Assessment of the condition of balance under the influence of training in a virtual environment: the analysis of own observations

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Abstract—Rehabilitation and training of the balance function is one of the most important areas of neurorehabilitation of patients with coordination disorders in diseases of the Central nervous system. The results of balance assessment in the group of healthy subjects demonstrated the ability to assess the functional state of balance using the virtual reality gaming system, and allows to build and record quantitative indicators of the balance of the subject. Evaluation of the balance function by the method of stabilography (Stabilan 01-2, Russia) demonstrated the positive effect of trainings in virtual reality on the balance of healthy subjects with a significant improvement in balance function quality after training.

Keywords—virtual reality, balance disorders, balance training, neurorehabilitation

INTRODUCTION

There are a lot of research about possibility of using virtual reality (VR) in neurology and rehabilitation at present.

Thanks to three-dimensional computer graphics, a virtual image adequate to reality is formed, which makes a person react to the dynamics of events and sensory information by real action. Therefore, VR is a physiological environment for the body. An important advantage of VR is the ability to establish feedback in real time. VR allows to control absolutely the patient's attention.

Rehabilitation of balance disorders with different etiologies is one of the most important areas of neurorehabilitation in patients with coordination and motor disorders in diseases of the Central nervous system.

OBJECTIVE

Estimate the condition of balance function after the training in a virtual environment.

MATERIALS AND METHODS

There were examined 50 healthy subjects (age 22.1±7.9). The balance assessment and training sessions were conducted using the environment for creating games and applications Unity3d on VR equipment "HTC Vive", which provides a standardized, secure and flexible platform of gaming activities.

There was used optical method for track the position and orientation of the controllers on the patient's body and helmet. The positioning accuracy is high, the average frame rate is 50 per second.

To assess the balance, there was developed software by authors. It based on the registration and evaluation of the body position of the test, the so-called postural axis (PO) in a given space.

The training includes control of the object in VR by voluntary movement of the body of the trial subject on a given of object trajectory and speed in game form. Trajectory and speed motion in VR depends on functional abilities of trial subject.

The balance was evaluated in the Romberg test (closed and open eyes) by the stabilography method ("Stabilan 01-2", Russia) using the parameters: the area of ellipse (AE) mm^2, the quality of balance function (QBF)%, the average speed of pressure center (ASPC) mm/s.

Statistical processing of the results in the survey group was carried by the STATISTICA 10.0 package (StatSoft, USA). Methods of statistical description and analysis were selected depending on the nature and type of data distribution. The data distribution type is represented by the normal distribution of the trait, and the results are described as mean and standard deviation (M=SD). To compare the data, the student's criterion (t) was calculated. Statistically significant differences were accepted when the value of error is less than 5% ($p<0.05$).

To assess the balance in the virtual environment, there were developed the indicators: the average speed of movement of the postural axis (ASM PA, m/c), the area of reference contour of the postural axis (ARC PA, m^2).

RESULTS

The training course included 4 to 8 sessions (10 minutes). According to the stabilography, the balance indices was high, in "open eyes test" before the training: QBF 79,8±9,8%, AE 123,8±76,4mm^2, ASPC 9,9±3,05 mm/s, after the training, the QBF 85,6±8,2% and AE 108,9±75,9mm^2, ASPC 10,4±3,1 mm/s, and has a tendency to improvement p=0,05. The deprivation of vision decreases the balance indices slightly before training: QBF 65,5±15,4%, AE 232,2± 138,1 mm^2, ASPC 13,8±4,6 mm/s, after training: QBF 65,1±15,3%, AE 29,6± 151,5mm^2, ASPC 14,07± 4,7 mm/s, there are not substantial difference p>0,05. The results of the assessment of the state of stable balance in the virtual environment are obtained. Installed, ARC PA until the start of training amounted to 0,00069±0,00074 m^2, ASM PA 0,79±1,18 m/c, after training ARC PA 0,00056±0,00051m^2, ASM PA 0,65±0,63 °/s.

CONCLUSION

The results of the research the balance in a group of healthy subjects demonstrated the possibility of assessing the balance using the VR gaming system. The author's approach allows to set up and register

quantitative indicators of the balance. The change of balance indicators is mediated by the impact on the afferents of vestibular, visual, proprioceptive cues of VR.

Evaluation of the balance by the indicators of static stabilography ("Stabilan 01-2", Russia) demonstrated the positive impact of VR training on the balance of healthy subjects with a significant improvement in QBF after training. Therefore, the results of the research demonstrate the possibility of using balance trainings in VR conditions in patients with balance desoders for more intensive and effective rehabilitation in combination with traditional therapy, as well as to ensure the continuation of rehabilitation at home.

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