EVALUATING THE RELATIONSHIPS BETWEEN SUPINE PROPRIORCEPTION ASSESSMENTS WITH UPRIGHT FUNCTIONAL MOBILITY AND BALANCE TESTS

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INTRODUCTION

Upon return to Earth, spaceflight sensorimotor adaptations can result in impaired posture and locomotion [1], [2], and current exercise countermeasures in the International Space Station are not sufficient to maintain sensorimotor function. In-flight countermeasures and assessment tools for sensorimotor function are needed to mitigate risks associated with mission-critical task performance upon return to Earth or arrival to 0.38 G on Mars. One proposed countermeasure for proprioceptive deconditioning includes training on a tilt board device [3], which will be tested in an upcoming bed rest study. In preparation for the said study, the objective of this pilot study is to compare performance in supine proprioceptive assessments to performance in functional upright activities. The results are intended to guide the selection of supine assessment tools for the upcoming bedrest study and the development of future inflight proprioceptive training and assessment tools for exploration missions.

METHODS

Seventeen healthy participants (8 males and 9 females, 27.9 ± 8.5 years) provided informed consent as approved by the Institutional Review Board (IRB) at NASA. A horizontal air-bearing sled was used to provide a proprioceptive challenge in a supine body orientation, allowing for mediolateral motion with minimal friction during supine stance [4]. Participants were loaded axially (30 to 60% body weight) with their feet on a vertically oriented tilt board and instructed to perform supine assessment activities using custom software that displays a cursor controlled by tilting the tilt board. In a single-leg static activity on the tilt board (TB-St), performance was measured as the percent time spent on a center target during a 30-second trial. During a two-feet dynamic activity on the tilt board (TB-Dy), performance was measured as the number of targets captured in 30 seconds. These supine tasks were compared to performance during two upright activities used to represent upright performance: completion time for a functional mobility task (FMT) [2],[5] and a performance score from force plate sway data during 30-second single-leg upright standing (USL).

RESULTS AND DISCUSSION

A Spearman's rank-order correlation was run to assess the relationship between upright and supine assessments. There were statistically significant, strong correlations between scores for the FMT and each TB activity, including TB-St, $r_s(17) = 0.50$, $p<0.05$, TB-Dy3, $r_s(17) = 0.73$, $p<0.001$, and TB-Dy9, $r_s(15) = 0.53$, $p<0.05$. There were no statistically significant correlations between USL and each TB activity. Despite a lack of correlation with upright single-leg balance, the ability of the TB to indicate upright performance in the FMT is promising, as this task is a standard post-flight measure designed to characterize locomotor dysfunction [2], [5].

CONCLUSION

These efforts will inform the selection of an appropriate sensorimotor assessment method for the upcoming bed rest study and similar future studies. While current work uses a bed rest analog to develop these technologies, future work aims to prepare capabilities for future in-flight sensorimotor training and assessment to mitigate the risks of proprioception impairment after spaceflight.

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