Immediate effect of virtual reality for the paretic upper limb on electroencephalographic activity in individuals after stroke

Miqueline Pivoto Faria Dias[1], Viviane Aparecida de Oliveira[2], Daiane Marques Ferreira[3], Ruanito Calixto Júnior[4], Sarah Cristina dos Santos[5],Adriana Teresa Silva Santos[6], Andréia Maria Silva[7]

[1,2,3,4]Master's Degree Student, Federal University of Alfenas /UNIFAL; [5]Graduation Physiotherapy Student, Federal University of Alfenas /UNIFAL [6,7] Teacher at Federal University of Alfenas /UNIFAL

Introduction: Subjects affected by stroke present a limitation on daily life activities, especially the upper limb may be the most affected.[1] One of the interventions used for this impairment is Virtual Reality (VR), a technique that provides integrated motor and cognitive stimulation for these patients.[2] This study aimed to evaluate the immediate effect of virtual reality for the paretic upper limb on the electroencephalographic activity in individuals after stroke.

Materials and Methods: A Controlled Randomized Clinical Trial was conducted in which the immediate effect of VR on the electroencephalographic activity was evaluated in a single day. Twenty-seven hemiparetic subjects with ischemic stroke, aged 53.70 ± 12.08, participated in the study; with more than three months of injury; good mental competence assessed by the Mini-Mental; being 15 men and 12 women. Subjects with severe spasticity assessed by modified Ashworth muscle tonus scale were excluded from the study. The patients were randomized into a control group, with 13 individuals (side affected: 8 right and 5 left) and intervention group with 14 participants (affected side: 7 right and 7 left). The patients in the intervention group (G2) underwent 4 sequences of 1 minute of VR training offered by the Xbox through the game Fruit Ninja, which requires active shoulder and elbow movements. The control group (G1) performed the same active movements, however without the stimulation of the VR game. Electroencephalographic assessment of resting individuals was performed and during the execution of active movements in both groups. Statistical analysis was performed using the Shapiro-Wilk Test (normalization), Friedman Test and Anova one way (intragroup for non-parametric and parametric) and Mann-Whitney and T Test (intergroup for non-parametric and parametric) tests with the SPSS 20.0 software. The respective EEG data channels of the ipsilesional area, and the right and left hemisphere, AF3/AF4, F3/F4, F7/F8, FC5/FC6 were analyzed using Matlab R2017a and EEGLab v14.1.1.

Results: The VR promoted immediate changes in frequency and power data in the intra and intergroup evaluation in the analysis of the right hemisphere channels (FC6 – increase the frequency p = 0,007; decrease the power p=0,015; AF4 increase de power p = 0,018 (G2); F8 decrease the power p=0,005 (G1)); in the left hemisphere (AF3; F7 and F3 for initial, during intervention and final evaluation increase de power p=0,00 (G2)) and ipsilesional area (F7 and F8 increase the frequency p=0,012 (G2)). The results suggest that the intervention group demonstrated an increase in the alpha frequency band and in the power data indicating less brain effort, compared to the control group.

Discussion: The main finding of the study was that the virtual stimulus promotes changes in the pattern of brain activity in the frontal areas. Fernandes *et al*. 2014[3] also observed the effect of VR on central excitability in subjects post stroke. They concluded that individuals with right brain injury benefited most from training in a virtual environment, with reduction of neural effort in ipsilesional areas and increase of the training performance.

Conclusion: The VR promoted immediate changes mainly in the left and right Pre-Frontal cortex (AF3 / AF4); in the left and right Frontal cortex (F3/F7/F8); and in the right Primary Motor cortex (FC6) on the power and frequency data. The results suggest that the virtual environment may promote changes in the pattern of brain activity in the patient's ipsilesional hemisphere.

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