical analysis using mean, standard deviation, independent t-test, and paired t-test revealed significant improvements ($p < 0.05$) in dizziness perception, postural control, visual vertigo, and both static and dynamic balance following the intervention.
Conclusion: Cawthorne-Cooksey vestibular exercises significantly improved balance, as measured by BBS, in pc--BPPV patients with residual dizziness. The study also observed a higher prevalence of pc-BPPV in females, particularly within the 30–40 years age group.

Keywords: Balance, posterior canal BPPV, residual dizziness, Cawthorne-Cooksey vestibular exercises, Berg Balance Scale.

Introduction

The vestibular system plays a crucial role in maintaining equilibrium and supporting auditory functions in the human body. It provides critical information regarding the linear and angular acceleration of the head, as well as its orientation relative to the gravitational axis [1]. Although many peripheral vestibular disorders tend to resolve spontaneously and are often benign in nature [2], benign paroxysmal positional vertigo (BPPV) remains a prevalent cause of vertigo. BPPV is characterized by the displacement of otoconia from the utricle into one or more semicircular canals. This results in brief, positional triggered episodes of vertigo, often accompanied by postural instability and an increased risk of falls [3].

BPPV is the most frequent cause of peripheral vestibular vertigo and ranks as the leading vertiginous disorder observed in clinical and community settings [4]. It accounts for approximately 20% of vestibular dysfunction diagnoses. Studies have shown that older adults are particularly vulnerable, and unrecognized BPPV is found in about 9% of this population [5]. Women appear to be more frequently affected than men, with a recurrence rate reported between 20% and 30% [6].

Most BPPV cases are idiopathic, with around 50%–70% occurring in individuals aged 50 to 70 years. Head trauma is the second most common cause, accounting for 7%–17% of cases [7]. Other secondary causes include viral neuritis (15%), Meniere's disease (5%), migraines (5%), and both otologic and non-otologic surgical procedures (1%) [6].

Vertigo episodes in pc-BPPV are typically brief, positional, and resolve within 30 seconds—particularly in posterior canal BPPV. However, many patients also report persistent symptoms such as light-headedness, nausea, unsteadiness, and difficulty standing or walking [1]. Additional characteristic symptoms include rotational vertigo (86%), oscillopsia (31%), nausea (33%), vomiting (14%), imbalance (49%), fear of falling (36%), and actual falls (1%) [6].

With diminished visual input, pc-BPPV patients become more reliant on vestibular cues for balance. An asymmetrical vestibular signal can impair sensory integration and cause abnormal vestibulospinal reflexes, increasing postural sway—an issue measurable through dynamic posturography [1]. Visually dependent individuals may misinterpret motion in their surroundings as self-motion, triggering inappropriate postural corrections and resulting in instability. Hence, reducing visual dependency and training patients to navigate across varied sensory environments is crucial. Unlike gaze stability, recovery of postural control in pc-BPPV patients tends to be gradual [8].

Cawthorne-Cooksey vestibular exercises is a common protocol for vestibular rehabilitation, which involves balance centers, such as visual, proprioceptive, and vestibular activities. [20] Patients are encouraged to move into positions that provoke symptoms and central nervous system then attempts to reduce this error signal by modifying the gain of the vestibular system, through adaptation of the vestibular system. This exercise program includes

1. Adaptation exercises to improve the gain of Vestibulo-Ocular Reflex VOR
2. Habituation exercises, the use of repeated head and visual movement activities to facilitate a reduction in the symptoms provoked by a specific movement,
3. Balance and gait exercises to improve in both static and dynamic balance abilities
4. General conditioning exercises.[21]

Vestibular rehabilitation therapy (VRT) is a key intervention for addressing persistent postural and balance dysfunction in such patients. The primary objectives of VRT for improving postural stability include teaching patients to utilize stable visual references, optimizing somatosensory feedback, maximizing any remaining vestibular input, developing efficient alternative movement strategies, and restoring normal postural control mechanisms [9]. Since pc-BPPV patients often experience difficulties in daily functional tasks due to visuo-proprioceptive conflicts, and their postural recovery is delayed, targeted interventions are essential to enhance stability and improve quality of life [9].

Research Methodology

Study Design and Setting

This was a pre–post experimental study conducted at Marwad Hospital and Research Center, Bikaner, India . Ethical clearance was obtained from the Institutional Ethical Review Committee prior to the commencement of the study.

Participants

Patients were recruited based on a positive Dix–Hallpike test , diagnosed by an ENT specialist along with characteristic clinical features.
Participants were selected according to the following inclusion and exclusion criteria:

Inclusion Criteria:

1. Individuals aged between 20 to 60 years.
2. Both male and female patients presenting with symptomatic pc-BPPV.
3. Willingness to participate and provide informed consent.

Exclusion Criteria:

1. Cases of secondary BPPV.
2. Patients diagnosed with inner ear disorders.
3. Individuals with a history of migraine.
4. Patients with cerebrovascular diseases.
5. Presence of systemic illnesses.
6. Participants with history of head injury.

Ethical Considerations

All participants provided written informed consent prior to enrollment. The study objectives and procedures were explained thoroughly, and demographic data were collected at baseline.
Assessment Tools
Participants were assessed at baseline and after 2 weeks using the following outcome measures:

- Berg Balance Scale (BBS)
- Visual Vertigo Analog Scale (VVAS)
- Dizziness Handicap Inventory (DHI)

Intervention Procedure

Participants were enrolled in a structured postural stability training protocol based on Cawthorne-Cooksey vestibular exercises . No vestibular suppressants or medications were administered to avoid bias. The intervention was delivered over a period of 2 weeks , with daily sessions lasting 20–25 minutes .

The protocol include :

- Static balance training: Participants stood with feet as close together as possible, progressing from wall support to minimal or no support while turning the head side-to-side for 1 minute.
- Dynamic balance tasks: Gradual progression in stance from feet apart to feet together, then semi-heel, and finally toe position. Arm positions varied from outstretched to folded across the chest, with each posture held for 15 seconds and repeated for 5 minutes.
- Surface variability training: Participants stood and performed tasks on various surfaces (hard floor, thin carpet, cushioned surface, pillow), gradually increasing difficulty. Backward walking was introduced with caution.
- Dual-task walking: Participants walked while counting backward and then progressed to walking with narrower base of support, minimizing reliance on wall support.
- Turning drills: Patients practiced walking in circles, starting with larger turns and progressing to smaller ones in both directions.
- Ball exercises: Patients practiced sitting and bouncing on an exercise ball while maintaining visual fixation on a stationary target.
- Outdoor training: Final sessions involved walking in external environments to expose patients to different sensory cues and reduce visual dependency.

Cawthorne-Cooksey vestibular exercises included the following items:

- **Eye and head movement, first sitting down slowly and then faster:**
- looking up and down,
- looking to the right and left,
- bringing the fingers closer and farther and looking at them,
- moving the head slowly and then faster to the right and to the left, with eyes open,
- moving the head slowly and then faster up and down, with eyes open, and
- repeating steps 4 and 5 with eyes closed;
- **Head and body movement, sitting down:**
- placing an object on the floor, pick it up and bring it above the head and place it on the floor again, looking at the object the whole time,
- shrinking the shoulders and make circular movements,
- bending forward and taking an object through the back and front of the knees;
- **Standing up exercises:**
- repeating A and B2,
- siting down and standing up twice,
- siting down and standing up twice, with eyes closed,
- standing up but turning to the right while standing,
- standing up, but turning to the left while standing,
- throwing a small ball from one hand to the other (above the horizon level), and
- throwing a small ball from one hand to the other under the knees and vice versa.

Other activities to improve balance are as follow:

1. climbing up and down the stairs using handrail, if necessary,
2. standing up and taking sudden 90o turns first with eyes open and then with eyes closed,

3. while walking, looking to the right and the left as if reading labels in the market,
4. practicing standing on one foot with the right foot and then the left foot first with eyes open and then with closed eyes,
5. standing up on a soft surface,

- walking on the surface to get used to it,
- walking on the tip of the feet first with eyes open and the, with eyes closed,
- practicing exercise 4 on a soft surface,
- circling around a person that is on the centre who throws a large ball, which should be thrown back, and
- walking around the room with eyes closed [18,19] .

Data Analysis

All collected data were entered and analyzed using IBM SPSS Statistics software, version 21 . Descriptive statistics including mean and standard deviation were calculated. Inferential analysis was conducted using both independent t-test and paired (dependent) t-test to determine pre–post intervention significance levels, with a p-value < 0.05 considered statistically significant.

Results

In this study, the pre- and post-intervention findings were evaluated using outcome measures including the Dizziness Handicap Inventory (DHI) , the Visual Vertigo Analog Scale (VVAS) , and the Berg Balance Scale (BBS) . A p-value < 0.05 was considered statistically significant for all analyses.

A total of 12 participants were included, comprising 11 females and 1 male , with a mean age of 31 years and an average duration of vertigo of 2 years and 8 months (Table 1). A higher prevalence of pc-BPPV was noted among females. It is important to acknowledge that the involvement of specific semicircular canals was not identified, representing a limitation of this study.

Table 1: Demographic data

Characteristic	Mean	SD
Age (in years)	31.00	11.59
Gender Distribution	1 Male	11 Females
Duration of Vertigo (in years)	2.83	1.40

Note :

> SD = Standard Deviation

> Duration of vertigo is represented in years (converted from 2 years and 8 months ≈ 2.83 years).

> Gender distribution highlights a higher prevalence of pc-BPPV among females in this study sample.

Table 2: Within-Group Comparison of Outcome Measures Before and After Cawthorne-Cooksey vestibular Exercises

Outcome Measure	Pre-Test Mean	SD	Post-Test Mean	SD	P-value
Dizziness Handicap Inventory (DHI) Score	39.67	19.48	17.17	7.93	0.0002

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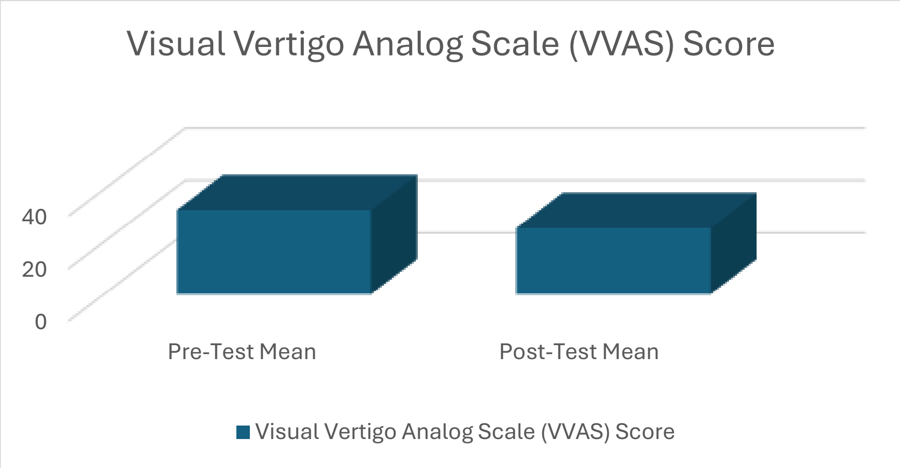
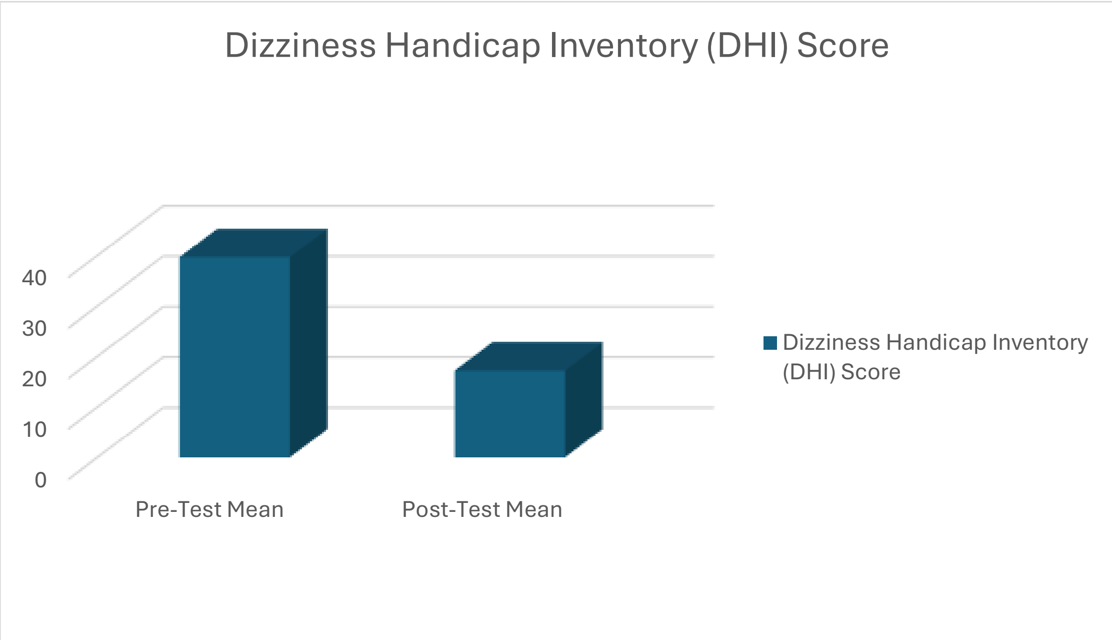
Visual Vertigo Analog Scale (VVAS) Score	32.13	12.29	25.30	10.83	0.0001
Berg Balance Scale (BBS) Score	35.58	7.01	47.50	3.85	0.0001

Interpretation :

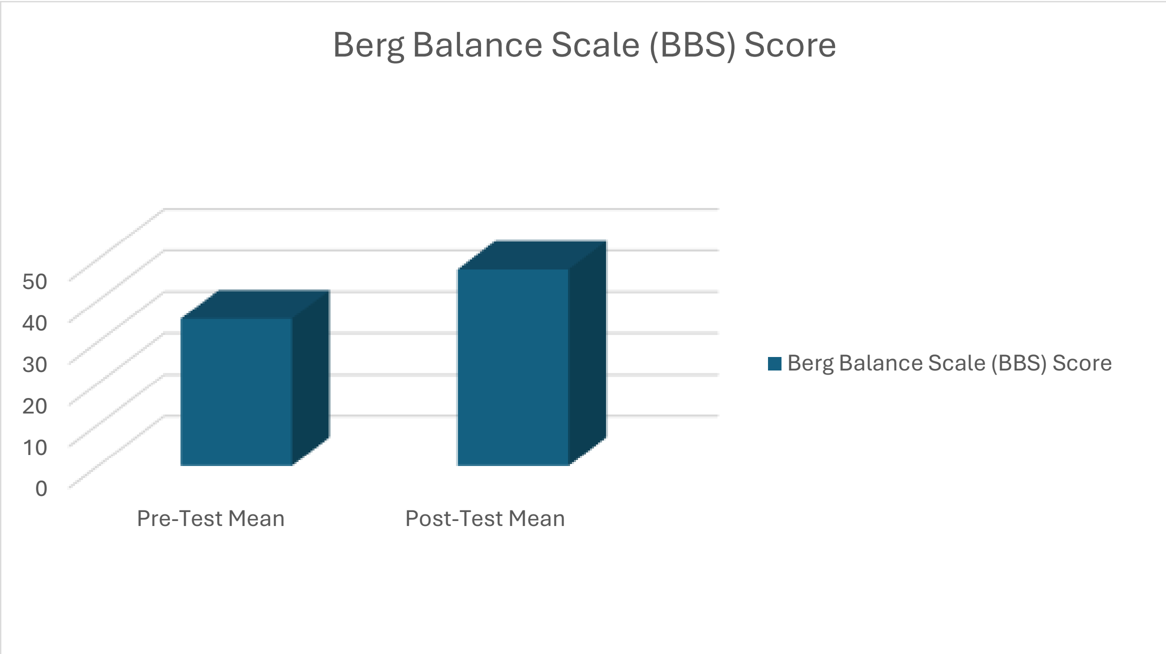
- All outcome measures demonstrated statistically significant improvement after postural stability exercises ($p < 0.05$).



- Lower post-test scores in DHI, and VVAS indicate improvement in postural stability, reduced dizziness handicap, and reduced visual vertigo, respectively.



- Higher post-test scores in Berg Balance Scale indicate better balance performance and reduced risk of falls.



Abbreviations :

- SD = Standard Deviation
- DHI = Dizziness Handicap Inventory
- VVAS = Visual Vertigo Analog Scale
- BBS = Berg Balance Scale

$p < 0.05$ considered statistically significant.

- The pre-intervention The DHI scores demonstrated a substantial reduction in dizziness-related handicap, with pretest values at 39.67 ± 19.48 and posttest at 17.17 ± 7.93 ($p = 0.0002$).
- A decrease in VVAS scores was also observed, from 32.13 ± 12.29 to 25.30 ± 10.83 , reflecting reduced visual vertigo symptoms, contributing to improved postural control and quality of life.
- The Berg Balance Scale showed a marked increase in scores, from 35.58 ± 7.01 at baseline to 47.50 ± 3.85 post-intervention, suggesting improved balance and a reduced risk of falls in participants following postural stability exercises.

Discussion

Participants in the present study were within the 20–60 year age range, with a mean age of 31 years , suggesting that pc-BPPV may be increasingly prevalent in the 30–40 year demographic. This aligns partially with previous studies indicating pc-BPPV onset typically occurs between 35–72 years . [6] Although pc-BPPV is less common in children, it may affect adults across all ages. [10] Contrary to studies identifying 50–70 years as the peak incidence range, [11] our findings highlight the condition's potential prevalence among younger adults, potentially due to undiagnosed labyrinthitis or vestibular ischemia associated with anterior vestibular artery involvement.

The predominance of female participants (11 out of 12) corroborates existing literature indicating a higher pc-BPPV incidence in women. [11] These female participants reported higher levels of dizziness and discomfort during prolonged episodes, which resolved post-intervention.

The posterior semicircular canal is typically the most affected in BPPV, due to gravitational migration of dislodged otoconia into the canal, leading to transient episodes of vertigo and balance disturbance. [12]
Postural control relies on the integration of visual, vestibular, and proprioceptive systems. In our study, assessment Post-intervention, BBS scores improved, indicating enhanced postural control and reduction in sway velocity. During the acute phase, patients exhibited difficulty with repeated head movements, single-leg standing, and ambulation on uneven terrain. These findings align with studies demonstrating greater sway and balance impairments in untreated pc-BPPV patients compared to healthy controls. [10]
When visual input was limited, reliance on vestibular input increased, revealing ineffective sensory reweighting and poor vestibulospinal responses. [13]
The intervention led to marked improvements in both static and dynamic postural tasks , as well as a reduction in the perception of disequilibrium. These outcomes are consistent with research showing early recovery in postural control through vestibular rehabilitation exercises . [14] Vertigo-related dizziness can severely impair daily function and contribute to psychological distress, including anxiety and depressive symptoms. [15] In our study, participants reported difficulties in basic tasks such as gaze fixation , looking up down , and head turning , all of which improved following the intervention.
Evaluation of postural sway using static posturography in prior studies suggests that pc-BPPV is associated with chronic postural disturbances even after the resolution of acute symptoms. Repositioning maneuvers have been shown to reduce lateral sway but not anteroposterior sway, indicating persistent deficits in dynamic balance control. [16] Interestingly, despite the short 2-week duration of intervention in our study, significant improvement in postural stability was achieved, suggesting early benefits from targeted postural training.
Participants with shorter durations of vertigo exhibited more pronounced dizziness symptoms, while those with longer pc-BPPV histories displayed more persistent balance deficits. This observation suggests that acute symptoms are predominantly vestibular , while chronic cases involve multisensory balance dysfunction .
Postural stability exercises appear to support compensation by maximizing residual vestibular function , reducing over-reliance on visual and somatosensory systems. [17] During the acute phase , individuals depend more on somatosensory feedback from the lower extremities, whereas in chronic stages , visual dependency becomes more prominent. In our findings, patients relied heavily on visual cues, resulting in increased instability when vision was occluded. Gaze fixation and head movement tasks remained challenging.
Aging may further compound balance issues due to delayed visuomotor processing , contributing to poor postural responses and increased fall risk, especially in geriatric populations. [10] However, older adults were not included in the current study, which may limit generalizability, given their higher susceptibility to BPPV.
the effectiveness of Cawthorne-Cooksey Exercises (CCE) for enhancing balance in individuals experiencing dizziness and vertigo, both with and without underlying vestibular dysfunction. Eight studies were included, out of which six demonstrated improvements in balance outcomes, while two showed no significant effect [27,28].
In study, the lack of improvement was attributed to the group performing home-based, unsupervised Cawthorne-Cooksey Exercises (CCE), which was less effective compared to customized, supervised vestibular rehabilitation. [28] Study reported no additional benefits of Cawthorne-Cooksey Exercises

(CCE) when combined with the Epley maneuver, likely due to the control group also receiving the Epley maneuver, possibly masking the effects of Cawthorne-Cooksey Exercises (CCE). [30]

On the other hand, studies reported varied but overall positive outcomes with the inclusion of Cawthorne-Cooksey Exercises (CCE) [22–28]. Study found benefits when Cawthorne-Cooksey Exercises (CCE) was combined with a modified Epley maneuver, [22] while highlighted the effectiveness of Cawthorne-Cooksey Exercises (CCE) when integrated with sensory-motor system strengthening. [25] Study observed improvements specifically in static balance and reduction of dizziness symptoms with modified versions of Cawthorne-Cooksey Exercises (CCE). [23] [27] Study compared Cawthorne-Cooksey Exercises (CCE) with instrumental rehabilitation and found both effective, though the latter showed more significant benefits. [28]Study emphasized that activity-based, functional Cawthorne-Cooksey Exercises (CCE) yielded better outcomes than traditional approaches. [26]

From these findings, it can be inferred that Cawthorne-Cooksey Exercises (CCE) is effective in improving balance and reducing vertigo-related symptoms, especially when used as part of a comprehensive rehabilitation program or in a multimodal exercise format. The studies showing no significant benefit may reflect limitations related to unsupervised home exercise programs [31], or study designs where both intervention and control groups received effective maneuvers such as the Epley , reducing the ability to isolate the effect of Cawthorne-Cooksey Exercises (CCE) [30]. In contrast, control conditions in other studies used less effective interventions, enabling clearer demonstration of Cawthorne-Cooksey Exercises (CCE)'s benefits [22].

Conclusion:

Cawthorne-Cooksey vestibular exercises significantly improved balance, as measured by BBS, in PC-BPPV patients with residual dizziness. The study also observed a higher prevalence of pc-BPPV in females, particularly within the 30–40 years age group.

Additional limitations include:

- The absence of canal-specific involvement data.
- Lack of long-term follow-up to assess sustained improvement.
- Unmeasured outcomes related to fall risk and quality of life (qol) .
- Exclusion of older adult populations, despite their increased BPPV prevalence.

Future studies should incorporate a longer intervention period , include canal-specific diagnoses , and track outcomes such as fall risk, daily activity impact, and long-term qol improvements to comprehensively assess the effectiveness of Cawthorne-Cooksey Exercises And postural stability exercises in managing BPPV.

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