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ORIGINAL ARTICLE

The Effect of Vestibular Rehabilitation on Balance and Quality of Life in Patients with Bilateral Vestibular Hypofunction

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Abstract This study aims to investigate the effectiveness of vestibular rehabilitation on balance, dynamic visual acuity, and quality of life in patients with bilateral vestibular hypofunction (BVH). 20 patients diagnosed by videonystagmography were included in the study. Balance tests, Visual Analogue Scale (VAS), testing of Dynamic Visual Acuity (DVA), Dizziness Handicap Inventory (DHI), Computer-modified Clinical Test of Sensory Interaction in Balance (m-CTSIB), and Limits of Stability Test were applied before and 3 and 6 months after the treatment. Physiotherapy sessions were given at two-week intervals. According to the development of the patients, they were asked to perform a home exercise program with 10 repetitions 3 times a day. After 6 months of vestibular rehabilitation, improvements in balance and quality of life parameters were observed in the patients. VAS, DVA, DHI, all static balance parameters except Romberg, Semi-tandem eyes open were significant ($p < 0.005$). In computerized M-CTSIB, while no significant results were obtained on the hard surface with the eyes open ($p = 0.126$), statistically significant improvement was observed on the hard surface with the eyes closed and on a foam surface with eyes open and close. LOS results showed significant improvement in velocity, reaching the endpoint, and maximal deviation in all directions except the right posterior. While significant results were found in the right, posterior, left anterior, and left posterior directions in the reaction time section, there was no statistical significance in any of the direct control sections ($p < 0.005$). *Trial registration* number: NCT05231109, Date of registration:27/01/2022 (Retrospectively registered).

Keywords Bilateral vestibular hypofunction · Quality of life · Balance · Vestibular rehabilitation

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Introduction

Bilateral vestibular function (BVH) is a heterogeneous chronic condition characterized by bilaterally decreased or absent function of vestibular organs, vestibular nerves, or both [1]. Patients present with various symptoms such as oscillopsia, imbalance, visual vertigo, cognitive deficits, autonomic symptoms, and impaired spatial orientation. Depending on the etiology, neurological symptoms, as well as auditory symptoms such as hearing loss or tinnitus may be present [2–4]. BVH is a rare disease, with an estimated prevalence of 28 per 100,000 adults in 2008 [5]. However, growing evidence suggests that BVH causes a significant decline in quality of life and imposes a high socioeconomic burden due to work-related disabilities [6].

BVH can be difficult to diagnose, and therefore it is often underdiagnosed or misdiagnosed. Many challenges are encountered when diagnosing BVH. Among the diagnostic methods, many different diagnostic tests such as caloric test, revolving chair tests, head impulse test (HIT), vestibular evoked myogenic potentials (VEMP), dynamic visual acuity test (DVA) are used [7].

BVH may occur secondary to a number of different problems such as ototoxicity, meningitis, sequential vestibular neuritis, chronic inflammatory peripheral polyneuropathy, congenital loss, and neurofibromatosis. However, in most cases, BVH is considered "idiopathic" because the underlying cause cannot be identified. The incidence of the various forms of BVH is also unclear because it varies with the type of clinical practice studied [8].

In addition to vestibular tests, many other tests (on indication) such as cerebral imaging, audiometry, and blood tests can be used in the diagnostic process. These tests do not evaluate the vestibular function and are mainly used to determine the etiology of BVH or accompanying problems [9].

Vestibular rehabilitation increases postural stability, reduces the sense of imbalance, and improves visual acuity during head movements, which allows people with BVH to lead a more normal life [10, 11]. Unfortunately, most patients have residual functional problems and subjective complaints [12]. In patients with BVH, exercises aim to encourage the substitution of alternative strategies to compensate for lost vestibular function and improve remaining vestibular function.

The aim of this study is to investigate the effect of vestibular rehabilitation on quality of life and balance in patients with BVH.

Methods

Patients who applied to the Otorhinolaryngology outpatient clinic with complaints such as dizziness, loss of balance, and gait disturbance will be included as patients diagnosed with BVH by videonystagmography.

Ethics of the study Ethics committee approval with file number 789 was obtained by the Non-Interventional Clinical Research Ethics Committee on 19.12.2018.

Inclusion criteria;

1- Diagnosis with bilateral vestibular hypofunction by VNG test
2- Patients between the ages of 18–75
3- Having communication and cooperation skills
4- Not having problems originating from the central nervous system
5- Not having had ear infections before, not having undergone surgery

Exclusion criteria;

1- Having cognitive dysfunction
2- Presence of temporal bone pathologies detected by magnetic resonance imaging
3- Presence of other inner ear disorders that may cause dizziness and imbalance as determined by an audiogram, tympanogram, and acoustic reflexes
4- Previous lower extremity injuries
5- The presence of central findings in VNG results

It was planned that the first evaluation of the patients would be carried out by an otolaryngologist. These assessments consisted of physical examination and VNG testing. Bithermal caloric test, one of the most important components of the VNG test, is the gold standard for the diagnosis of vestibular hypofunction [13]. With this test, the vestibulo-ocular reflex was evaluated by giving thermal stimuli. While the patient was lying in the supine position, with the head flexed at 30 degrees, 8 L of air at 50 degrees and 24 degrees Celsius, respectively, were sent to both eardrums in 60 s at 5 min rest intervals. Involuntary eye movements were recorded for 120–140 s and the results were calculated by graphing [14]. In the absence of a caloric response to standard bithermal stimuli, the ice water test is used to determine whether there is a residual low-frequency function in the test ear. The ice water test is applied with cold water (10 degrees Celsius). This temperature can be achieved by placing sterile ice in a glass and then filling it with water [15].

Afterwards, patients were sent to the physiotherapist for balance, dizziness, quality of life measurement (Dizziness Handicap Inventory), evaluation of dynamic visual acuity and Limits of Stability on balance platform and computerized m-CTSIB.

Evaluation Methods

Demographic Data Form

The age, gender, smoking, and alcohol use of the patients were questioned.

Evaluation of Balance

Tandem, semi tandem, Romberg, and single leg stance tests were used to evaluate static balance, and m-CTSIB, Limits of Stability and static posturography tests on a computerized balance platform were used to evaluate the effect of vestibular, somatosensory and visual inputs on postural control.

Static Balance Evaluation

For balance tests, tandem, semi tandem, Romberg, standing on single leg on a hard ground, and standing on one leg on a soft ground were evaluated with eyes open and eyes closed, and the second was recorded as seconds with a stopwatch. The test was considered completed in patients who could stand for 30 s [16].

Static Posture Evaluation with ICS

With the limits of stability (LOS) program on the balance device called Otometrics ICS Balance Platform, the body's final reaching points, the speed of movement, and direct control were evaluated, in 8 directions. Within this device, the m-CTSIB test was evaluated by showing areas of oscillation. Modified-CTSIB is a clinical test that is generally used as a semi-quantitative test measurement and is scored according to the person's ability to perform various standing static positions. CTSIB is a test developed to distinguish between visual, vestibular, and somatosensory interventions to design a treatment program for neurological patients with balance disorders. This test was originally developed by Shumway-Cook and Horak in 1986. The control of the balance reflexes of more than one system was made to separate the errors into the systems [17]. Before removing the patient from the device, the center of gravity is determined by entering the height and weight, and the patient visually sees the center of gravity when he/she gets on the balance platform. Then all tests are done according to this center of gravity (Fig. 1).

Evaluation of Dizziness Severity

A 10-cm visual analog scale was used for evaluation. Patients were asked to rate the severity of dizziness on a scale of 0–10. It was explained that a score of "0" meant no dizziness at all, while a score of "10" indicated the presence of unbearable dizziness, and the patient was asked to mark the appropriate part [18].

Dynamic Visual Acuity

Dynamic visual acuity is the state of realizing the visual event clearly while in motion. The test is initiated by passively moving the patient's head rhythmically in the horizontal plane at 20° amplitude and at a speed of 2 Hz, while the patient begins to read the letters on the Snellen card. The clearly visible line is recorded. The dynamic visual acuity score is the difference between the number of lines on the visual graph when moving passively against the still head. In healthy individuals, visual acuity may vary by one order in younger individuals and by two orders in older individuals. In uncompensated patients, the degree of visual acuity may change [19].

Evaluation of Quality of Life

Dizziness Handicap Inventory was used to evaluate the quality of life of patients. This scale consists of 25 items that determine the aggravating factors of patients' dizziness and balance disorder, as well as emotional and functional outcomes in vestibular system diseases. Turkish validity and reliability were established by Canbal et al. in 2016 [20].

Rehabilitation Protocol

After the initial evaluations, the patients included in the study were included in the rehabilitation program. The rehabilitation program consisted of two phases. The first phase included patient education. All patients were planned to receive verbal training for 30 min by the physiotherapist,

Fig. 1 Using the ICS static posturography device

including the definition of unilateral vestibular hypofunction, its importance, risk factors, ways of prevention, and recommendations for preventing falls. The second phase consisted of the vestibular exercise program. In this phase, vestibular adaptation exercises, oculomotor exercises, standing by changing the support area, the support surface and the arm positions, heel-toe walking, walking with head rotation, backward walking, counting on a soft surface with eyes open and closed, and dynamic balance exercises were taught to the patients. The exercises are shown in Table 1. The exercise program was arranged 3 times a day for 6 months, and each exercise was 10 repetitions. The patients were called for physiotherapist control once every 2 weeks. Patients were re-evaluated before the treatment, at the 3rd month and after the 6th month.

Statistical Analysis

"Statistical Package for Social Sciences for Windows" (SPSS 25.0) program was used for statistical analysis. The normal distribution of the variables was evaluated with the Kolmogorov Smirnov Test. Parametric tests were applied to the data. Analysis of dependent variables were performed with One-Way ANOVA. The significance value for all tests applied to the variables was accepted as $p < 0.05$.

Table 1 Exercises

	Exercises	Progression	Aim
Tracking exercises	Following the finger with the eye right-left Following the finger with the eye up-down Following the finger with the eye diagonal (SITTING)	Standing on hard ground Standing on foam surface Talking or making noise	Improve the visual system
VOR exercises	VOR*1 VOR*2 (SITTING)	Romberg standing on hard floor, semitandem and tandem position Standing on soft ground in romberg, semitandem and tandem position during walking	Developing the vestibolu-ocular reflex Coordinating the vestibulo-ocular reflex and the vestibulo-spinal reflex Increasing the coordination of vestibulo-ocular reflex, vestibulo-spinal reflex and vestibulo-collic reflex
Neck exercises	Turning head right-left eyes open-closed Head up-down eyes open-closed (SITTING)	Standing head right-left turning eyes open-closed on hard ground in romberg, semitandem and tandem position Standing head up-down eyes open-closed romberg, semitandem and tandem position on hard ground On foam surface	Activating the vestibulocollic reflex Reducing neck pain and tension due to dizziness Overcoming the fear of movement
Static balance training	Lean forward with the ball Ankle sway Reach Forward Keeping balls thrown from different points on the Twister	On foam surface When the lights are off	
Dynamic balance training	Walking looking around Throwing the ball from one hand to the other while walking Walking by turning the ball while walking Sudden stops and turns while walking	Eyes open Eyes are closed Hard surface Foam surface	
Walking training	Normal walking soldier march walking backwards sideways walking cross walk walking on the line	Eyes open Eyes are closed Hard Surface Foam Surface Hands at sides, hands behind and hands on shoulders crossed Counting or talking with music	Contributing to activities of daily living Prevent social isolation Prevent falls

VOR: Vestibulo-ocular reflexes

Results

The study was completed with 20 patients, as 25 of the 45 patients who participated in the study did not meet the inclusion and exclusion criteria. The mean age of the patients included in the study was 40.60 ± 16.76 years (2 males, 18 females). While the patients did not use alcohol, it was determined that 2 people smoked.

The results of VAS, dynamic visual acuity, DHI and static balance parameters, which are among the methods used for the evaluation of rehabilitation effectiveness, are shown in Table 2. A statistically significant improvement was obtained after the treatment in dynamic visual acuity, which has an important place in the treatment of VAS vestibular symptoms and oscillopsia, in which we evaluated the severity of dizziness ($p = 0.000$). In DHI, in which we evaluated the quality of life of our patients, a statistically significant result was obtained by decreasing from 48.20 ± 18.30 to 5.70 ± 10.90 ($p = 0.002$). In our static balance tests, improvement was obtained in all tests except semitandem eyes open and romberg tests, that is, tandem eyes open, semitandem eyes closed, and standing on one leg on soft and hard ground ($p < 0.005$).

In the computerized M-CTSIB, in which we wanted to investigate the effect of sensory inputs on postural control, no significant results were obtained in the eyes open position on a hard surface ($p = 0.126$), while a statistically significant improvement was observed on a hard surface with eyes closed and with eyes open and closed on foam cushion ($p < 0.005$). M-CTSIB results are shown in Table 3.

In the LOS results, which were evaluated from 5 different directions as speed, maximum deviation, reaching the endpoint and direct control, significant improvement was obtained in all directions in the speed section, except the right rear, in reaching the endpoint and in the maximum deviation section ($p < 0.005$). In the reaction time section, statistically significant results were obtained in right, posterior, left anterior and left posterior directions, while in the direct control section, results were not statistically significant in any sections ($p < 0.005$). LOS parameter results are shown in Table 4.

Table 2 VAS, dynamıc visual acuıty, DHI and balance parameters results

	Initial evaluation (n = 20)	3rd month evaluation (n = 20)	6rd month evaluation (n = 20)	*p* Value
	Mean ± SD	Mean ± SD	Mean ± SD	
Dizziness severity (VAS)	6.32 ± 0.92	0.82 ± 1.01	0.87 ± 1.28	0.000
Dynamic visual acuity	0.47 ± 0.23	0.17 ± 0.15	0.09 ± 0.09	0.000
DHI	48.20 ± 18.30	5.90 ± 7.06	5.70 ± 10.90	0.002
Tandem test				
Eyes open (s)	25.01 ± 8.57	30.00 ± 0.00	30.00 ± 00.00	0.003
Eyes close (s)	7.93 ± 9.36	28.90 ± 3.57	29.35 ± 1.86	0.000
Semitandem test				
Eyes open (s)	28.79 ± 5.40	30.00 ± 00.00	30.00 ± 00.00	0.377
Eyes close (s)	25.80 ± 7.77	30.00 ± 0.00	30.00 ± 00.00	0.006
Romberg (s)	27.02 ± 7.62	30.00 ± 00.00	30.00 ± 00.00	0.097
Standing on one leg, hard floor				
Eyes open (s)				
Right	22.46 ± 10.39	29.79 ± 0.93	30.00 ± 00.00	0.000
Left	18.35 ± 10.28	30.00 ± 00.00	30.00 ± 00.00	0.000
Eyes close (s)				
Right	06.19 ± 9.12	24.35 ± 7.61	27.11 ± 5.32	0.000
Left	06.05 ± 7.04	22.79 ± 9.64	27.23 ± 4.26	0.000
Standing on one leg, foam cushion				
Eyes open (s)				
Right	13.25 ± 11.19	28.12 ± 5.80	30.00 ± 00.00	0.010
Left	14.46 ± 12.71	28.50 ± 3.99	30.00 ± 00.00	0.000
Eyes close (s)				
Right	04.07 ± 06.17	22.76 ± 09.04	26.01 ± 06.39	0.000
Left	03.80 ± 05.40	21.76 ± 10.02	25.07 ± 04.78	0.000

One-Way ANOVA; VAS: Visual analogue scale; DHI: Dizziness handicap inventory; SD: Standard deviation; s: Second; n: Number of persons

Table 3 M-CTSIB results

	Initial evaluation (n = 20)	3rd month evaluation (n = 20)	6rd month evaluation (n = 20)	*p* Value
	Mean ± SD	Mean ± SD	Mean ± SD	
Hard ground eyes open (mm/s)	10.96 ± 2.85	9.53 ± 2.15	9.64 ± 4.26	0.126
Hard ground eyes close (mm/s)	15.78 ± 9.78	11.44 ± 5.23	10.46 ± 3.24	0.000
Foam cushion eyes open (mm/s)	15.02 ± 3.47	11.95 ± 2.53	12.42 ± 2.43	0.002
Foam cushion eyes close (mm/s)	26.86 ± 11.95	15.92 ± 6.16	15.89 ± 5.96	0.012

One-Way ANOVA; m-CTSIB: Modified for sensory interaction in balance clinical test; SD: Standard deviation; mm/s: Millimeter/second; n: Number of persons

Discussion

Bilateral reduction or loss of vestibular function results in a decrease in the patient's ability to see clearly, especially when walking in the dark or on uneven surfaces and during head movements. At the same time, patients with BVH complain of off-balance and uncomfortable sensations in their head with head movements. Because of these problems, BVH patients may restrict their activities of daily living and isolate themselves socially. In our study, improvements in balance, dizziness, quality of life and visual acuity were obtained in 20 patients who applied to our clinic with loss of balance, oscillopsia and related decrease in daily living activities.

Early gains in the acute recovery period may be related to the daily rehabilitation of all patients taken during this period and the natural time course of recovery, which is known to slow over time [21]. For this reason, if we consider whether the improvement in the first 3 months can be achieved in the long term, we can see that the effectiveness continues in the 6th month evaluation. These data here not only confirm the immediate effects of early exercise, but also show the long-term effects on postural control [22]. For this reason, in our study, after the evaluation of the 3rd month after the treatment, the 6th month evaluation was also made, and we stated that the effectiveness continued.

In the study conducted by Herdman et al. in 2001, a significant improvement was obtained in dynamic visual acuity in patients with vestibulopathy treated with vestibular rehabilitation when the exercise group was compared with the control group [12]. In another study by Badke et al., it was reported that dynamic visual acuity improved by more than two orders of magnitude with vestibular rehabilitation in 20 patients with peripheral and central vertigo [23]. As a diagnostic test, DVA, we can conclude that it provides a quantitative measure that can be used to reveal the disability level of the patient. In addition, it can be used as a treatment baseline and later to monitor developments during and after vestibular rehabilitation [24]. In our study, a significant improvement in dynamic visual acuity was observed in the 3rd and 6th months after vestibular rehabilitation, in line with the literature, compared to the initial evaluation. However, dynamic visual acuity evaluations in the literature have been based on 8-weeks results, not 6-months evaluation results. The long-term effect was demonstrated in our study.

The vestibular system plays an important role in spatial memory for both whole-body angular and linear displacements. The role of vestibular inputs in elaborating an accurate internal representation of the environment confirms the role of the vestibular system for idiothetic navigation and route planning more generally [25]. Dynamic balance is one of the requirements for motion, which requires resisting not only the force of gravity, but also other expected and unexpected forces. It is particularly critical for initiating gait, which is a transitional stage between a static standing state and a purely dynamic state with special requirements during gait. The consequences of vestibular loss on spatial performance depend on the complexity of the task. Indeed, such losses are particularly significant for tasks that require a high level of sensory integration to manipulate distance and/or direction with the eyes closed [26].

The LOS test is a reliable dynamic balance test, and this reliability increases as the number of test targets increases to eight. It requires concentration, attention span and visual perceptual abilities as well as static vertical balance and weight variation between different targets with a center point in a closed environment within a certain time. Therefore, a performance-based tool such as computerized LOS can be selected and used safely to determine the balance capacity of an individual with vestibular deficit [27]. For this reason, LOS parameters such as speed, reaction time, reaching the end point, linear control and maximum burst velocity, viewed in 8 directions, were evaluated by taking the body's center of gravity as a reference. Statistically significant results were obtained in both 3rd and 6th month evaluations compared to pre-treatment.

DHI, which is a questionnaire that best evaluates the quality of life of patients diagnosed with vestibular dysfunction, determines the handicap status that can vary from mild to severe in individuals who experience vestibular loss. In a study conducted by Guinand et al. in 2012, they stated that patients with BVH had a correlation with DHI and SF-36,

Table 4 LOS results

	Initial evalution (n = 20) Mean ± SD	3rd Month evaluation (n = 20) Mean ± SD	6rd Month evaluation (n = 20) Mean ± SD	*p* Value
Movement velocity (°/s)				
Forward	4.59 ± 0.77	4.81 ± 0.66	5.25 ± 0.67	0.010
Right forward	4.79 ± 0.98	5.32 ± 0.66	5.61 ± 0.82	0.011
Right	3.51 ± 0.62	3.89 ± 0.68	4.04 ± 0.55	0.020
Right backward	2.00 ± 0.52	2.25 ± 0.64	2.42 ± 0.51	0.078
Backward	1.14 ± 0.29	1.22 ± 0.38	1.30 ± 0.59	0.033
Left backward	1.97 ± 0.59	2.51 ± 0.77	2.79 ± 0.48	0.000
Left	3.61 ± 0.68	3.97 ± 0.60	4.25 ± 0.72	0.010
Left forward	4.91 ± 0.79	5.14 ± 0.67	5.44 ± 0.48	0.013
Endpoint (%)				
Forward	73.20 ± 17.51	82.20 ± 14.50	94.30 ± 12.57	0.016
Right forward	83.10 ± 18.72	93.55 ± 13.30	99.20 ± 9.32	0.005
Right	68.55 ± 12.60	78.75 ± 12.22	75.50 ± 10.76	0.012
Right backward	69.75 ± 21.05	84.60 ± 16.13	89.95 ± 19.10	0.000
Backward	76.05 ± 19.35	88.35 ± 21.20	84.95 ± 21.26	0.090
Left backward	70.90 ± 22.94	89.70 ± 18.66	100.40 ± 15.40	0.000
Left	74.15 ± 10.76	81.20 ± 11.78	88.45 ± 10.54	0.000
Left forward	89.00 ± 15.42	92.20 ± 12.23	101.15 ± 10.95	0.017
MXE (%)				
Forward	84.30 ± 13.56	89.05 ± 7.63	97.45 ± 8.99	0.007
Right forward	92.85 ± 11.51	98.40 ± 11.34	101.45 ± 7.56	0.023
Right	74.55 ± 8.35	85.60 ± 11.39	83.30 ± 7.40	0.000
Right backward	76.60 ± 15.21	91.70 ± 11.98	96.20 ± 14.06	0.000
Backward	85.85 ± 16.68	97.10 ± 14.54	99.70 ± 11.84	0.002
Left backward	81.65 ± 17.17	94.30 ± 14.68	104.50 ± 12.01	0.000
Left	79.65 ± 11.88	87.65 ± 8.95	91.75 ± 8.49	0.000
Left forward	95.10 ± 12.46	96.90 ± 8.11	103.40 ± 8.48	0.037
Reaction time (s)				
Forward	1.06 ± 0.18	0.92 ± 0.20	0.95 ± 0.21	0.076
Right forward	1.04 ± 0.33	0.91 ± 0.14	0.88 ± 0.24	0.118
Right	1.05 ± 0.39	0.87 ± 0.16	0.91 ± 0.11	0.000
Right backward	0.89 ± 0.26	0.90 ± 0.12	0.91 ± 0.16	0.917
Backward	0.88 ± 0.13	4.60 ± 16.33	0.84 ± 0.28	0.000
Left backward	0.81 ± 0.37	0.92 ± 0.10	0.86 ± 0.23	0.007
Left	0.94 ± 0.20	0.89 ± 0.14	0.91 ± 0.18	0.604
Left forward	1.01 ± 0.20	0.93 ± 0.12	101.15 ± 10.95	0.000
Directional control (%)				
Forward	82.70 ± 9.92	78.25 ± 12.31	78.95 ± 9.68	0.365
Right forward	66.35 ± 16.64	70.50 ± 16.17	72.85 ± 12.52	0.392
Right	68.40 ± 19.05	74.10 ± 16.98	73.55 ± 10.25	0.493
Right backward	64.45 ± 19.38	74.70 ± 11.05	70.65 ± 12.49	0.853
Backward	76.20 ± 12.34	73.70 ± 19.47	73.70 ± 20.27	0.853
Left backward	57.10 ± 21.49	69.75 ± 17.57	66.50 ± 15.97	0.055
Left	69.45 ± 18.29	74.70 ± 12.41	73.00 ± 12.49	0.498
Left forward	75.80 ± 10.32	74.50 ± 11.49	75.65 ± 11.80	0.903

One-Way ANOVA; LOS: Limits of stability; MXE: Maximum excursion; SD: Standard deviation; °/s: Degrees/second; s: Second; %: Percent; n: Number of persons and there was a correlation with DHI and oscillopsia [6]. In another study conducted by Jacobson et al., DHI was examined in 72 patients at the first evaluation, and it was shown that the DHI scores of the patients diagnosed with BVH were higher negatively [28]. In our study, patients were evaluated with DHI, and it was observed that the pre-treatment evaluation had much higher scores than the 3rd and 6th month evaluations, and thus the quality of life before the treatment was quite low. Although the number of patients is low, it has been shown that the patient is successful in long-term follow-up and there is no decrease in the quality of life with vestibular rehabilitation even as time progresses.

In the study of Agrawall et al., 10 patients diagnosed with unilateral vestibular hypofunction and 10 patients with BVH were evaluated with vestibular rehabilitation. M-CTSIB was checked with balance master and static balance was evaluated with sway area. As a result, even though the number of patients is small, vestibular rehabilitation has achieved a significant improvement in the sway area in M-CTSIB [29]. This is important because if the sway area is within the required limits, the risk of falling decreases and the balance of the person becomes normal. This enables the body to move in harmony and balance with each other while both standing still and walking. For this reason, in our study, a statistically significant improvement was obtained in the sway area in our m-CTSIB evaluation performed with the balance master device after the treatment in the 3rd and 6th months compared to the pretreatment.

The limitation of our study is the absence of a control group. BVH is a disease that is difficult to diagnose in clinics. It is equally difficult for patients to apply to the clinic, to be diagnosed and to follow their treatment processes. Due to the small number of patients, a control group could not be formed, but long-term follow-up was provided.

As a result, a significant improvement in balance status, dizziness and quality of life was achieved with vestibular rehabilitation of patients diagnosed with BVH.

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Declarations

Conflict of interest None declared.

Consent to Participate Informed consent was obtained from all individual participants included in the study.

Consent to Publish Patients signed informed consent regarding publishing their data.

Ethical Approval This study was approved by the Institute's Non-Interventional Clinical Research Ethics Committee, dated 19/12/2018 and numbered 789.

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