Istanbul Gelisim University Journal of Health Sciences (IGUSABDER), 25 (2025): 102-109.

Comparison of Fatigue Severity in Individuals with Vestibular Hypofunction*

Gamze KILIÇ**, Gönül ERTUNÇ GÜLÇELİK***, Ebru SEVER****, Adem AKTÜRK*****

Abstract

Aim: The aim is to compare fatigue severity in patients with unilateral and bilateral vestibular hypofunction.

Method: Patients with complaints of dizziness and balance were included in the study. The degree and direction of hypofunction of the patients were determined with videonystagmography test. Numerical Pain Scale was used to evaluate fatigue severity. Fatigue severity in patients with unilateral and bilateral vestibular hypofunction (VH) was compared.

Results: 100 patients with a mean age of 49.25±14.67 years were included in the study. It was observed that 37% of these patients had Right VH, 30% had Left VH and 33% had Bilateral VH. According to the hypofunction table, the fatigue severity of the groups was 6.57±1.96 in Right VH, 6.79±1.34 in Left VH and 7.51±1.44 in Bilateral VH. When fatigue severity was compared between the groups, no statistical superiority was found ($p \geq 0.05$).

Conclusion: There is no difference between the fatigue levels in Unilateral and Bilateral VH patients.

Keywords: Bilateral vestibular hypofunction, unilateral vestibular hypofunction, fatigue.

Vestibüler Hipofonksiyonu Olan Bireylerde Yorgunluk Şiddetlerinin Karşılaştırılması

Öz

Amaç: Unilateral ve bilateral vestibüler hipofonksiyonu (VH) olan hastalarda yorgunluk şiddetini karşılaştırmak amaçlanmıştır.

Yöntem: Baş dönmesi ve denge şikayeti olan hastalar çalışmaya katıldı. Hastaların hipofonksiyonunun derecesi ve yönü videonistagmografi testi ile belirlendi. Yorgunluk şiddetini değerlendirmek için Sayısal Ağrı Skalası kullanıldı. Unilateral ve bilateral vestibüler hipofonksiyonu olan hastalarda yorgunluk şiddeti karşılaştırıldı.

Bulgular: Çalışmaya yaş ortalaması 49,25±14,67 yıl olan 100 hasta dahil edildi. Bu hastaların %37'sinin Sağ VH, %30'unun Sol VH ve %33'ünün Bilateral VH olduğu görüldü. Hipofonksiyon tablosuna göre grupların yorgunluk şiddeti Sağ VH'de 6,57±1,96, Sol VH'de 6,79±1,34 ve Bilateral VH'de 7,51±1,44 idi. Gruplar arasında yorgunluk şiddeti karşılaştırıldığında istatistiksel olarak üstünlük bulunmamıştır ($p \geq 0{,}05$).

Özgün Araştırma Makalesi (Original Research Article)
Geliş / Received: 19.10.2024 & **Kabul / Accepted:** 24.02.2025
DOI: https://doi.org/10.38079/igusabder.1570183

* The oral presentation titled "Comparison of Fatigue Severıty in Individuals with Vestibular Hypofunction" was presented at the International Cappadocia Scientific Research Congress on 17.12.2021.

** Asst. Prof., Istanbul Nişantaşı University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul, Türkiye. E-mail: gamze.kilic@nisantasi.edu.tr ; fztgamzekilic@gmail.com ORCID https://orcid.org/0000-0002-3687-1014

*** Asst. Prof., Kocaeli Health and Technology University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Kocaeli, Türkiye. E-mail: gonul.ertunc@kocaelisaglik.edu.tr ; gonulertunc@gmail.com ORCID https://orcid.org/0000-0002-8319-1599

**** Lecturer, Kocaeli Health and Technology University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Kocaeli, Türkiye ; Istanbul Medipol University, Institute of Health Sciences, Physiotherapy and Rehabilitation Doctorate Program, Istanbul, Türkiye. E-mail: ebru.sever@kocaelisaglik.edu.tr ; fztebrusever@gmail.com ORCID https://orcid.org/0000-0002-9974-8718

***** Asst. Prof., Istanbul Gelisim University, Vocational School of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul, Türkiye. E-mail: draakturk@yahoo.com ORCID https://orcid.org/0000-0002-2487-5720

ETHICAL STATEMENT: This research has been approved by the ethics committee of Istanbul Nişantaşı University Rectorate Ethics Committee with the decision number 2024/01-SB dated 29.08.2024.

Sonuç: Unilateral ve bilateral VH hastalarında yorgunluk seviyeleri arasında fark yoktur.

Anahtar Sözcükler: Bilateral vestibüler hipofonksiyon, unilateral vestibüler hipofonksiyon, yorgunluk.

Introduction

Vestibular hypofunction (VH) is a condition resulting from partial or complete loss of vestibular function, occurring in the vestibular organs or the vestibular branch of the eighth cranial nerve, known as the vestibulocochlear nerve[1]. If the involvement is unilateral, it is defined as unilateral vestibular hypofunction (UVH), and if bilateral, it is termed bilateral vestibular hypofunction (BVH)[2]. The pathologies that lead to VH include Benign Paroxysmal Positional Vertigo (BPPV), Meniere's disease, labyrinthitis, vestibular neuritis, bilateral vestibular loss, and vestibular paroxysmia[3,4].

UVH is characterized by dizziness and balance disorders, accounting for approximately 14-20% of all inner ear pathologies[5]. If left untreated, it can lead to various chronic symptoms such as impaired movement and spatial perception, cognitive problems, autonomic complaints, and increased fatigue[6]. BVH, on the other hand, manifests with oscillopsia, imbalance, vertigo, dizziness, and cognitive and autonomic disorders. In addition to neurological symptoms, auditory symptoms such as hearing loss or tinnitus may also be present[7].

Fatigue severity in vestibular diseases is a significant factor that affects patients' participation in daily life activities. Disorders of the balance system can lead to increased energy expenditure due to the continuous effort to maintain stability, resulting in physical fatigue. Additionally, dizziness, disorientation, and cognitive overload caused by vestibular dysfunction can further contribute to emotional fatigue, negatively impacting overall well-being. Research indicates that chronic fatigue is commonly observed in vestibular diseases and significantly reduces quality of life. Therefore, assessing and managing fatigue severity should be considered a crucial component of the rehabilitation process for vestibular patients[8,9].

While fatigue is observed in patients with vestibular hypofunction, there is no clear evidence as to which group (unilateral or bilateral) experiences more severe fatigue. The aim of this study is to compare the severity of fatigue in patients with right and left unilateral and bilateral vestibular hypofunction.

Material and Methods

Study Design

The study included patients who presented with dizziness and balance problems at the Vestibular Rehabilitation Unit of Güneşli Erdem Hospital. Ethical approval was obtained from the Ethics Committee of Nişantaşı University on 29/08/2024 with the number 2024/01-SB. Informed consent forms were signed by patients who met the study criteria and were diagnosed with VH. Inclusion criteria for the study were being between the ages of 18 and 85 and having a diagnosis of peripheral VH. Exclusion criteria included inability to communicate and having neurological disorders. The degree and direction of hypofunction in patients were determined using videonystagmography testing. A demographic information form was used to collect details on age, gender, occupation, smoking and alcohol use, accompanying illnesses, surgeries, medications, daily activity level, medical history, onset and type of disease, falls in the past year, fear of heights, fear of darkness, and discomfort in crowded places.

Hypotheses of the Study

H1: Unilateral and bilateral VH patients differ in terms of fatigue severity.

Videonystagmography (VNG): The bithermal caloric test, a key component of the VNG assessment, is recognized as the gold standard for diagnosing vestibular hypofunction. It plays a crucial role in determining the severity, location, and whether the dysfunction originates from a central or peripheral source[10]. During the test, thermal stimuli are used to assess the vestibulo-ocular reflex and identify the affected side. The procedure involves delivering 8 liters of air at 50°C and 24°C to each tympanic membrane sequentially for 60 seconds, with 5-minute rest intervals. Involuntary eye movements (nystagmus) are then recorded for 120-140 seconds, calculated, and graphically analyzed[11]. When interpreting the results, the onset time, speed, and suppression of nystagmus during fixation are considered[12].

Assessment Methods

Demographic Data Form: It is a form consisting of questions such as name, surname, age, smoking and alcohol consumption, previous illnesses and/or surgeries, medications used, whether there is a history of falls, their frequency, fear of heights, whether they are bothered by the dark, severity of fatigue, etc.

Numerical Pain Scale: Fatigue was assessed using the Numerical Pain Scale. This scale is scored from 0-10 cm, where 0 cm represents "no fatigue" and 10 cm represents "extreme fatigue." Patients were asked to rate their fatigue on the scale from 0 to 10, and the provided value was recorded.

Data Analysis

Data analysis was performed using the “Statistical Package for Social Sciences” (SPSS version 25.0, SPSS Inc., Chicago, IL, USA). The demographic characteristics of the patients were expressed as numbers, percentages, means, and standard deviations. The One-Sample Kolmogorov-Smirnov test was used to check the normality of the data. One-Way ANOVA was used for statistical analysis.

The sample size was determined using the "G*Power sample size calculator". The sample size was calculated as 30 participants using the "ANOVA: Fixed effects, omnibus, one-way" design for three groups with a single repeated measurement, with a power of 95% ($\alpha=0.05$, $\beta=0.95$, $\lambda=19.20$, $F=3.35$) and an effect size of 0.05.

Results

The study was completed with 100 VH patients (mean age 49.25±14.67), aged between 18-65 years. The demographic characteristics of the VH patients are shown in Table 1.

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Table 1. Demographic characteristics

		Frequency (n)	Percent (%)
Gender	Female	72	72
	Male	28	28
Cigarette Consumption	No	74	74
	Yes	26	26
Alcohol Consumption	No	100	100
	Yes	-	-
Diagnosis	Right VH	37	37
	Left VH	30	30
	BVH	33	33
		Mean±Sd	
Age (years)		49,25±14,67	

Sd: Standard Deviation; VH: Vestibular Hypofunction; BVH: Bilateral Vestibular Hypofunction; n: Number of People; %: Percent

The comparison of fatigue severity between groups is given in Table 2. There was no difference in fatigue severity between groups (p ≥ 0,05).

Table 2. Fatigue severity assessment results

Fatigue Severity Assessment	**Right VH (n=37)**	**Left VH (n=30)**	**BVH (n=33)**	
	Mean±sd	Mean±sd	Mean±sd	p
Numerical Pain Scale (cm)	6,57±1,96	6,79±1,34	7,51±1,44	0,055

One-Way ANOVA test; SD: Standard Deviation; VH: Vestibular Hypofunction; BVH: Bilateral Vestibular Hypofunction; n: Number of People; * (p≤ 0.05).

Discussion

In this study, the hypothesis that fatigue severity differs between unilateral and bilateral vestibular hypofunction patients was tested; however, our findings did not support this hypothesis, as no significant difference in fatigue levels was found between the two groups.

It is well known that emotional fatigue can lead to physical fatigue. Accordingly, studies in the literature have predominantly focused on emotional fatigue in individuals with vestibular hypofunction, emphasizing its impact on overall well-being.

Extensive research on animals has indicated that damage to the vestibular system may be linked to cognitive deficits. However, human studies on this topic remain relatively limited compared to animal-based research. In recent years, emerging evidence suggests that vestibular disorders can lead to cognitive impairment. This growing body of evidence has spurred further investigations into the interaction between the cognitive system and the vestibular system, as well as the underlying pathophysiological mechanisms.

A 2022 review by Divya et al. examined the current literature on the pathophysiology of cognitive-vestibular interactions, highlighting the clinical significance of these findings.

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The review involved a systematic search using keywords such as "brain fog", "cognition", "cognitive impairment", "chronic fatigue", "attention", "memory", "spatial orientation" and "vestibular hypofunction". The results revealed that individuals with vestibular disorders often experience long-term deficits in both spatial and non-spatial cognitive domains. While the exact mechanisms linking the vestibular system to cognitive functions remain unclear, various neurobiological correlates have been identified. The authors also stressed the need for further studies to identify individuals at risk of cognitive decline and to determine whether treating vestibular hypofunction (VH) can reverse these deficits[13]. This study aimed to assess the presence of chronic fatigue in individuals with VH and to explore whether the impact of hypofunction in specific vestibular regions correlates with the severity of fatigue.

In a 2006 study by Hanes and colleagues, it was noted that patients with vestibular disorders often report symptoms such as chronic fatigue, brain fog, and memory loss. However, systematic research into the extent of the vestibular system's involvement in cognitive functions has only recently begun. As our understanding of the pathophysiology of cognitive decline and imaging technologies has advanced, this previously overlooked area of research is gaining attention. Physical fatigue can lead to cognitive dysfunction, triggering a condition known as "brain fog". This condition manifests with symptoms such as difficulty concentrating, memory problems, and mental cloudiness. Brain fog symptoms are particularly common in cases of chronic fatigue. Animal models have demonstrated that vestibular damage can result in a variety of cognitive deficits, particularly those related to spatial memory and navigation. Emerging human studies also suggest that vestibular loss can cause long-term cognitive impairments not only in visuospatial abilities but also in areas such as memory, attention, and executive function[14].

Functional imaging has revealed that the vestibular system is connected to several cortical areas, including the hippocampus, inferior parietal lobe, and temporal gyrus. Specifically, the transmission of vestibular signals to the hippocampus plays a crucial role in cognitive processes such as spatial memory and navigation. Additionally, the connections with the inferior parietal lobule and superior temporal gyrus facilitate the integration of vestibular inputs in attention and perceptual processing. The interactions with these cortical regions support the comprehensive role of the vestibular system in cognitive functions. Therefore, the connections between the vestibular system and these cortical areas are critical for a holistic understanding of cognitive processes[15]. In a 2003 study by Brandt et al., comparisons between patients with bilateral vestibular hypofunction (BVH) and healthy controls showed that those with BVH had significantly reduced hippocampal volumes[16]. Similarly, a 2007 study by Hüfner et al. found that hippocampal atrophy was more pronounced in BVH patients compared to those with unilateral vestibular hypofunction (UVH)[17].

Further research by Dieterich and colleagues in 2008 suggested that, beyond the hippocampus, other brain regions such as the temporoparietal cortex, retrosplenial cortex, putamen, anterior cingulate cortex, insula, and subiculum also receive vestibular projections. This finding highlights that patients with VH may experience cognitive

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difficulties due to dysfunctions in these areas, requiring greater effort to perform daily tasks, which in turn may contribute to chronic fatigue[18].

In a 2015 study by Harun et al., it was found that VH primarily impacts cognitive rather than functional activities, with cognitive impairment being a major predictor of disability and handicap in individuals with VH. The authors also noted that fatigue, as a secondary consequence of cognitive impairment, negatively affects the quality of life in these patients[19].

In this study, we evaluated the presence of chronic fatigue in patients with both unilateral and bilateral VH, taking into account the cognitive and daily life impairments linked to the affected vestibular regions. Our findings showed no significant difference in fatigue levels between individuals with right-sided, left-sided, or bilateral vestibular hypofunction, leading us to conclude that VH can lead to fatigue regardless of the affected side.

A 2018 study by Tramontano et al. explored the effects of vestibular rehabilitation on balance, fatigue, and daily living activities in patients with multiple sclerosis (MS). In a sample of 30 participants with EDSS scores of 6-7, the experimental group (which received vestibular rehabilitation) showed significant improvements in fatigue levels and daily activity performance compared to the control group. This research demonstrated that vestibular rehabilitation can help reduce fatigue and improve balance and daily functioning in MS patients[20].

Similarly, a 2022 study by Ghaffari investigated the effects of vestibular rehabilitation on fatigue and depression in stroke patients. The study found that patients who underwent 24 sessions of vestibular rehabilitation showed significant improvements in fatigue levels, as measured by the Fatigue Impact Scale and Fatigue Assessment Scale, compared to those who received standard rehabilitation. These results suggest that vestibular rehabilitation can effectively alleviate fatigue and improve daily functioning[21].

Conclusion

These findings highlight the importance of rehabilitation programs for patients with vestibular hypofunction in clinical settings. In particular, vestibular rehabilitation may serve as an effective intervention for managing fatigue, enhancing participation in daily activities, and ultimately improving quality of life. Furthermore, considering that fatigue severity does not differ based on whether vestibular dysfunction is unilateral or bilateral, rehabilitation approaches can be applied similarly across all patient groups. Accordingly, clinicians can incorporate vestibular rehabilitation into standard treatment plans to support patients' functional independence and overall well-being.

Limitations of the Study

• Using the Numerical Pain Scale to assess fatigue severity may prevent objective results.

• The sample size was limited to 100 participants.

• There was an inability to match the number of patients with unilateral and bilateral vestibular hypofunction equally

Conflicts of Interest/Competing Interests Employment: The authors are not employed by any organization.

Financial Interests: The authors have no financial interests.

Non-financial Interests: The authors have no non-financial interests.

Strengths of the Study

• Highlighted fatigue as a symptom that should be considered in vestibular hypofunction.

• Contributed to the limited number of studies on this subject in the literature.

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