Oral Communication

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Upper Limb Kinematics in Immersive Virtual Reality: Comparison Between Stroke and Healthy Subjects During A Box and Block Test With Controllers and Hand Tracking

Topic: Virtual Reality

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BACKGROUND

The Box Block Test (BBT) is one of the recommended outcome measures for evaluating manual dexterity after stroke, assessing the number of blocks moved in one minute. It is now also recommended to assess kinematics to characterize movement quality. Virtual reality (VR) enables the simultaneous assessment of both aspects. In this context, we developed an immersive VR version of the BBT using controllers (BBT-VR-C) and hand tracking (BBT-VR-HT), allowing for the analysis of upper limb kinematics. This study aimed to compare upper limb kinematics between stroke and healthy subjects during manual dexterity tasks in VR using both controllers and hand tracking.

METHODS

Twenty-one stroke subjects and 21 healthy subjects (matched by age, gender, and laterality) performed the BBT-VR-C and BBT-VR-HT in a randomized order. The kinematic indices analyzed included the speed-accuracy trade-off (SAT) and the spectral arc length of the instant velocity (SPARC; an index of movement smoothness). Using hand tracking, we also calculated the mean distance between the thumb and index finger during the approach (Dti-app) and displacement (Dti-dis) phases of the movement.

RESULTS

Compared to healthy subjects, stroke subjects had significantly lower SPARC values (BBT-VR-C: -2.2 [–3.02 - –2.02] *vs.* –2.0 [–2.34 - –1.92], p = 0.03; BBT-VR-HT: -3.5 [–6.01 - –3.10] *vs.* –2.8 [-3.38 - –2.39], p = 0.003) indicating poorer fluidity. SAT values were also significantly lower in stroke subjects (BBT-VR-C: 2.4 [1.32-3.29] *vs.* 4.6 [3.50-6.82], p < 0.001; BBT-VR-HT: 1.6 (0.92) *vs.* 2.7 (1.23), p = 0.001), reflecting a worse balance between velocity and precision. The Dti-app was significantly lower in stroke subjects (0.06 [0.049-0.067] m *vs.* 0.23 [0.200-0.310] m, p < 0.001), suggesting a smaller hand opening during the approach phase. No significant differences were found for Dti-dis (0.03 [0.023-0.031] m *vs.* 0.03 [0.022-0.033] m, p = 0.989).

CONCLUSION

The BBT-VR-C and BBT-VR-HT allow for the assessment of manual dexterity and the characterization movement patterns in stroke subjects, highlighting the potential of immersive VR for integrating objective and quantitative movement quality assessments into functional evaluation.

Statement of Disclosures

None

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