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Simultaneous Motor-Cognitive Virtual Reality Training To Improve Ambulation in Young Adults with TBI

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***Abstract* — Training that simultaneously targets motor and cognitive domains may lead to improved ambulation recovery. The objective of the investigation was to evaluate the efficacy of simultaneous motor & cognitive training (SMCT) to improve ambulation, using biomechanical and functional outcomes. Preliminary data for a single subject with traumatic brain injury (TBI) who utilized a virtual reality integrated treadmill to provide SMCT during the chronic phase is shown.**

***Clinical Relevance* —Preliminary data provides initial evidence for SMCT as a therapeutic intervention for gait and balance rehabilitation in young adults with TBI.**

I. Introduction

Traumatic brain injury (TBI) is a leading cause of long-term disability in the US. TBI impairs cognitive and motor functions, with debilitating consequences on gait and balance[1]. Conventional rehabilitation post TBI focuses on either motor-only or cognitive-only training. Separately training motor and cognition may not provide the most effective treatment, as cognitive-only tasks might not be able to activate all brain regions associated with motor tasks, reducing their efficiency. Evidence suggests that cognitive function is positively correlated to physical function. In addition, cognitive effort positively contributes to motor recovery, the ability of motor control, and ADL performance[2]. Therefore, training that simultaneously targets motor and cognitive domains may lead to improved ambulation recovery. Virtual reality (VR) has emerged as a useful approach to neurorehabilitation, providing consistent, customized motor & cognitive therapy that is both engaging and challenging. The current investigation presents one individual diagnosed with TBI who utilized a VR integrated treadmill to provide simultaneous motor & cognitive training (SMCT). The objective of the study was to evaluate the efficacy of SMCT, using biomechanical and functional outcomes.

II. Methods

One participant diagnosed with TBI (TBIP) and one healthy control (HC) (age and sex matched) were consented to participate in this investigation. The TBIP received SMCT utilizing the C-MILL (Figure 1), a VR-based instrumented treadmill. Task difficulty (cognitive: attention & executive function; and motor: gait & balance) was individually adjusted to target the participant's ambulation recovery. SMCT was administered for up to 1 hour per day for 10 days. The TBIP completed two data collection sessions: baseline and follow-up (after SMCT training). The HC did not undergo training and completed one data collection session. During each data collection session, participants walked 10-12 meters at a self-selected speed on the Zeno™ walkway. Outcome measures included temporal & spatial characteristics, symmetry, and speed during the 10 meter walks (10MWT). All procedures performed in this investigation were approved by the IRB at Kessler Foundation.

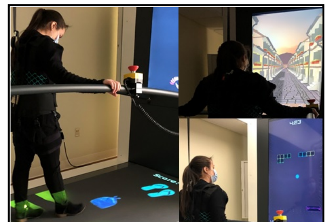

Figure 1: SMCT environment.

III. Results

After 10 sessions of SMCT, the TBIP increased walking speed (during the 10MWT) from baseline to follow-up. In addition, step length increased, and total gait cycle time decreased (Figure 2). There was no change in temporal & spatial symmetry from baseline to follow-up, but the TBIP had a symmetry close to 1, which was similar to the HC.

IV. Discussion & Conclusion

Individuals with moderate to severe TBI have gait & balance deficits, and recovery may be slow during the chronic phase. This preliminary data shows that after 10 sessions of an integrated motor & cognitive intervention, there was an increase in step length, accompanied by an increase in walking speed (Figure 2). These results suggest that the increased step length may have contributed to the increased walking speed, while spatial & temporal symmetry remained close to 1, which was similar to the HC. The functional impact of an increase in speed could improve community ambulation and, by extension, ADLs. Thus, SMCT may result in improved biomechanics and function.

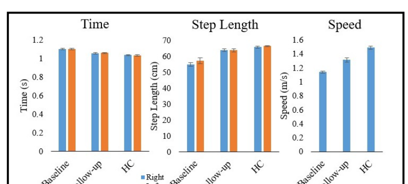

Figure 2: a) Time & b) Step length during each gait cycle, c) speed during 10MWT in TBIP at baseline and follow-up and HC.

References

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[2] G. Pichierri, P. Wolf, K. Murer, and E. D. De Bruin, “Cognitive and cognitive-motor interventions affecting physical functioning: A systematic review,” *BMC Geriatrics*, vol. 11. 2011.

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