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Effectiveness of Tele-Rehabilitation Based Brandt-Daroff Exercise Versus Cawthorne-Cooksey Exercises on Dizziness and Disability in Patients with Posterior Canal Benign Paroxysmal Positional Vertigo: An Experimental Study

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ABSTRACT

Background: Benign paroxysmal positional vertigo (BPPV) is the most common peripheral vestibular disorder and is frequently associated with residual dizziness following successful canalith repositioning. Vestibular rehabilitation may help alleviate persistent dizziness and functional disability. This study compared the effectiveness of tele-rehabilitation-based Brandt-Daroff and Cawthorne-Cooksey exercises in patients with posterior canal BPPV following successful Epley maneuver.

Methods: This experimental study included 48 patients with posterior canal BPPV who continued to experience dizziness or unsteadiness after successful Epley maneuver. Participants were randomly allocated to two groups (24 per group). Group A received Epley maneuver followed by tele-rehabilitation-based Brandt-Daroff exercises, whereas Group B received Epley maneuver followed by tele-rehabilitation-based Cawthorne-Cooksey exercises for 2 weeks. One exercise session per day was supervised remotely, while two additional sessions were performed independently using a prescribed home exercise program. Dizziness severity and dizziness-related disability were assessed before and after intervention using the Numeric Dizziness Rating Scale (NDRS) and Dizziness Handicap Inventory (DHI), respectively. Within-group changes were analyzed using the Wilcoxon signed-rank test, and between-group differences were assessed using the Mann-Whitney U test.

Results: Both groups demonstrated statistically significant improvements in DHI and all NDRS measures following the 2-week intervention ($p \leq 0.001$). Between-group analysis showed no statistically significant differences in DHI ($U=273$, $p=0.50$), NDRS current ($U=291.5$, $p=0.93$), or NDRS best scores ($U=208$, $p=0.66$). A statistically significant between-group difference was observed for NDRS worst score ($U=394.5$, $p=0.016$).

Conclusion: Tele-rehabilitation-based Brandt-Daroff and Cawthorne-Cooksey exercises were associated with significant improvements in residual dizziness and dizziness-related disability following successful Epley maneuver in patients with

posterior canal BPPV. The two interventions demonstrated comparable outcomes for most measures, although a significant between-group difference was observed for worst-rated dizziness.

Keywords: *BPPV, Benign Paroxysmal Positional Vertigo, Tele-rehabilitation, Brandt-Daroff, Cawthorne-Cooksey exercises.*

1. INTRODUCTION

Benign Paroxysmal Positional Vertigo (BPPV) is known as the most frequently occurring disorder affecting the peripheral vestibular system. It is characterized by brief episodes of vertigo that are triggered by changes in head position relative to gravity, resulting in a sensation of spinning or movement.[1] BPPV shows an annual incidence of approximately 0.6%, with varying prevalence across populations. Although all semicircular canals may be involved, the posterior semicircular canal is most commonly affected due to its anatomical orientation and gravitational dependence when an individual assumes a recumbent position.[2]

The underlying mechanism of BPPV involves the displacement of otoconia from the utricle into the semicircular canals. These displaced particles may remain free floating within the canal, referred to as canalithiasis, or adhere to the cupula, known as cupulolithiasis. Both mechanisms disturb normal endolymphatic flow during head movements, leading to abnormal stimulation of the vestibular system and can cause vertigo. [3,4]

Canalith repositioning maneuvers are widely accepted as the first line treatment approach for BPPV. Among these, Epley's maneuver has demonstrated high effectiveness in relocating otoconia from the semicircular canal back to the utricle. Despite successful repositioning and resolution of the symptoms, a considerable number of patients continue to report residual symptoms such as dizziness, imbalance, or unsteadiness. Persistent postural instability following successful repositioning has been documented in the literature, suggesting that symptom resolution may not always be immediate. [2,5]

Vestibular rehabilitation exercises are commonly practiced to resolve these persistent symptoms. Brandt-Daroff exercises are movement based habituation exercises involving repeated lateral head and trunk movements. These exercises are believed to be effective in facilitating the dislodgement of otoconia through mechanical stimulation and repeated exposure to symptom-provoking positions, thus managing residual dizziness. [6] A recent study by Muhammad Jaffar et al. (2023) demonstrated that individuals performing Brandt Daroff exercises showed greater improvement in dizziness severity and quality of life compared to those performing half-somersault exercises.[7]

Cawthorne Cooksey exercises were originally developed for patients with labyrinthine injuries and are widely used in vestibular rehabilitation. These exercises focus on progressive exposure to eye movements, head movements, eye and head coordination, postural control, and balance activities. Repeated exposure to vestibular stimuli through these exercises promotes central compensation and reduces abnormal vestibular responses. [4,8] A systematic review by Barnana Roy et al. reported that Cawthorne Cooksey exercises are effective in improving balance and reducing symptoms in individuals experiencing vertigo and dizziness.[9]

The effectiveness of vestibular rehabilitation is commonly evaluated using outcome measures such as the Dizziness Handicap Inventory (DHI), which assesses the impact of dizziness on daily functioning, and the Numeric Dizziness Rating Scale (NDRS), which measures the perceived intensity of dizziness.

In recent years, tele-rehabilitation has emerged as an alternative method for

delivering rehabilitation services, defined as the provision of therapy through information and communication technologies. [10,11] Tele-rehabilitation has gained importance in vestibular rehabilitation by enabling supervised home-based exercise programs, improving accessibility and patient adherence. A study by Haciabbasoğlu et al. reported that patients undergoing tele-rehabilitation for BPPV demonstrated greater improvements in vertigo severity, disability, and quality of life compared to those following unsupervised home exercise programs. [12] Although previous research supports the effectiveness of vestibular rehabilitation and tele-rehabilitation individually, limited evidence exists comparing tele-rehabilitation-based Brandt Daroff and Cawthorne Cooksey exercises in patients with posterior canal BPPV. Therefore, this study aims to compare the effectiveness of tele-rehabilitation-based Brandt Daroff and Cawthorne Cooksey exercises in reducing dizziness and disability, while also considering patient compliance with the intervention program.

MATERIALS & METHODS

METHODOLOGY

- Study design: An Experimental study
- Sampling: Purposive sampling
- Study population: Patients with posterior canal BPPV Study setting: ENT clinics of Vadodara city.
- Study duration: 1 year (2024-2025)
- Study period: 2 weeks
- Sample size: 48 (Calculated by G power software at 95% power.)

SELECTION CRITERIA

INCLUSION CRITERIA:

- Diagnosed cases of posterior canal BPPV by physician (within past 3 months).[5]
- Patients of both genders between 18 and 50 years of age.
- Patients having complaint of dizziness after successful Epley's maneuvers.
- MMSE score > 24
- Patients who can read and write in Hindi / English/ Gujarati.
- Patients who are willing to participate.

EXCLUSION CRITERIA:

- Restricted cervical range of motion.
- Patients who complaint of dizziness due to any other disorders such as neurological disorders, cardiovascular disorders and musculoskeletal disorders that will influence the treatment protocol and the outcome measures.
- Prior history of ear surgery.
- Patient with any ongoing vestibular rehabilitation.
- Patients having problem with any online application compliance.

PROCEDURE

The study was commenced after receiving approval from the institutional ethical committee. Various ENT clinics were approached and permission to recruit their patients for the study and to conduct the study in their clinic were taken. Patients with posterior canal BPPV diagnosed by the physician (within past 3 months) were approached. Each patient received a thorough explanation of the study program. Following a comprehensive explanation of the study's purpose, written consent forms were taken from the patients. The patients were then chosen in accordance with the inclusion criteria and the exclusion criteria through proper screening of all the patients.
All patients were treated with a successful canalith repositioning maneuver a maximum of 2-3 times until a negative Dix Hall-pike Test is achieved. After Epley's maneuver patients were advised to maintain upright position for 20 minutes and avoid sleeping on involved side for 24 hours. Patient who complaint of dizziness or sensation of unsteadiness after successful Epley's procedure were recruited. Outcome measures were taken in those patients and the patients were randomly allocated into

two groups. The patients were unaware of the group they are allocated into.
Group A - Epley's + Brandt Daroff
Group B – Epley's + Cawthorne Cooksey
The patients were explained and demonstrated the Brandt Daroff and Cawthorne Cooksey exercises respectively. [2] Appropriate instructions and detailed explanation about when and how the sessions to be conducted were given to the patients, after which the patients were handed a copy of the booklet which demonstrated the home exercise program. The first session was conducted under direct supervision of the therapist. One session per day was conducted under supervision through tele-rehabilitation using feasible software for the patient on smart phone. Whereas the other 2 sessions per day were performed by the patients themselves with the help of the booklet given to them. There after the patient were advised to follow the exercise protocol 3 sessions per day for 2 weeks. [13] The patients were asked to regularly implement the exercise program and record in the exercise maintenance log. [14]

Following the intervention program's conclusion, numeric dizziness rating scale and the dizziness handicap inventory scale were the outcome measures that were collected. The participants were made aware in advance that they would be required to cease the intervention if and when their symptoms worsen over the course of the treatment program and were encouraged to make a clinic appointment. It was required of the participants to continue taking the medications that their reputable ENT experts had prescribed. [2]

OUTCOME MEASURES

1. NUMERIC DIZZINESS RATING SCALE (NDRS) - for assessing intensity of dizziness. (ICC= 0.93) [15]
2. DIZZINESS HANDICAP INVENTORY(DHI) - for assessing impact of dizziness on ADLs. (ICC=0.81) [16,17]

INTERVENTIONS

The following intervention were given to Group A and Group B

GROUP A: BRANDT DAROFF EXERCISE: It includes a sequence of rapid lateral head/trunk tilts repeated serially. [2,18]

Figure 1. Brandt Daroff exercise (sitting with face turned to side)

Figure 2. Brandt Daroff exercise (lying on opposite side with face facing upwards)

GROUP B: CAWTHORNE COOKSEY EXERCISES: These exercises include pursuit and saccadic eye movements, movements of the head, eye-head coordination, total body movements and balance tasks. [19]

Figure 3. lying down: eye movements and head movements.

Figure 4. sitting exercises: eye movements, head movement and trunk movement.

Figure 5. standing exercises: eye movements, head movement, trunk movement, changing position and turning to left and right while standing.

Figure 6. moving around exercises: walking around the room with eyes open and then closed and walking on a soft surface.

Statistical Analysis

A total of 48 subjects were recruited in the study, 24 in each group. Analysis was done using SPSS version 30.0. All the outcome measures were analyzed at baseline and at the end of the intervention using appropriate statistical tests.

Data was analyzed at a 5% level of significance with a confidence interval of 95%.

To test the normality of data for all the outcomes using Shapiro-Wilk's Test at 5% L.O.S was used, it showed that the data was not normally distributed for the outcome measures NDRS and DHI.

Descriptive baseline data such as age, gender, MMSE and DHI were analyzed using mean and SD.

Data were analyzed by using a Wilcoxon signed test and Mann-Whitney U test for within-group and between group comparison respectively for NDRS and DHI in both the groups.

RESULT

The mean value and SD for age and DHI distribution among 48 subjects with 24 in each group.

TABLE 1: DESCRIPTIVE ANALYSIS OF GROUP A AND GROUP B

Demographic Data		Group A	Group B	p value
Age (mean ±SD)		36.77 ± 5.43	36.16 ± 5.45	0.69
Gender	Female(n)	11	12	
	Male(n)	13	12	
DHI (mean±SD)		36 ± 5.05	37.91 ± 6.50	0.094

INTERPRETATION: The above table showed the mean value and SD for age and DHI distribution among 48 subjects with 24 in each group.

At baseline, there was no statistically significant difference in the Age and DHI scores between both groups.

TABLE 2: WITHIN GROUP COMPARISON OF DHI AND NDRS IN GROUP A

VARIABLES	PRE INTERVENTION (Mean±SD)	POST INTERVENTION (Mean±SD)	W VALUE	p VALUE	SIGNIFICANCE
DHI	36 ± 5.05	10.83 ± 2.94	-4.30	<0.001	HIGHLY SIGNIFICANT
NDRS current	0.95 ± 0.80	0.16 ± 0.38	-3.75	<0.001	HIGHLY SIGNIFICANT
NDRS worst	6.54 ± 1.02	1.58 ± 1.10	-4.48	<0.001	HIGHLY SIGNIFICANT
NDRS best	0.5 ± 0.58	0 ± 0	-3.20	0.001	HIGHLY SIGNIFICANT

INTERPRETATION:
Wilcoxon test was used for within group comparison of DHI (W= -4.30, p<0.001), NDRS CURRENT (W= -3.75, p<0.001), NDRS WORST (W= -4.48, p<0.001), and NDRS BEST (W= -3.20, p=0.001) which showed statistically significant difference in group A.

TABLE 3: WITHIN GROUP COMPARISON OF DHI AND NDRS IN GROUP B

VARIABLES	PRE INTERVENTION (Mean±SD)	POST INTERVENTION (Mean±SD)	W VALUE	p VALUE	SIGNIFICANCE
DHI	37.91 ± 6.60	11.83 ± 3.10	-4.30	<0.001	HIGHLY SIGNIFICANT
NDRS current	1.04 ± 0.80	0.20 ± 0.50	-3.40	<0.001	HIGHLY SIGNIFICANT
NDRS worst	6.12 ± 1.03	1.83 ± 1.16	-4.33	<0.001	HIGHLY SIGNIFICANT
NDRS best	0.83 ± 0.63	0 ± 0	-3.87	<0.001	HIGHLY SIGNIFICANT

INTERPRETATION: Wilcoxon test was used for within group comparison of DHI (W= -4.30, p<0.001), NDRS CURRENT (W= -3.40, p<0.001), NDRS WORST (W= -4.33, p<0.001) and NDRS BEST (W= -3.87, p<0.001) which showed statistically significant difference in group B.

TABLE 4: BETWEEN GROUP COMPARISON OF DHI AND NDRS

VARIABLES	GROUP A		GROUP B		U VALUE	p VALUE	SIGNIFICANCE
	PRE INTERVENTION (Mean±SD)	POST INTERVENTION (Mean±SD)	PRE INTERVENTION (Mean±SD)	POST INTERVENTION (Mean±SD)			
DHI	36 ± 5.05	10.83 ± 2.94	37.91 ± 6.50	11.83 ± 3.10	273	0.50	NOT SIGNIFICANT
NDRS current	0.95 ± 0.83	0.16 ± 0.38	1.04 ± 0.80	0.20 ± 0.50	291.5	0.93	NOT SIGNIFICANT
NDRS worst	6.54 ± 1.02	1.58 ± 1.10	6.12 ± 1.03	1.83 ± 1.16	394.5	0.016	SIGNIFICANT
NDRS best	0.50 ± 0.58	0 ± 0	0.83 ± 0.63	0 ± 0	208	0.66	NOT SIGNIFICANT

INTERPRETATION: Mann-Whitney U test was used for between group comparison of DHI (U=273, p=0.50), NDRS CURRENT (U= 291.5, p=0.93), and NDRS BEST (U= 208, p=0.66), which showed no statistically significant difference between the two groups.
Mann-Whitney U test was used for between group comparison of NDRS WORST (U= 394.5, p=0.016), it showed statistically significant difference between the two groups.
Results showed no statistically significant difference between both the groups in DHI, NDRS CURRENT and NDRS BEST.
Result showed statistically significant difference between both the groups in NDRS WORST

DISCUSSION

The present study was conducted to identify an effective exercise-based rehabilitation approach for managing residual dizziness in patients with posterior canal BPPV following successful Epley's maneuver. The primary objectives were to evaluate the effects of tele-rehabilitation-based Brandt Daroff exercises and Cawthorne Cooksey exercises on dizziness severity and dizziness related disability using the Numeric Dizziness Rating Scale (NDRS) and the Dizziness Handicap Inventory (DHI).

The findings of the study revealed significant improvements in both dizziness severity and disability among participants in Group A who performed Brandt Daroff exercises. After two weeks of intervention, patients demonstrated reduced NDRS scores and improved DHI scores, indicating effective symptom relief. Brandt Daroff exercises are believed to facilitate symptom improvement by promoting habituation and utilizing gravitational forces to assist in the repositioning of displaced otoconia away from the affected semicircular canal.[20]

Vijayaraj (2018) reported that patients undergoing Brandt-Daroff exercises following Epley's maneuver experienced significant reductions in dizziness severity and improvements in quality of life. The mechanism underlying this improvement is attributed to vestibular habituation, wherein repeated exposure to symptom provoking movements reduces the intensity of vestibular responses over time. Vestibular habituation continues to play an important role in the management of BPPV related symptoms. [2,21,22]

The second objective of the study was to examine the effectiveness of tele-rehabilitation based Cawthorne Cooksey exercises. Participants in Group B demonstrated significant improvements in both DHI and NDRS scores, reflecting reduced dizziness intensity and decreased functional limitations. Cawthorne Cooksey exercises aim to stimulate vestibular adaptation by progressively challenging the visual, vestibular, and somatosensory systems. The improvement observed in this group supports the knowledge that repeated multisensory stimulation enhances central nervous system compensation.[23]

These exercises encourage the development of tolerance mechanisms within the brain, allowing patients to better manage vestibular symptoms. Previous studies have emphasized that such exercises facilitate central compensation by promoting sensory integration and reducing vestibular hypersensitivity, which may explain the observed reduction in dizziness severity in Group B participants. [24,25]

The third objective of the study involved comparing the effects of tele-rehabilitation-based Brandt Daroff and Cawthorne Cooksey exercises. The results indicated that both interventions were equally effective in improving DHI scores, as well as NDRS current and best scores. These findings align with earlier studies comparing these exercise protocols in clinical settings, which reported comparable improvements in dizziness related disability and symptom severity.[2]

However, a statistically significant difference was observed between the two groups for the NDRS worst score, with Group A demonstrating greater improvement compared to Group B. This superior outcome may be attributed to the mechanical component of Brandt Daroff exercises, which place patients in symptom-provoking positions that facilitate otoconial repositioning in addition to promoting vestibular habituation. [26] Repetitive movements performed during these exercises may assist in dislodging otoconia from abnormal locations and enhancing their movement toward the utricle, thereby reducing abnormal endolymphatic flow and alleviating dizziness. [27]

Overall, the findings of the present study suggest that both tele-rehabilitation-based Brandt Daroff and Cawthorne Cooksey exercises are effective in managing residual dizziness following successful Epley's

maneuver in patients with posterior canal BPPV. Tele-rehabilitation offers a practical and accessible approach to delivering vestibular rehabilitation, particularly for individuals with limited mobility or restricted access to healthcare facilities. It may also enhance patient engagement, adherence, and safety through supervised remote sessions.

Despite these positive outcomes, the study has certain limitations. Long term follow up was not conducted, which limits the ability to determine sustained treatment effects. Additionally, technological barriers such as poor internet connectivity, limited access to smartphones, and unfamiliarity with digital platforms may have influenced patient participation and compliance. Future research may explore the use of advanced technologies such as motion tracking systems or virtual reality-based rehabilitation to enhance exercise monitoring and effectiveness. Long term follow up studies are also recommended to assess the durability of treatment outcomes.

CONCLUSION

The results of this study demonstrate Brandt Daroff and Cawthorne Cooksey exercises incorporated through tele-rehabilitation can be a successful therapy approach as an alternative for managing residual dizziness by relieving symptoms and improving its impact on the daily activity of the individuals. Both exercises are safe, easy to perform and helpful in treating post Epley's residual dizziness.

Declaration by Authors

Ethical Approval: Ethical approval was obtained from the Institutional Review Board with the proposal number: PPC/OW/686A/2024 dated 14/09/2024.

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