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Original Article

The impact of cervical exercises in addition to vestibular rehabilitation on unilateral peripheral vestibular system disorders accompanied by neck pain: A prospective, randomized-controlled trial

Ezgi Yıldız Güvercin[1], Yeşim Kirazlı[2], Hale Üzümcügil[2], Ece Çınar[2], Musa Baklacı[3], Gülce Kirazlı[4], Tayfun Kirazlı[5], Neşe Çelebisoy[6], Figen Gökçay[6]

[1]Department of Physical Therapy and Rehabilitation, Doç. Dr. Mustafa Kalemli Tavşanlı State Hospital, Kütahya, Türkiye
[2]Department of Physical Medicine and Rehabilitation, Ege University Faculty of Medicine, İzmir, Türkiye
[3]Department of Physical Therapy and Rehabilitation, Kemalpaşa State Hospital, İzmir, Türkiye
[4]Department of Audiology, Ege University Faculty of Health Sciences, İzmir, Türkiye
[5]Department of Ear, Nose and Throat Diseases, Ege University Faculty of Medicine, İzmir, Türkiye
[6]Department of Neurology, Ege University Faculty of Medicine, İzmir, Türkiye

ABSTRACT

Objectives: The aim of this study was to investigate the effect of neck exercises in addition to vestibular rehabilitation treatment in unilateral peripheral vestibular system (PVS) diseases accompanied by neck pain and to evaluate the relationship between neck pain severity and clinical balance parameters in this patient population.

Patients and methods: In this prospective, randomized-controlled study, a total of 70 patients (30 males, 40 females; mean age: 52.6±14.9 years; range, 37 to 68 years) who were diagnosed with unilateral PVS disease with concomitant neck pain were included between September 2019 and May 2022. The patients were randomized into two equal groups. Group 1 (n=35) received a vestibular rehabilitation program for four weeks, and Group 2 (n=35) received neck exercises in addition to the standard rehabilitation protocol. As the compensation improved in the vestibular rehabilitation treatment, additional compelling exercises were added to the program. At Week 4, all patients were evaluated with clinical parameters including the severity of balance, neck pain, dizziness, Dizziness Handicap Inventory (DHI), Functional Gait Assessment (FGA), Activity-specific Balance Confidence (ABC) scale, Dynamic Gait Index (DGI), Berg Balance Scale (BBS), Timed Up-and-Go (TUG) test, Falls Efficacy Scale (FES)-International, postural stability, and Neck Disability Index (NDI).

Results: After the rehabilitation program, a statistically significant improvement was observed in all clinical parameters in both groups ($p<0.05$). Compared to Group 1, there was a statistically significant difference in all other clinical parameters in Group 2, except for the two parameters: the Romberg eye-open time and TUG test ($p<0.05$). A significant correlation was found between the severity of neck pain and the severity of dizziness, BBS, DHI, FGA, and NDI ($p<0.05$).

Conclusion: Neck exercises may yield positive clinical outcomes when combined with vestibular rehabilitation and should be taken into consideration for planning rehabilitation program in patients with unilateral PVS disease and neck pain.

Keywords: Dizziness, neck pain, rehabilitation.

Vertigo and dizziness are symptoms which negatively affect quality of life of individuals.[1] Dizziness and vertigo are among the most common complaints in medicine. Previous studies have shown that they affect approximately 20 to 30% of the general population.[2]

Central and peripheral vestibular system (PVS) diseases, metabolic and cardiac pathologies, drug side effects, somatoform and psychogenic pathologies are thought to be implicated in the etiology.[3] Pathologies occurring distal to the vestibulocochlear nerve cause PVS diseases, and pathologies proximal to central

Corresponding author: Ezgi Yıldız Güvercin, MD. Mustafa Kalemli Tavşanlı Devlet Hastanesi, Fizik Tedavi ve Rehabilitasyon Kliniği, 43300 Kayaarası, Tavşanlı, Kütahya, Türkiye.
E-mail: mdezgiyildiz@gmail.com

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vestibular system diseases.[4] However, there is an additional group of patients who lack of these diseases in the etiology and have dizziness only. Cervicogenic causes should be emphasized as the cause of dizziness in these patients.[5]

Existing theories have suggested that neck pain causes disturbances in the cervical proprioceptive sensory system, resulting in dizziness.[6] Another theory has proposed that the limitation of neck movements as a result of avoidance of neck movements by patients with dizziness and an increase in cervical region muscle spasm increase the complaint of neck pain and delay recovery.[7] However, the link between dizziness and neck pain has long been debated.

Neck pain is a common complaint in the musculoskeletal system.[8] Coexistence of neck pain and dizziness is common.[9] However, the prevalence of concomitant dizziness and neck pain is uncertain.

Cervicogenic dizziness, which is difficult to diagnose, was first named as cervical vertigo in 1955.[10] It is currently known as cervicogenic dizziness, as true vertigo is rare in vertigo of cervical origin.[11] Mechanical irregularities of the cervical spine cause dizziness, particularly due to the balance function of the receptors in the joints and ligaments of the first three cervical vertebrae.[12]

Manual therapy and neck exercises for myofascial pathologies in PVS diseases have been suggested, by showing the underlying cervical myofascial pathologies as the true cause of a series of end-organ involvements which cause vestibular symptoms at the inner ear level.[13]

Neck pain frequently accompanies PVS diseases.[14] In a three-year observational study of PVS disease accompanied by neck pain, it was reported that the exercise program for the treatment of neck pain also had a curative effect on vestibular symptoms.[15]

Dizziness may continue after surgical and pharmacological treatment in PVS diseases. Vestibular rehabilitation has become the mainstay of treatment for prolonged and persistent dizziness.[16] It is an exercise-based program that has been around for over seven decades.[17] It has changed many forms over the years, from group exercises to personalized exercise programs.[18] Vestibular rehabilitation which includes habituation, substitution and adaptation exercises, increases the capacity, compensation and restoration of the vestibular system.[19]

There is no randomized-controlled study in the literature in which neck exercises are applied in addition to vestibular rehabilitation treatment in unilateral PVS diseases accompanied by neck pain. Adding neck exercises in addition to vestibular rehabilitation treatment in this disease group would provide positive results, both due to the role of the underlying cervical pathologies in the pathophysiology of PVS diseases and as the avoidance of neck movements in patients with vestibular symptoms causes myofascial pathologies and increases dizziness.

The primary objective of this study was to investigate the effect of neck exercises in addition to vestibular rehabilitation treatment in unilateral PVS diseases accompanied by neck pain. The secondary objective was to investigate the relationship between neck pain severity and clinical balance parameters in this patient population.

PATIENTS AND METHODS

Study design and study population

This single-center, prospective, randomized-controlled trial was conducted at Ege University Faculty of Medicine, Department of Physical Medicine and Rehabilitation between September 2019 and May 2022. Patients were screened during Vertigo Council Meetings of our center. The patients who consented to participate in the study were informed about the study. Those diagnosed with unilateral PVS disease accompanied by neck pain were enrolled. Inclusion criteria were as follows: the presence of neck pain which started simultaneously with or after the symptom of dizziness; having a diagnosis of unilateral PVS disease; absence of neuropathic pain accompanying the neck pain; having normal neurological examination findings; being older than 18 years of age; and not being in the active vertigo period. Exclusion criteria were the presence of neck pain before the onset of dizziness, presence of neuropathic pain, presence of neurological deficit, unstable disease, physical disability that prevents walking, significant affective disorder or serious psychiatric illness, severe inner ear pathology which prevents patient compliance with the test. Finally, a total of 70 patients (30 males, 40 females; mean age: 52.6±14.9 years; range, 37 to 68 years) who met the inclusion criteria were recruited. Written informed consent was obtained from each patient. The study protocol was approved by the Ege University Faculty of Medicine Ethics Committee (date: 18.09.2019, no: 19-9.1T/54). The study was conducted in accordance with the principles of the Declaration of Helsinki.

All patients were randomized into two equal groups according to a computer-generated randomization algorithm. Group 1 (n=35) received a vestibular rehabilitation program for four weeks, and Group 2 (n=35) received neck exercises in addition to the standard rehabilitation protocol. As the compensation improved in the vestibular rehabilitation treatment, additional compelling exercises were added to the program. At Week 4, all patients were evaluated with clinical parameters. At the end of the study, additional neck exercises were taught to the group who did not receive neck exercises.

Neck exercises were given to a group by the co-researcher who provided the randomization. The investigator, who evaluated the clinical parameters of the patients at the beginning and the end of the treatment, was blinded to the study group, and prescribed the individualized vestibular rehabilitation program to both groups after the clinical evaluations. The patients were unable to be blinded to the treatment allocation. The CONSORT flowchart is shown in Figure 1.

Data collection and assessment

Data including age, sex, body mass index (BMI), marital status, educational status, occupational characteristics, and comorbidities were recorded in both groups. Subtype of PVS disease, duration of disease (months), symptom characteristics, stimulating factor, presence of hearing loss were evaluated before treatment in both groups.

Outcome measures

Using the Visual Analog Scale (VAS), the severity of the complaints of dizziness, imbalance, and neck pain that the patients felt in the last week were reported on a 10-cm chart.

Functional mobility and fall risk were evaluated with the Timed Up-and-Go (TUG) test. A TUG score of more than 12 sec was considered to reflect an elevated fall risk.[20]

The Romberg open and closed eye test, feet side by side or tandem, and eyes open and closed on a foam mat were used to evaluate postural stability.

Functional gait assessment (FGA) and dynamic gait index (DGI) were used in all patients. The DGI was originally developed to assess postural stability during walking tasks in older adults at high risk of falling.[21] This scale consists of eight walking tasks. The maximum score is 24. A score of 19 or lower indicates an increased risk of falls in older adults and patients with vestibular disorders.[22]

The FGA includes seven of the eight tasks in the original DGI. The maximum score is 30. Scores

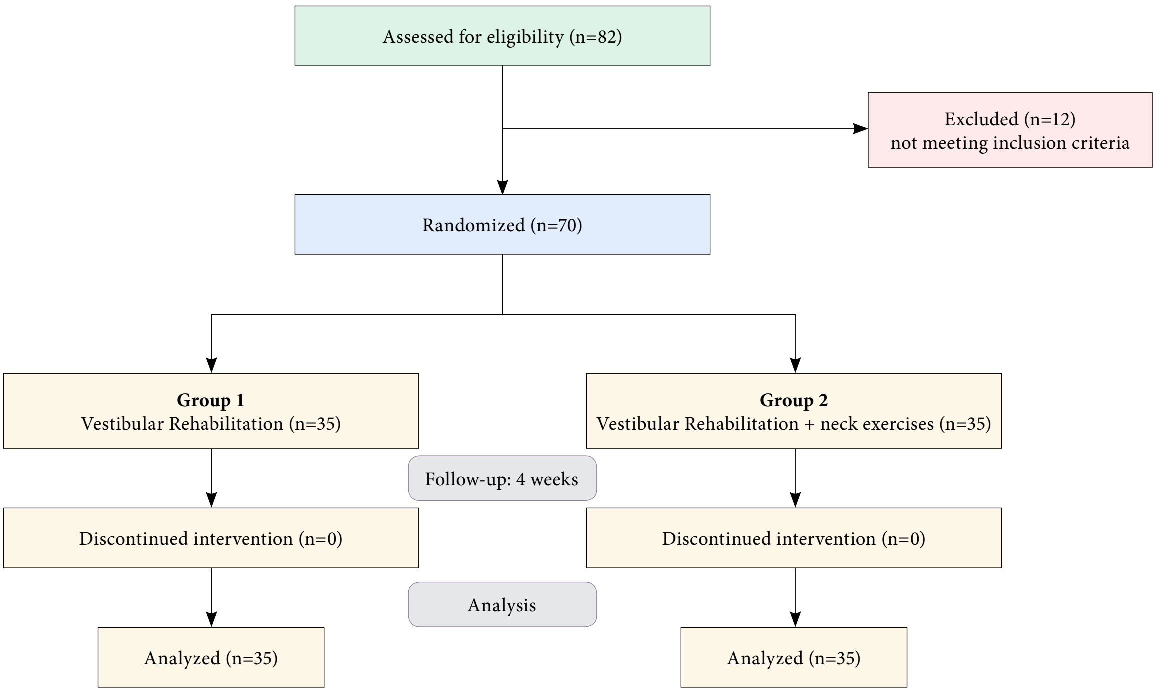

Figure 1. CONSORT diagram.

of 24 points or lower indicate the risk of falling in patients with vestibular disorders.[23]

The perception of disability caused by dizziness on the patient was evaluated using the Dizziness Handicap Inventory (DHI). The DHI consists of 25 questions covering the functional, emotional, and physical aspects of disability. The results between 0 and 100 points are obtained.[24]

The confidence that the patients felt during activities of daily living at home and in the community was evaluated using the Activity-Specific Balance and Confidence Scale (ABC). It consists of 16 questions and each question is scored between 0 (I don't have confidence) and 100 (I have full confidence).[25]

The Berg Balance Scale (BBS) was used to determine the risk of falling in patients. The maximum score is 56. A score of 45 or lower less indicates the risk of falling, and a score of 36 or lower indicates a high risk of falling.[26]

Falling anxiety of the patients was evaluated using the Falls Efficiency Scale (FES)-International. A score of 24 and above indicates fear of falling. Higher scores indicate greater fear of falling.[27]

The perception of disability, in which the patients evaluated themselves due to neck pain, was evaluated using the Neck Disability Index (NDI). A score of 35 and above indicates complete disability, a score of 25-34 indicates severe disability, a score of 15-24 indicates moderate disability, a score of 5-14 indicates

TABLE 1
Demographic data

	Group 1 VR (n=35)			Group 2 VR + Neck exercise (n=35)			Total (n=70)			
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (year)			53.1±15			52±15.2			52.6±14.9	0.758
Body Mass Index (kg/m²)			26.4±3.1			25.1±2.9			25.8±3	0.092
Sex										0.629
Male	14	40		16	46		30	43		
Female	21	60		19	54		40	57		
Marital status										0.430
Married	26	74		28	80		52	76		
Single	9	26		7	20		16	24		
Education status										0.840
Primary education	12	35		12	34		24	34		
Secondary education	12	34		10	29		22	32		
University or higher	11	31		13	37		24	34		
Occupation										0.065
White collar	6	17		12	34		18	26		
Blue collar	12	34		5	14		17	24		
Homemaker	11	31		7	20		18	26		
Retired	6	17		11	31		17	24		
Concomitant diseases										N/A (numbers too low for statistical analysis)
HT	10	29		8	23		18	26		
DM	2	6		1	3		3	4		
CAD	0	0		3	9		3	4		
Thyroid dysfunction	0	0		1	3		1	1		
Chronic renal failure	1	3		1	3		2	3		
Addison disease	1	3		0	0		1	1		
Rheumatic diseases	1	3		0	0		1	1		
Asthma	0	0		1	3		1	1		
CRF+DM	1	3		0	0		1	1		
HT+DM	4	11		4	11		8	11		
CAD+HT	2	6		1	3		3	4		
Epilepsy	0	0		1	3		1	1		
Migraine	1	3		1	3		2	3		
None	12	34		13	37		25	36		

VR: Vestibular rehabilitation; SD: Standard deviation; HT: Hypertension; DM: Diabetes mellitus; CAD: Coroner artery disease; CRF: Chronic renal failure nominal data chi square test, numerical data independent sample t test.

mild disability, and a score of 0-4 indicates no disability.[28]

All clinical parameters were evaluated before and after treatment in both groups.

Vestibular rehabilitation

After the initial clinical parameters were evaluated, vestibular rehabilitation program was applied to both groups. Adaptation, habituation, substitution and conditioning exercises were given to each patient. These exercises were administered to the patients two times a day, for 30 sec with 10 reps gradually.

As a condition-enhancing exercise, each patient was advised to walk for 20 min, five days a week, at a strength that would not aggravate their complaints, and resting when they were tired.

As the compensation improved, challenging exercises were added. At Week 4, both groups were evaluated with clinical parameters.

Neck exercises

One of the randomly allocated patient groups was applied the program of neck exercises by the co-researcher. This program includes stretching exercises for trapezius, levator scapula and sternocleidomastoid muscles, neck isometric exercises, cervical strengthening exercises with exercise ball and elastic bands. The exercises were applied to the patients one-to-one in practice. It is indicated to do 10 reps for 15 sec, two times a day. Clinical parameters were assessed at Week 4.

Statistical analysis

The power analysis and sample size calculation were performed using the G*Power version 3.1.9.4 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) to ensure the adequate sample size for the independent samples t-test. The sample size was calculated based on the DHI parameter in the study of Giray et al.[29] It was calculated as 35 participants in each group, with a level of significance of 95%, a power of 80% (effect size=0.84) with a 20% drop probability.

Statistical analysis was performed using the IBM SPSS for Windows version 20.0 software (IBM Corp., Armonk, NY, USA). Nominal demographic data were evaluated using the chi-square test. Continuous data were expressed in mean ± standard deviation (SD) or median (min-max), while categorical data were expressed in number and frequency. Clinical parameters were evaluated using the

TABLE 2
Disease and symptom characteristics of both groups before treatment

	Group 1 VR (n=35)			Group 2 VR + Neck exercise (n=35)			Total (n=70)			
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	*p*
Disease										0.754
MD	18	51		17	49		35	50		
VN	14	40		13	37		27	39		
Other (BPPV, perilymph fistula, acoustic neuroma)	3	9		5	15		8	11		
Duration (mo)			21.3±14.1			17.7±13.2			19.5±13.9	0.274
Symptom										0.549
Dizziness	13	37		15	43		28	40		
Dizziness and vertigo	21	60		18	51		39	56		
Stimulating factor										Numbers too low for statistical analysis
CP	12	34		15	43		27	39		
Vw	0	0		0	0		0	0		
Darkness	0	0		1	3		11	1		
CP+Vw	8	23		6	17		14	20		
CP+darkness	0	0		1	3		1	1		
CP+Vw+darkness	15	43		12	34		27	39		
Hearing loss										0.794
Yes	25	71		24	69		49	70		
No	10	29		11	31		21	30		

VR: Vestibular rehabilitation; SD: Standard deviation, MD: Meniere disease; VN: Vestibular neuritis; BPPV: Benign paroxysmal positional vertigo; CP: Change of position; Vw: Visual warning. Nominal data chi square test, numerical data independent sample t test.

TABLE 3
Initial clinical parameters of both groups before treatment

	Group 1 VR (n=35)	Group 2 VR + Neck exercise (n=35)	Total (n=70)	
	Mean±SD	Mean±SD	Mean±SD	*p*
Dizziness VAS	6.3±1.2	6.5±1.4	6.4±1.3	0.524
Balance VAS	5.3±1.9	5.6±1.7	5.4±1.8	0.404
Neck pain VAS	4.2±1.8	4.4±1.5	4.3±1.6	0.566
Timed up and go (sec)	14.6±4.7	13.4±3.2	14.3±4	0.510
Romberg eye open (sec)	27.3±5	27.9±4.8	27.6±5	0.615
Romberg eye close (sec)	18.4±9.6	16.5±10.6	17.4±10.1	0.447
Tandem Romberg eye open (sec)	14.6±8.8	14.1±8.3	14.4±8.5	0.824
Tandem Romberg eye closed (sec)	6.9±6.6	5.5±5.7	6.2±6.2	0.349
Foam Romberg eye open (sec)	24.9±6.4	22.4±8.6	23.6±7.6	0.177
Foam Romberg eye closed (sec)	13.6±8	12.4±9.1	13±8.5	0.579
Functional gait assessment	15.3±5.9	13.7±5.7	14.5±5.9	0.248
Dynamic gait index	13.1±5.2	11.5±5.1	12.6±5.2	0.178
Dizziness handicap inventory	65.7±17.6	67.3±19.2	66.6±18.3	0.713
Activity-specific balance confidence scale	52.8±15.7	49.7±15.1	51.3±15.4	0.413
Berg balance scale	31.1±9.8	30.9±9.7	31±9.7	0.913
Falls Efficacy Scale	43.7±10.1	44.6±9.9	44.1±10	0.740
Neck disability index	14.1±6.4	15.1±6.9	14.6±6.6	0.486

VR: Vestibular rehabilitation; SD: Standard deviation; VAS: Visual Analog Scale; Nominal data chi square test, numerical data independent simple t test.

TABLE 4
Change of clinical parameters over time, in-group, and between-group analysis

	Group 1 VR (n=35)			Group 2 VR + Neck exercise (n=35)			
	Pre-treatment	Post-treatment	In-group analysis	Pre-treatment	Post-treatment	In-group analysis	Between-group analysis
	Mean±SD	Mean±SD	*p*	Mean±SD	Mean±SD	*p*	*p*
Dizziness VAS	6.3±1.2	3.1±1	0.000*	6.5±1.4	2.4±0.8	0.000*	0.001*
Balance VAS	5.3±1.9	2.7±1.5	0.000*	5.6±1.7	2.2±0.9	0.000*	0.001*
Neck pain VAS	4.2±1.8	2.3±1.8	0.000*	4.4±1.5	1.2±1.1	0.000*	0.000*
Timed up and go (sec)	14.6±4.7	12.2±3.3	0.000*	13.4±3.2	11.1±1.5	0.000*	0.055
Romberg eye open (sec)	27.3±5	29.4±2.3	0.003*	27.9±4.8	30±0	0.000*	0.156
Romberg eye close (sec)	18.4±9.6	24.8±6.8	0.000*	16.5±10.6	21.1±7.5	0.000*	0.05*
Tandem Romberg eye open (sec)	14.6±8.8	23.5±6.1	0.000*	14.1±8.3	27.1±4.6	0.017*	0.008*
Tandem Romberg eye closed (sec)	6.9±6.6	15.8±7.7	0.000*	5.5±5.7	21.1±4.5	0.000*	0.005*
Foam Romberg eye open (sec)	24.9±6.4	28.8±3.5	0.000*	22.4±8.6	29.6±2.5	0.000*	0.027*
Foam Romberg eye closed (sec)	13.6±8	22.1±6.9	0.000*	12.4±9.1	25.6±6.1	0.000*	0.027*
Functional gait assessment	15.3±5.9	22.6±5.9	0.000*	13.7±5.7	26.6±3.8	0.000*	0.001*
Dynamic gait index	13.1±5.2	19.1±5	0.000*	11.5±5.1	21.7±3.6	0.000*	0.014*
Dizziness handicap inventory	65.7±17.6	39.7±16.6	0.000*	67.3±19.2	26.9±13.5	0.000*	0.000*
Activity-specific balance confidence scale	52.8±15.7	69.8±11.3	0.000*	49.7±15.1	73.8±10.9	0.000*	0.001*
Berg balance scale	31.1±9.8	42.6±8.5	0.000*	30.9±9.7	46.1±6.8	0.000*	0.015*
Falls Efficacy Scale	43.7±10.1	26.7±8.3	0.000*	44.6±9.9	24±5.3	0.000*	0.001*
Neck disability index	14.1±6.4	6.8±5.7	0.000*	15.1±6.9	3.8±4.7	0.000*	0.019*

VR: Vestibular rehabilitation; SD: Standard deviation; VAS: Visual Analog Scale; Nominal data chi square test, numerical data independent simple t test.

TABLE 5
Correlation of age, disease duration, body mass index, neck pain severity and clinical parameters

	AGE	DRT	BMI	NVAS	TUG	DZVAS	BVAS	REO	REC	TEO	TEC	FEO	FEC	FGA	DGI	DHI	ABC	BERG	FES
DRT	−0.089																		
BMI	0.494*	−0.145																	
NVAS	0.099	0.149	0.209																
TUG	0.508*	−0.019	0.355*	0.070															
DZVAS	0.023	0.066	−0.039	0.366*	0.342*														
BVAS	0.051	−0.045	−0.048	0.273*	0.397*	0.660*													
REO	−0.176	0.051	−0.178	−0.067	−0.543*	−0.464*	−0.453*												
REC	−0.310*	0.127	−0.137	−0.101	−0.525*	−0.442*	−0.433*	0.606*											
TEO	−0.349*	0.154	−0.331*	0.013	−0.364*	−0.314*	−0.181	0.506*	0.675*										
TEC	−0.408*	−0.003	−0.303*	−0.181	−0.471*	−0.273*	−0.270*	0.408*	0.643*	0.664*									
FEO	−0.181	0.032	−0.138	−0.101	−0.342*	−0.428*	−0.453*	0.669*	0.674*	0.637*	0.526*								
FEC	−0.396*	0.064	−0.277*	−0.183	−0.553*	−0.356*	−0.319*	0.484*	0.792*	0.626*	0.791*	0.671*							
FGA	−0.250*	−0.037	−0.203	−0.309*	−0.443*	−0.556*	−0.477*	0.581*	0.628*	0.616*	0.626*	0.620*	0.621*						
DGI	−0.189	−0.073	−0.108	−0.267*	−0.407*	−0.539*	−0.451*	0.572*	0.605*	0.582*	0.568*	0.599*	0.573*	0.973*					
DHI	0.148*	−0.101	0.210	0.341*	0.215	0.560*	0.378*	−0.400*	−0.468*	−0.405*	−0.234	−0.397*	−0.311*	−0.553	−0.545*				
ABC	−0.254*	0.034	−0.293*	−0.238*	−0.493*	−0.445*	−0.414*	0.601*	0.526*	0.515*	0.480*	0.489*	0.478	0.726*	0.727*	−0.624*			
BERG	−0.359*	−0.008	−0.267*	−0.363*	−0.427*	−0.524*	−0.403*	0.496*	0.618*	0.472*	0.463*	0.469*	0.495	0.636*	0.635*	−0.716*	0.641*		
FES	0.197	−0.099	0.111	0.266*	0.052	0.469*	0.327*	−0.239	−0.339*	−0.345*	−0.287*	−0.192	−0.142	−0.526*	−0.527*	0.642*	−0.400*	−0.594*	
NDI	0.208	0.137	0.311*	0.814*	0.250*	0.305	0.302*	−0.163	−0.204	−0.052	−0.312*	−0.228	−0.330*	−0.395*	−0.337*	0.311*	−0.427*	−0.375*	0.193

AGE: Patients age; DRT: Duration; BMI: Body mass index; NVAS: Neck pain severity; TUG: Timed up and go test; DZVAS: Dizziness severity; BVAS: Balance severity; REO: Romberg eye open; REC: Romberg eye closed; TEO: Tandem eye open; TEC: Tandem eye closed; FEO: Foam eye open; FEC: Foam eye closed; FGA: Functional gait assessment; DGI: Dynamic gait index; DHI: Dizziness handicap inventory; ABC: Activity-specific balance confidence scale; BERG: Berg balance test; FES: International falling efficiency scale; NDI: Neck disability index. Pearson correlation analysis, R correlation coefficient. 0.10-0.30: low correlation, 0.30-0.50: medium correlation, 0.50-1: high correlation; * $p<0.05$.

Kolmogorov-Smirnov test and showed a normal distribution. In terms of initial clinical parameters, the groups were compared with the independent sample t-test. Changes of the evaluated parameters over time were evaluated using the paired samples t-test. Clinical parameters measured at the second visit were compared using the independent sample t-test. The correlation of the clinical parameters before the treatment and the changes in the clinical parameters after the treatment were evaluated using the Pearson correlation analysis. A p value of <0.05 was considered statistically significant.

RESULTS

Demographic data of the patients are shown in Table 1. The disease and symptom characteristics of both groups before treatment are presented in Table 2. The initial clinical parameters of both groups are shown in Table 3. After the four-week treatment program applied to both groups, clinical parameters were evaluated. Intra- and intergroup analysis of the change in clinical parameters compared to baseline is shown in Table 4. In Group 2, a statistically significant improvement was found in all other clinical parameters, except for the TUG test and the Romberg eye-open time, compared to Group 1. The correlation of age, disease duration, BMI, severe neck pain and clinical parameters are shown in Table 5. A statistically significant correlation was found between the severity of neck pain and the severity of dizziness, FGA, DHI, BBS, NDI ($p<0.05$). The correlation between the change in neck pain severity after treatment and the change in clinical parameters is shown in Table 6. Accordingly, a statistically significant correlation was found between the change in the severity of neck pain and the change in severity of dizziness and balance disorder, foam eye closed time, tandem Romberg eye closed time, FGA, DGI, DHI, ABC scale, BBS and NDI ($p<0.05$).

DISCUSSION

In the present study, we investigated the effect of neck exercises in addition to vestibular rehabilitation treatment in unilateral PVS diseases accompanied by neck pain and evaluated the possible relationship between neck pain severity and clinical balance parameters in this patient population. Our study demonstrated the importance of adding neck exercises to vestibular rehabilitation in patients with unilateral PVS accompanied by neck pain. In our study, we found significant improvements in the balance parameters of the group in which neck exercises were applied in addition to vestibular rehabilitation treatment and found a significant correlation between neck pain and balance parameters.

Dizziness, visual disturbances, and balance disorders resulting from vestibular dysfunction are associated with serious limitations in activities of daily living.[30] Dizziness persists in 30 to 50% of cases.[31] Although both dizziness and neck pain are common in the general population, the co-existence of these two symptoms suggests a reciprocal relationship as well as an additional burden for the patient.[32]

Several studies have shown that there is a close link between dizziness and neck pain.[33,34] Neck pain causes dizziness through the connections between the cervical proprioceptive system and the vestibular nuclei.[35] Restricting neck movements in order not to increase dizziness causes muscle spasm and neck pain.[36] Our study was designed considering that dizziness and neck pain affect each other adversely and both symptoms should be considered together for a successful recovery. In the study of Williams et al.,[37] patients with peripheral vestibular dysfunction avoiding neck activity to prevent vertigo attacks might affect cervical kinematics. In a study evaluating 24 cases with a diagnosis of Meniere disease, 75% of the patients reported neck pain.[15] In two studies conducted with patients with benign paroxysmal positional vertigo (BPPV), 82 to 87% of patients reported neck pain.[38,39] Due to the high prevalence of neck pain in PVS diseases in studies in the literature, unilateral PVS diseases accompanied by neck pain were included in our study. The effect of neck pain treatment, which has a role in the pathogenesis of dizziness in this disease group, on vestibular symptoms was investigated. Malmström et al.[32] found that patients with neck pain felt more vestibular symptoms and there was a significant correlation between DHI and neck pain severity. Kalland Knapstad et al.[1] investigated the frequency of neck pain and its possible relationship with DHI, NDI, and mental-physical quality of life in patients with PVS disease. Neck pain was found in 59% of 236 patients diagnosed with PVS disease. Higher DHI score, higher NDI, and lower mental-physical quality of life scores were obtained in the group diagnosed with PVS disease accompanied by neck pain. In this study, the authors concluded that neck pain should be evaluated as an amplifier of severity in this disease group, suggesting to investigate the improvement

TABLE 6
Correlation of change in neck pain severity after treatment and change in clinical parameters

	NVAS	DZVAS	BVAS	TUG	REO	REC	TEO	TEC	FEO	FEC	FGA	DGI	DHI	ABC	BERG	FES
DZVAS	0.418*															
BVAS	0.328*	0.597*														
TUG	0.140	0.305*	0.376*													
REO	0.094	−0.155	−0.300*	−0.395*												
REC	−0.192	−0.345*	−0.418*	−0.409*	0.321*											
TEO	−0.034	−0.285*	−0.176	−0.177	0.248*	0.563*										
TEC	−0.330*	−0.395*	−0.337*	−0.301	0.124	0.271*	0.308*									
FEO	−0.127	−0.201	−0.393*	−0.200	0.505*	0.514*	0.460*	0.017								
FEC	−0.434*	−0.340*	−0.355*	−0.493*	0.145	0.620*	0.459*	0.567*	0.347*							
FGA	−0.394*	−0.598*	−0.456*	−0.198	0.300*	0.399*	0.408*	0.504*	0.347*	0.409*						
DGI	−0.319*	−0.562*	−0.337*	−0.148	0.242*	0.378*	0.381*	0.500*	0.299*	0.388	0.919*					
DHI	0.337*	0.595*	0.511*	0.306*	−0.142	−0.322*	−0.265*	−0.455*	−0.152	−0.223	−0.560	−0.531				
ABC	−0.387*	−0.480*	−0.433*	−0.426*	0.368*	0.331*	0.236*	0.368*	0.297*	0.320*	0.542*	0.492*	−0.618*			
BERG	−0.346*	−0.504*	−0.564*	−0.437*	0.287*	0.403*	0.238*	0.457*	0.362*	0.426*	0.511*	0.435*	−0.575*	0.639*		
FES	0.234	0.511*	0.338*	−0.104	0.083	−0.173	−0.169	−0.405*	−0.044	−0.023	−0.577*	−0.547*	0.469*	−0.394*	−0.449*	
NDI	0.638*	0.384*	0.373*	0.323*	−0.133	−0.183	−0.030	−0.422*	−0.275*	−0.396*	−0.494*	−0.376*	0.400*	−0.524*	−0.466*	0.217

NVAS: Neck pain severity; DZVAS: Dizziness severity; BVAS: Balance severity; TUG: Timed up and go test; REO: Romberg eye open; REC: Romberg eye closed; TEO: Tandem eye open; TEC: Tandem eye closed; FEO: Foam eye open; FEC: Foam eye closed; FGA: Functional gait assessment; DGI: Dynamic gait index; DHI: Dizziness handicap inventory; ABC: Activity– specific balance confidence scale; BERG: Berg balance test; FES: International falling efficiency scale; NDI: Neck disability index. Pearson correlation analysis, R correlation coefficient. 0.10–0.30: low correlation, 0.30–0.50: medium correlation, 0.50–1: high correlation; * $p<0.05$.

in vertigo symptoms and quality of life with the reduction of neck pain. In our study, the correlation of neck pain severity with dizziness, FGA, DHI and BBS indicates that neck pain is of utmost importance as a severity-increasing factor on balance parameters in this patient group.

In another study in which 24 patients with neck pain accompanying Meniere disease were followed for three years, relaxation, posture training, and stretching exercises for the trapezius and levator scapula muscles were applied to this disease group. With these treatments, simultaneous improvements were observed in all Meniere disease-related symptoms, as well as neck pain after a three-year follow-up.[15] However, this study was not a randomized-controlled trial; therefore, the effect of other treatments administered over a three-year period on symptoms is unclear.

The current study was designed as a randomized-controlled trial to complete the gap in the literature, and improvements in clinical parameters were observed in the group which received neck exercises compared to the group that did not receive neck exercises. These findings indicate that neck exercises should be included in the treatment of this disease group. Although TUG test and Romberg eye-open time showed a significant improvement in both groups, no statistically significant difference was found between the groups. This can be attributed to the fact that the study has a relatively short follow-up and the baseline mean score of the Romberg eye-open time was high.

In a study investigating the correlation between disease duration and postural stability in patients with vestibular neuritis, a negative correlation was found between the duration of the disease and the duration of standing on the Romberg, tandem Romberg, and foam.[40] In another study evaluating postural instability in patients with a diagnosis of Meniere disease, a positive correlation was found between the shortness of the time elapsed from the last vertigo attack to the postural assessment and the duration of standing on the foam.[41] Although there are several studies in the literature showing a link between disease duration and balance parameters, no significant correlation was found between disease duration and clinical balance parameters in our study.

The main strengths of this study are that it is the first randomized-controlled study to evaluate the effect of neck exercises applied to reduce neck pain in addition to vestibular rehabilitation treatment on balance parameters in unilateral PVS diseases accompanied by neck pain. In addition, the number of patients calculated based on the sample size was reached. Finally, evaluations were performed by the investigator blinded to the randomization and the neck exercise group.

Nonetheless, there are some limitations to this study. First, the patients were evaluated only at the end of the four-week treatment and, therefore, its long-term effectiveness is still unclear. Second, there is no third control group in which only neck exercises were applied due to the ethical reasons. Third, patients were unable to be blinded to the treatment allocation, as they did the exercises practically.

In conclusion, our study results showed significant improvements in the balance parameters of the group in which neck exercises were applied in addition to vestibular rehabilitation treatment and a significant correlation between neck pain and balance parameters in patients with unilateral PVS disease accompanied by neck pain. Taken together, neck pain should be questioned in every patient who is scheduled for vestibular rehabilitation with a diagnosis of unilateral PVS, and appropriate neck exercises should be added to the vestibular rehabilitation treatment with proven effectiveness. Despite profound short-term effectiveness of this program, further studies are needed to assess its long-term effectiveness.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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