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Original article

EVALUATION OF HADO SPORT WITH STATIC POSTUROGRAPHY

OĞUZ YILMAZ[1], DUDU BANU ÇAKIR[2], KEREM ERSİN[1], OĞULCAN GÜNDOĞDU[1], EMRE GÜRLEK[1], HAKAN GÜLER[1], GÜL ÖLÇEK[1]

Abstract

Objective. Balance is one of the most important factors referred to as an ability to maintain the body in space. Human balance system consist of vestibular system, visual system and proprioseptif system. Static posturography is an important balance control test and is usually used for patients with postural instability or vestibular disorders. HADO is a sport game called technospor dominated by augmented reality where the balance system is used extensively. The aim of this study, investigate the effect of HADO on the balance system.

Methods. People who had not professional HADO sports were included in the study. The average age of the participants was 20.62 ± 1.63. Static posturography and balance tests were applied to the subjects before and after HADO sports. Results before and after sports were compared. The analysis of the data obtained was made with the Wilcoxon Sign Rank test.

Results. In the comparison of Romberg foam eyes open HADO sport before and after HADO sport, a statistically significant difference was found between the test performed before and after the sports test ($p < 0.05$). No statistically significant difference was found in other static posturography and balance evaluations ($p > 0.05$).

Conclusions. It was concluded that practicing HADO sports for a short time did not have effect on posture.

Key words; Balance, HADO, Static Posturography, Augmented Reality, Vestibular System.

Introduction

In many sports branches, superior balance ability is required in order to achieve the highest level of competition and to avoid any injury. A good balance correlates positively with enhanced athletic performance and negatively with sports injuries (Han et.al., 2015). Balance system is a complex one that consists of cerebral cortex, subcortical region, and spinal cords efferents and afferents of the visual, auditory, somatosensory and proprioceptive systems (Shin et.al., 2015.). In addition to this, it is a function that is affected by high cortical functions such as wakefulness and attention and all kinds of internal and external environments that affect these functions (Ardiç, 2005).

Impairments in balance performance and postural instability are also shown as risk factors for sports injuries (Bahar, 2019). Efficient postural balance not only reduces the risk of imbalance in the body, falls, or future injuries but also contributes to the optimization of motor performance in various athletic disciplines (Brachman et.al., 2017).

Posturography systems, which are accepted as "the gold standard" in balance assessment, grants quantitative data about postural control by assessing the systems that provide postural control. Posturography is a general term used for methods that measure postural stability and balance function on static or dynamic measurement platforms. While dynamic posturography methods provide the measurement of mechanisms, inputs and central integration that constitute effective postural balance, static posturography systems help the measurement of changes in the center of pressure (Musat, 2013). These methods are frequently preferred in balance assessment because they are objective measurement methods and do not require subjective interpretation.

Smartphone motion accelerometer program is a postural balance assessment application that uses a motion accelerometer program. These programs, each of which is installed separately on each smartphone, are motion accelerometer programs that are based on the Android operating system. These programs use the momentary acceleration of a smartphone for assessment by using the built-in accelerometer according to the x, y, and z axis. It records one dot

[1] Audiology Department, Faculty of Health Sciences, Istanbul Medipol University, Istanbul, Turkey
[2] Neurosports and Sports Department, Faculty of Sports Sciences, Fenerbahçe University, Istanbul, Turkey
Email: hakann.guler7@gmail.com
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every 60 ms and 1000 dots per minute. The data process is conducted by dividing a horizontal plane into eight planes and data is processed in each plane. The data process includes the sum of data points that are distributed from each plane, the distance between the origin point and the furthest data point, and the percentage of points located in the specific plane. It is a simple and affordable balance assessment method to control, so it is highly practical to assess the postural balance in daily life (Park et.al., 2013).

Augmented reality (AR) is the addition of a computer-generated image to a user's real-world view to provide a composite view. Augmented reality can be realized by using transparent stereoscopic screen, transparent holographic or volumetric three-dimensional screen (Krueger, 2017; Valis et.al., 2012). HADO is a 3-to-3 team sport that combines the head mounted display (HMD), smartphone, AR, and dodgeball, creating a brand-new experience that we call "Techno Sports".

We aim to investigate the effect of HADO on the vestibular system by making vestibular assessments on the participants who play HADO before and after the game. Fort his study, static posturography (modified CTSIB, Unilateral Stance, Romberg test) and balance test were applied to 20 athletes who play HADO.

Methods

The study was conducted in İstanbul Medipol University between 01/02/2021-01/03/2021. 14 individuals between the ages of 18-25 who had not practiced any professional sports before participated in the study.

The aims and the duration of the study, all practices and expectations were explained too all participants in the study and their consent forms were signed. Inclusion criteria in the study was determined as being between the ages of 18-25, not having practiced any professional sports, not having physical disability, neurological, visual or orthopedic problems.

The study of "Evaluation of HADO Sport with Static Posturography" has been approved by İstanbul Medipol University Girişimsel Olmayan Clinical Research Ethics Committee with the order number 20, dated 07/01/2021.

Individuals who had not done professional sports before participated in the study. Static Posturography and balance tests were applied to individuals before HADO sport and after one competition of it. A comparison of pre-sports and post-sports values was made.

The data analysis of our study was conducted by using "Statistical Package for Social Sciences" (SPSS Inc., Chicago, IL, USA) statistical software. The mean and standard deviation (Mean±SD) are given in descriptive statistical data. Statistical significance level was accepted as 0.005 in all analysis results.

"Kolmogorov-Smirnov Test" was used in order to find out whether the data collected in the study showed normal distribution or not. The data obtained according to the test result did not show normal distribution and nonparametric tests were used. The data obtained from Static Posturography and Balance tests before and after HADO sports were compared by using "Wilcoxon Sign Rank Test". The statistical significance level in the result was accepted as 0.05.

Results

The ages of the cases included in the study are between 18-25 and their mean age is 20.62±1.63.

No statistically significant difference was observed in the comparison of the Balance tests data before and after HADO sports (p>0.05) (Table 1., Table 1.1., Table 1.2. ve Table 1.3.).

Table 1. The comparison of the Balance tests data before and after HADO sports

	M±SD	P
BALANCE EYES OPEN ANTERIOR LEFT BEFORE MATCH	4,52±6,83	0,737
BALANCE EYES OPEN ANTERIOR LEFT AFTER MATCH	5,78±7,06	
BALANCE EYES OPEN ANTERIOR RIGHT BEFORE MATCH	7,55±10,54	0,923
BALANCE EYES OPEN ANTERIOR RIGHT AFTER MATCH	7,18±13,37	
BALANCE EYES OPEN LEFT ANTERIOR BEFORE MATCH	6,44±19,73	0,648
BALANCE EYES OPEN LEFT ANTERIOR AFTER MATCH	4,20±8,48	

BALANCE EYES OPEN LEFT POSTERIOR BEFORE MATCH	6,93±11,15	0,28
BALANCE EYES OPEN LEFT POSTERIOR AFTER MATCH	3,58±5,30	

***p<0.05**

Tablo 1.1. The comparison of the Balance tests data before and after HADO sports

	M±SD	**P**
BALANCE EYES OPEN POSTERIOR LEFT BEFORE MATCH	5,22±7,78	0,829
BALANCE EYES OPEN POSTERIOR LEFT AFTER MATCH	4,88±9,39	
BALANCE EYES OPEN POSTERIOR RIGHT BEFORE MATCH	3,32±4,33	0,701
BALANCE EYES OPEN POSTERIOR RIGHT AFTER MATCH	4,12±5,57	
BALANCE EYES OPEN RIGHT ANTERIOR BEFORE MATCH	8,27±11,04	0,962
BALANCE EYES OPEN RIGHT ANTERIOR AFTER MATCH	8,18±10,20	
BALANCE EYES OPEN RIGHT POSTERIOR BEFORE MATCH	5,60±6,94	0,719
BALANCE EYES OPEN RIGHT POSTERIOR AFTER MATCH	8,10±12,22	

***p<0.05**

Tablo 1.2. The comparison of the Balance tests data before and after HADO sports

	M±SD	**P**
BALANCE EYES CLOSED ANTERIOR LEFT BEFORE MATCH	4,24±6,10	0,848
BALANCE EYES CLOSED ANTERIOR LEFT AFTER MATCH	3,86±5,22	
BALANCE EYES CLOSED ANTERIOR RIGHT BEFORE MATCH	7,99±13,27	0,737
BALANCE EYES CLOSED ANTERIOR RIGHT AFTER MATCH	11,15±22,67	
BALANCE EYES CLOSED LEFT ANTERIOR BEFORE MATCH	3,05±6,18	0,201
BALANCE EYES CLOSED LEFT ANTERIOR AFTER MATCH	5,69±10,73	
BALANCE EYES CLOSED LEFT POSTERIOR BEFORE MATCH	3,42±6,26	0,757
BALANCE EYES CLOSED LEFT POSTERIOR AFTER MATCH	5,57±13,17	

***p<0.05**

Tablo 1.3. The comparison of the Balance tests data before and after HADO sports

	M±SD	P
BALANCE EYES CLOSED POSTERIOR LEFT BEFORE MATCH	4,28±6,80	0,501
BALANCE EYES CLOSED POSTERIOR LEFT AFTER MATCH	2,72±3,85	
BALANCE EYES CLOSED POSTERIOR RIGHT BEFORE MATCH	5,99±8,08	0,341
BALANCE EYES CLOSED POSTERIOR RIGHT AFTER MATCH	5,10±11,71	
BALANCE EYES CLOSED RIGHT ANTERIOR BEFORE MATCH	8,09±14,10	0,943
BALANCE EYES CLOSED RIGHT ANTERIOR AFTER MATCH	7,10±9,88	
BALANCE EYES CLOSED RIGHT POSTERIOR BEFORE MATCH	10,77±25,69	0,395
BALANCE EYES CLOSED RIGHT POSTERIOR AFTER MATCH	4,49±6,22	

***P<0.05**

In the comparison of the static posturography test data before and after HADO sport, a statistically significant difference was observed in the paired comparison of romberg1 foam eyes open cop-romberg2 foam eyes open cop ($p<0.05$). (Table 1.4., Table 1.5., Table 1.6.,

Table 1.4. Comparison of Static Posturography Balance data before and after HADO

MCTSIB COMPOSITE BEFORE MATCH
MCTSIB COMPOSITE AFTER MATCH
MCTSIB SOM SISTEM BEFORE MATCH
MCTSIB SOM SISTEM AFTER MATCH
MCTSIB VISUAL SISTEM BEFORE MATCH
MCTSIB VISUAL SISTEM AFTER MATCH
MCTSIB VESTIBULAR SISTEM BEFORE MATCH
MCTSIB VESTIBULAR SISTEM AFTER MATCH

***p<0.05**

Table 1.5. Comparison of Static Posturography Romberg data before and after HADO

	M±SD	P
ROMBERG FIRM EYES OPEN COP BEFORE MATCH	179,67±40,81	0,484
ROMBERG FIRM EYES OPEN COP AFTER MATCH	164,88±37,12	
ROMBERG FIRM EYES CLOSED COP BEFORE MATCH	194,76±53,35	0,123
ROMBERG FIRM EYES CLOSED COP AFTER MATCH	165,97±29,72	
ROMBERG FOAM EYES OPEN COP BEFORE MATCH	196,16±45,87	0,05*
ROMBERG FOAM EYES OPEN COP AFTER MATCH	160,35±29,97	
ROMBERG FOAM EYES CLOSED COP BEFORE MATCH	214,65±54,11	0,123
ROMBERG FOAM EYES CLOSED COP AFTER MATCH	166,56±77,64	
ROMBERG COMPOSITE COP BEFORE MATCH	196,31±44,67	0,093
ROMBERG COMPOSITE COP AFTER MATCH	167,53±26,18	

***p<0.05**

Table 1.6. Comparison of Static Posturography Romberg data before and after HADO

	M±SD	P
ROMBERG FIRM EYES OPEN ELLIPSE BEFORE MATCH	37,52±22,00	0,484
ROMBERG FIRM EYES OPEN ELLIPSE AFTER MATCH	60,62±47,29	
ROMBERG FIRM EYES CLOSED ELLIPSE BEFORE MATCH	63,73±57,60	0,889
ROMBERG FIRM EYES CLOSED ELLIPSE AFTER MATCH	66,75±46,35	
ROMBERG FOAM EYES OPEN ELLIPSE BEFORE MATCH	141,63±108,23	0,208
ROMBERG FOAM EYES OPEN ELLIPSE AFTER MATCH	86,03±39,93	
ROMBERG FOAM EYES CLOSED ELLIPSE BEFORE MATCH	92,12±48,07	0,889
ROMBERG FOAM EYES CLOSED ELLIPSE AFTER MATCH	175,60±214,98	
ROMBERG COMPOSITE ELLIPSE BEFORE MATCH	60,62±47,29	0,779
ROMBERG COMPOSITE ELLIPSE AFTER MATCH	97,25±53,96	

***p<0.05**

Discussion

With the global industry changing thanks to technological advancement, it has become fashionable to watch sports events on mobile devices. This situation inspires more personalized, socialized and diverse solutions (Shu). With the development of the latest technology, virtuality has entered the sports types. Augmented reality and virtual reality are added to sports played as games. We also investigated the effect of HADO on the vestibular system.

AR applications in the sports industry fall into two categories: watching and participating. In terms of viewing, AR has been widely adopted in sports broadcasting. For example, Ericsson introduced Piero AR in 2016, which allows broadcasters to overlay 3D graphics in real time during live studio productions and sports games. On the other hand, AR integrates with traditional sports when it comes to participating in AR sports events. Meleap, a Japanese startup company (hereinafter referred to as The Company), combined AR with dodgeball and created HADO AR sports to expand the sports industry, making it the world's first AR sports game (Shu).

Meleap, a Japanese startup that develops AR games, created Techno-Sports, which combines AR with traditional sports. The company also founded HADO to shape the competitive sport of the future. HADO is a 3-on-3 team sport that combines AR and dodgeball. In a HADO match, players can throw energy balls and block the other team's attack with a shield. The team with the higher score at the end of the match wins. HADO is the first competitive AR sport in the world. One of the researchers is a designer from Meleap; Therefore Meleap has agreed to assist in this work on HADO and to provide the necessary assistance and related information (Shu).

In this study, we analyzed different balance parameters found on a static posturography device to participants with no professional sports background. We performed Modified CTSIB, Romberg and Unilateral Stance tests before and after HADO. We found a significant difference in the open eyes of the Romberg test compared to after HADO. No meaningful result could be obtained in other tests. We think that a HADO competition will take about 10 minutes and therefore vestibular involvement will be less. The fact that the participants in the study did not have previous HADO experience may also have been effective in these results. However, we think that if HADO is performed for a long time, it may have a positive effect on the vestibular system. Because we think that being active and constantly in motion during the competition can have an effect on this.

Augmented reality (AR) is a variation of virtual environments (VE) or more commonly called virtual reality. AR allows the user to see the real world with virtual objects superimposed or combined with it. Hence, AR complements reality rather than completely replaces reality. AR can be thought of as the "middle ground" between VE (fully synthetic) and telepresence (Milgram et.al., 1995).The traditionally held view of the Virtual Reality (VR) environment is one in which the participating presenter can fully immerse and interact in a fully synthetic world.

The solution goes one step further by developing a virtual coach that will provide real-time feedback by monitoring the user via a hologram avatar during rehabilitation and execution of muscle strengthening exercises. In addition, the user's physical activity outside the home will be monitored and subject to continuous evaluation and adjustment of personalized recommendations using motivational strategies (Ozakin, 2020).

In other studies, Virtual Reality (VR) has been used to overcome any temporal and spatial limitations and has been used to simulate complex, risky and costly tasks such as sports activity, flight simulation, surgical techniques and rehabilitation tools for people with various diseases. Since supervision and feedback are essential elements for an effective training outcome, VR coaches have the ability to adapt to the motivational and emotional state of the trainee as well as knowledge and needs . Several studies have shown that when older adults enter a VR-based exercise program, they are highly motivated and their balance control improves significantly (Fricoteaux et.al., 2014, Kim et.al., 2013).

Using AR, the user does not interact with a computergenerated world but with the real world, including computergenerated objects. AR applications, especially when designed for educational purposes, sharpen user's investigation, processing and spatial skills, while concurrently increase motivation (Akçayir, 2017, Martín-Gutiérrez et al., 2015.)

Sensory and physical assistive devices have been developed for a long time to support impaired functions in patients. Even a reinforced suit has been developed recently to strengthen muscle strength . In addition, current virtual reality (VR) technology not only extends sensory effects but also physical activities, and potential effects are expected in rehabilitation engineering (Kawamoto et.al., 2003, Kenyon et.al., 2004).

In this study, we analyzed different balance parameters and balance tests found on a static posturography device to participants without professional sports background. We found a significant difference in the Romberg test with eyes open compared to after HADO. No significant difference was obtained in other tests. We think that a HADO competition will take about 10 minutes and therefore vestibular attendance will be less. The fact that the participants of the study did not have previous HADO experience may also have been effective in these results. However, we think that HADO may have a positive effect on the vestibular system if it is performed for a long time. Because we think that being active and constantly in motion during the competition can have an effect on this.

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