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Original article

THE EFFECTS OF HADO SPORT ON THE VESTIBULAR SYSTEM

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Abstract

Objective. Balance is the postural adaptation performed by individuals in order to keep the center of gravity on the support surface. There are three mechanisms that provide input to the balance system, which are the visual system, vestibular system and somatosensory system. These three systems provide balance and posture with the inputs it receives. HADO is one of the sports where balance performance is important. HADO is a sport that integrates reality and virtual world. Also HADO is a team sport that creates a brand-new experience called "Techno Sports" played with augmented reality technology, motion sensor, head-mounted HMD, and smart phone. The aim of our study is to investigate the effects of sports on the vestibular system by conducting vHIT and spatial navigation tests before and after sports for those who do HADO sports.

Methods. Twenty-seven people who had not previously played professional sports participated in the study. The average age of the participants was 20.25 ± 1.63. Video Head Impulse Test (VHIT) and spatial navigation tests were applied to the participants before HADO sport. These tests were repeated after playing a match HADO. The results before the sport were compared with the results after the sport.

Results. Twenty-seven people who had not previously played professional sports participated in the study. The average age of the participants was 20.25 ± 1.63. Video Head Impulse Test (VHIT) and spatial navigation tests were applied to the participants before HADO sport. These tests were repeated after playing a match HADO. The results before the sport were compared with the results after the sport.

Conclusions. In the evaluation of the people after HADO sports, it was concluded that they were close to the starting position compared to pre-sports, even though there were no significant differences statistically, after long-term exposition to the HADO sports, outcome could be better for spatial navigation.

Key Words: Balance, HADO, Spatial Navigation, vHIT, Vestibular System.

Introduction

Balance is the postural adaptation performed by individuals in order to hold the center of gravity on the surface. Balance system; provided with data from vestibular, visual and proprioceptive systems. The visual system collects data by eyes. The somatosensory system collects data with muscles, joints and tendons. The vestibular system collects data with the peripheral vestibular organ. Data is collected from three systems are used to maintain balance and maintain posture (Baloh, 2010, Van De Graaff, 2001). Balance, the ability to remain stable when stationary and in motion can be achieved by these receptor systems transmitting healthy and compatible data.

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Augmented reality is a variation of virtual reality. Augmented reality allows the user to see the real world with virtual objects superimposed. Augmented reality is supportive of reality rather than completely changing the reality (Azuma, 1997). Augmented reality can be thought of as the middle ground of virtual and reality (Milgram et.al., 1995; Van De Graaff, 2001)

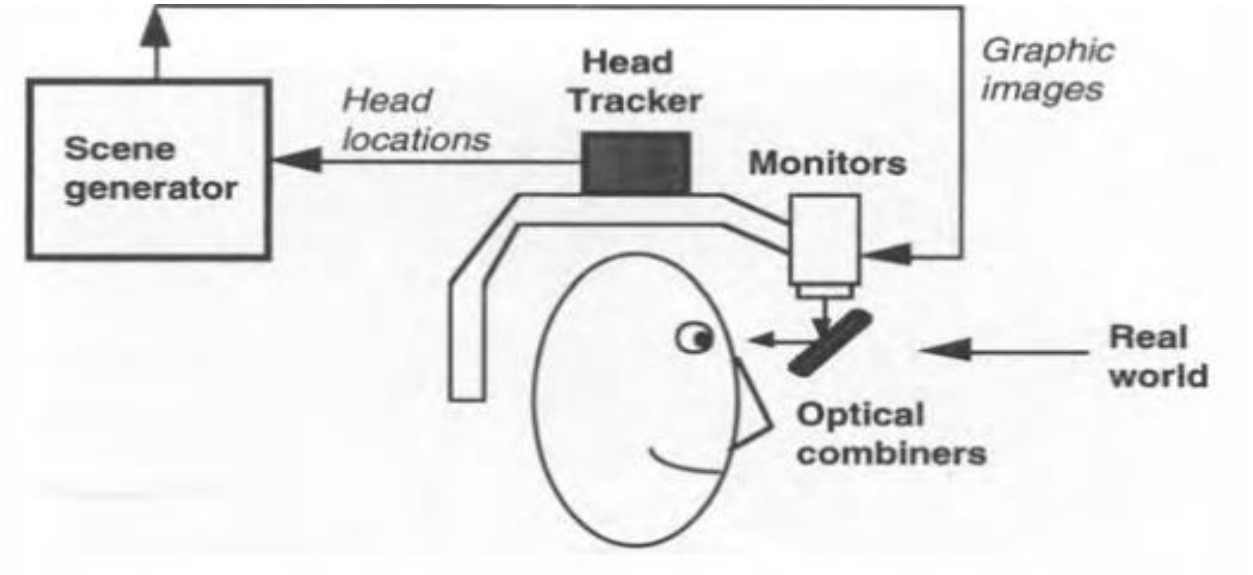

Figure 1. HADO Mechanism

Recently, there has been an increasing interest in games played with virtual reality and augmented reality in the young age group. HADO is recognized as one of the sports of the future with its virtual world. HADO can be thought of as an augmented reality sport that integrates the virtual world with reality. Augmented reality technology, motion sensor, head-mounted HMD (Head Motion Display) is a combination of sports played with a smartphone and creating a brand-new experience we call techno sport (Figure 1.).

The aim of this study is to investigate the effect of HADO on the vestibular system by performing vestibular evaluations before and after the game to the participants who play HADO.

Methods

The study was conducted in Istanbul Medipol University between 01/02/2021 and 01/03/2021. 27 individuals between the ages of 18-25 who had not practiced professional sports before participated in the study. Individuals between the ages of 18-25, without professional sports background, without vision problems, without a physical disability, and without any neurological or orthopedic problems were included in the study.

This study on "The Effect of HADO Sport on the Vestibular System" has been approved by the Istanbul Medipol University Non-Interventional Clinical Research Ethics Committee with the decision number 20, dated 07/01/2021. The aims of the study, how long it will continue, all practices and expectations were explained to all individuals included in the study, and their consent form was signed.

Video Head Impulse Test (vHIT) and Spatial Navigation tests were applied to the participants before HADO sport and after playing HADO (one match).

With vHIT (Interacoustics VisualEyes Videonystagmography), 6 different semicircular canals in the vestibular labyrinth can be evaluated separately. Right and left horizontal canal VOR gains were evaluated with lateral vHIT. VOR gain assessment was calculated by proportioning the person's head speed to eye speed. Head velocity of the person was measured with the accelerometer on the glasses. Eye velocity was measured by the camera in the glasses recording the eye. It is determined that the ideal VOR gain, that is, the ratio of eye and head speed to each other, is close to 1 in healthy individuals.

Spatial navigation test is a new test that measures the role of the vestibular system in navigation. In this test, it was tested how much people provided the navigation ability with the vestibular system, such as sensing the position of the people when their eyes were closed, and being able to return to the starting position.

The data analysis of our study was performed using the Statistical Package for Social Sciences (SPSS) Version 22.0 (SPSS inc., Chicago, IL, USA) statistical program. In descriptive statistical information, mean and standard deviation (Mean ± SD) are given. Statistical significance level was accepted as 0.05 in all analysis results.

"Kolmogorov – Smirnov Test" was used 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 vHIT and Spatial Navigation tests performed before and after HADO sports were compared using the "Wilcoxon Sign Rank Test". The statistical significance level in the results was accepted as 0.05.

Results

The ages of the cases included in the study are between 18-25 years old and their mean age is 20.25 ± 1.63.

No statistically significant difference was observed in the comparison of right and left horizontal canal VOR gains in vHIT performed before and after HADO sports (Table 1.).

Table 1. Comparison of Horizontal Channel VOR gains before and after HADO sports

	MEAN ± SD	P
VHIT LEFT VOR GAIN BEFORE MATCH	0,86±0,07	0,344
VHIT LEFT VOR GAIN AFTER MATCH	0,90±0,10	
VHIT RIGHT VOR GAIN BEFORE MATCH	0,98±0,06	0,753
VHIT RIGHT VOR GAIN AFTER MATCH	1,01±0,13	

*p<0.05

In the spatial navigation test performed before and after the HADO sport, a statistically significant difference was observed in the comparison of the transition time to the starting point before sports versus the transition time to the starting point after sports (p<0.05).

There was no statistically significant difference in the comparison of their last position before and after sports (p>0.05) (Table 1.1.).

Table 1.1. Comparison of Spatial Navigation data before and after HADO sport

	MEAN ± SD	P
NAVIGATION FINAL POSITION COORDINATE X BEFORE MATCH	48,70±9,15	**0,031***
NAVIGATION FINAL POSITION COORDINATE X AFTER MATCH	52,40±9,13	
NAVIGATION FINAL POSITION COORDINATE Y BEFORE MATCH	16,88±26,40	0,524
NAVIGATION FINAL POSITION COORDINATE Y AFTER MATCH	11,51±22,26	
NAVIGATION TRANSITION TIME STARTPOINT BEFORE MATCH	11,18±42,12	0,254
NAVIGATION TRANSITION TIME STARTPOINT AFTER MATCJ	5,55±41,55	

*p<0.05

Discussion

Augmented reality has been widely adopted in sports broadcasting. On the other hand, the participation of augmented reality in sports activities has been mentioned and augmented reality has been integrated into traditional sports. Meleap, a Japanese startup company, combined augmented reality with a traditional game dodge ball. As a result of this move to develop the sports industry, HADO, the world's first augmented reality sport, was created. With the introduction of augmented reality into sports, the ways of watching and participating in sports games have changed. We are now officially in the "age of augmented reality competitive sports". In the past, augmented reality technology was mostly used to improve the interaction between audience and events. On the other hand, there has not been enough discussion about the viewer experience while watching augmented reality sports games. This shows that augmented reality sports games are still challenges when it comes to spectator experience, and this requires innovation (Shih et.al., 2020).

Augmented reality offers the opportunity to create new methods for training and rehabilitation with spatially calibrated 3D visualizations. Thanks to augmented reality, people with balance disorders can get help with instructions and get feedback on progress in balance training. Blomqvist and others used augmented reality-based visual-interactive guidance balance training twice a week for 6 weeks in their study. This study shows that training with new technology is suitable for patients with impaired balance to a certain extent. In addition, augmented reality technology encourages motivation in education. New technology and training require further development and testing (Blomqvist et.al., 2021). In our study, we evaluate horizontal semisircular canal vestibulo-ocular reflex (VOR). There is no significant difference between before and after three rounds. But both left and right side there is a little increase in data. This may be the result of reacting to sudden visual events in the match.

Virtual Reality (VR) and Augmented Reality (AR) have been shown to increase adherence to training protocols and stimulate cognitive abilities (Kanyılmaz et al., 2018) Virtual reality is a three-dimensional simulation model that gives its participants the feeling of being real and allows mutual communication with a dynamic environment created by computers. Augmented reality can provide instant processing, which transforms into a more portable and high quality user experience compared to virtual reality (Shih et al., 2020).

There is a lot of balance work done with VR. Clark et al. They demonstrated that the Wii balance board has excellent test-retest reliability, with the feature that it receives raw body center of gravity data similar to other force plate generating vehicles, and that the Wii balance board can be used to improve postural control (Clark et al., 2010). Verdecchia et al. investigated the effect of the vestibular rehabilitation program completed with Wii therapy on the feeling of disability, the risk of falling, and gaze stability in patients with chronic unilateral vestibular hypofunction. After all participants completed the exercise therapy with the Nintendo Wii virtual reality device, a statistically significant difference was found in their balance (Verdecchia et.al., 2014).

In our study we assess the instant spatial effect for HADO and there is significant difference between before and after match in returning to origin. Also, proximity to origin was closer after the match but this change not significant difference. This may be due to learning effect or positively influencing the vestibular system. It is also known that the training should include strength, balance, flexibility, endurance and include dynamic exercises; also, it should be done 2–3 times a week for three months to be effective (Sherrington et al., 2008). Maybe we can find positive effect for HADO to vestibular system after training 2–3 times a week for three months.

People feel the game is fun and can contribute to the game's outcome if they put in the right amount of effort. In a situation where people with different skill levels and physiology play together, it is necessary to use balancing so that all players can enjoy the activity. The addition of analog balancing techniques, such as new rules, can make the game confusing and difficult to follow, while using technology allows us to add a new layer to the game that allows us to create new and sophisticated rules that the system and players follow. Can concentrate on the game. HADO is new, fun, necessary good strategies, balance, and teamwork. Therefore HADO could be become a part of vestibular rehabilitation in the future.

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