ABSTRACT

Postural balance is the result of complex coordination between the visual, vestibular, and somatosensory systems. Visual motion perception, or optic flow, plays an important role in maintaining postural stability. This study aims to evaluate the effects of visual stimulus variations on gastrocnemius muscle activity and postural stability, measured using gyroscope sensors. Six healthy participants age 18 to 25 years were exposed to four visual conditions (moving-white, moving-red, static-white, and static-red) delivered through VR glasses. Muscle activity was recorded using surface electromyography (sEMG) on channels A1 and A2, while body stability was measured using an MPU-6050 gyroscope sensor on three axes (X, Y, and Z).

Data were analyzed using Two-Way Repeated Measures ANOVA and Pearson correlation. Under stable standing conditions, no significant differences in muscle activity were found ($p > 0.05$); however, there was a significant increase in postural sway in the antero-posterior direction in response to moving visual stimuli (MAV $p = 0.0212$; RMS $p = 0.0263$; STD $p = 0.0435$). Under unstable conditions, activity in the left gastrocnemius (A1) increased significantly in response to visual motion (MAV $p = 0.0127$; RMS & STD $p = 0.0227$), while A2 showed no significant changes. Pearson correlation revealed a significant relationship between A2 muscle stability and rotational body sway in the stable condition ($r = 0.45$; $p = 0.0280$), and a stronger correlation between A1 activity and rotational sway in the unstable condition ($r = 0.63$; $p = 0.0010$).

Overall, visual motion had a greater effect than color on neuromuscular activity and postural stability. These findings suggest that dynamic visual stimuli can be effectively applied in balance training programs, especially in situations that challenge the postural control system.

Keywords: *postural balance, muscle activity, visual motion perception, optic flow, electromyography (EMG).*