T.R.
PAMUKKALE UNIVERSITY
FACULTY OF MEDICINE
DEPARTMENT OF EAR, NOSE AND THROAT DISEASES

USE OF VIRTUAL REALITY DEVICES FOR VESTIBULAR REHABILITATION IN PATIENTS WITH VESTIBULAR INSUFFICIENCY

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SYMBOLS AND ABBREVIATIONS

UVY	:Unilateral Vestibular Insufficiency
SSS	:Central Nervous System
BPPV	:Benign Paroksismal Pozisyonel Vertigo
TREAT	:Vestibular Evoked Myogenic Potentials
MRG	:Magnetic Resonance Imaging
NARROW	:Electrocystography
VNG	:Videonystagmographs
vHIT	:Video Head Impulse Test
SVV	:Subjective Visual Diket Test
BEFORE	:Vestibulo Ocular Reflex
MLF	:Medial Longitudinak Fasiculus
VSR	:vestibülo spinal reflex
VK	:Vestibular Compensation
VR	:Vestibular Rehabilitation
GSI	:General Stability Index
APSCENC E	:Front-Back Set İndeksi
MLSI	:Medial-Lateral Stabilite İndeksi
DRT	:D Cold Risk Test
GA	:Eye Open
GK	:Eye Closed
SZ	:Hard Floor
AI	:Soft Ground
DHI	:Dizziness Handicap Inventory
BDI	:Berg Equilibrium Scale
LIMIT	:Hospital Anxiety and Depression Scale
MBDS	:Monteral Cognitive Assessment Scale
mCTSIB	: Modified Balance Sensory Interaction Clinical Test
SG	:Virtual reality
HMD	:Head-Mounted Display

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SUMMARY

Use of virtual reality devices for vestibular rehabilitation in patients with vestibular insufficiency

Today, the concept of vestibular rehabilitation is a comprehensive approach to the treatment of dizziness and balance disorder based on individual, programmed exercises for disorders and functional limitations detected during evaluation. The aim of this study is to investigate the effects of the use of virtual reality glasses on static and dynamic balance, risk of falling, fear of falling, anxiety and depression with vestibular rehabilitation exercises. Out of a total of 41 patients, 21 people were included in the traditional vestibular rehabilitation group and 20 people were included in the virtual reality-based vestibular rehabilitation group. The group that received vestibular rehabilitation with virtual reality was given 20 sessions of exercise within 1 month, 20 minutes per day. Patient controls were performed as pre-treatment, 15th day, 30th day, 90th day and 180th day. Patient controls were performed with dynamic posturography, Berg balance scale, static SVV (subjective visual vertical) and dynamic SVV, subjective quality of life scales. Dynamic posturography, SVV, Berg balance scale (BDI), hospital depression and anxiety scale (HAD), dizziness disability inventory (DHI-S) form and Montreal cognitive scale were used. In the results of dynamic posturography, a statistical difference was observed in the anteior posterior stability index and medial lateral stability index in the postural stability test in the virtual reality-based vestibular rehabilitation group; In the traditional rehabilitation group, only a statistical difference was observed in the medial lateral stability index. In the comparison of dynamic posturography tests between groups, no statistical difference was observed between the virtual reality-based vestibular rehabilitation group and the traditional vestibular rehabilitation group. There was no statistically significant difference between the 2 groups in static SVV and dynamic SVV tests. In group 2 who underwent virtual reality-assisted vestibular rehabilitation, a statistically significant improvement was found in all BDI, CFD (depression), HAD (anxiety) and DHI-S scores ($p<0.05$). To the traditional rehabilitation group

A statistically significant difference was found in HAD (depression), HAD (anxiety) and DHI-S scores ($p<0.05$) but; There was no statistically significant difference in BDI score. There was no statistically significant difference between the group that received virtual reality-assisted vestibular rehabilitation and the group that received traditional vestibular rehabilitation in terms of BDI, CFD (depression), CFD (anxiety) and Montreal Cognitive Assessment Scale scales. Considering these promising findings, we can advocate for the use of virtual reality devices in conjunction with traditional vestibular rehabilitation. The aim of this will be to maximize the effects on patients affected by unilateral vestibular hypofunction, even in the long term.

ABSTRACT

Use of viral reality devıces for vestıbular rehabilitation in patıents wıth vestıbular dysfunction

Today, the concept of vestibular rehabilitation is a comprehensive clinical approach based on individual, programmed exercises for the treatment of dizziness and balance disorders, especially for the disorders and functional limitations detected during the evaluation. The aim of this study is to investigate the effects of vestibular rehabilitation exercises with virtual reality glasses on static and dynamic balance, risk of falling, fear of falling, anxiety, and depression. A total of 41 patients, 21 people were included in the traditional vestibular rehabilitation group, and 20 people were included in the virtual reality-based vestibular rehabilitation group. The group, who received vestibular rehabilitation with virtual reality, was given 20 sessions of exercise, 20 minutes a day, within 1 month. Patient controls were performed before treatment, at day 15, day 30, day 90, and day 180. Patient controls were performed with dynamic posturography, Berg balance scale, static SVV (Subjective visual vertical), and dynamic SVV, subjective quality of life scales. Dynamic posturography, SVV, Berg balance scale (BBS), hospital depression and anxiety scale (HAD), dizziness handicap inventory-screening form (DHI-S), and Montreal cognitive assessment were used. In the dynamic posturography results, a statistical difference was observed in the postural stability test, anterior posterior stability index and medial lateral stability index in the virtual reality-based vestibular rehabilitation group, but; In the traditional rehabilitation group, statistical difference was observed only in the medial lateral stability index. In the comparison between groups in dynamic posturography tests, no statistical difference was observed between the virtual reality-based vestibular rehabilitation group and the conventional vestibular rehabilitation group. No statistical difference was observed between the two groups in static SVV and dynamic SVV tests. Statistically significant improvement was found in all Berg Balance Scale(BBS), HAD (depression), HAD (anxiety), and DHI-S scores in group 2 who underwent Virtual Reality-assisted vestibular rehabilitation ($p<0.05$). When we look at the traditional rehabilitation group, there was a statistically significant difference in HAD (depression), HAD (anxiety), and DHI-S scores ($p<0.05$). But; No

statistical difference was observed in the BBS score. There was no statistical difference in the BBS, HAD (depression), HAD (anxiety) and Montreal Cognitive Assesment scales between the virtual reality assisted vestibular rehabilitation group and the traditional vestibular rehabilitation group. Considering these promising findings, we can advocate the use of virtual reality devices in conjunction with traditional vestibular rehabilitation. The aim of this would be to maximize the effects on patients affected by unilateral vestibular hypofunction, even in the long term.

1. INTRODUCTION AND PURPOSE

Dizziness and balance disorders affect patients' daily living activity and ability to live independently. Physical, functional and emotional disability caused by dizziness is an important health problem at all ages. Secondary damages may occur due to falling, especially in the elderly. It can lead to sudden imbalance or fear of falling, activity restrictions, emotional problems, panic and anxiety(1). Unilateral vestibular insufficiency (UVY); It causes problems such as vertigo, imbalance, oscillopsia, impaired balance and gait(2). The acute phase is generally managed with pharmacological treatments in primary care and heals with the vestibular compensation process (3). Vestibular rehabilitation is the safest and most effective treatment for patients who cannot recover after this (4,5).

Today, the concept of vestibular rehabilitation is a comprehensive approach to the treatment of dizziness and balance disorder based on individual, programmed exercises for disorders and functional limitations detected during evaluation. Fall prevention programs in the elderly are generally similar and include exercises to improve muscle strength, range of motion, aerobic capacity, and balance. Vestibular exercise programs, which include repetitive head, eye and trunk movements as well as postural control and balance exercises, have been shown to have positive effects on the risk of falling in the elderly (6,7). Exercises using virtual reality technologies have been reported to have positive effects on walking, postural control, balance and mobility in the elderly (8–10).

. In this study, our aim was to determine that the use of virtual reality glasses can be used in the short and long term with vestibular rehabilitation exercises; to investigate the effects on static and dynamic balance, risk of falling, fear of falling, anxiety and depression.

GENERAL INFORMATION

2.1. VESTIBULAR SYSTEM AND BALANCE

2.1.1. Description and Related Systems

Balance can be described as the 6th sense. It can also be expressed as the state of stopping an object or a person without tipping over, or if it is desired to be described in a more physical expression, it can also be expressed as the state of stopping, which is the result of forces that cancel each other. In other words, it is the ability of the body to control the center of gravity on the base of support in static or dynamic positions with minimal muscle activity and energy loss (11).

The vestibular system is a complex structure that provides communication between the vestibular organ, ocular system, postural muscle and joint receptors, central system and includes sensory organization. This system detects head movements and gravitational forces, stabilizes images in the retinal fovea, and provides postural control during head movements (12,13). Functions such as postural control, visual stabilization, and spatial orientation are controlled by the interaction of different sensory stimuli and dynamic sensorimotor processes (14,15)

Balance is a complex system that is realized by synthesizing and evaluating impulses from three sensory systems (vestibular, visual, somatosensory) by the central nervous system (CNS) and creating appropriate responses in the musculoskeletal system. The vestibular pathways, starting from the inner ear, reach the vestibular nerve and the vestibular nuclei. The connections of the vestibular nuclei with the ocular motor nuclei form the vestibulo-ocular reflex. Thanks to the vestibulo-ocular reflex, the images of the objects are kept fixed in the fovea during the movement, allowing a clear view of the surroundings. The descending connections starting from the vestibular nuclei reach the medulla spinalis and form the vestibulo-spinal reflex. This reflex regulates the posture and ensures that the balance is maintained. Starting from the vestibular nuclei, the ascending pathways reach the thalamus and temporo-parietal and posterior insular regions from the brain stem and provide movement perception and spatial orientation. These regions are multisensory cortical areas and

They also have projections into the vestibular nucliuse. This corticopharic feedback helps regulate the vestibular functions of the brainstem (16).

The brain ignores erroneous information and selects information to perform coordinated motor movements for postural control (17). As a result of "faulty data flow" caused by any of these systems, dizziness and balance disorder occur. This problem in data transmission may arise from the sensory organ or from the conduction pathway (18).

2.1.2 Vestibuler Reflexler

2.1.2.1 Vestibulo-Ocular Reflex

The Vestibulo Ocular Reflex (VOR) helps stabilize the retinal image during head movements. It provides image stabilization by producing eye movements in the opposite direction at the same speed during the movements of the head in three-dimensional space (19).

The direct pathway for VOR consists of the connection of vestibular nuclei and ocular motor neurons. The vestibular nucleus and oculomotor nucleus are connected in two ways, direct and indirect. The medial logitidinal fasciculus (MLF) plays an important role in the connections between the vestibular nuclei and the ocular motor nuclei in the direct pathway. The indirect pathway, on the other hand, is multisynaptic and involves short and long axonal junctions in the reticular body. The direct pathway allows eye movements to start quickly, while the indirect pathway helps to provide spontaneous tone and fine control in the eyes with feedback circuits (20).

The connections established by afferent fibers from the semicircular canals with motor neurons that innervate the eye muscles, and the stimulation of afferents coming from a channel end with eye movements in the plane of that channel. For example; When the head is turned to one side in the horizontal plane, the eyes move in the opposite direction. Stimulation of the right horizontal semicircular canal crista activates the muscles of the left lateral rectus and right medial rectus, while inhibiting the right lateral rectus and left medial rectus. Thus, the eyes move to the opposite side of the stimulus. Left posterior canal bulbs nerve stimulation ends with excitation of the left superior oblique and right inferior rectus muscles, inhibition of the left inferior oblique and right superior rectus muscles. This

As a result, an oblique and downward movement takes place in the plane of the left posterior canal in the eyes (21).

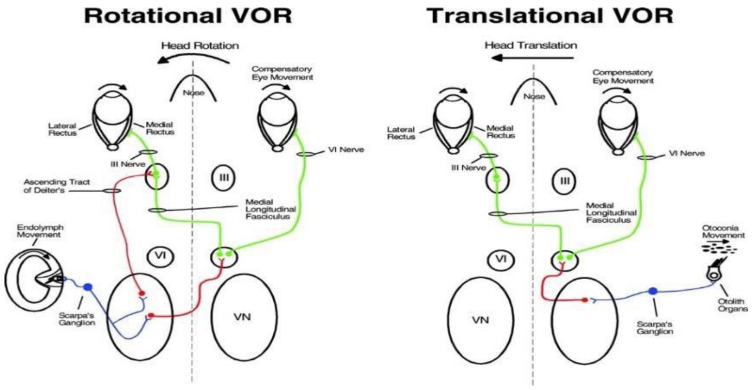

Figure 1: Vestibulocular reflex(22)

2.1.2.2 Vestibulo-spinal reflex:

The Vestibulo Spinal Reflex (VSR) is responsible for adjusting the contractions of the muscles that defy gravity, maintaining the upright position of the body and head, and maintaining balance during movement. VSR coordinates compensatory body movements through the lateral and medial vestibulospinal tract in order to prevent falls, provide postural stability and maintain the balance of the head during body movement (16).

2.1.2.3 Vestibulo-Colic Reflex

It is the activation or inhibition of the neck muscles to stabilize the movements of the head and neck in the spatial space. Unexpected head movement perceived by the autolytic or semicircular canals brings the head back to its original position with a reflex starting from the vestibular system and extending to the neck muscles (23). It cooperates with the cervicocolic reflex.

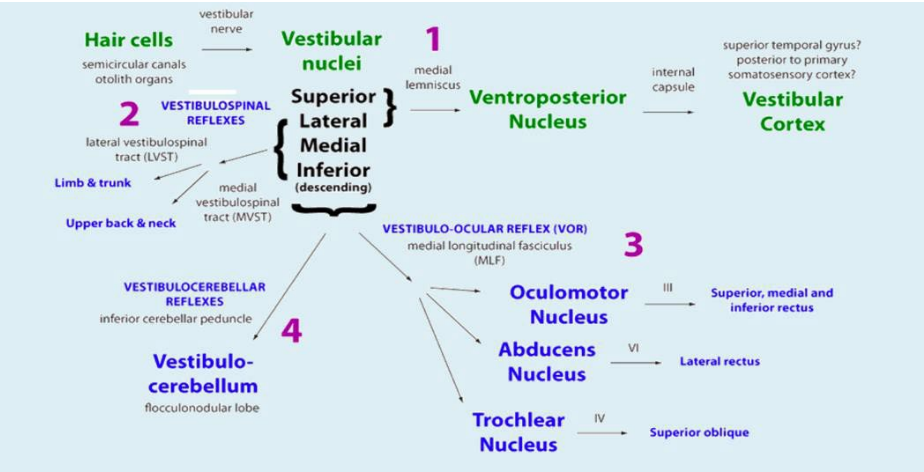

Figure 2: Vestibular reflex pathways(24)

1.2. UNILATERAL VESTIBULAR INSUFFICIENCY

A common cause of dizziness and loss of balance is vestibular insufficiency. The vestibular system describes the balance system of the inner ear. Vestibular dysfunction is caused by a chronic problem with the balance organs in the inner ear. This problem can be total or partial, unilateral or bilateral. Depending on this problem, the movement of the head or body results in dizziness, visual impairment and loss of balance. A combination of at least two or three sensory inputs (visual, vestibular, somatosensorial) should be used to ensure normal postural stability while walking. Although other sensory and motor systems compensate for vestibular loss in patients with vestibular loss, they cannot fully reflect a healthy balance system.

In patients with unilateral vestibular insufficiency (UVI), there are differences in the onset and course of the disease depending on the severity and type of vestibular damage. Depending on these reasons, different symptoms may occur from person to person (25). These symptoms are; Symptoms such as dizziness or vertigo, gait disturbance, imbalance, blurred vision with head movements, nausea and vomiting. In addition, anxiety, depression and cognitive problems are frequently manifested in patients due to these symptoms (26).

We need to be able to understand the difference between dizziness and vertigo from the complaints of the patients. Dizziness is generally used to express three feelings.

These; visual disorientation (visual misidentification of objects), lightheadedness (feeling of emptiness in the head, feeling fainting without confusion) and imbalance. Vertigo, on the other hand, is a misperception of the sensation of movement and the sensation of rotation. However, patients also described it as a feeling of slipping, falling or rolling (27).

Symptoms are divided into static and dynamic. Static symptoms are those that manifest themselves continuously, even when the person is standing still. Dynamic symptoms, on the other hand, are those that occur in motion. Immediately after UVY, spontaneous, usually horizontal, ocular nystagmus occurs. Rapid eye movements are observed in both eyes, these movements are usually in the form of moving away from the affected side with the development of compensation. The horizontal component of spontaneous nystagmus occurs because UVI causes the disappearance of peripheral vestibular impulses to one vestibular nucleus and creates an imbalance between it and the other vestibular nucleus (28).

Idiopathic acute unilateral vestibulopathy, also known as vestibular neurinitis, is the second most common cause of vertigo. Although the etiology is not clear, the viral etiology is supported by histopathological changes in the vestibular nerves of patients who sometimes encounter conditions such as epidemic events and diseases (29). Other causes include Benign Paroxysmal Positional Vertigo (BPPV), Meniere's disease and perilymphatic fistula, acoustic neuroma, and gentamicin ototoxicity. It may also occur after surgical interventions such as unilateral labyrinthectomy or neurectomy (acoustic or vestibular) (30, 31).

The first thing to do in patients with vestibular hypofunction is a detailed anamnesis. A detailed history takes precedence over physical examination and vestibular tests in making the diagnosis. We can reach the diagnosis of the disease by questioning the symptoms described by the patient in detail. Diseases such as upper respiratory tract infection, surgical interventions, ototoxic drugs, alcohol and cigarette use, long-term bed rest, trauma history, the patient's diet, comorbid diseases, medications, stress and fatigue, and other findings accompanying vertigo or dizziness should be questioned. After that, in the physical examination

It is important to perform otoscopic examination (in terms of chronic otitis media), audiological examination, cranial nerve examination and cerebellar tests.

Positional tests of the patient for BPPV should be performed. Vertical nystagmus usually shows central pathologies, while torsional or horizontal nystagmus can be caused by both peripheral and central pathologies. In the continuation of this, tests such as caloric tests, electronystagmography (ENG) and videonistagmography (VNG), vHIT (Video Head Impulse Test), VEMP (Vestibular evoked myogenic potentials), SVV (Subjective visual vertical test) will make it easier for us to make the correct diagnosis. In terms of assessing postural balance, clinical tests (Berg balance test, Tinetti test) and laboratory tests (static and dynamic posturography) help us understand the postural stability of the patient. In addition, the patient's gait can be evaluated, the risk of falling can be evaluated, and quality of life scales can also be evaluated.

The main treatment of vestibular hypofunction is based on exercise. In the chronic period, medical treatment, surgical treatment and vestibular rehabilitation can be applied in a multidisciplinary manner (32,33).

1.3. VESTIBULAR COMPENSATION

Many diseases involving the vestibular system are often self-limiting and usually heal within a certain period of time. This condition, which is a feature of the central nervous system, is called vestibular compensation (VK), which provides regression and recovery of symptoms after labyrinth injury. Persistence of symptoms after vestibular injury may be due to incomplete recovery or insufficiency of central vestibular compensation.

There are many important factors that affect the concept of VK from a neurophysiological point of view. These include adaptation of input and output responses from the vestibulo-spinal and vestibulo-ocular pathways, substitution of sensory or motor responses, or alteration of alternative motor responses (34). Inhibitory inputs from vestibular nucleus and cerebellar purkinje cells to vestibular nuclei are due to GABA, which has inhibitory properties. Inhibitor such as GABA

Benzodiazepines (diazepam, etc.), which have an enhancing role in the action of effective neurotransmitters, have been reported to delay vestibular compensation in some studies (34,35). In another study, dimenhydrinate, which is an antihistamine, delayed VOR compensation, but; It has been stated that the effect of diazepam is minimal (36).

VK; It undergoes important processes based on the concepts of restoration, habituation and adaptation. Restoration; It means that lost vestibular function is restored by changes in the same nerve connections as it was before the vestibular injury. Habituation; It is the progressive reduction of the pathological response triggered by movement and the asymmetry caused by vestibular lesions with frequent repetition of trigger signals. In adaptation, functional loss cannot be corrected again, but; Attempts are made to create new situations. Vestibular is an important recovery mechanism that occurs in the form of reshaping visual and somatosensory integration and "sensory displacement", which are new methods using sensory inputs, or "behavioral replacement", in which new learned motor strategies are prepared that resemble vestibular function by using various neuronal networks in the brain (34,35,37).

In VK, the final point is the reorganization of balance control. Sensory inputs, vestibular nucleus activity, motor responses, and sensoriomotor responses in general are reorganized to provide balance control and postural stability, and this is called the synergistic phase (37).

1.4. VESTIBULAR REHABILITATION

Vestibular rehabilitation (VR); In the treatment of dizziness and balance disorder, it is a multidisciplinary treatment method based on individually programmed exercises for pathologies and functional deficiencies detected during evaluation (38).

The development process of vestibular rehabilitation was first explained by Cawthorne in 1944 after the physiological basis of head exercises was proposed, and in 1946 Cawthorne and Cooksey described the vestibular exercise approach. It has been advocated as an important form of treatment since the 1940s; Over the past 15 years

As knowledge about the physiology and plasticity of the vestibular system increases, it has been supported more and more comprehensive vestibular rehabilitation programs have been used (39, 40).

Objectives of vestibular rehabilitation; It can be stated as helping the compensation of the central vestibular system and accelerating this compensation process, reducing the sensitivity of the patient's symptoms and visual movement that increase with movement, increasing the activity level, improving balance and walking and reducing the risk of falling (41). Vestibular rehabilitation therapy should be started as the primary treatment approach in any case where the natural compensation mechanism cannot be fully realized and chronic vestibular dysfunction is accompanied by balance disorders (42).

Vestibular rehabilitation reduces exercise intolerance and postural instability, improves physical performance, gives clear vision during head movements, increases the patient's self-confidence, reduces fear and anxiety of falling, increases participation in physical activity and return to work. It helps patients cope with symptoms of dizziness and imbalance by relieving daily discomfort and improving quality of life (43,44). To get the maximum benefit from rehabilitation, treatment should be started as early as possible and should include specific exercises based on the patient's needs and active patient participation (45).

There are some elements of a VR program. These; can be classified as.

2.4.1 Elements of the Vestibular Rehabilitation Program

2.4.1.1 Education

Patients benefit from information about the symptoms of diseases related to the vestibular system and the course of the disease and therapeutic strategies to alleviate the dysfunction they cause. Since exercise therapy is not a usual treatment for patients, the aims, potential effects and vestibular rehabilitation approaches of exercise should be clearly explained to the patient. It is very important to motivate patients and ensure patient compliance for an effective treatment (42).

2.4.1.2 Exercises

Gaze Stabilization Exercises:

Gaze stabilization exercises are exercises aimed at reducing oscillopsy and increasing image clarity during head movements. As a result of new information about compensation mechanisms, the concepts of adaptation and substitution, which were previously defined separately from each other, are now defined as gaze stabilization exercises (46). We use VOR to focus on a visual target during head movements or to fix the gaze. This is ideally done in the opposite direction to the head movements and with equal eye movement. Decrease in VOR gain (VOR gain = speed of movement of the eyes/speed of movement of the head) causes oscillopsy (47,48). These exercises are eye-head coordination exercises that contain stimuli that induce adaptation of VOR. Adaptation in vestibular literature; It means that neural responses to head movements are altered in the long term to reduce symptoms, normalize gaze and achieve postural stability. Gaze stabilization exercises are based on providing vestibular adaptation with head movement while focusing on a fixed or moving target. In order to provide an alternative strategy to compensate for decreased vestibular function, gaze stability training based on replacement principles has been developed (49).

Adaptation exercises are performed with head movements in the vertical and horizontal planes. These exercises are; It includes the movements of the eye in the vertical and horizontal directions when the head is stationary, the movements of the head in the vertical and horizontal directions when the eye is fixed, the movement of the head and the eye in the opposite direction when there is an object in the hand, and the saccadic and pursuit eye movements between two objects placed vertically and hozirontal on the wall (49,50).

Replacement exercises are used when adaptation exercises are insufficient to stabilize the gaze or when there is bilateral vestibular dysfunction. Mechanisms used to improve gaze stabilization due to loss of VOR; visual and behavioral substitution mechanisms such as adaptation of saccadic eye movements, enhancement of smooth-pursuit eye movements, central preprogramming, and enhancement of cervico-ocular reflex gain. Adaptation

It takes time. During the compensation process, in which the brain tries to reduce the error signal, there may be an increase in symptoms. Despite the symptoms, the patient should be encouraged to continue exercising (41,47,51). Depending on the patient's condition, the level of exercise should be made more difficult. When determining the level; Repositioning of the patient (supine, sitting, standing) can be decided by opening and closing the eyes, changing the speed of head movement. Exercise should be done 4-5 times a day for 20-40 minutes (52).

Postural Stability Exercises:

Postural control is the ability to keep the center of mass within the support field of the external sensory environment. Postural control enables somatosensory, visual, and vestibular information to be recognized, appropriately selected, and the appropriate motor response to be produced. Exercises that improve postural stability; It aims to use visual and somatosensory information, to use the rest of the vestibular function, to use alternative postural movement strategies and to strengthen normal postural movements. By changing the accuracy and presence of vestibular, visual and somatosensory inputs, the use of sensory components of postural stability can be achieved by trying to maintain balance during static and dynamic movements that become more difficult as they progress. Because a crowded visual environment reduces reliance on visual cues, it can be used to increase the use of vestibular and somatosensory stimulation. Walking on narrow contact surfaces and soft surfaces reduces somatosensory stimulation and makes movement difficult (53,54).

Postural strategies may vary from patient to patient, and strategies that are effective for each patient should be identified, developed, and implemented. The ankle strategy can be performed with small amplitude forward, backward and lateral oscillations without bending the hip and knee towards the patient. Small pushing and pulling movements are used on the hips and shoulders. The hip strategy is performed by practicing in a narrow support area (standing on one leg, tandem position, etc.) in cases where center of gravity changes are faster and wider, and by maintaining balance without taking a step (54,55).

Balance exercises for motor movements; It is designed to improve coordination of muscle responses during standing, walking, and other functional activities. During these exercises, it is important to carry out activities that allow both the VOR and VSR to work together. These require the patient to maintain gaze stability during dynamic balance activities. If the forward and backward thrust is much larger, a stepping strategy can be used to increase the patient's range of support (55,56).

Habituation Exercises

In the vestibular literature, habituation refers to a decrease in behavioral responses caused by repeated exposure to provocative stimuli in order to reduce symptoms related to the vestibular system. The Cawthorne-Cooksey and Norre approaches *focused on obtaining compensation through the habituation* training mechanism (57).

During the Cawthorne-Cooksey exercises, it was emphasized that the patient should be encouraged to exercise in movements that present symptoms. It has been mentioned that with frequent exposure to a stimulus, the patient can gradually make the movement without symptoms. These movements include head movements, movements that require coordination of the head and eyes together, whole body movements and balance movements (42,57). The Norre approach is based on encouraging certain movements during the examination that exacerbate the symptoms. Norre recommended the use of vestibular adjustment training in the management of patients with unilateral peripheral vestibular loss (42). In both approaches, stimuli are made with stimuli whose intensity can be modified through the manipulation of stimulus parameters such as speed, direction of stimulus movement, size/color of the stimulus, and instruction given to the patient.

Habituation exercises can be used in individuals with visual motion sensitivity using high-tech optokinetic stimulation and virtual reality environments such as optokinetic discs, moving rooms, or computer screens, video, mixed visual environments. It is performed by manipulating stimulus parameters such as the speed of the visual stimulus, the direction of its movement, its size/color, and the instructions given (50,58).

Flexibility, Strengthening, Proprioceptive and Conditioning Exercises

Muscle tension and anxiety are reduced with relaxation exercises and massages. Joint movement and stretching exercises can be used to treat biomechanical limitations. Mobility of the neck, hips and ankles is especially important. It is important to strengthen the antigravity muscles involved in postural control. Ankle and hip proprioceptive exercises can be used to teach balance strategies. Conditioning exercises can help improve patients' overall cardiovascular endurance and increase tolerance to general head and body movements (59). General conditioning exercises, such as walking or aerobic endurance exercises, are often a necessary component of rehabilitation. Because patients with peripheral vestibular dysfunction often limit their physical movements to avoid symptoms that provoke the disease. However; The benefit of performing general conditioning exercises alone (such as stationary cycling) in patients with peripheral vestibular insufficiency has not been demonstrated (60).

Posturography Training

The main principle and logic of the equilibrium system is based on measuring the pattern of displacement of the pressure center using the platform's sensors to monitor the standing momentum. Measurements in posturography systems are generally based on the angular evaluation of human body vibrations according to the laws of physics and their mathematical formulations. These devices, which can calculate the drop index, are very useful for doctors. Posturography training is carried out using equipment (Balance Master-Neurocom, Biodex, etc.), in which the body's center of gravity is projected onto a platform and supported by a computer screen. These devices can be used in conjunction with diagnostic procedures for educational purposes in rehabilitation work. This training may involve asking the patient to follow a visual goal during weight-shifting movements or to keep the center of gravity within certain limits. In the case of postural instability, visual or sensory cues provide feedback to the patient about head-body orientation and lower extremity weight-bearing symmetry. It is applied 2-5 times a week in sessions of 20 minutes. Posturography training, It allows you to create individual treatment programs based on patient data and assess treatment effectiveness(61).

Virtual Reality Training

The basis of the use of virtual reality is the use of realistic visual environments with the help of devices. Realistic visual environments cause retinal shift and trigger adaptation. The use of computer visual technology has several advantages over physical environment education. With greater control and flexibility, you can get immediate feedback and your schedule can be tailored to your patient's symptoms (42).

1.5. VIRTUAL REALITY

Virtual reality (VR) is a general term that describes systems in which new physical worlds or environments are created virtually using digital techniques(62). These virtual environments can be created using computer effects and animations, or by using highly realistic or real images.

Non-immersive systems are referred to as desktop-based virtual reality systems. Virtual reality environments are presented using computer screens, but such systems have little immersive features. Non-immersive systems are less expensive than the other two types and have made significant contributions to the development of virtual reality technology due to their low cost(63).

Semi-immersive systems typically include multiple large screens and advanced computer systems. These systems allow the screen to be flat or concave to increase realism. The images you see on your screen are usually different angles of the image. For example, you can split the image you're viewing to display it side-by-side on multiple screens, or view it side-by-side. These types of systems are often used in simulator systems to give the impression of being in the driver's seat of a vehicle such as a car or airplane (64).

Fully immersive systems are those that completely surround the user's field of view. In order to completely isolate the user from the real world, an environment designed with titles such as HMD (Head Mounted Display) is created. In addition, by producing real or virtual sounds and using headphones, hearing can be adapted to the real world(65).

Stereoscopic vision is the basis of the images in these virtual reality glasses, with separate right and left eye images presented to the user to improve depth perception. The image shown by the virtual reality glasses can change according to the movement of the person's head, and at the same time, if the user turns his head in the direction of the sound, the direction of the sound can also change in reverse. These features are made possible by gyroscopes, accelerometers and magnetometers built into the glasses (66). Gyroscope is a gyroscope that is used to measure or maintain the orientation of an object and is used to ensure that the angular motion

It is a name given to the device that works with the principle of conservation. The gyroscope consists of two interlocking rings and a rotating disk (rotor) suspended in the middle of the rings. The two rings and rotors are fixed at right angles to each other. Anchor points create axes around which you can rotate. In this way, the position of the center of mass is maintained regardless of where the applied force comes from (for example: external force or gravity). Accelerometers measure acceleration and magnetometers measure magnetic fields like a compass to help align images(67).

Virtual reality technology is widely used in the medical field. Its use in rehabilitation, disability management, surgical training, military training, sports science performance analysis, treatment of psychiatric disorders, and pain management has been reported (68–71). Virtual reality applications are used in the rehabilitation of motor function and skill training of patients in central nervous system problems such as stroke, traumatic brain injury, spinal cord injury, cerebral palsy; It has been used in the evaluation and rehabilitation of memory, focus, spatial ability and other cognitive functions (72,73). Virtual reality applications create an engaging and fun environment, motivate people by engaging them, and enable the development of various skills and task-based techniques. For this reason, patient engagement issues are less monitored than traditional methods.

1.5.1. Virtual Reality and Vestibular Rehabilitation

SG systems have recently established themselves as an effective therapy in the field of vestibular rehabilitation. Games that include adaptation, habituation, and substitution exercise elements are used as an effective treatment method, especially in the management of imbalance that develops as a result of vestibular disorders, in gaze stabilization exercise training in patients with vestibular dysfunction, and in the restoration of postural control (74,75).

The purpose of using virtual reality technology in vestibular rehabilitation; to reduce symptoms, to use a realistic visual environment that causes retinal shifts and causes habituation, to increase VOR gain and optokinetic responses, and to improve postural stability (76,77).

Virtual reality therapy is a modern rehabilitation method that is performed in a virtual environment, unlike traditional exercises. Thanks to modern technology, virtual reality can create synthetic environments and sensor alerts close to today's world. This reflects the person's physical reaction to the stimulus on the monitor in the virtual reality system. These capabilities of virtual reality technology increase user engagement and motivation by creating a pleasant environment rather than preventative treatment. Interaction and high patient motivation can be considered as one of the most important advantages observed in virtual reality-based rehabilitation (78,79).

Virtual reality technology, which is primarily made for entertainment purposes, is easier to use in the field of vestibular rehabilitation due to its adaptations, home use and commercial potential for a wider audience. Today, there are important companies in the virtual reality market. Examples include the HTC Vive Pro©, Oculus Rift©, and Sony Play Station VR©.

Virtual reality systems have found a wide range of applications and have been included in many academic and scientific studies. The increase in investments in virtual reality systems and the development of rehabilitation games have also contributed to rehabilitation research. In the Cochrane update, it was stated that there is sufficient evidence that virtual reality simulators used in rehabilitation programs support treatment (77). In addition, it has been stated that rehabilitation with virtual reality is safer than the real environment (80). It has been stated that the use of mixed visual environments in treatment is more effective than traditional rehabilitation programs or Cawthorne-Cooksey exercises alone (81). It has been reported that exposure of patients with vestibular hypofunction to dynamic visual environments reduces symptoms and facilitates adaptation (82).

It has been shown that the average time spent in the virtual reality environment is more efficient than the number of exercises performed in the virtual reality environment. It has been stated that patients need to spend a minimum of 120-150 minutes in virtual reality in order to benefit from rehabilitation in a meaningful way (83).

3. MATERIALS AND METHODS

3.1. Sample

This prospective randomized controlled study was conducted in patients diagnosed with chronic unilateral vestibular insufficiency at Pamukkale University Ear, Nose and Throat Diseases clinic between 2020-2023.

It was observed that the effect size obtained in the reference study was strong (d=1.08). As a result of the power analysis made considering that an effect size at this level can be obtained; It has been calculated that when at least 40 people (at least 20 people for each group) are included in the study, 90% power can be obtained at the 95% confidence level. The patients were randomly divided into 2 equal groups using the random table method (78,84).

Demographic information, detailed medical histories and detailed physical examinations of the patients were recorded. Routine vestibulospinal (Romberg, straightline, Unterberger), and vestibulcular (visual tracking, head shaking, head shrug) tests were performed.

Pure tone audiometry, videonistagmography (VNG), dynamic posturography, video head shrugging test (VHIT), subjective visual vertical (SVV) and ear magnetic resonance imaging (MRI) examinations were performed in all patients.

After the middle ear functions were checked by tympanometry (Madsen electronics, Denmark), the auditory thresholds were determined between 250-8000 Hz and bone conduction between 250-4000 Hz (AC 40, Interacoustics, Denmark).

During videonistagmography (VNG), patients were asked to stop taking their medications at least 3 days in advance and were ensured not to drink alcohol at least 48 hours before the test. Sackadik, gaze, trekking, optokinetic, Hallpike, positional and bithermal caloric tests were applied. (Chartr ENG, ICS Medical, USA). In the bithermal caloric test, a warning of 30 seconds was given after the recording started, a total of 105 seconds were recorded, and the eyes were opened in the last 15 seconds of the recording. As soon as you open the eyes, nystagmus suppression was quantified by calculating the fixation index (FI). Caloric weakness, directional superiority were calculated according to Jonkee's formulas.

ICS Impulse Autometrics (*Gn Otometrics, Ics Impulse, Denmark*) was used for VHIT. By fixing the patient's eyes on a target placed 1 meter in front of him, unpredictable manual head impulses were applied at approximately 20 degrees in the horizontal plane with an average speed of 150 degrees/second and an average acceleration of 1,000 to 2,500 degrees/second2 (85). For each test, at least 20 adequate impulses were applied to the right and left side. VHIT criteria; VOR gain 0.8< for horizontal canals, anterior and posterior canals
When it was <0.7, the test was considered abnormal. The presence of overt or hidden sackads was also taken into account.

VIRTUALIS® PHYSIO Virtual Reality[SVV and Dynamic SVV](Virtualis, France) were used for Virtual Reality Subjective Visual vertical (SVV). The first angle was selected as ±40° and 10 measurements were made. The rod angles are given in a random order and variations are made in speeds. The visual background rotation rate for Dynamic SVV was determined as ±30°/sec(86). Studies in various population groups using different methods have shown that normal SVV values range from 1.5° to ± 3°± (87,88)(89)(90).

Figure 3: Use of virtual reality technology

Then, the patients were evaluated by a Physical Medicine and Rehabilitation specialist in terms of general musculoskeletal diseases. Vitamin D checks of the patients were performed by the Physical Medicine and Rehabilitation specialist, and if there was a deficiency, replacements were made.

Inclusion criteria:

1. Complaints of dizziness and/or imbalance for more than 3 months
2. Patients 18 years of age and older
3. Caloric: Unilateral horizontal canal insufficiency according to bithermal caloric test results>25%(91)
4. 2± ≥2° in SVV (87,88,92)
5. VHIT criteria VOR gain for horizontal channels>0.8, anterior and posterior channels >0.7(93)

Exclusion criteria:

1. Recurrent disease
2. Acute illness
3. Ear disease, head trauma

4. Use of ototoxic drugs
5. Neurological and psychiatric disease that causes cooperation disorder
6. Patients with orthopedic and systemic diseases that will prevent them from doing the exercise
7. Patients with active malignancies
8. Patients with central pathology affecting balance
9. Bilateral vestibular pathology
10. Diseases that will affect the use of glasses (epilepsy, vision loss, etc.)

Ethics committee approval was obtained from Pamukkale University clinical research ethics committee (Date: 29/11/2019, No:60116787-020/85007). All participants were informed about the procedure and written informed consent was obtained. The study was supported by the University Research Fund (BAP No: 2020TIPF007).

3.2. Intervention

All patients received a 30-minute training verbally by the physician at the beginning, including information about the definition of falling, its importance, risk factors, ways of protection and recommendations to prevent falls. Then, the patients were divided into 2 equal groups by randomization with the random number table method:

1. Traditional vestibular rehabilitation exercises were applied to the group: A home-based vestibular rehabilitation program including vestibular adaptation exercises, oculomotor exercises, static and dynamic balance exercises was given in the form of a booklet (94). All exercises were shown and performed for the first time under supervision in the hospital. The exercises were given as 10 repetitions per day. Each time the exercise was performed, the patient was asked to mark a chart. A log chart was used to track compliance with the program for a month.

2. Vestibular rehabilitation supported by virtual reality technology (VR): VR exercise was performed 5 times a week in the form of 35-minute exercises for 4 weeks. VR exercises;

- **a.** 5 minutes (min) 1 warm-up set (Relaxation)

Figure 4: Relaxation exercise image

- 30 seconds (sec) rest,

- **b.** 5-minute optokinetic stimulation exercise [Working in a standing position by sliding slowly in a landscape (Optokinetics)],

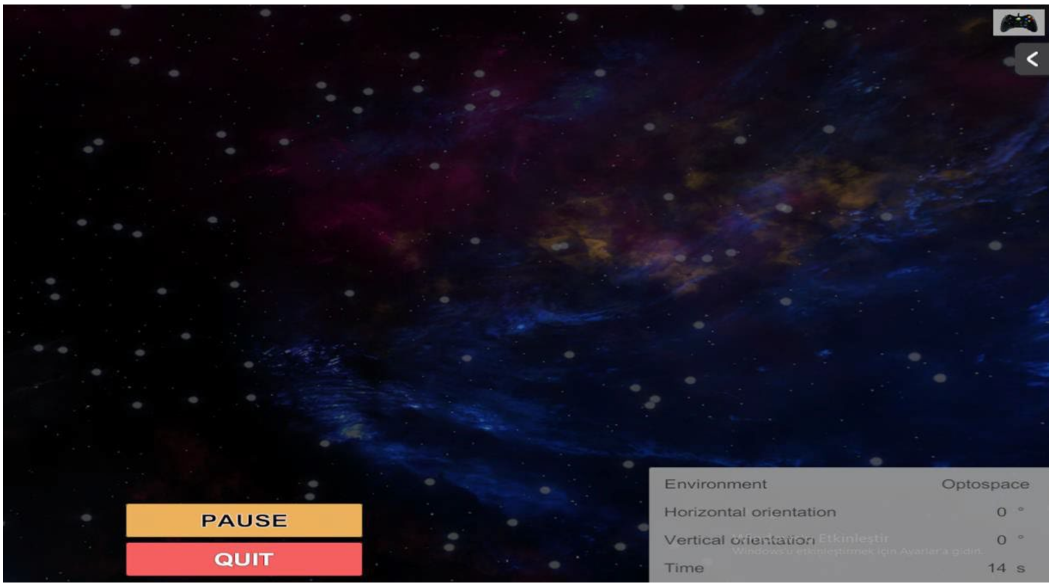

Figure 5: Optokinetic stimulation exercise image

- **b.** A 5-minute exercise that fights against visual dependence by strengthening the vestibulo-spinal reflex [Head-Eye Coordination],

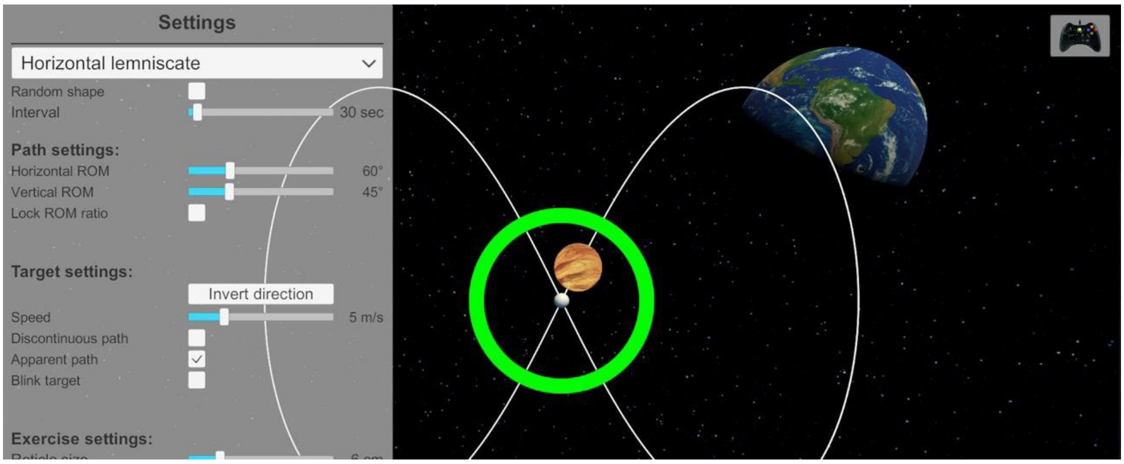

Figure 6: Head-Eye coordination exercise image

- **b.** An exercise that helps to rehabilitate 5-minute activities of daily living [Crowd walking (CrowdVR)],

Figure 7: CrowdVR workout image

A total of 15 minutes of exercises are in the form of 2 sets (B items) with 1 minute intervals and applied in the form of a total of 35 minutes of exercise per day. The total duration of the VR exercises is 700 minutes and the total number of sessions is 20 calculated. During the exercises, a supported ambulation system will be used to ensure the safety of the patient and to prevent falls. VIRTUALIS® PHYSIO VR (Virtualis*, France*) model virtual reality vertigo and physiotherapy system was used for VR exercises, and HTC VIVE PRO (HTC® *Corporation, New Taipei, TAIWAN*) was used.

Figure 8: HTC Vive Pro

3.3. Outcome criteria

At the beginning of the study, 10. At the end of the session, at the end of the treatment, after 3 months and after 6 months, the patients were evaluated. Outcome criteria; static and dynamic balance, physical functions, subjective complaints, functional mobility and psychological criteria.

Posturography, SVV, Berg balance scale, Hospital anxiety and depression scale, DHI (Dizziness Handicap Inventory)-Screening form and Montreal cognitive assessment scale (MBSS) were used as patient evaluation criteria.

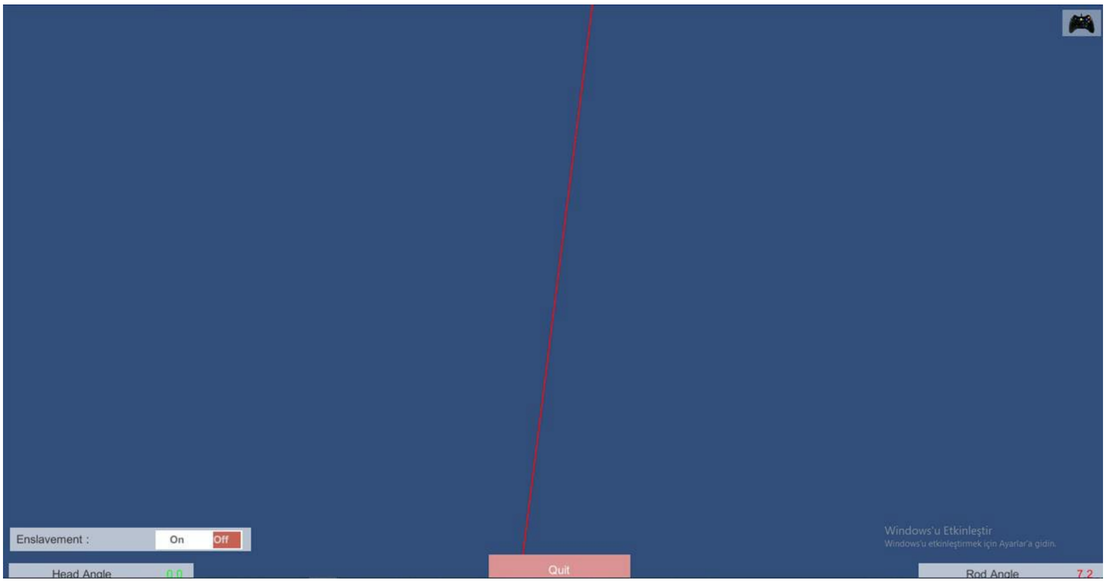

Figure 9: Static SVV test screenshot

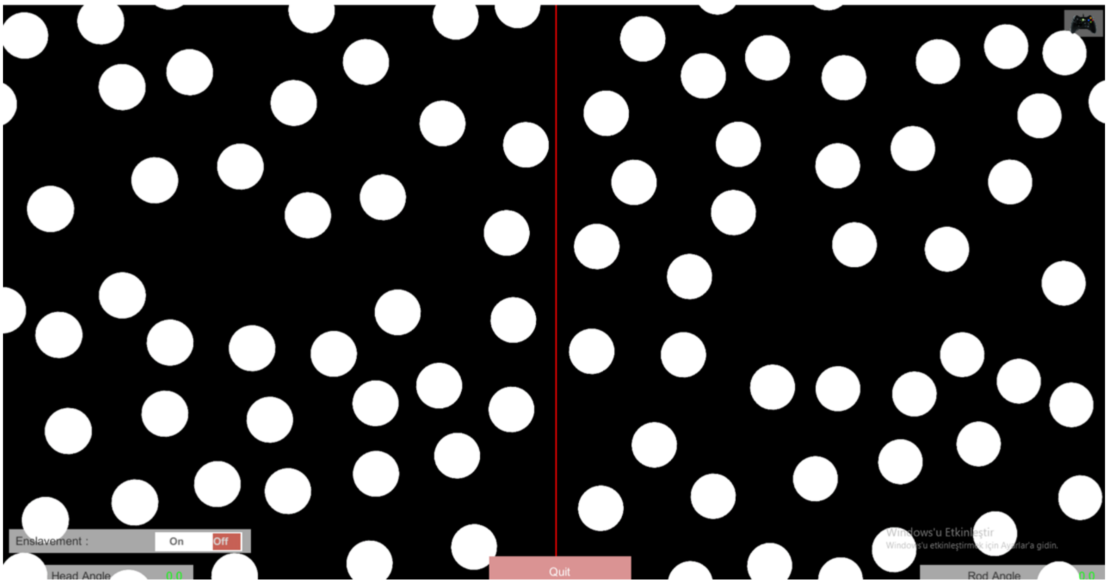

Figure 10: Dynamic SVV test screenshot

Clinically, Turkish validity in the elderly was evaluated with the BDI (Berg Balance Scale), for which a reliability study was conducted. The maximum score that a patient can get in BDI is 56. A score of 0–20 is considered a 'bad balance' and a score of 40–56 is considered a 'good balance' (95).

Postural stability test and fall risk test using the Biodex Balance System (Biodex, Inc, Shirley, New York) for laboratory measurement of balance measured. Biodex balance device; It consists of a movable platform that allows the participant to stand still as well as move forward-backward and sideways. The platform has a mobility rating of 0-12. 12; while the most stationary platform, 0; It creates the most mobile platform. Postural stability measurement includes overall (G), anterior/posterior (AP), and medial/lateral (ML) stability scores. The fall risk test includes the "overall stability index (OSI)" measurement. High scores in the indices indicate poor balance and an increased risk of falling (96).

Figure 11: Patient assessment with dynamic posturography

Hospital anxiety and depression scale (HAD) was used for psychological measures (97,98). The Hospital Anxiety and Depression Scale is a 14-question scale in which anxiety and depression are subjectively evaluated, 7 of which are anxiety and 7 are depression. Aydemir et al. made the validity and reliability of the scale in our country. Responses are evaluated in a quadruple Likert format and are scored on a scale of 0-3. The cut-off points of the Turkish form of the HAD scale were determined as 10 for the anxiety subscale and 7 for the depression subscale (99).

The Dizziness Handicap Inventory (DHI) was developed to assess the level of disability associated with vertigo (100). DHI's Turkish version has already been adapted and approved (101). The Dizziness Handicap Inventory-Screening version (DHI-S) is an abbreviated version of the DHI of 10 questions and is highly associated with the original DHI. The questions were selected from the questions of the original scale. Each question is answered "No (0 points)", "Sometimes (2 points)", or "Yes (4 points)". The scale does not have any subscales. The maximum score is 40. Since the analyses of different factors produced different results, the analysis was performed according to the total score (102).

Cognitive functions were evaluated with the Montreal Cognitive Assessment Scale. The short-term memory recall task (5 points) was assessed with delayed recall of five names after about 5 minutes after two learning attempts. Visuospatial abilities were assessed using a clock drawing task (3 points) and copying a three-dimensional cube (1 point). Multiple aspects of executive functions were assessed using an alternate task adapted from the tracing task (1 point), the phonemic fluency task (1 point), and the two-item verbal abstraction task (2 points). Attention, concentration, and working memory were assessed using a sustained attention task (target detection by touch; 1 point), a serial subtraction task (3 points), and a task of counting numbers forward and backward (1 point each). Language was assessed using a three-item naming task, repetition of two syntactically complex sentences (2 points), and the aforementioned verbal fluency task with little-known animals (lion, camel, rhinoceros; 3 points). Finally, time and space orientation were evaluated (6 points). The highest score is 30. A score of 21 or more is considered normal (103). Adaptation of the scale to Turkish and validity-reliability studies were carried out (104,105). MBSS was found to be more suitable for audiology clinics than the Mini Mental State Assessment test and was more sensitive in assessing cognitive impairment (106).

3.4. Statistical Analysis

The data were analyzed with SPSS 25.0 package program. Continuous variables are given as mean ± standard deviation, median (25th and 75th percentiles), minimum - maximum values, and categorical data as frequency, percentage. The conformity of the data to the normal distribution was examined by Shapiro Wilk test. Parametric test assumptions t-test in independent groups in comparison of independent group differences; When parametric test assumptions were not provided, Mann Whitney U test was used to compare independent group differences. In dependent group comparisons, when parametric test assumptions are provided, t-test in dependent groups and analysis of variance in repeated measurements (post hoc: Bonferroni method); When parametric test assumptions were not met, Wilcoxon paired two-sample test and Friedman's test (post hoc: Wilcoxon paired two-sample test with Bonferroni correction) were used. In addition, difference values were used to compare the changes between the two groups. The differences between the categorical variables were analyzed by Chi-square test. Spearman correlation analysis was used to examine the relationships between numerical data. In all reviews, $p<0.05$ was considered statistically significant. It was observed that the effect size obtained in the reference study was strong (d=1.08). As a result of the power analysis made considering that an effect size at this level can be obtained; It has been calculated that when at least 40 people (at least 20 people for each group) are included in the study, 90% power can be obtained at the 95% confidence level (78,84).

4. RESULTS

A total of 41 patients over the age of 18 who applied to the Otorhinolaryngology Outpatient Clinic of Pamukkale University Faculty of Medicine Hospital with the complaint of dizziness and met the criteria for inclusion and exclusion were included in the study. The patients were divided into two groups by block randomization method. 21 patients who participated in the study were included in the control group (Group 1) and 20 patients were included in the study group (Group 2). Of the patients participating in the study, 56.1% were female and 43.9% were male. The mean age of group 1 was 52.24 ± 14.57, and the mean age of group 2 was 49.6 ± 10.48. All patients were diagnosed with unilateral vestibular insufficiency. Table 1 shows the data of age and caloric test results between groups. The results of the gender and caloric test sides between group 1 and group 2 are given in Table 2.

Table 1: Age and caloric test values between groups

	n	Age			Caloric		
		A.O.± S.S	Med (IQR)	min - max	A.O.± S.S	Med (IQR)	min - max
Group1	21	52,24 ± 14,57	57 (47 - 61,5)	18 - 76	55,86 ± 20,97	52 (40,5 - 79)	25 - 94
Group 2	20	49,6 ± 10,48	51 (41 - 57,75)	29 - 65	55,75 ± 24,26	47,5 (31 - 78,25)	25 - 100

n: Number of patients, A.O.: Arithmetic mean, S.S.: Standard deviation Med: Medium value, Min: Minimum value, Max: Maximum value

Table 2: Comparison of gender and caloric test sides between group 1 and group 2

			Group			
			Group 1	Group 2	Total	p-value
GENDER	K	n	7	16	23	
		%	33,3%	80,0%	56,1%	
	And	n	14	4	18	
		%	66,7%	20,0%	43,9%	p=0,003
SIDE	Ground	n	11	7	18	
		%	52,4%	35,0%	43,9%	
	Right	n	10	13	23	
		%	47,6%	65,0%	56,1%	p=0,262
Total		n	21	20	41	
		%	100,0%	100,0%	100,0%	

n: Number of patients, K: Female, M: Male

Due to the COVID-19 pandemic, not all patients were able to participate in all follow-ups. The number of patients participating in all follow-ups was n=10 in Group 1 and n=17 in Group 2. For this reason, 2 types of examinations were performed in the evaluation of the patients, statistically dependent and independent. In dependent statistical examinations, only all patients who came to follow-up were evaluated by comparing them with the patient's own follow-up, and p-values were determined within the group. In independent statistical reviews, all follow-ups were compared as the mean of all patients based on the evaluation day, and p values were determined between groups. Posturography results from independent statistical examinations are given in tables 3 and table 4, SVV results are given in table 5, and evaluation of quality of life scales are given in table 6. Table of posturography results from dependent statistical examinations

7 and the results of SVV are given in table 8, the results of SVV are given in table 9, and the evaluation of quality of life scales are given in table 10. Table 11 shows the comparison of posturography results according to the standard mean value.

Table 3: Independent evaluation of posturography test results

PST-GSI	**Group 1**				**Group 2**				
	n	A.O.± S.S	Med (IQR)	min - Max	n	A.O.± S.S	Med (IQR)	min - Max	Between groups, p
Therapy Before	21	0,56 ± 0,26	0,5 (0,4 - 0,7)	0,2 - 1,2	19	0,52 ± 0,16	0,5 (0,4 - 0,6)	0,2 - 0,8	0,559 (t=0,589)
Day 15	21	0,46 ± 0,14	0,5 (0,35 - 0,55)	0,2 - 0,7	20	0,48 ± 0,22	0,4 (0,3 - 0,6)	0,2 - 1,1	0,8 (z=-0,253)
Day 30	18	0,43 ± 0,15	0,4 (0,38 - 0,53)	0,2 - 0,7	20	0,5 ± 0,23	0,45 (0,3 - 0,6)	0,2 - 1,1	0,613 (z=-0,538)
Day 90	15	0,41 ± 0,14	0,4 (0,3 - 0,5)	0,2 - 0,7	18	0,39 ± 0,17	0,3 (0,3 - 0,5)	0,3 - 1	0,464 (z=-0,794)
Day 180	15	0,46 ± 0,2	0,4 (0,3 - 0,6)	0,2 - 0,9	19	0,53 ± 0,33	0,4 (0,3 - 0,6)	0,2 - 1,7	0,706 (z=-0,389)
PST-APSI	**Group 1**				**Group 2**				
	n	A.O.± S.S	Med (IQR)	min - Max	n	A.O.± S.S	Med (IQR)	min - Max	Between groups, p
Before treatment	21	0,4 ± 0,19	0,3 (0,3 - 0,5)	0,2 - 1	19	0,37 ± 0,14	0,3 (0,3 - 0,5)	0,2 - 0,7	0,83 (z=-0,226)
Day 15	21	0,31 ± 0,11	0,3 (0,25 - 0,35)	0,1 - 0,6	20	0,36 ± 0,22	0,3 (0,2 - 0,4)	0,2 - 1,1	0,838 (z=-0,204)
Day 30	18	0,31 ± 0,11	0,3 (0,2 - 0,4)	0,1 - 0,5	20	0,34 ± 0,14	0,3 (0,2 - 0,48)	0,2 - 0,7	0,675 (z=-0,437)
Day 90	15	0,33 ± 0,13	0,3 (0,2 - 0,4)	0,1 - 0,6	18	0,28 ± 0,17	0,2 (0,2 - 0,3)	0,2 - 0,9	0,086 (z=-1,81)
Day 180	15	0,36 ± 0,17	0,3 (0,2 - 0,4)	0,2 - 0,8	19	0,4 ± 0,33	0,3 (0,3 - 0,4)	0,2 - 1,7	0,945 (z=-0,09)
PST-MLSI	**Group 1**				**Group 2**				
	n	A.O.± S.S	Med (IQR)	min - Max	n	A.O.± S.S	Med (IQR)	min - Max	Between groups, p
Therapy Before	21	0,28 ± 0,22	0,2 (0,1 - 0,4)	0,1 - 1,1	19	0,27 ± 0,09	0,3 (0,2 - 0,3)	0,1 - 0,4	0,405 (z=-0,869)
Day 15	21	0,24 ± 0,13	0,2 (0,1 - 0,4)	0,1 - 0,5	20	0,23 ± 0,12	0,2 (0,1 - 0,3)	0,1 - 0,5	0,705 (z=-0,379)
Day 30	18	0,26 ± 0,21	0,2 (0,1 - 0,3)	0,1 - 1	20	0,24 ± 0,17	0,2(0,13 - 0,28)	0,1 - 0,8	0,851 (z=-0,201)
Day 90	15	0,17 ± 0,1	0,2 (0,1 - 0,2)	0 - 0,4	18	0,16 ± 0,09	0,1 (0,1 - 0,2)	0 - 0,4	0,532 (z=-0,701)
Day 180	15	0,21 ± 0,12	0,2 (0,1 - 0,3)	0,1 - 0,5	19	0,23 ± 0,16	0,2 (0,1 - 0,3)	0,1 - 0,7	0,864 (z=-0,2)
DRT	**Group 1**				**Group 2**				
	n	A.O.± S.S	Med (IQR)	min - Max	n	A.O.± S.S	Med (IQR)	min - Max	Between groups, p
Therapy Before	21	1,05 ± 0,54	1 (0,65 - 1,3)	0 - 2,6	19	0,93 ± 0,47	1 (0,5 - 1,2)	0 - 2,1	0,456 (t=0,753)
Day 15	21	0,93 ± 0,4	0,9 (0,6 - 1,25)	0 - 1,6	20	0,81 ± 0,45	0,65 (0,5 - 1,28)	0,3 - 1,7	0,214 (z=-1,242)
Day 30	18	0,77 ± 0,42	0,83 (0,4 - 1)	0 - 1,6	20	0,83 ± 0,65	0,6 (0,5 - 0,95)	0,1 - 3,2	0,573 (z=-0,572)
Day 90	15	0,91 ± 0,42	0,9 (0,53 - 1,28)	0,4 - 1,8	18	0,8 ± 0,56	0,7 (0,4 - 1)	0,2 - 2,7	0,266 (z=-1,148)
Day 180	15	0,96 ± 0,51	1 (0,7 - 1,4)	0 - 1,7	19	0,86 ± 0,45	0,7 (0,5 - 1,3)	0,2 - 1,8	0,528 (t=0,638)

PST: Postural Established Test, GSİ: Genel Established Indeksi, APSİ: Anterior-Posterior Established Indeksi, MLSİ: Medial-Lateral Established Indeksi, DRT: Düşme riski testi

Table 4: Posturografide Modified Equilibrium Sense Interaction Independent results of the Clinical Test (mCTSIB)

GA-SZ	Group 1				Group 2				
	n	A.O.± S.S	Med (IQR)	min - max	n	A.O.± S.S	Med (IQR)	min - max	Between groups, p
Average value	-	0,35 ± 0	0,35 (0,35 - 0,35)	0,35 - 0,35	-	0,35 ± 0	0,35 (0,35 - 0,35)	0,35 - 0,35	-
Therapy Before	21	0,5 ± 0,14	0,46 (0,41 - 0,6)	0,31 - 0,82	19	0,52 ± 0,13	0,48 (0,42 - 0,66)	0,31 - 0,75	0,659 (t=-0,445)
Day 15	21	0,47 ± 0,2	0,42 (0,34 - 0,6)	0,17 - 1,09	20	0,46 ± 0,18	0,44 (0,3 - 0,6)	0,26 - 0,81	0,744 (z=-0,326)
Day 30	18	0,56 ± 0,31	0,49 (0,41 - 0,59)	0,19 - 1,67	20	0,51 ± 0,24	0,45 (0,34 - 0,58)	0,25 - 1,27	0,346 (z=-0,951)
Day 90	15	0,5 ± 0,25	0,42 (0,4 - 0,53)	0,22 - 1,26	18	0,42 ± 0,12	0,4 (0,33 - 0,48)	0,29 - 0,75	0,421 (z=-0,816)
Day 180	15	0,51 ± 0,22	0,47 (0,42 - 0,55)	0,29 - 1,24	19	0,48 ± 0,16	0,47 (0,32 - 0,6)	0,2 - 0,83	-
GK-SZ	**Group 1**				**Group 2**				
	n	A.O.± S.S	Med (IQR)	min - max	n	A.O.± S.S	Med (IQR)	min - max	Between groups, p
Average value	-	0,73 ± 0	0,73 (0,73 - 0,73)	0,73 - 0,73	-	0,73 ± 0	0,73 (0,73 - 0,73)	0,73 - 0,73	-
Therapy Before	21	0,98 ± 0,29	0,98 (0,8 - 1,19)	0,49 - 1,65	19	1,28 ± 0,61	1,18 (0,8 - 1,57)	0,61 - 2,83	0,153 (z=-1,449)
Day 15	21	1,02 ± 0,33	1,01 (0,76 - 1,19)	0,58 - 1,97	20	1,3 ± 0,55	1,14 (0,91 - 1,67)	0,64 - 2,51	0,127 (z=-1,526)
Day 30	18	1,14 ± 0,74	0,95 (0,77 - 1,32)	0,36 - 3,78	20	1,21 ± 0,51	1,07 (0,81 - 1,54)	0,56 - 2,33	0,409 (z=-0,833)
Day 90	15	1,05 ± 0,42	1,02 (0,65 - 1,23)	0,55 - 2,07	18	1,15 ± 0,7	1 (0,77 - 1,13)	0,54 - 3,34	0,929 (z=-0,09)
Day 180	15	1,27 ± 0,8	0,97 (0,81 - 1,41)	0,63 - 3,82	19	1,07 ± 0,47	0,87 (0,67 - 1,54)	0,36 - 2	0,451 (z=-0,781)
GA-YZ	**Group 1**				**Group 2**				
	n	A.O.± S.S	Med (IQR)	min - max	n	A.O.± S.S	Med (IQR)	min - max	Between groups, p
Average value	-	0,54 ± 0	0,54 (0,54 - 0,54)	0,54 - 0,54	-	0,54 ± 0	0,54 (0,54 - 0,54)	0,54 - 0,54	-
Therapy Before	21	1,05 ± 0,32	1,08 (0,8 - 1,2)	0,42 - 1,8	19	1,01 ± 0,24	1 (0,8 - 1,2)	0,63 - 1,53	0,608 (t=0,517)
Day 15	21	0,93 ± 0,33	0,83 (0,71 - 1,21)	0,5 - 1,71	20	1,02 ± 0,44	0,89 (0,74 - 1,23)	0,4 - 2,4	0,442 (z=-0,77)
Day 30	18	0,93 ± 0,29	0,89 (0,66 - 1,21)	0,5 - 1,39	20	0,99 ± 0,34	0,94 (0,72 - 1,26)	0,56 - 1,95	0,592 (t=-0,541)
Day 90	15	0,9 ± 0,3	0,85 (0,7 - 1,06)	0,41 - 1,49	18	0,83 ± 0,2	0,78 (0,68 - 1,02)	0,54 - 1,24	0,44 (t=0,782)
Day 180	15	0,93 ± 0,39	0,84 (0,69 - 1,08)	0,52 - 2,01	19	0,93 ± 0,25	0,93 (0,72 - 1,11)	0,52 - 1,51	0,493 (z=-0,694)
GK-YZ	**Group 1**				**Group 2**				
	n	A.O.± S.S	Med (IQR)	min - max	n	A.O.± S.S	Med (IQR)	min - max	Between groups, p
Average value	-	1,65 ± 0	1,65 (1,65 - 1,65)	1,65 - 1,65	-	1,65 ± 0	1,65 (1,65 - 1,65)	1,65 - 1,65	-
Therapy Before	21	3,44 ± 1,25	3,22 (2,53 - 4,76)	1,23 - 6	19	3,39 ± 1,11	3,24 (2,56 - 4,52)	1,06 - 5	0,879 (t=0,153)
Day 15	21	3,2 ± 1,06	3,01 (2,56 - 3,52)	1,66 - 5,53	20	3,22 ± 0,8	3,1 (2,62 - 3,79)	1,96 - 5	0,639 (z=-0,47)
Day 30	18	3,01 ± 1,14	2,63 (2,28 - 3,13)	1,84 - 6	20	3,14 ± 0,96	3,24 (2,28 - 3,81)	1,75 - 5,09	0,478 (z=-0,716)
Day 90	15	2,82 ± 0,88	2,87 (2,21 - 3,29)	1,58 - 5	18	2,78 ± 0,54	2,72 (2,38 - 3,03)	2,05 - 4,15	0,858 (t=0,18)
Day 180	15	3,08 ± 0,92	2,95 (2,25 - 3,64)	1,7 - 5	19	2,92 ± 0,69	2,8 (2,5 - 3,11)	1,77 - 5	0,515 (z=-0,676)
GS	**Group 1**				**Group 2**				
	n	A.O.± S.S	Med (IQR)	min - max	n	A.O.± S.S	Med (IQR)	min - max	Between groups, p
Average value	-	0,81 ± 0	0,81 (0,81 - 0,81)	0,81 - 0,81	-	0,81 ± 0	0,81 (0,81 - 0,81)	0,81 - 0,81	-
Therapy Before	21	1,29 ± 0,36	1,3 (0,99 - 1,5)	0,72 - 2,35	19	1,4 ± 0,27	1,36 (1,17 - 1,59)	1,02 - 1,94	0,326 (t=-0,995)
Day 15	21	1,35 ± 0,38	1,31 (1,12 - 1,46)	0,77 - 2,26	20	1,46 ± 0,34	1,45 (1,18 - 1,73)	0,97 - 2,07	0,326 (t=-0,995)

Day 30	18	1,28 ± 0,42	1,23 (1,05 - 1,36)	0,74 - 2,5	20	1,46 ± 0,41	1,39 (1,14 - 1,82)	0,84 - 2,14	0,158 (z=-1,418)
Day 90	15	1,25 ± 0,33	1,22 (1,01 - 1,46)	0,72 - 2,01	18	1,29 ± 0,32	1,19 (1,08 - 1,45)	0,92 - 2,24	0,825 (z=-0,224)
Day 180	15	1,38 ± 0,48	1,23 (1,01 - 1,59)	0,83 - 2,83	19	1,31 ± 0,25	1,3 (1,19 - 1,39)	0,85 - 1,94	0,758 (z=-0,33)

GA: Eye open, GK: Eye closed, SZ: Hard ground, AI: Soft ground, GS: Overall score

When we look at Table 3 and Table 4, there was no statistical difference between the pre-treatment and follow-up scores between the group that received SG-assisted vestibular rehabilitation and the group that received traditional vestibular rehabilitation in the posturography tests GSI, APSI, MLSI, DRT, and mCTSIB scores that were evaluated independently (p>0.05).

Table 5: Independent evaluation of SVV tests

	Group 1				**Group 2**				
SIA statics	n	A.O.± S.S	Med (IQR)	min - max	n	A.O.± S.S	Med (IQR)	min - max	Between groups, p
Before treatment	21	-0,29 ± 2,62	-0,81 (-1,46 - 1,58)	-7,7 - 3,45	18	-0,08 ± 2,14	0,21 (-1,55 - 1,3)	-4,5 - 5,04	0,787 (t=-0,272)
Day 15	21	0,29 ± 2,18	0,19 (-1,89 - 1,88)	-2,57 - 4,01	18	-0,53 ± 2,54	0 (-2,25 - 0,77)	-5,67 - 4,11	0,283 (t=1,09)
Day 30	18	-0,29 ± 3	-0,38 (-2,9 - 2,31)	-5,4 - 4,75	18	-0,46 ± 1,59	0,04 (-1,93 - 0,47)	-3,21 - 2,2	0,834 (t=0,211)
Day 90	16	0,99 ± 2,71	0,34 (-1,08 - 2,83)	-2,71 - 7,27	16	-0,31 ± 1,73	-0,7 (-1,42 - 1,15)	-3,54 - 2,99	0,117 (t=1,613)
Day 180	16	0,13 ± 2,07	-0,24 (-1,8 - 2,43)	-2,7 - 3,54	17	-0,1 ± 1,94	-0,17 (-1,67 - 1,66)	-3,07 - 3,03	0,744 (t=0,329)
Dynamic SVV	n	A.O.± S.S	Med (IQR)	min - max	N	A.O.± S.S	Med (IQR)	min - max	Between groups, p
Before treatment	21	-0,36 ± 4,4	-1,02 (-3,39 - 2,44)	-7,57 - 11,84	18	-0,27 ± 4,61	-0,28 (-3,01 - 3,66)	-8,73 - 7,47	0,946 (t=-0,068)
Day 15	21	0,34 ± 2,58	-0,15 (-1,5 - 2,52)	-3,11 - 5,61	18	-0,62 ± 4,63	-1,23 (-3,02 - 0,74)	-9,45 - 12,35	0,417 (t=0,82)
Day 30	18	0,52 ± 3,82	0,1 (-2,11 - 2,62)	-4,12 - 11,78	18	-0,17 ± 3,53	0,34 (-1,76 - 0,8)	-7,85 - 8,56	0,58 (t=0,559)
Day 90	16	0,39 ± 1,97	0,82 (-1,15 - 1,34)	-2,63 - 4,43	16	-0,73 ± 3,23	-0,47 (-3,18 - 1,73)	-6,69 - 4,96	0,245 (t=1,191)
Day 180	16	-0,26 ± 2,81	-0,42 (-2,31 - 1,71)	-5,04 - 5,31	17	0,48 ± 4,63	0,68 (-2,9 - 3,4)	-9,84 - 10,6	0,586 (t=-0,55)

When we look at Table 5, there was no statistically significant difference between the pre-treatment and follow-up scores between the group that received SG-assisted vestibular rehabilitation and the group that received conventional vestibular rehabilitation in the statically evaluated comparisons of static SVV and dynamic SVV scores with SG SVV (p>0.05).

Table 6: Independent evaluation of quality of life scales

	Group 1				Group 2				
BDÖ	n	A.O.± S.S	Med (IQR)	min - Max	n	A.O.± S.S	Med (IQR)	min - Max	Between groups, p
Before treatment	21	53,71 ± 5,51	56 (54 - 56)	32 - 56	20	53,45 ± 3,68	55,5 (51 - 56)	44 - 56	0,306 (z=-1,023)
Day 15	20	55,6 ± 1,39	56 (56 - 56)	50 - 56	20	55,8 ± 0,7	56 (56 - 56)	53 - 56	0,989 (z=-0,052)
Day 30	16	55,88 ± 0,5	56 (56 - 56)	54 - 56	20	55,75 ± 0,79	56 (56 - 56)	53 - 56	0,838 (z=-0,432)
Day 90	16	55,88 ± 0,34	56 (56 - 56)	55 - 56	18	55,83 ± 0,51	56 (56 - 56)	54 - 56	0,986 (z=-0,062)
Day 180	16	55,5 ± 0,97	56 (55,25 - 56)	53 - 56	19	56 ± 0	56 (56 - 56)	56 - 56	0,217 (z=-2,278)
HAD(Depression)	n	A.O.± S.S	Med (IQR)	min - Max	n	A.O.± S.S	Med (IQR)	min - Max	Between groups, p
Before treatment	21	6,86 ± 4,49	7 (3,5 - 10,5)	0 - 16	20	5,6 ± 3,93	4,5 (2 - 10)	1 - 13	0,333 (z=-0,969)
Day 15	20	3 ± 2,25	2,5 (1,25 - 5)	0 - 8	20	3,9 ± 3,67	3 (1 - 5,75)	0 - 14	0,64 (z=-0,491)
Day 30	16	1,94 ± 1,88	2 (0 - 3,75)	0 - 6	20	3,4 ± 3,86	2,5 (0,25 - 5,75)	0 - 16	0,29 (z=-1,089)
Day 90	16	2,19 ± 2,51	1 (0 - 5)	0 - 7	18	2,78 ± 2,84	2 (1 - 4)	0 - 11	0,403 (z=-0,877)
Day 180	16	1,69 ± 2,21	1 (0 - 2,75)	0 - 7	19	2,72 ± 2,7	2 (0,75 - 4,5)	0 - 9	0,187 (z=-1,359)
HAD(Anksiyete)	n	A.O.± S.S	Med (IQR)	min - Max	n	A.O.± S.S	Med (IQR)	min - Max	Between groups, p
Before treatment	21	8,62 ± 5,28	8 (5,5 - 12,5)	0 - 18	20	8,15 ± 4,58	8 (5 - 11,5)	1 - 18	0,763 (t=0,303)
Day 15	20	4,5 ± 4,1	4,5 (0,25 - 6,75)	0 - 13	20	5,95 ± 5,59	5 (0,25 - 10)	0 - 18	0,565 (z=-0,587)
Day 30	16	2,44 ± 2,73	1 (0 - 5)	0 - 7	20	4,75 ± 4,91	3 (0,25 - 7,75)	0 - 18	0,149 (z=-1,491)
Day 90	16	3,25 ± 3,34	2 (0 - 6,5)	0 - 9	18	2,94 ± 2,78	2,5 (0 - 5)	0 - 9	0,932 (z=-0,105)
Day 180	16	2,19 ± 2,99	1 (0 - 4)	0 - 11	19	3,5 ± 3,31	3 (0 - 5,5)	0 - 10	0,297 (z=-1,094)
DHI-S	n	A.O.± S.S	Med (IQR)	min - Max	n	A.O.± S.S	Med (IQR)	min - Max	Between groups, p
Before treatment	21	20 ± 9,03	22 (12 - 24)	4 - 38	20	23,1 ± 6,63	23 (18 - 28)	12 - 38	0,22 (t=-1,247)
Day 15	20	11,2 ± 9,61	10 (2 - 18)	0 - 34	20	17,6 ± 9,68	16 (8,5 - 25,5)	4 - 36	0,038* (z=-2,078)
Day 30	16	7,13 ± 7,86	5 (0,5 - 11,5)	0 - 28	20	12,2 ± 9,9	9 (4 - 21,5)	0 - 34	0,083 (z=-1,761)
Day 90	16	6,38 ± 7,6	2 (2 - 12)	0 - 22	18	10,33 ± 7,8	10 (3,5 - 18)	0 - 26	0,117 (z=-1,587)
Day 180	16	6,25 ± 9,9	2 (0 - 7,5)	0 - 36	19	9,89 ± 9,29	7 (1,5 - 16,5)	0 - 28	0,154 (z=-1,473)
MBDÖ	n	A.O.± S.S	Med (IQR)	min - max	n	A.O.± S.S	Med (IQR)	min - max	Between groups, p
Before treatment	21	23,4 ± 2,35	23 (21 - 25)	21 - 28	20	23,05 ± 2,46	22 (21 - 26)	21 - 28	0,627 (z=-0,526)
Duration(min)	21	5,65 ± 1,53	5,5 (4,56 - 6,38)	3 - 10	20	6,34 ± 2,04	6 (5 - 7)	3 - 12	0,239 (t=-1,197)

BDI: Berg balance scale, HAD: Hospital anxiety and depression scale, DHI-S: Dizziness handicap inventory-screening form, MBDS: Montreal cognitive assessment scale

When we look at Table 6, there was no statistically significant difference between the pre-treatment and follow-up scores between the group that received SG-assisted vestibular rehabilitation and the group that received traditional vestibular rehabilitation in the comparisons that were evaluated independently in the BDI, CFD (depression), CFD (anxiety) and MBS scales (p>0.05). 15th in the DHI-S survey. Traditional vestibular per day

A statistically significant improvement was observed in the rehabilitation group (p=0.038), but; In the follow-ups, we see that this difference disappears.

Table 7: Dependent evaluation of posturography test results

PST-GSI	**Group 1** (n=10)			**Group 2** (n=17)		
	A.O.± S.S	Med (IQR)	min - max	A.O.± S.S	Med (IQR)	min - max
Before treatment	0.57 ± 0.25	0.55 (0.38 - 0.73)	0.3 - 1.1	0.52 ± 0.17	0.5 (0.4 - 0.6)	0.2 - 0.8
Day 15	0.49 ± 0.12	0.5 (0.4 - 0.6)	0.3 - 0.7	0.44 ± 0.22	0.4 (0.3 - 0.55)	0.2 - 1.1
Day 30	0.43 ± 0.12	0.4 (0.4 - 0.53)	0.2 - 0.6	0.45 ± 0.19	0.4 (0.3 - 0.55)	0.2 - 1
Day 90	0.44 ± 0.15	0.45 (0.3 - 0.53)	0.2 - 0.7	0.39 ± 0.18	0.3 (0.3 - 0.5)	0.3 - 1
Day 180	0.46 ± 0.24	0.4 (0.28 - 0.65)	0.2 - 0.9	0.53 ± 0.35	0.4 (0.3 - 0.6)	0.2 - 1.7
Intragroup p	0.186 (fr=6.182)			0.071 (fr=8.648)		
PST-APSI	**Group 1** (n=10)			**Group 2** (n=17)		
	A.O.± S.S	Med (IQR)	min - max	A.O.± S.S	Med (IQR)	min - max
Before treatment	0.45 ± 0.23	0.4 (0.3 - 0.53)	0.2 - 1	0.38 ± 0.14	0.3 (0.3 - 0.5)	0.2 - 0.7
Day 10	0.31 ± 0.12	0.3 (0.2 - 0.33)	0.2 - 0.6	0.34 ± 0.23	0.3 (0.2 - 0.4)	0.2 - 1.1
Day 20	0.3 ± 0.09	0.3 (0.28 - 0.4)	0.1 - 0.4	0.33 ± 0.15	0.3 (0.2 - 0.45)	0.2 - 0.7
Day 90	0.34 ± 0.15	0.35 (0.2 - 0.43)	0.1 - 0.6	0.29 ± 0.17	0.2 (0.2 - 0.3)	0.2 - 0.9
Day 120	0.37 ± 0.21	0.3 (0.2 - 0.53)	0.2 - 0.8	0.41 ± 0.35	0.3 (0.25 - 0.4)	0.2 - 1.7
Intragroup p	0.18 (fr=6.269)			0.004* (fr=15.223) (0-90)		
PST-MLSI	**Group 1** (n=10)			**Group 2** (n=17)		
	A.O.± S.S	Med (IQR)	min - max	A.O.± S.S	Med (IQR)	min - max
Before treatment	0.22 ± 0.11	0.2 (0.1 - 0.33)	0.1 - 0.4	0.26 ± 0.09	0.3 (0.2 - 0.3)	0.1 - 0.4
Day 10	0.28 ± 0.12	0.25 (0.2 - 0.4)	0.1 - 0.5	0.21 ± 0.09	0.2 (0.1 - 0.3)	0.1 - 0.4
Day 20	0.22 ± 0.09	0.2 (0.18 - 0.3)	0.1 - 0.4	0.21 ± 0.11	0.2 (0.1 - 0.2)	0.1 - 0.5
Day 90	0.2 ± 0.09	0.2 (0.1 - 0.23)	0.1 - 0.4	0.16 ± 0.09	0.1 (0.1 - 0.2)	0 - 0.4
Day 120	0.19 ± 0.12	0.2 (0.1 - 0.2)	0.1 - 0.5	0.22 ± 0.16	0.2 (0.1 - 0.3)	0.1 - 0.7
Intragroup p	0.039* (fr=10.097) (10 - 120)			0.001* (fr=18.244) (0-90)		
DRT	**Group 1** (n=11)			**Group 2** (n=17)		
	A.O.± S.S	Med (IQR)	min - max	A.O.± S.S	Med (IQR)	min - max
Before treatment	0.92 ± 0.5	0.9 (0.6 - 1.3)	0 - 1.9	0.92 ± 0.49	1 (0.5 - 1.2)	0 - 2.1
Day 10	0.81 ± 0.44	0.9 (0.5 - 1.1)	0 - 1.4	0.76 ± 0.44	0.6 (0.45 - 1.05)	0.3 - 1.7
Day 20	0.79 ± 0.44	0.8 (0.4 - 1)	0 - 1.6	0.81 ± 0.69	0.6 (0.5 - 0.8)	0.1 - 3.2
Day 90	0.82 ± 0.37	0.9 (0.4 - 1.2)	0.4 - 1.4	0.8 ± 0.57	0.6 (0.4 - 1)	0.2 - 2.7
Day 120	0.84 ± 0.52	0.92 (0.4 - 1.2)	0 - 1.7	0.86 ± 0.47	0.7 (0.5 - 1.3)	0.2 - 1.8
Intragroup p	0.932 (F=0.209)			0.883 (F=0.291)		

PST: Postural Established Test, GSİ: Genel Established Indeksi, APSİ: Anterior-Posterior Established Indeksi, MLSİ: Medial-Lateral Established Indeksi, DRT: Düşme riski testi

In Table 7, the group that received SG-assisted vestibular rehabilitation and the groups that received traditional vestibular rehabilitation were evaluated between the pre-treatment and follow-up scores. In the traditional rehabilitation group (group 1), there was no statistically significant difference in GSI, APSI and DRT scores, a statistically significant improvement in MLSI score (p=0.039). When we look at the SG supported rehabilitation group (group 2); A significant improvement was observed in APSI and MLSI scores within the group (p<0.05). There was no statistically significant difference in GSI and DRT scores (p>0.05).

Table 8: Dependent Results of the Modified Balance Sensory Interaction Clinical Test (mCTSIB) in Posturography

GA-SZ	**Group 1** (n=10)			**Group 2** (n=17)		
	A.O.± S.S	Med (IQR)	min - max	A.O.± S.S	Med (IQR)	min - max
Before treatment	0.52 ± 0.12	0.48 (0.43 - 0.62)	0.37 - 0.74	0.51 ± 0.13	0.48 (0.42 - 0.65)	0.31 - 0.7
Day 15	0.46 ± 0.11	0.43 (0.37 - 0.58)	0.32 - 0.66	0.45 ± 0.17	0.37 (0.29 - 0.6)	0.26 - 0.74
Day 30	0.6 ± 0.38	0.49 (0.43 - 0.57)	0.39 - 1.67	0.46 ± 0.17	0.43 (0.34 - 0.52)	0.25 - 0.87
Day 90	0.53 ± 0.28	0.42 (0.41 - 0.58)	0.25 - 1.26	0.43 ± 0.12	0.42 (0.34 - 0.48)	0.29 - 0.75
Day 180	0.5 ± 0.27	0.43 (0.38 - 0.48)	0.29 - 1.24	0.47 ± 0.16	0.47 (0.32 - 0.6)	0.2 - 0.83
Intragroup p	0.133 (fr=7.047)			0.259 (F=1.357)		
GK-SZ	**Group 1** (n=10)			**Group 2** (n=17)		
	A.O.± S.S	Med (IQR)	min - max	A.O.± S.S	Med (IQR)	min - max
Before treatment	0.93 ± 0.26	0.95 (0.76 - 1.09)	0.53 - 1.35	1.24 ± 0.62	1.01 (0.79 - 1.57)	0.61 - 2.83
Day 15	1.08 ± 0.4	0.98 (0.76 - 1.28)	0.72 - 1.97	1.27 ± 0.5	1.17 (0.84 - 1.65)	0.64 - 2.3
Day 30	1.28 ± 0.91	0.95 (0.84 - 1.32)	0.76 - 3.78	1.19 ± 0.5	1.05 (0.83 - 1.49)	0.56 - 2.33
Day 90	1.19 ± 0.44	1.14 (0.85 - 1.45)	0.64 - 2.07	1.18 ± 0.71	1 (0.77 - 1.14)	0.54 - 3.34
Day 180	1.24 ± 0.94	0.92 (0.79 - 1.41)	0.63 - 3.82	1.01 ± 0.46	0.81 (0.67 - 1.37)	0.36 - 2
Intragroup p	0.287 (fr=5.005)			0.311 (F=1.219)		
GA-YZ	**Group 1** (n=10)			**Group 2** (n=17)		
	A.O.± S.S	Med (IQR)	min - max	A.O.± S.S	Med (IQR)	min - max
Before treatment	0.93 ± 0.24	0.98 (0.78 - 1.1)	0.42 - 1.26	0.98 ± 0.24	0.94 (0.8 - 1.2)	0.63 - 1.53
Day 15	0.84 ± 0.24	0.82 (0.7 - 0.92)	0.52 - 1.38	0.93 ± 0.28	0.89 (0.75 - 1.12)	0.4 - 1.5
Day 30	0.85 ± 0.29	0.73 (0.63 - 1.12)	0.56 - 1.39	0.97 ± 0.26	1 (0.74 - 1.25)	0.57 - 1.33
Day 90	0.86 ± 0.26	0.79 (0.7 - 1.03)	0.5 - 1.42	0.85 ± 0.19	0.78 (0.7 - 1.02)	0.61 - 1.24
Day 180	0.86 ± 0.43	0.73 (0.63 - 0.9)	0.52 - 2.01	0.94 ± 0.26	0.96 (0.73 - 1.14)	0.52 - 1.51
Intragroup p	0.366 (fr=4.305)			0.116 (F=1.931)		
GK-YZ	**Group 1** (n=10)			**Group 2** (n=17)		
	A.O.± S.S	Med (IQR)	min - max	A.O.± S.S	Med (IQR)	min - max
Before treatment	3.37 ± 1.09	3.02 (2.43 - 4.63)	2.28 - 5	3.29 ± 1.11	3.17 (2.51 - 4.41)	1.06 - 5
Day 15	3.07 ± 0.59	3.04 (2.6 - 3.31)	2.18 - 4.36	3.14 ± 0.73	3.08 (2.64 - 3.77)	1.96 - 4.41
Day 30	2.89 ± 0.84	2.69 (2.38 - 3.12)	2.05 - 5	3.26 ± 0.95	3.27 (2.4 - 3.88)	1.75 - 5.09
Day 90	2.68 ± 0.6	2.7 (2.19 - 3.2)	1.84 - 3.53	2.81 ± 0.54	2.72 (2.43 - 3.12)	2.05 - 4.15
Day 180	2.93 ± 0.77	2.92 (2.22 - 3.56)	1.7 - 4.27	2.8 ± 0.5	2.64 (2.49 - 3.1)	1.77 - 3.69
Intragroup p	0.158 (F=1.761)			0.215 (fr=5.794)		
GS	**Group 1** (n=11)			**Group 2** (n=17)		
	A.O.± S.S	Med (IQR)	min - max	A.O.± S.S	Med (IQR)	min - max

Before treatment	1.2 ± 0.26	1.24 (0.93 - 1.39)	0.83 - 1.69	1.39 ± 0.28	1.36 (1.16 - 1.63)	1.02 - 1.94

Day 15	1.42 ± 0.29	1.41 (1.31 - 1.47)	0.94 - 2.07	1.45 ± 0.33	1.42 (1.19 - 1.69)	0.97 - 2.07
Day 30	1.38 ± 0.48	1.24 (1.06 - 1.43)	0.91 - 2.5	1.46 ± 0.38	1.39 (1.15 - 1.82)	0.84 - 2.14
Day 90	1.31 ± 0.3	1.24 (1.06 - 1.49)	0.93 - 2.01	1.31 ± 0.32	1.19 (1.1 - 1.46)	0.99 - 2.24
Day 180	1.34 ± 0.53	1.23 (1.01 - 1.39)	0.83 - 2.83	1.3 ± 0.26	1.27 (1.15 - 1.36)	0.85 - 1.94
Intragroup p	0.549 (fr=3.056)			0.093 (F=2.084)		

GA: Eye open, GK: Eye closed, SZ: Hard ground, AI: Soft ground, GS: Overall score Table 8 shows that both mCTSIB subgroups, one of the posturography tests,

There was no statistically significant difference in the group (p>0.05).

Table 9: Dependent Assessment of SVV Tests

SIA statics	**Group 1** (n=12)			**Group 2** (n=15)		
	A.O.± S.S	Med (IQR)	min - max	A.O.± S.S	Med (IQR)	min - max
Before treatment	0.11 ± 2.19	-0.52 (-1.2 - 2.47)	-3.63 - 3.45	-0.27 ± 2.29	-0.61 (-1.6 - 1.13)	-4.5 - 5.04
Day 15	0.29 ± 2.55	-0.05 (-2.16 - 2.87)	-2.57 - 4.01	-0.67 ± 2.77	-0.01 (-2.68 - 1.23)	-5.67 - 4.11
Day 30	-0.2 ± 3.25	-0.5 (-2.96 - 2.99)	-5.4 - 4.75	-0.58 ± 1.72	-0.37 (-2.03 - 0.84)	-3.21 - 2.2
Day 90	1 ± 2.98	0.34 (-1.08 - 3.04)	-2.71 - 7.27	-0.26 ± 1.77	-0.56 (-1.52 - 1.25)	-3.54 - 2.99
Day 180	0.31 ± 2.1	-0.18 (-1.7 - 2.43)	-2.7 - 3.54	-0.42 ± 1.81	-0.56 (-1.83 - 1.2)	-3.07 - 2.57
Intragroup p	0.522 (F=0.816)			0.922 (F=0.227)		
Dynamic SVV	**Group 1** (n=12)			**Group 2** (n=15)		
	A.O.± S.S	Med (IQR)	min - max	A.O.± S.S	Med (IQR)	min - max
Before treatment	0.79 ± 4.92	1.59 (-2.73 - 3.2)	-7.57 - 11.84	-0.43 ± 4.96	-0.52 (-3.73 - 4.93)	-8.73 - 7.47
Day 15	0.91 ± 3.06	0.71 (-2.27 - 3.11)	-3.11 - 5.61	-0.97 ± 4.97	-1.67 (-3.73 - 0.08)	-9.45 - 12.35
Day 30	1.31 ± 4.21	0.98 (-1.86 - 3.01)	-4.07 - 11.78	-0.31 ± 3.87	-0.58 (-1.85 - 0.9)	-7.85 - 8.56

Day 90	0.5 ± 1.95	0.82 (-1.13 - 1.34)	-2.63 - 4.43	-0.83 ± 3.32	-1.17 (-3.2 - 1.83)	-6.69 - 4.96
Day 180	0.14 ± 2.95	0.26 (-1.78 - 1.8)	-5.04 - 5.31	0.09 ± 4.8	-0.46 (-2.96 - 2.56)	-9.84 - 10.6
Intragroup p	0.977 (fr=0.467)			0.69 (F=0.563)		

When Table 9 is evaluated, there was no statistical difference in SVV tests in both rehabilitation groups ($p>0.05$).

Table 10: Dependent assessment of quality of life scales

BDÖ	**Group 1** (n=10)			**Group 2** (n=18)		
	A.O.± S.S	Med (IQR)	min - Max	A.O.± S.S	Med (IQR)	min - max
Before treatment	52.7 ± 7.47	56 (52.5 - 56)	32 - 56	53.83 ± 3.05	55.5 (51 - 56)	45 - 56
Day 15	55.2 ± 1.93	56 (55.5 - 56)	50 - 56	55.78 ± 0.73	56 (56 - 56)	53 - 56
Day 30	55.8 ± 0.63	56 (56 - 56)	54 - 56	55.72 ± 0.83	56 (56 - 56)	53 - 56
Day 90	55.9 ± 0.32	56 (56 - 56)	55 - 56	55.83 ± 0.51	56 (56 - 56)	54 - 56
Day 180	55.7 ± 0.67	56 (55.75 - 56)	54 - 56	56 ± 0	56 (56 - 56)	56 - 56
Intragroup p	0.053 (fr=9.353)			0.0001* (fr=27.145) (0-120)		

HAD(Depression)	**Group 1** (n=10)			**Group 2** (n=17)		
	A.O.± S.S	Med (IQR)	min - Max	A.O.± S.S	Med (IQR)	min - max
Before treatment	7.1 ± 4.28	6.5 (4 - 8.5)	2 - 16	5.65 ± 4.01	5 (2 - 10)	1 - 13
Day 15	2.6 ± 2.01	2.5 (0.75 - 4.25)	0 - 6	3.59 ± 2.96	3 (1 - 5.5)	0 - 10
Day 30	1.8 ± 2.2	1 (0 - 4)	0 - 6	3 ± 2.55	3 (0.5 - 5.5)	0 - 8
Day 90	1.4 ± 2.27	0 (0 - 2.75)	0 - 6	2.88 ± 2.89	2 (1 - 4)	0 - 11
Day 180	1.1 ± 2.13	0.5 (0 - 1)	0 - 7	2.88 ± 2.69	2 (1 - 5)	0 - 9
Intragroup p	0.0001* (fr=22.575) (0-20, 0-90, 0-120)			0.04* (fr=10.019) (0-90)		

HAD(Anksiyete)	**Group 1** (n=10)			**Group 2** (n=17)		
	A.O.± S.S	Med (IQR)	min - Max	A.O.± S.S	Med (IQR)	min - max
Before treatment	7.6 ± 4.84	8 (4.25 - 9.75)	0 - 17	7.88 ± 4.61	8 (4 - 11)	1 - 18
Day 15	3.6 ± 4.3	1.5 (0 - 6.25)	0 - 13	6 ± 5.7	5 (0.5 - 10)	0 - 18
Day 30	2.5 ± 3.14	0.5 (0 - 6.25)	0 - 7	4.18 ± 4.05	3 (0 - 7.5)	0 - 11
Day 90	2.4 ± 3.44	1 (0 - 5)	0 - 9	3.12 ± 2.76	3 (0.5 - 5)	0 - 9
Day 180	1.8 ± 3.46	0.5 (0 - 1.75)	0 - 11	3.53 ± 3.41	3 (0 - 6)	0 - 10
Intragroup p	0.0001* (fr=20.522) (0-20, 0-90, 0-120)			0.0001* (fr=24.416) (0-20, 0-90, 0-120)		

DHI-S	**Group 1** (n=10)			**Group 2** (n=17)		
	A.O.± S.S	Med (IQR)	min - Max	A.O.± S.S	Med (IQR)	min - max
Before treatment	22 ± 9.66	24 (15.5 - 28.5)	6 - 38	23.41 ± 6.55	22 (18 - 28)	14 - 38
Day 15	10.6 ± 10.54	9 (2 - 16.5)	0 - 34	18 ± 9.7	18 (9 - 25)	4 - 36
Day 30	7.6 ± 9.13	4 (0 - 13)	0 - 28	11.41 ± 9.13	8 (4 - 21)	0 - 30

Day 90	5 ± 7.32	2 (0 - 8)	0 - 22	10.71 ± 7.87	10 (3 - 18)	0 - 26
Day 180	5.4 ± 11.12	1 (0 - 6.5)	0 - 36	9.65 ± 9.52	6 (1 - 17)	0 - 28
Intragroup p	0.0001* (F=14.86) (0-20, 0-90, 0-120)			0.0001* (F=13.614) (0-20, 0-90, 0-120, 10-120)		

BDI: Berg balance scale, HAD: Hospital anxiety and depression scale, DHI-S: Dizziness handicap inventory-screening form, MBDS: Montreal cognitive assessment scale

When we look at Table 10, a statistically significant improvement was found in all BDI, HAD (depression), HAD (anxiety) and DHI-S scores in group 2 who underwent SG-assisted vestibular rehabilitation in intra-group dependent evaluations ($p<0.05$). When we looked at the traditional rehabilitation group, a statistically significant difference was found in HAD (depression), HAD (anxiety) and DHI-S scores ($p<0.05$) but; There was no statistically significant difference in BDI score.

Table 11: Dependent statistical results of the Modified Balance Sensory Interaction Clinical Test (mCTSIB) in Posturography compared to the standard value

	Group 1				**Group 2**			
	n	A.O.± S.S	Med (IQR)	min - max	n	A.O.± S.S	Med (IQR)	min - max
GA-SZ	-	0,35 ± 0	0,35 (0,35 - 0,35)	0,35 - 0,35	-	0,35 ± 0	0,35 (0,35 - 0,35)	0,35 - 0,35
Before treatment	21	0,5 ± 0,14	0,46 (0,41 - 0,6)	0,31 - 0,82	20	0,52 ± 0,13	0,48 (0,42 - 0,66)	0,31 - 0,75
Intragroup p (based on mean value)		0.0001* (t=-5.009)			0.0001* (t=-5.653)			
Day 15	21	0,47 ± 0,2	0,42 (0,34 - 0,6)	0,17 - 1,09	20	0,46 ± 0,18	0,44 (0,3 - 0,6)	0,26 - 0,81
Intragroup p (based on mean value)		0.006* (z=-2.726)			0.05* (z=-1.961)			
Day 30	18	0,56 ± 0,31	0,49 (0,41 - 0,59)	0,19 - 1,67	20	0,51 ± 0,24	0,45 (0,34 - 0,58)	0,25 - 1,27
Intragroup p (based on mean value)		0.002* (z=-3.031)			0.003* (z=-2.959)			
Day 90	15	0,5 ± 0,25	0,42 (0,4 - 0,53)	0,22 - 1,26	18	0,42 ± 0,12	0,4 (0,33 - 0,48)	0,29 - 0,75
Intragroup p (based on mean value)		0.021* (z=-2.303)			0.026* (z=-2.229)			
Day 180	15	0,51 ± 0,22	0,47 (0,42 - 0,55)	0,29 - 1,24	19	0,48 ± 0,16	0,47 (0,32 - 0,6)	0,2 - 0,83
Intragroup p (based on mean value)		0.002* (z=-3.173)			0.002* (t=-3.614)			
	Group 1				**Group 2**			
	n	A.O.± S.S	Med (IQR)	min - max	n	A.O.± S.S	Med (IQR)	min - max
GK-SZ	-	0,73 ± 0	0,73 (0,73 - 0,73)	0,73 - 0,73	-	0,73 ± 0	0,73 (0,73 - 0,73)	0,73 - 0,73
Before treatment	21	0,98 ± 0,29	0,98 (0,8 - 1,19)	0,49 - 1,65	20	1,28 ± 0,61	1,18 (0,8 - 1,57)	0,61 - 2,83
Intragroup p (based on mean value)	0.001* (t=-3.933)				0.001* (z=-3.361)			
Day 15	21	1,02 ± 0,33	1,01 (0,76 - 1,19)	0,58 - 1,97	20	1,3 ± 0,55	1,14 (0,91 - 1,67)	0,64 - 2,51
Intragroup p (based on mean value)	0.001* (z=-3.477)				0.0001* (t=-4.656)			
Day 30	18	1,14 ± 0,74	0,95 (0,77 - 1,32)	0,36 - 3,78	20	1,21 ± 0,51	1,07 (0,81 - 1,54)	0,56 - 2,33
Intragroup p (based on mean value)	0.005* (z=-2.788)				0.001* (t=-4.159)			

Day 90	15	1,05 ± 0,42	1,02 (0,65 - 1,23)	0,55 - 2,07	18	1,15 ± 0,7	1 (0,77 - 1,13)	0,54 - 3,34
Intragroup p (based on mean value)	0.011* (t=-2.942)				0.003* (z=-3.009)			
Day 180	15	1,27 ± 0,8	0,97 (0,81 - 1,41)	0,63 - 3,82	19	1,07 ± 0,47	0,87 (0,67 - 1,54)	0,36 - 2
Intragroup p (based on mean value)	0.003* (z=-2.984)				0.006* (t=-3.131)			
	Group 1				**Group 2**			
	n	A.O.± S.S	Med (IQR)	min - max	n	A.O.± S.S	Med (IQR)	min - max
GA-YZ	-	0,54 ± 0	0,54 (0,54 - 0,54)	0,54 - 0,54	-	0,54 ± 0	0,54 (0,54 - 0,54)	0,54 - 0,54
Before treatment	21	1,05 ± 0,32	1,08 (0,8 - 1,2)	0,42 - 1,8	20	1,01 ± 0,24	1 (0,8 - 1,2)	0,63 - 1,53
Intragroup p (based on mean value)	0.0001* (t=-7.313)				0.0001* (t=-8.502)			
Day 15	21	0,93 ± 0,33	0,83 (0,71 - 1,21)	0,5 - 1,71	20	1,02 ± 0,44	0,89 (0,74 - 1,23)	0,4 - 2,4
Intragroup p (based on mean value)	0.0001* (t=-5.478)				0.0001* (z=-3.808)			
Day 30	18	0,93 ± 0,29	0,89 (0,66 - 1,21)	0,5 - 1,39	20	0,99 ± 0,34	0,94 (0,72 - 1,26)	0,56 - 1,95
Intragroup p (based on mean value)	0.0001* (t=-5.76)				0.0001* (t=-5.887)			
Day 90	15	0,9 ± 0,3	0,85 (0,7 - 1,06)	0,41 - 1,49	18	0,83 ± 0,2	0,78 (0,68 - 1,02)	0,54 - 1,24
Intragroup p (based on mean value)	0.0001* (t=-4.642)				0.0001* (t=-6.224)			
Day 180	15	0,93 ± 0,39	0,84 (0,69 - 1,08)	0,52 - 2,01	19	0,93 ± 0,25	0,93 (0,72 - 1,11)	0,52 - 1,51
Intragroup p (based on mean value)	0.001* (z=-3.351)				0.0001* (t=-6.668)			
	Group 1				**Group 2**			
	n	A.O.± S.S	Med (IQR)	min - max	n	A.O.± S.S	Med (IQR)	min - max
GK-YZ	-	1,65 ± 0	1,65 (1,65 - 1,65)	1,65 - 1,65	-	1,65 ± 0	1,65 (1,65 - 1,65)	1,65 - 1,65
Before treatment	21	3,44 ± 1,25	3,22 (2,53 - 4,76)	1,23 - 6	20	3,39 ± 1,11	3,24 (2,56 - 4,52)	1,06 - 5
Intragroup p (based on mean value)	0.0001* (t=-6.599)				0.0001* (t=-6.786)			
Day 15	21	3,2 ± 1,06	3,01 (2,56 - 3,52)	1,66 - 5,53	20	3,22 ± 0,8	3,1 (2,62 - 3,79)	1,96 - 5
Intragroup p (based on mean value)	0.0001* (z=-4.015)				0.0001* (t=-8.717)			
Day 30	18	3,01 ± 1,14	2,63 (2,28 - 3,13)	1,84 - 6	20	3,14 ± 0,96	3,24 (2,28 - 3,81)	1,75 - 5,09
Intragroup p (based on mean value)	0.0001* (z=-3.724)				0.0001* (t=-6.939)			
Day 90	15	2,82 ± 0,88	2,87 (2,21 - 3,29)	1,58 - 5	18	2,78 ± 0,54	2,72 (2,38 - 3,03)	2,05 - 4,15
Intragroup p (based on mean value)	0.0001* (t=-5.164)				0.0001* (t=-8.815)			
Day 180	15	3,08 ± 0,92	2,95 (2,25 - 3,64)	1,7 - 5	19	2,92 ± 0,69	2,8 (2,5 - 3,11)	1,77 - 5
Intragroup p (based on mean value)	0.0001* (t=-6.059)				0.0001* (z=-3.823)			
	Group 1				**Group 2**			
	n	A.O.± S.S	Med (IQR)	min - max	n	A.O.± S.S	Med (IQR)	min - max
GS	-	0,81 ± 0	0,81 (0,81 - 0,81)	0,81 - 0,81	-	0,81 ± 0	0,81 (0,81 - 0,81)	0,81 - 0,81
Before treatment	21	1,29 ± 0,36	1,3 (0,99 - 1,5)	0,72 - 2,35	20	1,4 ± 0,27	1,36 (1,17 - 1,59)	1,02 - 1,94
Intragroup p (based on mean	0.0001* (t=-6.141)				0.0001* (t=-9.383)			

value)								
Day 15	21	1,35 ± 0,38	1,31 (1,12 - 1,46)	0,77 - 2,26	20	1,46 ± 0,34	1,45 (1,18 - 1,73)	0,97 - 2,07
Intragroup p (based on mean value)	0.0001* (t=-6.481)				0.0001* (t=-8.707)			
Day 30	18	1,28 ± 0,42	1,23 (1,05 - 1,36)	0,74 - 2,5	20	1,46 ± 0,41	1,39 (1,14 - 1,82)	0,84 - 2,14
Intragroup p (based on mean value)	0.0001* (z=-3.574)				0.0001* (t=-7.039)			
Day 90	15	1,25 ± 0,33	1,22 (1,01 - 1,46)	0,72 - 2,01	18	1,29 ± 0,32	1,19 (1,08 - 1,45)	0,92 - 2,24
Intragroup p (based on mean value)	0.0001* (t=-5.337)				0.0001* (z=-3.724)			
Day 180	15	1,38 ± 0,48	1,23 (1,01 - 1,59)	0,83 - 2,83	19	1,31 ± 0,25	1,3 (1,19 - 1,39)	0,85 - 1,94
Intragroup p (based on mean value)	0.001* (z=-3.409)				0.0001* (t=-8.754)			

GA: Eye open, GK: Eye closed, SZ: Hard ground, AI: Soft ground, GS: Overall score

In Table 11, a statistical difference was observed between the standardization value of the subgroups before treatment and follow-up in the mCTSIB subgroup scores of group 1 and group 2, and a significant statistical difference was observed in both groups according to the standardization value in all subgroups ($p<0.05$).

5. ARGUMENT

Our aim in doing this study is to reduce the use of virtual reality glasses in the short and long term with vestibular rehabilitation exercises of patients; to investigate the effects on static and dynamic balance, risk of falling, fear of falling, anxiety and depression. When we evaluated our main findings, significant statistical improvements were observed in the MLSI subscale, HAD (anxiety), HAD (depression) and DHI-S scales from dynamic posturography tests in patients in both virtual reality glasses and traditional vestibular rehabilitation groups. In the virtual reality-based vestibular rehabilitation group, more significant statistical improvements were observed in the dynamic posturography tests, in the APSI subscale and on the BDI scale compared to the traditional vestibular rehabilitation group. No significant changes were observed in both groups in static SVV and dynamic SVV tests.

Unilateral vestibular insufficiency (UVI) is the loss or reduction of vestibular system function in one ear and can cause balance disorder. The main symptoms of UVY are constant dizziness, oscillopsia, balance disorders with a tendency to walk and fall, nausea and vomiting. All of these symptoms are acute or subacute and last for days or weeks. Although there are no typical auras or triggers, some patients may experience a rare episode of dizziness a few days earlier. UVY leads to serious deterioration in the patient's quality of life. It has also been shown to have a significant socioeconomic burden due to its physical, functional, and emotional impact on individuals (107). Ward et al. observed a 31-fold increase in the risk of falls in people diagnosed with vestibular hypofunction (108). Therefore, appropriate treatments that can reduce the risk of falls can reduce individual independence and functional decline as well as overall health care costs in patients with vestibular dysfunction.

Patients diagnosed with UVY have many treatment options. These are medical, surgical and vestibular rehabilitation applications. A personalized vestibular rehabilitation treatment program has been shown to reduce dizziness, improve postural stability, improve head movement vision, and reduce the risk of falls in patients with UVI (109). Medical treatment of peripheral vestibular system diseases and when rehabilitation programs are ineffective, surgical options may be considered to solve the problem when patients become incapacitated and isolated from life due to vertigo attacks (110).

Virtual reality (SG) technology has found wide application in the field of vestibular rehabilitation in recent years. This method has a lot of positive effects that can be effectively used in the treatment of diseases of the vestibular system. SG can be an effective tool for retraining the vestibular system by simulating movements that patients can perform in vestibular rehabilitation exercises in real-world conditions. For this reason, virtual reality technology; It can be an effective option in improving vestibular functions such as balance, coordination, movement perception and walking. However, most of the studies in the literature have not provided sufficient numbers of participants to determine the effectiveness of these rehabilitation methods.

Recent studies have shown that the use of virtual reality glasses in combination with vestibular rehabilitation exercises improves balance control in UVY patients. One study found that vestibular rehabilitation with the addition of virtual reality exercises yielded better results than vestibular rehabilitation alone (111). Another study found that combining virtual reality exercises with traditional exercises yielded better results than traditional exercises alone (112). However; In a study comparing traditional vestibular rehabilitation with SG-based rehabilitation in patients with multiple sclerosis, it was stated that both types of rehabilitation benefited and were not superior to each other (113). However, the sample size of some of these studies was small, and it is clear that larger studies are needed in this regard. In addition, the effectiveness of different types of SG-based rehabilitation and different SG platforms should be investigated.

The use of SG-based rehabilitation in ENT patients has also been investigated. For example; SG-assisted vestibular rehabilitation has been shown to reduce symptoms and improve quality of life in patients with Meniere's disease (114). Similarly, in patients with benign paroxysmal positional vertigo (BPPV), SG-based

Rehabilitation has been found to yield superior results than traditional exercise (115). In a study they conducted, Tabanfar et al. designed an environment where the Epley maneuver could be performed after placing a smartphone inside the SG glasses and asked healthy subjects to perform step-by-step reduction maneuvers in this virtual environment. They reported that these practices may be promising techniques to improve the accuracy and effectiveness of home treatment for BPPV (116).

In older adults with a history of dizziness, balance disorders, or falls, using techniques to create human-computer interactions and exercises applied to the SG system has been shown to reduce dizziness and vertigo-related disorders, improve balance and increase self-esteem, reduce fear of falling, and reduce the risk of falling (117).

Today, it is known that the use of smartphones is at very high rates and it is estimated that virtual reality technology will become widespread in the coming years. Smartphones are involved in measurement applications such as SVV and dynamic visual acuity related to vestibular rehabilitation, applications with optomotor stimulation, applications for balance measurement with accelerometers, or medical education applications (118). In addition, it is reported that better results can be obtained in medical education by using virtual reality environments created with smartphones and virtual reality glasses (119).

In our prospective randomized controlled study; Between 2020 and 2023, we monitored the effects of performing vestibular rehabilitation exercises with virtual reality support using traditional methods and virtual glasses technology on dizziness, imbalance, risk of falling, static and dynamic balance, static SVV, dynamic SVV, quality of life, anxiety and depression on 41 patients who applied to our Pamukkale University Faculty of Medicine Hospital Ear, Nose and Throat Diseases outpatient clinic with the complaint of dizziness between 2020 and 2023.

When we evaluated the findings of our study, we observed that the mean age was 52.24 ± 14.57 in group 1 (n=21) and 49.6 ± 10.48 in group 2 (n=20) and there was no statistical difference. The mean caloric test results were 55.86 ± 20.97 in group 1 and 55.75 ± 24.26 in group 2.

there was no statistical difference. In the caloric tests, no statistical difference was observed between the 2 groups as right and left ears. When we look at the gender comparison between the 2 groups, we observed 7 females and 14 males in group 1 and 16 females and 4 males in group 2 and a statistically significant difference. However; We see that this statistical difference is random due to the randomization of the study. When we look at the literature, we can see that gender is not important in vestibular rehabilitation (120, 121).

There was no statistical difference in the comparison of follow-ups between the 2 groups in Table 3, which compares the follow-ups of the patients with postural stability test (PST) and fall risk test (DRT), which are dynamic posturography tests between the 2 groups. However; When we look at Table 7, where there is a statistical analysis within their own groups, a statistical improvement is observed in the postural stability test (PST), APSI and MLSI values, which are dynamic posturography tests in which balance is evaluated in the virtual reality-based vestibular rehabilitation group, while there is a statistical improvement in only the MLSI value in the traditional vestibular rehabilitation group. There is no statistically significant difference in GSI value in the two groups. Again, when the dynamic posturography fall risk test (DRT) was evaluated, we saw that the scores improved in each follow-up, but no statistical difference was observed in the 2 groups. When we evaluate the pre-treatment and follow-up scores in Table 3 and Table 7, we see that the scores that are improving until the 90th day are 180. Although it is better than before the treatment in the day follow-up, we observe that it is worse than the 90th day follow-up. This suggests that the effect of both traditional and SG-based vestibular rehabilitation decreases in long-term follow-up. When we look at the studies, in a study by Sparrer et al., traditional vestibular rehabilitation and SG-based vestibular rehabilitation were compared
Day 5 and Day 10. The results of the static posturography sensory organization test of SG-based vestibular rehabilitation were found to be statistically significant in favor of SG-based vestibular rehabilitation (122). In another study conducted by Meldrum et al., when comparing traditional vestibular rehabilitation and SG-based vestibular rehabilitation, significant improvement was observed in both groups; They did not find a statistically significant difference between the 2 groups (79).

We observe the results of the Modified Balance Sensory Interaction Clinical Test (mCTSIB) in dynamic posturography in table 4, table 8 and table 11. In Table 4, no statistical difference was observed in the comparison of follow-ups between group 1 and group 2. However; When we examine the table in detail, when we look at the overall score, we see that the score from the pre-treatment to the 90th day is improved, and the 180th day score is worse than the 90th day. In Table 8, when the groups were compared within themselves, no statistical difference was observed in both group 1 and group 2. When we look at the overall score, it is striking that the improvement in the scores of the SG-based rehabilitation group is better than the traditional vestibular rehabilitation group. In Table 11, we see a comparison of the mCTSIB test with each follow-up of patients in both groups compared to the average of healthy people. All follow-ups show a significant statistical difference in the direction of healthy people. In a study conducted by Garcia et al., although they did not find a significant difference in the posturography results of 41 Meniere's patients who underwent SG-based vestibular rehabilitation, they observed a significant improvement in their DHI scores (123).

When we look at Table 5 and Table 9, we see the static SVV and dynamic SVV test results. In Table 5, there was no statistical difference in both tests in the comparison between the groups. In Table 9, there is no statistical difference in the comparison of the patients in the group with each other. However; When we look at the tables, it is clearly clear that in both groups, especially in the 90th day follow-up, the min-max values approach 0 degrees, which is the neutral position compared to the pre-treatment period, especially in the SG-based rehabilitation group. Toupet et al. In a study conducted by the United States, it was stated that SVV was affected in children, the elderly, women and patients with unilateral vestibular insufficiency (124). When we look at the literature, it has been stated that the SVV test can be used in the follow-up of peripheral vestibular diseases (125, 126).

When we look at Table 6 and Table 10, we observe the intergroup and intra-group comparisons of the patient's objectively evaluated Berg Balance Scale (BDI), Montreal Cognitive Assessment Scale (MBSS) and subjectively evaluated Hospital Anxiety and Depression Scale (HAD), Dizziness Handicap Inventory-Screening form ([DHI-

S]Dizziness Disability Inventory) scores. Pre-treatment and follow-up in Table 6

There was no statistically significant difference between the VR-assisted vestibular rehabilitation group and the traditional vestibular rehabilitation group in the comparisons evaluated independently on the BDI, CFD (depression), CFD (anxiety) and MBSS scales. 15th in the DHI-S survey. A statistically significant improvement was observed in the traditional vestibular rehabilitation group per day, but; In the follow-ups, we see that this difference disappears. When we look at the MBSS scores, we observe that there is no statistical difference between the cognitive scores of the patients before the treatment and the time it takes to complete the scale. When we look at Table 10, a statistically significant improvement was found in all BDI, CFD (depression), HAD (anxiety) and DHI-S scores in group 2 who underwent SG-assisted vestibular rehabilitation in intra-group dependent evaluations. When we looked at the traditional rehabilitation group, a statistically significant difference was found in HAD (depression), HAD (anxiety) and DHI-S scores; There was no statistically significant difference in BDI score. In line with these data, it was found that statistically significant benefits were seen in both groups on the objectively evaluated scale, but; We observed that only the SG-based vestibular rehabilitation group saw statistically significant benefit in the subjectively evaluated BDI score. Viziano et al. completed a long-term (12-month) vestibular rehabilitation treatment based on wearable SG for individuals diagnosed with unilateral vestibular hypofunction. The study found a statistically significant reduction in DHI scores at the end of the year in patients who received 20 minutes of sessions per day per month (84). Coelho et al. found that the DHI score decreased from 56 points to 25 points at the end of 12 sessions of 2 sessions per week for 6 weeks, and from 25 points to 19 points at 3-month follow-up (127). In a study conducted by Stankiewicz et al., we applied an integrated vestibular rehabilitation program using wearable SG technology to 10 patients diagnosed with unilateral vestibular hypofunction. They showed that the scores obtained by the patients on the 'Vertigo Symptom Scale' decreased by 8 points compared to the pre-rehabilitation period and achieved a statistically significant difference (128).

In 2015, Bergeron analyzed the results of seven studies that included a total of 176 patients using SG to treat peripheral vestibular disorders. It has been reported that virtual reality-assisted rehabilitation is effective on objective parameters that evaluate patients' perceptions of symptoms and disability. Protocols

There were significant differences between and the evaluation criteria were not standardized. In addition to immersive systems such as "BRU", head-mounted display (HMD), immersive projection stage, in which immersive SG glasses are used for visual stimulation as a virtual environment in patients, virtual systems such as Wii Fit, which are non-immersive such as working on the balance board by giving visual stimulus on the screen, were also used. Additionally, researchers have found that virtual reality offers a comfortable and safe option for patients. They found that the magnitude of the therapeutic effect in virtual reality therapy was related to the cumulative exposure to the virtual reality environment rather than the duration of the session, and that the cumulative minimum exposure time to the virtual environment should be 150 minutes (83). In our study, vestibular rehabilitation based on SG technology was applied to each patient for 700 minutes of rehabilitation and the exercise time above the minimum cumulative dose was reached.

In recent years, SG-based vestibular rehabilitation has evolved into a treatment model that enables clinicians to follow patients reliably, make treatment enjoyable for patients, and increase patient satisfaction (78,79). In our study, the fact that SG-based vestibular rehabilitation patients (n=18) who continued their follow-up were higher than traditional vestibular rehabilitation patients (n=12) who continued their follow-up completely explains this.

The use of SG technology for vestibular rehabilitation promotes adaptation and compensation by causing retinal shifting. Stimulation of retinal shift produces optokinetic eye movements, which in turn stimulate adaptive mechanisms. A virtual reality system dedicated to vestibular rehabilitation; symptom reduction, VOR gain, optokinetic response coordination and postural stabilization training (118). Micarelli et al. compared a 30-40 minute home-use vestibular rehabilitation protocol limited to two sessions a day for 4 weeks and vestibular rehabilitation with a 'track speed game' application using virtual glasses and a smartphone. Individuals in the virtual playgroup practiced an exercise protocol in which they tilted their heads to the right and left in a horizontal plane for 20 minutes. Patients in the SG-based rehabilitation group, compared with patients who received conventional vestibular rehabilitation alone, had an increase in VOR and a significant improvement in all functional, Emotional and physical subscores increased significantly (78). In our study, we aimed to reduce the symptoms in patients with vestibular compensation by increasing VOR gain, and a statistically significant improvement was found in all BDI, HAD (depression), HAD (anxiety) and DHI-S scores in group 2 who underwent SG-assisted vestibular rehabilitation in patients. When we looked at the traditional rehabilitation group, a statistically significant difference was found in HAD (depression), HAD (anxiety) and DHI-S scores; There was no statistically significant difference in BDI score.

Suarez et al. performed 6 weeks of vestibular rehabilitation using dynamic visual and optokinetic stimulation in a virtual reality (BRU) environment provided by HMD in older adults with vestibular disorders. They found that postural responses were significantly reduced compared to stationary visual spaces and fixed visual information (129). Pavlou et al. reported that incorporating a mixed visual environment into a therapeutic program is more effective than a single program or only Cawthorne-Cooksey exercises (130). Places where repetitive visual sensory stimulation is intense, such as supermarkets and shopping malls, increase dizziness and postural fluctuations and enable adaptation, but monitoring patient performance in real-life situations is impractical and may not be safe. Therefore, virtual reality offers a viable alternative to virtually immerse patients in real-life spaces in the safe environment of the clinic(75). Based on the findings of the literature, we gave exercises for navigating the supermarket and providing optokinetic stimulation in our SG-based vestibular rehabilitation exercises, and we observed a statistically significant result, especially in the subjective results of the patients.

In our study, the group that underwent vestibular rehabilitation without a virtual reality environment was the active control group. Vestibular rehabilitation exercises aim to increase vestibular ocular gain in head movements and increase static and dynamic postural stability in situations that produce contradictory sensory information. Vestibular rehabilitation has positive effects on static and dynamic balance, walking, confidence and quality of life, and reduces symptoms of dizziness, anxiety and depression (4).

In a 2012 study, Singh et al. compared the effects of a balance game and traditional balance exercises of increasing difficulty to the Nintendo® Wii Fit Balance Board in a virtual reality environment for 6 weeks in a 40-minute session twice a week. A simplified version of the Physiological Profile Approach was used to assess the risk of falling and the fear of falling, and FallScreen© computer software was used to calculate the risk of falling. The Activity-Specific Balance Confidence Scale was used to assess fear of falling. Researchers reported that a six-week exercise program increased balance confidence and reduced the risk of falls in patients who took both virtual reality games and traditional balance exercises (131). However, no significant difference was found between the two approaches. In our study, unlike this study, HMD SG-based vestibular rehabilitation was applied. Although we did not find any difference between the 2 groups in posturography tests and SVV tests, the SG-based vestibular rehabilitation group gave more significant statistical results on the BDI scale.

In a study, Verdecchia et al. planned to reveal measurements after Wii treatment and vestibular rehabilitation in patients with chronic unilateral vestibular hypofunction. This study included patients who underwent vestibular rehabilitation between April 2009 and May 2011. Dynamic Gait Index, DHI and Dynamic Visual Acuity were used as evaluation scales. All patients received Wii therapy. A total of 69 patients, 41 females and 28 males, with a mean age of 64 years, were included in the study. The starting DHI score is 40 points and the final score is 24 points. The starting point of the dynamic visual acuity index is 21 points and the end point is 23 points. All results were statistically significant (132). In our study, all patients who received both traditional and SG-based vestibular rehabilitation benefited from rehabilitation.

In a systematic review evaluating the effectiveness of vestibular rehabilitation in the elderly; The most common complaints associated with vestibular dysfunction in older adults have been found to be dizziness and imbalance, and the DHI scale is the most commonly used assessment tool to assess the impact of vertigo on quality of life. The exercise protocol proposed by Cawthorne and Cooksey has been widely used as a treatment protocol in studies with the elderly and

Vestibular rehabilitation therapy has been reported to be an effective tool in the management of elderly patients with vestibular dysfunction (133). Vestibular rehabilitation has been shown to be effective in improving activities of daily living, balance and gait impaired by vertigo and falls accompanied by depression and anxiety in people with vestibular dysfunction (134). In our study, we recorded significant statistical improvements in both the traditional vestibular rehabilitation group and the SG-based vestibular rehabilitation group on the DHI-S scale and on the HAD (depression) and HAD (anxiety) scales.

In a review by Eric et al., the goal was to provide a systematic interpretation of results reported by patients in vestibular clinical trials, and all publications from 1950 to 2013 were searched in the PUBMED, CINAHL, and PyscINFO databases. There was disparity in consensus among commentators. In the literature review, 2260 articles were initially found. 255 full texts were used for the evaluation. 104 studies that met the data collection criteria were included. Among the 50 measurements determined, 4 measurements were determined in particular. These measurements are DHI, vertigo symptom scale, special balance reliability scale, and visual visual analog scale (135). For this reason, we used the DHI-S form, which is the summary form of the DHI scale and has been proven to be valid, in our study (102).

Studies conducted in the last 20 years show that vestibular system diseases are not only related to the vestibular system, but also play an active role in cognitive processes (136). In the literature, it has been emphasized that the problem of imbalance in patients with unilateral vestibular loss is not only due to peripheral vestibular disease, and that disorders in this process may impair both cognition and spatial orientation (137). Individuals with vestibular disorders exhibit an imbalance in the activation of the postural control muscles, resulting in inappropriate postural situations. This postural imbalance can also be caused by serious cognitive effects, such as inattention to a given task (138). Patients were included in both groups of patients due to the fact that cognitive dysfunction may lead to imbalance in patients, and they were questioned with the MBSS scale. There was no statistically significant difference between the 2 groups in both MBSS scores and the measured time during the completion of the form.

These findings suggest that the use of virtual reality in vestibular rehabilitation is an effective treatment. These results are consistent with other literature studies. Previous studies have shown that the use of virtual reality in vestibular rehabilitation yields results comparable to conventional treatment and reduces symptoms.

There are several reasons why the use of virtual reality is effective in the treatment of vestibular rehabilitation. Virtual reality allows patients to control the environmental factors they may encounter in real life. For example, virtual reality games can control environmental factors, such as car racing on a racetrack. Therefore, controlling the factors that cause symptoms can help to achieve more successful results in the treatment process. In addition, virtual reality allows patients to be more involved in their treatment and rehabilitation programs. Virtual reality is fun, motivating, and increases the patient's involvement in the treatment process.

Considering these promising findings, we can advocate for the use of virtual reality devices in conjunction with traditional vestibular rehabilitation. The aim of this will be to maximize the effects on patients affected by unilateral vestibular hypofunction, even in the long term.

In conclusion, the use of virtual reality in vestibular rehabilitation can be seen as an effective treatment option for symptomatic patients. The use of virtual reality has been shown to help patients become more involved in treatment and rehabilitation programs. The use of virtual reality in vestibular rehabilitation can therefore be used more frequently and combined with other treatments.

6. RESULTS

In this study, in patients over 18 years of age with unilateral chronic vestibular dysfunction, traditional vestibular rehabilitation and virtual reality glasses-based vestibular rehabilitation exercises were performed in the short and long term; The effects of static and dynamic balance, risk of falling, fear of falling, anxiety and depression have been investigated and the results we have reached are as follows;

1. Statistically significant improvements were observed in the DHI-S scale, which evaluates dizziness after treatment, in patients who underwent virtual reality glasses-based vestibular rehabilitation.

2. Statistically significant improvements were observed in the DHI-S scale, which evaluates post-treatment dizziness in patients undergoing conventional vestibular rehabilitation.

3. A statistically significant improvement was found in the HAD (anxiety) subscale, which evaluates post-treatment anxiety in patients who underwent virtual reality glasses-based vestibular rehabilitation. Statistically significant improvements were observed in the CFD (depression) subscale, in which depression was evaluated.

4. A statistically significant improvement was found in the HAD (anxiety) subscale, in which anxiety was evaluated after treatment in patients undergoing traditional vestibular rehabilitation. Statistically significant improvements were observed in the CFD (depression) subscale, in which depression was evaluated.

5. In patients who underwent virtual reality goggle-based vestibular rehabilitation, a significant improvement was observed within the group in the scores of BDI, in which static and dynamic balance were evaluated, and in APSI and MLSI scores, which were evaluated by dynamic posturography. There was no statistically significant difference in GSI and DRT scores evaluated by dynamic posturography.

6. A statistically significant improvement was observed in the MLSI score evaluated by dynamic posturography, in which static and dynamic balance were evaluated after treatment, in patients undergoing traditional vestibular rehabilitation. There was no statistically significant difference within the group in GSI, APSI and DRT scores evaluated by BDI and dynamic posturography.

7. There was no statistical difference in static SVV and dynamic SVV tests after treatment in patients who underwent virtual reality glasses-based vestibular rehabilitation; It is observed that min-max values approach the neutral position.

8. There was no statistical difference in static SVV and dynamic SVV tests after treatment in patients undergoing traditional vestibular rehabilitation; It is observed that min-max values approach the neutral position.

9. Significant differences were observed in the direction of improvement in both groups, but; The groups were not found to be superior to each other in dynamic posturography tests and SVV tests.

10. In the comparison between the 2 groups, no statistically significant difference was observed between the dynamic posturography tests PST, DRT and mCTSIB subtests.

11. In the comparison between the 2 groups, no statistical difference was observed between static SVV and dynamic SVV.

12. There was no statistically significant difference in the BDI, CFD (depression), CFD (anxiety) and MBSS scales between the group that received SG-assisted vestibular rehabilitation and the group that received traditional vestibular rehabilitation.

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8. **APPENDICES**

EK-1:Dizziness Handicap Inventory-Screening Form

The American Journal of Otology
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A Screening Version of the Dizziness Handicap Inventory (DHI-S)

Gary P. Jacobson and Jaynee H. Calder

Division of Audiology, Henry Ford Hospital, Detroit, Michigan, U.S.A.

Instructions: The purpose of this scale is to identify any difficulties you may experience due to your dizziness or imbalance. Please answer each question with "yes", "no" or "sometimes". Answer each question only in relation to your dizziness or imbalance issue.

1	Due to your complaint, you will be suspended from your work, travels, and Do you restrict your hobbies?	Yes	Sometimes	No
2	From your complaints like dinners and cinema Are your social activities affected?	Yes	Sometimes	No
3	Without a person with you because of your complaint Are you afraid to leave your home?	Yes	Sometimes	No
4	In front of others because of your dizziness Are you embarrassed?	Yes	Sometimes	No
5	Dizziness when going downhill or off the curb Increasing	Yes	Sometimes	No
6	Distracting yourself from your dizziness Are you having difficulty?	Yes	Sometimes	No
7	Walking in the dark due to dizziness Would you have a hard time?	Yes	Sometimes	No
8	You may find yourself depressed because of your dizziness Do you feel it?	Yes	Sometimes	No
9	Dizziness can interfere with your work or home responsibilities Is it blocking?	Yes	Sometimes	No
10	Does bending over too much increase your dizziness?	Yes	Sometimes	No

Each question is given No (0), Sometimes(2), Yes (4) points. Full score 40.

APPENDIX-2: Berg Equilibrium Scale

erg Denge Ol egi

Has ta11111Adi 5oyad1: _ _ ______ History: _ / /_

Seating Position.ondairke11 Ayaja Kall<mak

Yon@rg! I!: Lumm,ay.aya kalkm. Ell rini!zd 11 .stekalmama,yaaf1 111.

☐', Ellei'irukullanma.-d'sari a.ya,ga kalkabilir,.. ekentli lendir.edenge saglayabtlir,

, ☐, Ellelini 11:ullar.arak stand up Can get up.

☐ llirka trydenso:nraelleri ku'.llanyla k.alkabik

☐, Ayaga k.a1kmak and kurm.ak ii;in (ok the yarthmail'itiy'.ao Yardk

☐ Ayaga.ka1krnak ii;irl oita duzeyd.e ya dak.)"ilrd:irna ih iyaci va.rdir_

.stE'ksisiz **Standing**

I' m a member of the 100-100-minute-old.

☐4 / minute EM11IYETLI k n o w source standing d'ura'b:ilif,

2 ☐J Ghazelirin al:t1nd112 minayaktil d'urabiland.

☐a ™steksi.! 30 saniy.e ay;:iktadu.rabilir.

☐, oestexitis is cautioned to try to be able to stand for 30 seconds. Wu.

☐Q 'fardim alritaidan IO cannot stand on the side.

ooksiiz Otumlak (Ark:aya1Ya:slanmadan Otmmak) (2_s;,oru 4 pmm I ail'e,tlenmlifSI!soruyu.a.tla}llrrnz}.

Yonarg:.: Lutfon koHarim.z1kavu urara',kiki dakii,l@ oturn11.

☐ I can sit for 2 minutes.

3i ☐ Gaze im ali:1mfa 2 minuteotll.'rabilir_

☐• 30 sani:,ieoturabUit

☐,, of 10 Sunny11eOtarbigi

☐h 10 seconds without support , az.,

A.m@lc to the otufflla Position when he is near

Y-on■r,g;e: Ol' Liitfon! Llrull.

☐1 EllerindlE!n asgani level:e y:utfirn Alarak Safety I tt"er -klt can sit down.

,4 ☐ Ellerind.en yan:foil a1ara.'k k-cm.trollii b e e r lilde okm:1r_

0a IBaaUanrylasandaty.eden d1mektakingkonnoll▫a$1!goes.

☐, Kend1 ba rna,grazing but not contr•O:ltu is not.

☐ Oturm.ak i,;in yattf1ma lhtiyac11vard11,

Trans.for

Yon■r,g; e: Sandalyel1Mi trans.fE!r yap1lacak@kilde gou! yerfoltiri11. Hastaya bir kalluldu bir de kolluksuz lcoltuga dogru yer d@,gi tirm .s.ini s.oyl@Yin.[l:i s:iooa[ye {birl1kollukl'.udige ıkolll!llmul ya d11blrcyatik V@ibir k:oltulk.u.11.arnabll i:!inl!.

5 ☐, l:lnj Law ,; Elk azkullanara:lt emni11etUbir $el:province transfer Olabiliyol'.

☐l Commanding one eliiJde transier It can be, Hands'n:i k.esjnlik kultlal.niyor.

☐ S.ozl,Guided by,and !:lci:tetim!e or göz.etimsiz.transfer.

☐, Yard1m edieoek ki iy,e need 'rilr.

Do Gu... endeolasii inyard1m edec:ekor gii.ze two,ki ,ye gereks[nim, Yar.

APPENDIX-3: Hospital Anxiety and Depression Scale

Hospital Anxiety and Depression Disorder (HAD)

(Hospital Anxiety and Depression Scale (HADS))

Patient's Name and Surname1: _ Date: ____ / ____ / ______

Read each article and the last one; The best expression of how you feel with your eyes on your giiniinii yan1tm Yamnd aki kut uyu i meat. Yamhmz ii,in t; :0k don't worry, the first thing that comes to mind will be the best.

1. I feel nervous, "like it's going to explode".

☐, (ogu zaman ☐, From time to time, sometimes
☐, A(ok time

2. I used to enjoy it, I still enjoy it.

☐0 Ayn1 as much as before ☐, It's just a little bit like before

☐, It's not as much as it used to be. ☐, Hir; A time

3. I'm terrified that something bad is going to happen.

Di Certainly is, and we have been(a fierce)

☐, Yes, but the arrow is not violent either

☐, a little, but it doesn't really criticize me

☐0 Hay1r, long; de i:iyle degii

4. I can laugh and see the funny side of things.

☐U As always ☐, It's definitely not that worth it.

☐, (ogu zaman ☐, Zaman Zaman, ok s1k degii
☐, Not so much now ☐, Art1k hi degil
☐, A(ok time To Yaln1zca pool

5. I had some thoughts in my mind; "I think it's a good

6. What a hand I feel.

☐, Never ☐, Sometimes
☐, Not S1k ☐0 I.....

7. I can sit comfortably *and* I feel comfortable.

On Absolutely ☐, not S1k
☐, Hir; A time

8. I feel like I'm m1 with stagnation.

☐1 Almost always ☐, Sometimes
☐, (ok s1k ☐0 Hir; A time

9. It's like, I'm getting nervous about whether I'm doing it.

Do Hi A Time ☐, 0lduk a s1k
☐, Sometimes ☐, (ok s1k

10. D1 view? I've lost interest in um.

☐1 Absolutely

☐, I don't pay as much attention as I should

☐, I may not show so much i:izen

☐0 I'm showing 6zen as usual

11. I feel uneasy like I always have to do something.

☐, And it's really OK ☐, (ok not too much
☐, 0lduk a more than Not Du Hi

12. I'm looking forward to what's to come.

☐0 As always

☐, a little less than usual

☐, certainly less than ever

☐1 Hemen hemen hi
☐, Ger ekten de ok s1k ☐, i:;:ok s1k degil
☐, 0lduk a s1k Do Hi A Time

13. Suddenly, I felt panicked.

14. enjoy a good book, television or radio program1

Can.

☐, S1klikla ☐, Pek s1k degil
☐, Sometimes ☐1 i:;:ok seyrek

The blue colored box is ir; In 1clan questions are anxiety, orange sub1 r; Questions with a grid of 1 give depression scores1. 0-7 points: normal ||| 8-1Oscore: s1nirda ||| llve iistU abnormal

Acta psychiatr. scand.1983:67:361-370 A. 5. Zigmond and R. P. Snaith

Total Score: Depression Anxiety

APPENDIX-4: Montreal Cognitive Assessment Scale

Montreal Cognitive Assessment

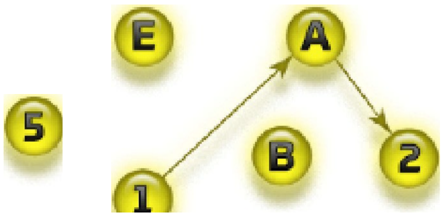
Montreal Cognitive Assessment (MoCA)

H11stmm Adi Soyad1: ______________________ Histor ___/___/_____

Momreal Bil ir; i'.rege:rhmdirm@ (Mo(AJ, hafif bili se1b02!u'klu'k i in h1 zl1bir ta@ma testi ol.iralo: 9'11lli liirilmi tir. 8\1 test lie dlkl<:rti,,e k.cmmilliM)'lm, yurutilcil ltli!"vler, oolIQ:, 11 :n,g011!11! I yap1landirma bet'@tllerl, soyuit daturw:e,h,mp'lam.' I V@Y<\Mli.m Oilmak.ili.eirea rali:lJ blli sel I levde!':ledendi1llmekNdl1.MoCA'nm uygul.'lmas1yaklat 10 dak!ika s rer.iestt:en al'ln,1bilectken yilksek teplam pua:n 30',d ur.Bunagfue 21 puan Vil!! as,1:and,e.1111:nl!ln puannorm.'ll Olln; ik degerlendJlllit.

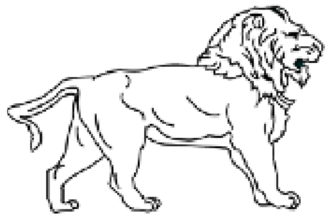
Wtfen 'I 'den ba lay.arak bir s.1 yi l:rir hart sm1s111,ebirbllinl IzleyeTlsay1 V@ harflel'lbir (lzgl liebillie t i:n.

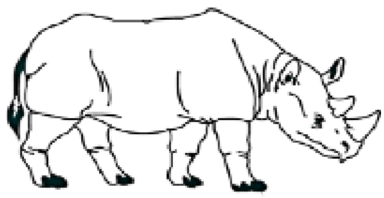
Left-handed::bu h.i,yi,,a ann name.si'.iyl,eyin Ldo NJ hillMll i;;,r i'ill')'Wlll ll!'iil I 1 p!l l'l].

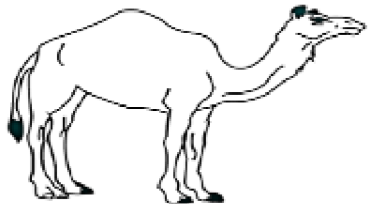
1 

4

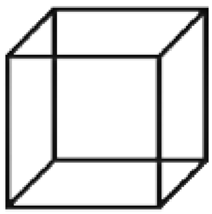
4







This is k!ll olablld gllill: elm 'll b ekIld yanch bo lug:i, ,i;l:iln (l;izim a Dimensional. . Tiim lzgiler izilmiJi (in,rnamJ flillad0nlzgi eklelV'IM!fl1ilalm0hz.,gils ! J<ir<!a p Rael""Read@nttr longjukl.fl almBl dikltiirt9@nlerprlmtl ILbul i!<lilirl

2 

Bubirbellek (hafiza) testldlr. Sl!!! e blr11:ellmel st:esl okuv.:.cag1mve b<tJ llstl!ideki11:ellmeleti imdl ve di!lM,s.<mra hat I maniz1lsteyec:eg1m_Olkkalfa dlnleyl.n. Ohl:m 1 bltlrd imde h::i.t1rlayab1ldlglnlz kadar(oll::k.elllfl'l,eyi:it.'lna s&y:11:!yln.t::elimel i hangl s1radl! ls&y:11:!diglnizonemli deglldl.r'. [Klltilim,=1- digl lterbir kelim I ilgil lwruye bir I 'm going to say, "I'm going to say,"H3tlllam.i,ya(al1,1n ve llk de11em,e,dye ledl!":llnlz

5 k.ellmelel'l d.l!! l!apsayacakeklld , l:t.'ln:i,1Mt1rlayab!lldl!}lnlz k.acla1 k keli.mes&y; leyln'. (t; e1ll11ntr11nsoyledigi li,melt i lnilklutU)fil ilB\fe lJir ilBl'<!t Oil kllfp'Un..)

b Sunnah (l:111) Sa:rata tm m1 tak.ln practice:n1 or ninety Q. 11 , 110

S ,ge,i;ey,igi'.is.tersl.n !!!f 1puan k0ml0r 1 puan1 ekle,p\f yelbmnl puBn).

D,

Dz

Of

'Testi.n End of it. that!li.mel,ffll h:rtul<'!manm isteyect i.m' deyln.

Burun□□ Kadifu□□ Ca.mi□□

Papatya ❏ ❏ Mo:rDD

Montreal! Bili sel Evaluation page-2

6 I'm going to tell you some numbers, after I'm done.
Repeat the figures I have discourse.

☐, 2 8 5 4

\+ Now I'm going to say another number1llar: slope, but this time after I'm done, then repeat the count1lan reverse s1rada

☐, 7 4 2

I'm going to read you a series of harts1m. Every time I say the letter A,

\+ Hand vunm to the table. If farkh one hart If I say, Hand Don't bang on the table. 1111;; 1acanJ

☐, FBACMNAAJKLBAFAKDEAAAJAMOFAAB

Now 7 from IOO until I tell you to stop.

\+ ,; I'd like to be the treasurer121. (2-3 points in 2 points and 4-5 points in 3 points; After counting the mistakes, the truths are collected, even if the correct continues.)

❑2

❑3

10(1 93 86 79 72

I will read you a sentence11m. I'll repeat the sentence exactly after reading it. Now say *"My only flildt°fim is the nose*
The person who needs help1 is Ahmed ofduga{Yanmn

7 then); Now I'm going to read you another 1m, I'm

Repeat it exactly after reading the dimlley1n.
'When the dogs are in the room, the cat is always hiding on the couch .

It must be complete and dajrn again'. Be aware of errors caused by the words omitted1$, use instead of11l'm11$, klenmi$ (e.g. omitted::. k', 'hep', can be substituted! That is the word private. 'hidden', 'hidden' and added keli,meler. When the children were in the room, her cat would always hide under the sofa 'in fear,' 1).

I'm asking you to say as many words as you can , starting with letters, which I'll give you a minute later. With proper names such as Ahmet, Izmir, numerals or ay1n1 kokte:n tiiretillmi nouns d1 1ndaany tiirlu you want

8 You can say it.Also, **stop you** when the **kika** is full
I will say. I-laz1r m1sm11z? Now the one that starts me with the letter K

☐ Say 1 word as much as you can (keep time for 60 seconds). Stop'.

60 sani,ye i inde 11 or,more,fa!la say,daword u,etil!di lie "I rate.Kat1l1mc1rnn yan,tla.,,n, save the test fo,mu in the space below it"

Tell me the similarity between ponacal and banana'
is called. If the can' t be wrong, it will be said to me , 'Give me this article; Tell me if there is a resemblance'

9 is called.If k.it1hmc1 does not produce the desired yamtl (fruit), 'Yes

They're both fruit.' Dah:a phaselaa9klama.

☐

10 Delayed recall; I have read all of the words you have read before.I want you to say those words ha,t1rlamamz1ve.The word you can remember say1in'. (Hi,; one,pucu bes111n spon!iln ol11rak do{iru hallrlanm,i nabir kerime i,; ooliimei$aret is put.)

❑1 ❑2 ❑3 ❑4 ❑5

Burun ☐1 Velvet ☐1 Mosque ☐1

In the sinful ☐,

Se m,eli; And I read some of the words before you did. I want you to remember and say those words.
Say the words you can remember.(Hi,; t,i, ipu(u, in Spontaneously, the word "Nerb" is put in the relevant section .)

BURUNipucu: vlirut bolumu (a< and the turd)

CAMI ipucu: bina Ulrii NEW DADTYAou:i:,e,e

PURPLE TIP:.onecolor

ipu,; If it doesn't work out despite the facts, it is given to the follower..'Beer! Which of the words I will count later, do you have done it before ? nose-yiiz-el lipek-cottonl'u-bdifelcami-school-hospitall giH-daisy-tulipII mor-ma.vi-y il

No points are awarded for words that are referred to Ipucuyard, m, lahat1r.!Pu lan is only clinically known andclinically informed.glamakamac,yla use. Katil1mc1 with the clue habrlayalbiliymsa,geri tirmeyeba.gli, ipumna despite the recall,tired,tired,encoding.baghbir memory bo2ukl'ugudil$iinulur.

11 Tell me the date of today.' If kat1hmc1 is a complete If he fails to answer, he can additionally add 'Ba:na,(day, month· , the year and the week of which guinu'. Then he said, ' Now to me
AD1N1 of the place we are in and the city we are in
Tell me'. (True each yamt i,in1 pointve,in.Killer1mc1larih and ye,i netve a,;,k (ha:s!ane, kllinlikin, ofi:sin, k11rum's name)should be si:yla"Kat1l1mc1 should not give points if he makes a mistake in any of the lunit.)

❑1 ❑2 ❑3 ❑4 ❑5 ❑6

Day☐,

Gilns n,eD, Buramn ad1☐, ehrinad1D,

N-"-ZS. Phillij,5 HA (20051 J Am Gmatr5oc 2005 Apr,'iJialJ:6115-9

1 Correct answer to each item: 1 point

❑2	Tren	Bicycle	Ula , ma, aa, travel, ride and ride both.
	Hour	Ruler	8l u ilra lan, 81,; Similar to mek i (numbersvar false1})

CTR la1111 Points (0-30): _{>21normal)