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VESTİBÜLER BOZUKLUĞU OLAN HASTALARDA KALÇA STRATEJİSİ KULLANIMI: RETROSPEKTİF BİR ÇALIŞMA

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ÖZET

Amaç: Duruş ve hareket için kullanılan üç ana postüral strateji ayak bileği, kalça ve adımlama stratejileridir. Ağırlık merkezi izdüşümü sınırları içindeyken ayak bileği ile denge sağlanırken ağırlık merkezi bu sınırların dışına çıktığında kalça stratejisi kullanılır.. Bu çalışmanın amacı, vestibüler sistem bozukluğu olan hastaların postürlerini ayarlarken hangi stratejiyi kullandıkları ve düştüklerinde hangi stratejiyi kullanamadıkları araştırmaktır.

Materyal-Metod: 2014-2021 yılları arasında İstanbul Medipol Üniversitesi Mega Hastanesi Odyoloji Kliniğine başvuran ve vestibüler disfonksiyonu olan 40 kişi ve sağlık 40 kişi çalışmaya alınmıştır. Katılımcılar bilgisayarlı dinamik postürografi test ile değerlendirildi. Katılımcıların duyusal organizasyon testi (SOT) puanları için değerlendirildi.

Bulgular: Ayak bileği stratejisi, SOT 5. ve 6. durumlarında vestibüler disfonksiyonlu hastalara göre anlamlı şekilde daha bir iyi çıktı ($p<0.05$). Hastaların düştükleri ve düşmedikleri durumlardaki strateji skorlarında da anlamlı fark gözlendi ($p<0.05$). 5. koşuldaki puanların düşme ve düşmeme karşılaştırılmasında anlamlı olarak bir fark gözlenirken, 6. koşulda önemli bir fark gözlenmedi.

Sonuç: Vestibüler hipofonksiyonlu hastalarda düşmeyi azalmak için vestibüler rehabilitasyon planlanırken kalça stratejisi egzersizlerine önem verilmelidir.

Anahtar Kelimeler: Postür, düşme, hareket, kalça, ayak bileği

USE OF HIP STRATEGY IN PATIENTS WITH VESTIBULAR DISORDER: A RETROSPECTIVE STUDY

Abstract

Objective: The three main postural strategies used to adjust posture and movement are ankle, hip and stepping strategies. While normal individuals use ankle strategy when center of gravity (COG) is within the limits of stability, they transition to hip strategy when COG approaches or exceeds the limits of stability. The aim of this study is to investigate which strategy is dominantly used by people with vestibular disorders whilst adjusting their posture and which strategy cannot be used when they fall.

Materials & Method: Forty patients who had been refered to Istanbul Medipol University Mega Hospital Audiology Clinic and wascdiagnosed with vestibular dysfunction and forty healthy individuals evaluated between the years 2014-2021 were included in the study. The participants were assessed for balance with the computer dynamic posturography. Participants` sensory organization test (SOT) scores were collected for evaluation.

Results: Use of ankle strategy was superior in normal individuals in comparison to individuals with vestibular disorders using SOT 5th and 6th conditions ($p<0.05$). Significant difference was observed between the strategies used by the participants in situations where they did and did not fall ($p<0.05$). While a statistically significant difference was observed in the comparison of falls within 5th condition, a significant difference was not observed in 6th condition.

Conclusion: Due to the impairment of the vestibular system leading to the usage of the ankle strategy in challenging conditions, patients with vestibular defects fall more frequently. During the planning of vestibular rehabilitation for such patients, improving the hip strategy should be considered essential.

Keywords: Posture, falls, movement, hip, ankle

1. INTRODUCTION

Postural stability is maintained by the integration of vestibular, visual and somatosensory inputs to produce motor output. The balance system adjusts the position (or movement) of the head and body (1,2). There are three main postural strategies used to adjust posture and movement: ankle, hip and stepping strategies (3,4). Ankle strategy is the activation of muscles around the ankle joint after the disturbance of base of support when standing on a firm support surface. A significant amount of ankle strength and mobility is required for the successful execution of said strategy (4). The hip strategy is especially useful in narrow spaces and with quick turns of the trunk and the hip. The body uses stepping strategies other than fixed-support strategies, depending on the direction, location, and size of the postural perturbations (5). These postural control strategies are programmed by the central nervous system and they adjust the physical position according to expectations and experiences (6,7). While normal individuals use ankle strategy when centre of gravity (COG) is within the limits of stability, they use hip strategy when COG approaches or exceeds the limits of stability (8–11).

Computed dynamic posturography (CDP) is an objective method used to identify and distinguish balance system disorders. CDP evaluates balance problems and provides the level of insufficiency with multisensory analysis (12,13). CDP systems can also provide some information about the movements of ankles, hips and upper body to maintain balance. The outcome of these data are reflected in CDP as strategy scores.

Shear forces and the sway frequencies give us information about the forementioned strategies. Low frequencies and small shear forces are primarily related to the ankle strategy while higher frequencies and larger shear forces are related to the hip strategy (14). The aim of this study is to investigate which strategy is dominantly used by people with vestibular disorders whilst adjusting their posture and which strategy is used when they fall.

2. MATERIAL AND METODS

Hasta Seçimi

The experiments were approved by the Human Ethics Committee of Istanbul Medipol University (05/10/2018 - 535). The described study has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki).

Patients who complained of dizziness and/or vertigo between the years 2014-2020 and were evaluated at Medipol Mega University Hospital with sensory organization test (SOT) in Natus NeuroCom Smart EquiTest® Computer Dynamic Posturography (Natus Medical Incorporated, San Carlos, CA, USA) were assessed. Forty patients (24 males - 16 females, age = 46.75 ± 17.3) and forty healthy individuals (26 males - 14 females, age = 44.57 ± 14.8) were included in the study.

Inclusion Criteria

The included patients were diagnosed with acute bilateral vestibular hypofunction. Inclusion criteria for patients were decreased SOT vestibular system data (pathological) and a SOT composite score below 70. In addition, the patients did not take a vestibular suppressant before assessments. The control group consisted of healthy individuals that had no visual, physical, neurological and psychological impairments with SOT composite scores above 70.

Study Protocol

There are six different conditions in the SOT and Table 1 shows which systems are used predominantly to establish balance in these conditions. Each condition includes three trials and all of the individuals participated in these 18 trials. In the 5th condition, the support surface is unstable, and eyes are closed. In the 6th condition, the support surface and visual area are unstable. These conditions both cause obstruction of the visual data and reduction of the somatosensory data therefore the vestibular system is dominantly used (Table 1).

The device measures the strategy scores via the formula (Movement Strategy=(1-(SHmax-SHmin)/25)*100). In this formula, 25 lbs. are the difference measured between the greatest shear force and the lowest shear force generated. This comparison is expressed as a percentage, with scores near 100 indicating little if any shear (i.e., full ankle strategy), while scores approaching zero indicate maximum shear (i.e., full hip strategy). Postural strategy scores are valued between 0-100. If the usage of the hip strategy is more dominant the score is close to 0, while if the ankle strategy is the dominant strategy the score is closer to 100 (Fig 1) (15). For this study, sensory analysis and strategy scores in SOT were compared. In addition, we investigated the 5th and 6th conditions strategies used by these patients if they fell.

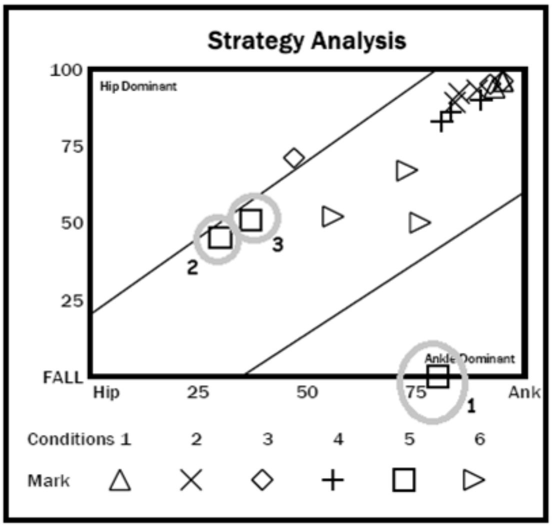

Fig. 1 Image of strategy analysis of a patient whose vestibular dysfunction was not very advanced and who had decreased his balance due to using ankle in the first attempt of situation 5 in SOT and who had a hip strategy in the second and third attempt.

İstatistiksel Analiz

SPSS IBM 22.0 program was used to for statistical analysis. Normal distribution of the values was measured using One-Sample Kolmogorov-Smirnov test. Mann Whitney U was used to determine whether there was a significant difference between the values. Significance value was taken as 0.05.

3. RESULTS

There was a significant difference in composite scores and vestibular data between patients with vestibular disorders and the control group ($p=0.000$). Furthermore, significant differences were found in the SOT visual and somatosensory data ($p<0.05$), however there was no significant difference in the preference data (Table 2).

It was determined that the use of the ankle strategy was statistically significantly better in normal individuals in comparison to individuals with vestibular disorders in all conditions but the 1st and 2nd. ($p<0.05$) (Table 3).

In addition, in the evaluations of patients with vestibular dysfunction, a significant difference was observed in the 5th condition in the situations in which they fell and the ones they did not fall. ($p=0.004$). While a statistically significant difference was observed in the comparison of falls within 5th condition, a significant difference was not observed in 6th condition (Table 4).

4. DISCUSSION

Automatic postural movements are functionally effective responses that help maintain balance while an individual is standing up (16,17). Postural movements include movements of the ankle joints, knee joints and articular joints. Although the amplitude of automatic movement is related to the intensity of the triggering somatosensory stimulus; visual input, vestibular input, and the individual's experiences also affect the amplitude of the response (9,16,18). In our study, we investigated patients with vestibular dysfunction using CDP. As we expect, patients' vestibular data and average balance scores (composite) were statistically worse than normal individuals. These results also show that somatosensorial and visual data are statistically better in favor of normal individuals. Thus we see that automatic postural movements cannot work efficiently without vestibular inputs.

According to Horak and Nashner, the ankle strategy relies more on the somatosensory system in comparison to the vestibular system (14). Furthermore patients with vestibular dysfunction use the ankle strategy since they cannot use the hip strategy especially in tough situations such as standing in narrow spaces and/or while tiptoeing (19,20). The amplitude and velocity of ankle movements are biomechanically limited by the torque that can be applied to the ankles before the feet rise from the support surface (21). In relation to this, no statistical difference was found in the strategy scores of the first four conditions of SOT in which at least two systems (visual, somatosensory, vestibular) were operating normally in our study. However, there was a difference in 5th and 6th conditions, where the primary objective is to test the efficiency of the vestibular system. The vestibular system is considered more reliable while using the hip strategy for posture adjustment (1). That is why we found insufficient hip usage in patients with vestibular dysfunction in 5th and 6th conditions.

According to Keshner, patients with vestibular dysfunction cannot use hip strategy even though there is nothing preventing them physically (22). Instead, they choose to take steps in the needed direction to maintain upright posture. For the hip strategy to work correctly and effectively the trunk and body should be well aligned in regard to gravity (23). This situation supports the connection between the vestibular system and the hip strategy. In our study, patients with vestibular dysfunction who cannot use the hip strategy effectively were shown to be more of a fall risk. It was observed that in conditions where they fell, especially the 5th condition where the eyes are also closed, they had no usage of hip strategy.

Considering the interactive dependence of complex balance systems in various environments, interventions in the vestibular sense, which is one of the sensory strategies, may affect the reactive postural control of motor strategies (24). Mitsutake et al. (2021) observed that the vestibular system must adapt to changes of the visual and somatosensory inputs in order to maintain balance in the "Eyes Closed" foam balance assessment, where the hip strategy is used more actively (25). Mitsutake et al. (2022), in another study conducted with galvanic vestibular stimulation, suggested that the ankle joint movement effectively reduces the compensatory strategy of reactive postural control under vestibular-dominant postural control conditions (24). These results show us the connection between the vestibular system and hip strategy, as found in our study.

6. CONCLUSION

We saw that patients with vestibular dysfunction fall more frequently. The reason for this may be the desuetude of the hip strategy. Unusual body movements, such as rapidly flexing the knees or waving the arms, can also produce large high-frequency shear oscillations and keeping balance with hip strategy. Therefore, during the planning of vestibular rehabilitation for such patients, improvements of the hip strategy and automatic postural movements should be considered within the vestibular rehabilitation exercises. These said improvements would ensure less falls for the patients as well as an overall better posture.

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Tables

Table 1. Disturbed and evaluated systems in SOT (1)

Condition	Disturbed Systems	Evaluated Systems
1st Condition	-	Somatosensory
2nd Condition	Visual	Somatosensory
3rd Condition	Visual	Somatosensory
4th Condition	Somatosensory	Visual
5th Condition	Somatosensory + Visual	***Vestibular***
6th Condition	Somatosensory + Visual	***Vestibular***

Table 2. The comparison of sensory analysis score in SOT

Sensory Analysis	Groups		P
	Vestibular Disorders Mean (SD)	Normal Individuals Mean (SD)	
COM	59.89 (8.22)	79.50 (4.40)	0.000**
SOM	0.97 (0.08)	0.98 (0.01)	0.006*
VIS	0.81 (0.07)	0.85 (0.05)	0.027
VEST	0.28 (0.23)	0.73 (0.07)	0.000**
PREF	1.03 (0.15)	0.97 (0.05)	0.123

*p≤0.05, **p≤0.001

Table 3. The difference of postural strategy score of conditions

Condition	Groups		P
	Vestibular Disorders Mean (SD)	Normal Individuals Mean (SD)	
1	93.46 (3.59)	94.66 (1.84)	0.477
2	92.20 (3.77)	93.66 (2.44)	0.166
3	89.87 (6.40)	92.77 (3.43)	0.088
4	83.47 (7.99)	86.44 (5.54)	0.169
5	76.40 (7.84)	67.73 (13.97)	0.013*
6	78.10 (7.47)	71.63 (11.1)	0.012*

*p≤0.05

Table 4. The difference of postural strategy score of conditions 5th and 6th in falling situations

Condition	Groups		P
	Trial when patients fell Mean (SD)	Trial when patients did not fell Mean (SD)	
5+6	68.12 (29.92) n=47	59.09 (19.62) n=42	0.001**
5	70.77 (27.65) n=31	61.34 (16.61) n=26	0.003*
6	63.00 (34.26) n=16	55.43 (23.85) n=16	0.181