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ORIGINAL ARTICLE

Are Telerehabilitation Exercise Practices Effective in Patients Diagnosed with Benign Paroxysmal Positional Vertigo?

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Abstract The aim of this study was to investigate the effectiveness of classical Vestibular Rehabilitation Exercises (Control Group-CG) given as home exercise program and VR + balance exercises (Experimental Group-EG) applied with telerehabilitation method on patients with Benign Paroxysmal Positional Vertigo (BPPV). *Material and Methods:* The patients were randomly divided into 2 therapy groups in the ALKU Hospital (CG; 21 patients, and EG;22 patients). *Pre- and post-test experimental design was adopted and a* six-week training was offered. The participants' balance ability (Romberg, tandem and semi-tandem tests), vertigo severity (Vertigo Symptom Scale-VSS, VAS), vertigo-related disability level (Dizziness Handicap Inventory-DHI), anxiety (Beck Anxiety Inventory-BAI) and quality of life (Vertigo Dizziness Imbalance Questionnaire-VDI) were assessed. *Regarding the b*alance ability, findings in tandem and semi-tandem tests were significantly increased in the EG compared to CG ($p < 0.05$). According to VAS, the severity of dizziness decreased significantly compared to the CG ($p < 0.05$). Regarding the DHI score, symptoms of vertigo were reduced considerably after the treatment compared to the CG ($p < 0.05$). A significant improvement was observed in the quality of life of the EG group according to VDI scoring ($p < 0.05$). Although gains were observed in both groups, it was observed that the EG group obtained more effective improvement in the severity of vertigo, disability level due to vertigo, and quality of life compared to the home exercise group.These results confirmed the hypothesis that EG applications are effective and clinically applicable in patients with BPPV.

Keywords BPPV · Telerehabilitation · Vestibular rehabilitation · Vestibular exercise

Introduction

Today, the importance of digital applications such as teleconsultation, teletherapy, and telerehabilitation has increased with the Covid-19 outbreak [1, 2]. The rehabilitation method is frequently preferred by healthcare professionals as it is time and cost effective and distance free [2, 3]

Studies have indicated that the prevalence of Benign Paroxysmal Positional Vertigo (BPPV) is high and vestibular practices should be arranged on a digital platform due to the need for social isolation in current conditions [3]. Although there is a scarce body of literature on vestibular medicine and teleconsultation, and teletherapy in vestibular physiotherapy, it is stated that telehealth services are safe and effective for diagnosis, evaluation, and treatment in BPPV patients [3].

BPPV is the most common peripheral vestibular disorder [4]. One of the most critical findings of BPPV is nystagmus with positional vertigo [5]. Although the etiology of BPPV is still debated, it is defined as idiopathic (58%). Other causes include head trauma (6–18%) and infection and inner ear-related causes (3–9%) [6]. The involvement of the Posterior Semicircular Canal (SSC) is seen to be more common

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(85–95%) [5]. BPPV's incidence, time, and severity vary, and spontaneous recovery can be seen in patients [6, 7].

The Canalith Reposition Maneuver (CRM) is currently the gold standard treatment method in BPPV patients [7]. However, the change in proprioceptive input after CRM results in a change in static and dynamic balance in BPPV patients, which leads to an increase in the incidence of postural instability [8, 9]. Furthermore, the possibility of side effects in applied medical treatments and repeated CRM may not be sufficient in BPPV patients [9]. In this case, it has been shown that Vestibular Rehabilitation (VR) can be applied in addition to CRM in BPPV patients [10]. The literatüre on teleconsultation and telerehabilitation in BPPV patients is scarce. Keeping all this information in mind, the aim of this study is to compare the effectiveness of classical Vestibular Rehabilitation Exercises (Control Group-CG) given as a home exercise program and VR + balance exercises given with Telerehabilitation (Experimental Group -EG).

Material and Method

Study Place and Time

The research was carried out in Alanya Alaaddin Keykubat University Training, and Research Hospital Ear Nose and Throat (ENT) Diseases Polyclinic between April 2021 and September 2021. The study's ethics committee approval was obtained from the ethical committee of Alanya Alaaddin Keykubat University (date: 14/04/2021, ethical number: 10354421-2021/0709).

Before starting the study, all participants were informed about the aim, procedures and expected results of the study orally and in a written way in accordance with the Declaration of Helsinki. Written informed consent was delivered to the participants. The relevant physician performed the detailed ENT examination and audiometric examination of the patients included into the study.

Study Groups

In this study, the participants were selected on a voluntary basis. 42 individuals who applied to Alanya Alaaddin Keykubat University Training and Research Hospital Ear Nose and Throat Diseases Polyclinic and diagnosed with BPPV agreed to participate in the study. They were aged between 18 and 65 years. Random computer number generator R software was used to assign the participants to one of the groups, CG (n = 21) or EG (n = 21)[11]. All exercises were taught face-to-face to the patients in both groups during the first examination. The CG was given the adaptation exercises (Gaze Stabilization) included in Vestibular Rehabilitation (VR) [12]. They were asked to perform the exercises twice or three times a day [13]. Afterwards, individuals included in this group were called twice a week via whatsapp and questioned whether they did the exercises correctly. EG, on the other hand, was called twice a day via whatsapp and "adaptation exercise, balance and movement habituation exercises" were performed in company with a physiotherapist. In addition, they were asked to do the adaptation exercises alone three times a day.

Inclusion criteria for the study [13]

Following criteria were used to determine the participants:

- diagnosed with positional vertigo
- aged 18–65
- has Dix Halpike maneuver test positive (+),
- could understand the instructions given in Turkish
- competent in using technology
- had a smartphone and active internet connection
- volunteered to participate in the study.

Exclusion criteria from the study

Following criteria were used to exclude the participants from the study:

- Having the findings of acute or chronic infection after the examination by an Ear Nose Throat Doctor
- Having neurological pathology causing dizziness
- Having a history of head trauma, surgical operation, lower extremity pain that prevents standing and weight bearing
- Having a history or symptoms of vestibular system diseases other than BPPV
- Lower extremity Individuals having surgery, sudden sensory hearing loss and chronic otitis media,
- Pregnant or suspected of pregnancy
- Having severe cognitive impairment detected by the physician to prevent testing
- Mentally incapable of understanding and answering the questionnaire
- Having cervical pathology that may cause dizziness
- Having problems with online application compliance
- *Not* participating in the treatment in two consecutive sessions

Educational Program

In both groups, pre-and post-treatment evaluations were performed face-to-face in a hospital setting. Dix Hallpike maneuver was applied to both groups to confirm the diagnosis at the initial evaluation. Incase of the Dix Hallpike test positive, the Epley inserter maneuver was performed. All patients were called for control one week later. The attending physician repeated Dix Hallpike test, and, if necessary, the inserter maneuver was repeated every three to five days until the test was negative.

Before performing the maneuver, which was determined according to the direction of the involved canal, balance tests were applied to the participants in both groups. After the insertion maneuver, the severity of vertigo and the level of disability that result from vertigo, anxiety, and quality of life were evaluated.

Home Exercise Group—Control Group (CG)

Patients included in the Control Group (n = 21) were given a home exercise program and they were instructed to apply them twice or three times a day for six weeks. They were demonstrated how to practice the exercises during the first evaluation at the hospital. Adaptation Exercises in VR, which is used as a home exercise, consist of the image movements that occur on the retina with the movement of the head. The movement in which retinal shift is most effective is consecutive horizontal and vertical movements of the head while the eyes are fixed on a particular point. All the exercises were sent via Whatsapp in pdf format, supported by photographs and additional explanation.The home exercise group was called twice a week by phone and asked whether they did the exercises.

Adaptation Training is given in Table 1 (Table 1).

Combined Exercise Group—Experimental Group (EG)

In addition to the home exercises given to the EG group (n = 21), Balance Exercises in VR exercises were applied in company of a physiotherapist with WhatsApp application in 25–30 min sessions, twice a day for six weeks. Whatsapp application was preferred as it is user-friendly [13]. The exercises were individually planned from easy to difficult. In the first stage, the exercises started in sitting position and the participants rotated the head right-left, up-down. In the following stages, they did the same exercises in Romberg, semi-tandem, and tandem postures, respectively. During all positions, the exercises were performed with eyes open. After that, the same exercises were repeated in all positions with eyes closed. Then, various walking exercises were performed with eyes open and closed during walking. The EG program is shown in Table 2.

The participants' dizziness severity, vertigo-related disability level, balance ability, anxiety level, and quality of life were evaluated before and after the six-week treatment.

Evaluation Methods

Balance Assessment

Participants' balance; Romberg was assessed using the Tandem, Semitandem Posture Tests with eyes open and closed.

Romberg Test When we stand in a proper posture, postural control is provided by stimuli from the visual, somatosensory, and vestibular systems [14]. In the Romberg test, the patient stood with his feet together. He crossed his hands in front of his body. He tried to hold his position for 30 s (sec) with his eyes closed. If there is a vestibular system disorder, the patient tends to fall toward the side of the lesion [9]. The time it could stand was recorded in seconds.

Tandem Posture Test The patient is positioned so that the heel of one foot is on the toe of the other foot. He tried to maintain his position for 30 s with his hands outstretched and parallel eyes open and closed. The time he could stand was recorded in seconds [15].

Table 1 Home exercises—adaptation exercises

Vestibular rehabilitation—adaptation Exercises-gaze stabilization
(1) Eye movements to the right, left (horizontal), then up, and down (vertical) for one minute with the head fixed and in the sitting position
(2) While in the sitting position, holding the object in their hand steady and without taking their eyes off the object, eye movements are made for one minute in the right, left (horizontal), up, and down (vertical) directions
(3) In the sitting position, the patient moves their head in the opposite direction to the right and left consecutively for 1 min without taking their eyes off the object they are holding
(4) While the patient is in a sitting position, they hold objects in their both hands or their hands on both sides with the thumb pointing to the ceiling and move the eyes to the right and left sequentially for 1 min (saccadic eye movement) while the head is fixed

Table 2 Telerehabilitation program

Telerehabilitation program—(adaptation exercises (VR) + balance exrecises)	
Exercises performed in the sitting position	Exercises performed in the standing position
(1) Consecutive eye movements for one minute, fixing the gaze on the object they are holding and its right and left movement	(1) Eyes open, gaze is kept at a fixed point, rotation of the head to the right and left at Romberg (Picture 9), semi-tandem, and tandem stance
(2) Consecutive eye movements for one minute, fixing the gaze on the object they are holding and its up and down movement	(2) Movement of the head in flexion (down), extension (up) in Romberg, semi-tandem, and tandem stances, with eyes open, gaze held at a fixed point
(3) Keeping the gaze on a fixed object and moving their head left, right, and up and down. Rotation (movement) of the head left and right with eyes open and closed	(3) Rotation movement of the head in the right and left directions in Romberg, semi-tandem, and tandem stances, with eyes closed, gaze held at a fixed point
(4) Neck flexion (down) and extension (up) motion with eyes open and closed	(4) Eye movement in the direction of head flexion (down), extension (up) in Romberg, semi-tandem, and tandem stances, with eyes closed, gaze held at a fixed point
	(5) Walking with the rotation of the head to the right and left with the gaze fixed
	(6) Walking backwards, eyes open
	(7) Walking backwards, eyes closed
	(8) Rotation of the head to the right and left with eyes open while walking backwards
	(9) Rotation of the head to the right and left with the eyes closed while walking backwards
	(10) Walking in a tandem position with eyes open
	(11) Walking in a tandem position with eyes closed
	(12) Walking in a tandem position with hands at back, eyes open
	(13) Walking in tandem position with hands at back, eyes closed
	(14) Walking in tandem with hands on shoulders with open eyes
	(15) Hands on shoulders in tandem position

Semi Tandem Posture Test The patient positioned his feet with one foot slightly in front of and adjacent to the other. He tried to maintain his position for 30 s with his hands outstretched and parallel eyes open and closed. The time it could stand was recorded in seconds [15].

Dizziness Handicap Inventory

The Dizziness Disability Inventory (DHI) helps to determine the factors that trigger dizziness and balance disorder in patients with vertigo and their physical, functional and sensory status in vestibular system diseases [16]. The inventory consists of 25 questions. It includes seven questions examining physical effects, nine questions concerning functional effects, and nine questions regarding emotional factors. Answers to the questions are given as yes (4 points), sometimes (2 points), and no (0 points). Scoring the inventory is 28 points for the factors examining physical effects and 36 points for the factors examining sensory and functional effects. A high score is considered to have high vertigo symptoms, and it is thought that dizziness causes a limitation in activities of daily living.

Dizziness Rating

Visual Analog Scale (VAS) was used to determine the severity of dizziness. The patient was asked to score between 0 and 10. 0: I have no dizziness, 1–4: Mild severity, 4–8: Moderate, 10: I have severe dizziness [17].

Vertigo Symptom Scale-Short Form

The Vertigo Symptom Scale (VSS-sf) is a scale designed to determine somatic anxiety and autonomic complaints in patients with dizziness. It includes eight items related to vertigo (0–32 points) and seven items related to autonomic complaints (0–28 points). Scoring of the scale; 0: never, 1 point: very rarely, 2 points: often, 3 points: very often (every week), 4 points: always (every day) [18].

Beck Anxiety Inventory

The Beck Anxiety Inventory (BAI) was used to determine the anxiety levels of patients and the frequency of symptoms [19, 20]. It contains 21 items in total. 0 points = none, 1 point = mild, 2 points = moderate, 3 points = severe. It

is expressed as mild anxiety symptoms between 8 and 15 points, moderate anxiety between 16 and 25 points, and severe anxiety symptoms between 26 and 63 points.

Vertigo Dizziness Imbalance Questionnaire

The Vertigo Dizziness Imbalance Questionnaire (VDI) was used to measure the frequency of vertigo and dizziness complaints and to determine how much their quality of life was affected [18]. It consists of 14 questions for symptoms and 22 for measuring the quality of life. The questionnaire, which includes 36 questions in total, is scored as 0: always, 1: often, 2: often, 3: sometimes, 4: very rarely, and 5: never. The symptom scale total score is 70, quality of life is 100. A high score indicated that the person had few symptoms and high quality of life. Our study used the quality of life part of the scale.

Statistical Analysis

It was observed that the effect size obtained in the reference study named "Effect of Vestibular Exercises Associated With Repositioning Maneuvers in Patients With Benign Paroxysmal Positional Vertigo: A Randomized Controlled Clinical Trial" was at a strong level (d = 1.06). As a result of the power analysis, considering that smaller effect size can be obtained (d = 0.8); When at least 42 people (at least 21 people for each group) were included in the study, it was calculated that 80% power could be obtained at the 95% confidence interval. Data were analyzed with SPSS 25.0 (IBM SPSS Statistics 25 software (Armonk, NY: IBM Corp.) package program. Continuous variables were expressed as mean ± standard deviation, median (25th and 75th percentiles), and categorical variables as numbers and percentages. The conformity of the data to the normal distribution was examined by the -Shapiro–Wilk test. In independent group examinations, when parametric test assumptions were met, the t-test was used in independent groups. When parametric test assumptions were not met, the -Mann–Whitney U test was used. When parametric test assumptions were provided in comparing differences between measurements, T-test independent groups, parametric test Wilcoxon Paired-Sample Test was used when the assumptions were not met. Chi-square test was used to analyze the differences between categorical variables. $P < 0.05$ was considered statistically significant in all analyses.

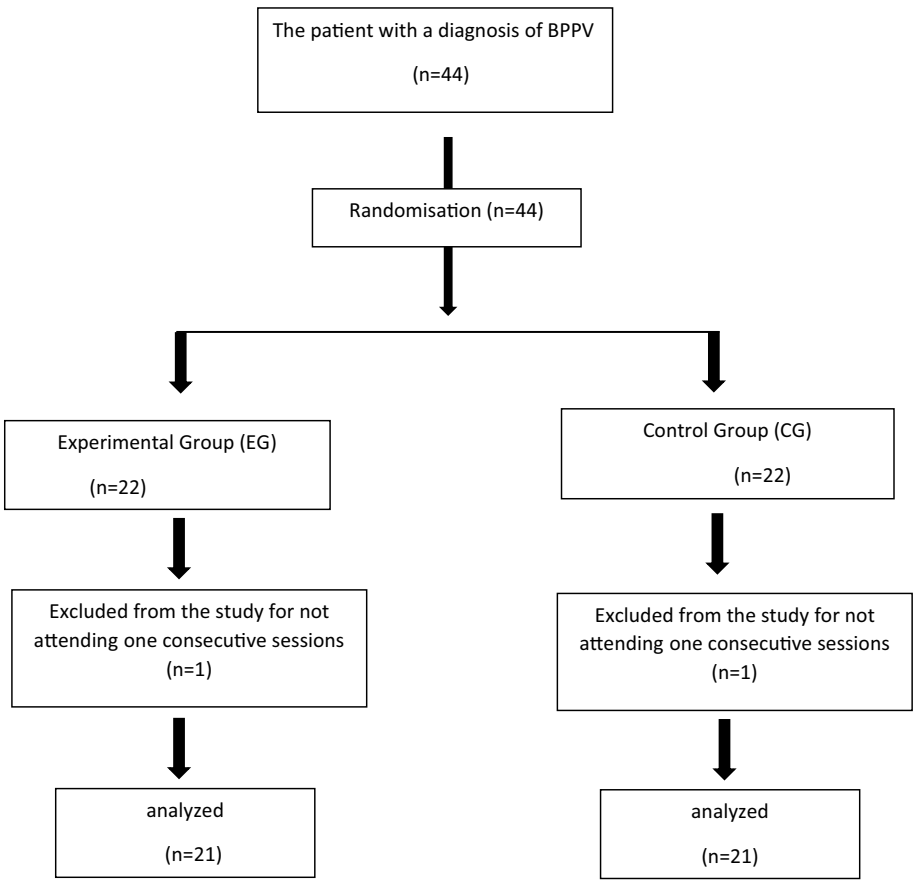

Fig. 1 Patient flow diagram

Results

44 patients with BPPV were admitted to our study as participants initially. Participants were randomly divided into two groups:CG and EG. One person from each group was excluded from the study as they did not continue the study. This study was completed with 42 people (CEG: 14 women, 7 men; HEG: 10 women, 11 men) (Fig. 1).

26 out of 42 patients (61.9%) had right labyrinth involvement after the Dix Hallpike test, while left labyrinth involvement was observed in 16 patients (38.1%). When the presence of drugs used due to vertigo was questioned in 42 patients included in the study, it was found that 21 patients (50%) were using drugs related to vertigo, while 21 patients (50%) were not using any drugs (Table 1). 12 (28.57) patients reported they experienced a falling during the last year, rest of them did not report a falling. The groups were demographically and clinically similar ($p > 0.05$) (Table 3).

According to pre and post Romberg Test results, no significant difference was found between CG and EG ($p > 0.05$) (Table 4).

It was observed that there was a statistically significant decrease in anxiety levels of both CG and EG exercise groups according to pre and post BAI scores ($p < 0.05$). However, there was no statistically significant difference between the two groups ($p > 0.05$) (Table 4).

There was a statistically significant decrease in the severity of vertigo in the two groups according to the pre and post VAS results ($p < 0.05$). There was no significant difference between the two groups in the pre-treatment examinations ($p > 0.05$). However, after the treatment, the VAS score of the EG group decreased significantly compared to the CG ($p < 0.05$) (Table 4).

A statistically significant increase was observed in the Tandem Test results of both the CG and EG pre and post treatment with their eyes open ($p < 0.05$). In addition, when the changes before and after the treatment were examined, it was observed that there was no statistically significant difference between the two groups ($p > 0.05$) (Table 4).

In the Eye Closed Tandem Test before and after the treatment, it was observed that there was a significant increase in the stance time in the EG exercise group compared to the CG. ($p < 0.05$) (Table 4).

No significant change was observed in the semi-tandem pre and post-test results of the CG ($p > 0.05$). However, there was a significant increase in the semi-tandem stance time according to pre and post-test results of the EG ($p < 0.05$). (Table 4).

Concerning semi-tandem examinations with eyes closed, no statistically significant difference was observed between the two groups before and after treatment ($p > 0.05$) (Table 4). Whereas, the eye-closed stance duration significantly increased after the treatment ($p < 0.05$) (Table 4).

Regarding Dizziness Handicap Inventory (DHI) examinations, no statistically significant difference was observed between the two groups in the pre-treatment evaluation ($p > 0.05$) (Table 4). However, after the treatment, the mean score of the EG was significantly lower than the CG ($p < 0.05$) (Table 4). In addition, there was a statistically significant decrease in the two groups after the treatment ($p < 0.05$) (Table 4).

Concerning VSS-sf examinations, no statistically significant difference was observed between the two groups both before and after the treatment ($p > 0.05$) (Table 4). Whereas, a statistically significant decrease was observed after the treatment ($p < 0.05$) (Table 4).

In the pre-treatment VDI examinations that evaluate the patient's quality of life, no statistically significant difference between the two groups was found ($p > 0.05$) (Table 4). However, after the treatment, there was a statistically significant increase in the two groups although EG's VDI scores were significantly higher than CG's ($p < 0.05$) (Table 4).

Regarding the between-groups-scores in the eyes-closed Semi Tandem Test, DHI, VAS, VSS-kf, BAI, VDI in the EG were significantly higher than CG ($p < 0.05$) (Table 5).

Table 3 Status of the use of medicine in patients and the frequency of falls in the previous year

		Control Group	Experimental Group	*p*
Age		51.24 ± 13.4	48.71 ± 8.91	0.241 (z = 1.172)
Sex	Female	10 (%47,61)	14 (%66,67)	0.212 (kk = 1.556)
	Male	11 (%52,38)	7 (%33,33)	
Medicine use	Yes	8 (%38.1)	13 (%61.9)	0.123 (ct = 2.381)
	No	13 (%61.9)	8 (%38.1)	
Fall incidence	Yes	7 (%33.33)	5 (%23.81)	0.495 (ct = 0.467)
	No	14 (%66.67)	16 (%76.19)	

Statistically significant difference; ct: Chi-square test*$p < 0.05$

Discussion

In this study, the Dix-Hallpike test and Epley Maneuver were performed together with routine medical treatment in patients with a diagnosis of BPPV. In addition, patients were randomly divided into 2 groups as CG and EG. Adaptation exercises included in Vestibular Rehabilitation (VR) were taught to both groups face to face in the hospital after the first examination. Both groups were asked to do their exercises twice or three times a day by themselves. The CG

Table 4 Comparison of intra- and intergroup Romberg Test, Beck Anxiety Inventory, Visual Analogue Scale, Romberg test, Eyes Open and Closed Tandem and Semi-Tandem Tests, Dizziness Handicap Inventory, Vertigo Symptom Scale, and Vertigo Dizziness Imbalance Questionnaire mean scores before and after treatment

	Control group Mean ± SD. Median (IQR)		Experimental group Mean ± SD. Median (IQR)		Intergroup *p*
Pre-treatment Romberg	29.24 ± 2.49	30 (30–30)	28 ± 5.73	30 (27.5–30)	0.409 (z = − 0.826)
Post-treatment Romberg	29.62 ± 1.24	30 (30–30)	29.62 ± 1.75	30 (30–30)	0.593 (z = − 0.535)
Intra-group p	0.18 (z = − 1.342)		0.173 (z = − 1.363)		
Pre-treatment BAI	31.05 ± 12.28	36.1 ± 11.47	36.1 ± 11.47	36 (25.5–45.5)	0.176 (t = − 1.376)
Post-treatment BAI	16.57 ± 11.77	15.19 ± 8.79	15.19 ± 8.79	12 (8–23.5)	0.669 (t = 0.431)
Intra-group p	**0.0001* (t = 4.701)**		**0.0001* (z = − 4.017)**		
Pre-treatment VAS	7.14 ± 2.29	7.86 ± 1.8	7.86 ± 1.8	8 (6–9.5)	0.339 (z = − 0.956)
Post-treatment VAS	2.95 ± 1.6	1.95 ± 1.2	1.95 ± 1.2	2 (1–3)	0.035*(z = 2.112)
Intragroup p	**0.0001* (t = 10.633)**		**0.0001* (t = 13.719)**		
Pre-treatment Tandem Open	21.24 ± 10.55	27 (10.5–30)	17.62 ± 11.72	16 (7.5–30)	0.412 (z = − 0.82)
Post-treatment Tandem Open	27.62 ± 4.61	30 (26.5–30)	27.86 ± 4.51	30 (27.5–30)	0.757 (z = − 0.309)
Intra-group p	**0.002* (z = − 3.062)**		**0.001* (t = − 3.709)**		
Pre-treatment Tandem Closed	6 ± 6.05	4 (2.5–7)	7.71 ± 8.32	4 (2–12.5)	0.909 (z = − 0.114)
Post-treatment Tandem Closed	15.81 ± 8.8	15 (8.5–24)	22.33 ± 8.81	30 (14.5–30)	**0.022* (z = 2.287)**
Intragroup p	**0.0001* (t = − 5.405)**		**0.0001* (t = − 7.056)**		
Pre-treatment Semi tandem Open	28 ± 6.2	30 (30–30)	24.9 ± 8.28	30 (19.5–30)	0.088(z = − 1.708)
Post-treatment Semi-tandem Open	29.9 ± 0.44	30 (30–30)	29.81 ± 0.87	30 (30–30)	0.973(z = − 0.034)
Intra-group p	0.109 (z = − 1.604)		**0.012* (z = − 2.521)**		
Pre-treatment Semi-tandem Closed	23.1 ± 10.13	30 (15–30)	17.14 ± 11.6	20(5–30)	0.077(z = − 1.771)
Post-treatment Semi-tandem Closed	26.86 ± 5.37	30 (24.5–30)	29.38 ± 2.01	30 (30–30)	0.054(z = − 1.928)
Intragroup p	**0.028* (z = − 2.194)**		**0.001* (z = − 3.301)**		
Pre-treatment DHI	64.48 ± 23.82	72 (42–86)	69.19 ± 10.49	68 (61–77)	0.98 (z = − 0.025)
Post-treatment DHI	39.95 ± 22.43	40 (23–51)	16.71 ± 10.53	16 (8–24)	**0.0001*(t = 4.298)**
Intra-group p	**0.0001* (t = 6.928)**		**0.0001* (t = 18.062)**		
Pre-treatment VSS-sf	39.95 ± 22.43	40 (23–51)	32.33 ± 12.22	35 (22–43)	0.114 (t = − 1.615)
Post-treatment VSS-sf	12.86 ± 9.48	9 (7–17.5)	9.29 ± 9.24	6 (3–15.5)	0.06 (z = − 1.878)
Intra-group p	**0.0001* (z = − 4.02)**		**0.0001* (t = 10.374)**		
Pre-treatment VDI	50.48 ± 25.49	52 (29–75)	44.19 ± 18.91	47 (28–61.5)	0.369 (t = 0.908)
Post-treatment VDI	66.67 ± 18.86	62 (55–82)	82.9 ± 15.21	81 (78–96.5)	**0.004* (t = 3.071)**
Intra-group p	**0.0001* (t = − 5.635)**		**0.0001* (t = − 13.453)**		

BAI: back anxiety inventory; DHI: dizziness handicap inventory; VSS-sf: vertigo symptom scale-short form; VDI: vertigo dizziness imbalance questionnare; VAS: visual analog scale; SD: standard deviation; IQR: 25 and 75percentile; t-test in independent groups; z: Mann Whitney-U test; Intragroup comparisons- t: t-test in dependent groups; z: Wilcoxon paired sample test

*$p < 0.05$ statistical significance Intergroup comparisons

(home exercise group) was called twice a week via whatsapp and it was questioned whether they did the exercises correctly. EG, on the other hand, was called twice a day via whatsapp and "adaptation exercises, balance and movement habituation exercises' ' were performed in company with a physiotherapist. When the results were evaluated; It was found that the experimental group had better results than the control group in terms of balance ability, severity of vertigo, disability level due to vertigo, anxiety and quality of life.

In our study, although there was no change in Romberg's findings in patients with both EG and CG, it was found that there was an increase in the balance times evaluated with tandem and semi tandem. In fact, an increase was observed in EG's Tandem and Semitandem posture test scores performed with eyes closed. There are studies in the literature

Table 5 Control Group and Experimental Group, Romberg Test, Eyes Open and Closed Tandem and Semi-Tandem Tests, DHI: Dizziness Handicap Inventory, Visual Analog Scale, Vertigo Symptom Scale-Short Form, Beck Anxiety Inventory, and Vertigo Dizziness Imbalance Questionnaire Intergroup Differences

	Control group		Experimental group		
Differences	Mean ± SD	Median (IQR)	Mean ± SD	Med (IQR)	Intergroup *p*
Romberg	−0.38 ± 1.24	0 (0 to 0)	−1.62 ± 4.8	0 (−2.5 to 0)	0.331 (z = −0.973)
Tandem-open	−6.38 ± 8.14	−2 (−12 to 0)	−10.24 ± 12.65	−10 (−22 to 0)	0.3 (z = −1.036)
Tandem-closed	−9.81 ± 8.32	−8 (−15.5 to −2)	−14.62 ± 9.49	−14 (−25 to −5.5)	0.088 (t = 1.746)
Semi-tandem-open	−1.9 ± 5.82	0 (0 to 0)	−4.9 ± 8.14	0 (−9.5 to 0)	0.091 (z = −1.692)
Semi-tandem-closed	−3.76 ± 8.15	0 (−5 to 0)	−12.24 ± 11.24	−8 (−24.5 to 0)	**0.02* (z = −2.333)**
DHI	24.52 ± 16.22	24 (12 to 41)	52.48 ± 13.31	54 (40 to 61)	**0.0001* (t = −6.104)**
VAS	4.19 ± 1.81	4 (3 to 5.5)	5.9 ± 1.97	6 (4.5 to 8)	**0.005* (t = −2.937)**
VSS-sf	13.48 ± 10.29	10 (6 to 23)	23.05 ± 10.18	24 (14 to 29.5)	**0.004* (z = −2.898)**
BAI	14.48 ± 14.11	11 (6 to 24.5)	20.9 ± 9	19 (15.5 to 24)	**0.024* (z = −2.254)**
VDI	−16.19 ± 13.17	−15 (−22.5 to −7)	−38.71 ± 13.19	−35 (−48.5 to −32)	**0.0001* (t = 5.539)**

DHI: dizziness handicap inventory; VAS: visual analog scale; VDI: vertigo dizziness imbalance questionnare; BAI: beck anxiety inventory; SD: standard deviation; IQR: 25th and 75th percentile; t-test in independent groups; z: Mann Whitney U test

*$p < 0.05$ statistical significance Intergroup comparisons

demonstrating that the use of Romberg and Tandem tests in clinical vestibulo-ocular reflex evaluations of patients with BPPV is both easy and effective [21]. Similar to our study, there are studies proving the effectiveness of classical CRM application and VR exercises in addition to CRM to increase balance [22]. Additional balance training to CRM is recommended in BPPV patients [8, 23]. In addition, after a successful CRM, BPPV patients may experience a feeling of imbalance and dizziness that dominates for a long time [23]. Balance training given in VR is effective in reducing long-lasting symptoms and related symptoms such as falling, imbalance, dizziness, and anxiety [24]. VR, which gained importance in the 1990s and where exercises that stimulate the vestibular system gradually, are applied, is effective in regulating the balance mechanism by stimulating the vestibular system by using head and trunk mobility and providing the development of central compensation [25]. It is among the priority treatments for patients with vestibular disorders. VR provides visual fixation with head movements in providing static and dynamic balance. Studies have shown that VR is more effective than CRM alone or in combination with CRM in BPPV patients [26]. In addition, VR may reduce the presence of medication taken after CRM [22]. In the study by Sever et al. (2021) on individuals diagnosed with vestibular hypofunction, they applied vestibular rehabilitation exercises consisting of ten repetitions three times a day for eight weeks. They used the Tandem Posture test within the balance evaluation parameters. As a result, they observed improvement especially in balance parameters. The reason for the improvement in vestibulo-ocular reflexes, especially due to vertigo symptoms, is attributed to an increase in balance, a decrease in the severity of vertigo, and thus an increase in quality of life [27].

In our study, patients were evaluated in terms of anxiety. Although there was a decrease in anxiety levels in both groups, there was no significant difference between the groups. According to the results of the difference between the groups, the decrease in anxiety level was higher in EG than in CG. In a similar study, Güneş and Yüzbaşıoğlu (2021) showed that the Dix Hallpike and Epley maneuver and routine medical treatments on patients with BPPV with Posterior Canal involvement showed a decrease in anxiety

levels after 4 weeks only [28]. In another study conducted on 72 patients with a diagnosis of BPPV; the effectiveness of the Epley maneuver on anxiety and quality of life was suggested to investigate. The results of the prior study confirm that the additional VR-based exercises was the strength of this present study [29].

The studies that evaluate the quality of life exist in the literatüre, but most of these studies measure the influence of maneuvers on quality of life [30]. One of these studies was conducted in order to explore the effectiveness of the Epley maneuver performed without medical treatment with 55 patients with BPPV and Epley maneuver was found more effective in patients with BPPV. The results confirmed the necessity of medical treatment because the epley maneuver was found effective in case it was applied with a medical treatment. In line with this result, in the present study, the medical treatment was offered with the epley maneuver and VR exercises [31]. To put it another way, The relationship between quality of life and VR-based exercises was another strength of this present study.

In the literature, there are studies reporting insufficient VR awareness and knowledge among therapists and doctors [32]. Rodrigues et al. (2019) conducted a randomized controlled study investigating the effectiveness of vestibular exercises in addition to CRM on dizziness and symptoms in BPPV patients. In our study, DHI and VSS-sf were used to examine vertigo-related dizziness and other symptoms. Although symptoms decreased in both groups, improvement in DHI was observed to be higher in EG compared to CG group [33]. Similarly, in the study by Rodrigues et al. (2019), it was stated that internet-based VR applied in chronic vestibular syndrome is as effective as face-to-face application [33]. In another study, it was proved that internet-based vestibular rehabilitation applied for 6 weeks in elderly adults with chronic dizziness due to vestibular dysfunction reduces dizziness and DHI levels without the need for clinical support [34].

The number of studies on teleconsultation and Telerehabilitation (TR) in (BPPV) patients are limited [35]. Internet-based VR is effective and safe in reducing vestibular symptoms, but tailoring the exercises to each patient is presented as the most beneficial option [34, 35]. In our study, we applied the exercises to BPPV patients in the EG group as personalized sessions with gradually increasing difficulties. Thus, we have increased the effectiveness of the rehabilitation process by working individually for each patient, even from a distance.

Study Limitations

Regarding the major limitation of this study, while EG was given extra balance exercises via telerehabilitation, CG was not given this treatment, so we did not compare effectiveness of balance exercises in two different settings, face to face and distance. Further studies may be designed to reveal the effectiveness of such exercises to compare these settings.

Conclusion

Results of this study demonstrated the applicability of Telerehabilitation in BPPV patients in evaluation, diagnosis, treatment, and rehabilitation processes by optimizing time, space, and cost. Considering the results, it is claimed that telerehabilitation could be used in extraordinary situations such as pandemic and normal conditions. However, this result should be supported by further work.

The present study gives evidence that vestibular rehabilitation exercise applications should be added to the treatment protocol and medical treatments applied together with maneuvering for BPPV. Also, it is concluded that vestibular exercises give effective results even when done through telerehabilitation.

Author Contributions RH: Substantial contributions to the conception or design of the work; To be collected data, to be provided and cared for study patients. The acquisition, analysis, or interpretation of data for the work. AA: Substantial contributions to the conception or design of the work; Final approval of the version to be published; Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Final approval of the version to be published. HG: Substantial contributions to the conception or design of the work; Drafting the work or revising it critically for important intellectual content. The acquisition, analysis, or interpretation of data for the work, to be provided and cared for study patients.

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Data Availability All data generated or analyzed during this study are included in this article. Further enquiries can be directed to the corresponding author.

Declarations

Conflict of interest The authors have no conflicts of interest to declare.

Ethical Approval The trial was registered at www.ClinicalTrials.gov (identifier: NCT05166473) and approved by the institutional review board of Alanya Alaaddin Keykubat University Ethics Committee (Date: 14/04/2021, Ethical number: 10354421-2021/0709) (Appendix 1). The participants signed an informed consent form according to the Declaration of Helsinki.' from your Methods and added it under a 'Statement of Ethics' heading.

Appendix 1

T.C.
ALANYA ALAADDİN KEYKUBAT ÜNİVERSİTESİ REKTÖRLÜĞÜ
TIP FAKÜLTESİ
KLİNİK ARAŞTIRMALAR ETİK KURULU

Sayı: 10354421-2021/07-09 14/04/2021
Konu: Etik Kurul Kararı

Sayın Dr. Öğr. Üyesi Ayça ARACI

Üniversitemiz Klinik Araştırmalar Etik Kurulu (ALKÜ-KAEK)'na yapmış olduğunuz **"Benign Paroksismal Pozisyonel Vertigo Tanılı Hastalarda Telerehabilitasyon Egzersiz Uygulamaları Etkili Midir?"** isimli başvurunuz incelenmiş olup 14/04/2021 tarihli ve 07-09 numaralı etik kurulu kararı ekte sunulmuştur.

Bilgilerinize rica ederim.

Prof. Dr. Şakir Özgür KEŞKEK
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