
ROBOTIC-LOCOMOTOR TRAINING AS A TOOL TO REDUCE NEUROMUSCULAR ABNORMALITY IN SPINAL CORD INJURY: THE APPLICATION OF SYSTEM IDENTIFICATION AND ADVANCED LONGITUDINAL MODELING.

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ABSTRACT

In this study, the effect of the LOKOMAT, a robotic-assisted locomotor training system, on the reduction of neuromuscular abnormalities associated with spasticity was examined, for the first time in the spinal cord injury (SCI) population. Twenty-three individuals with chronic incomplete SCI received 1-hour training sessions in the LOKOMAT three times per week, with up to 45 minutes of training per session; matched control group received no intervention. The neuromuscular properties of the spastic ankle were then evaluated prior to training and after 1, 2, and 4 weeks of training. A parallel-cascade system identification technique was used to determine the reflex and intrinsic stiffness of the ankle joint as a function of ankle position at each time point. The slope of the stiffness vs. joint angle curve, i.e. the modulation of stiffness with joint position, was then calculated and tracked over the four-week period. Growth Mixture Modeling (GMM), an advanced statistical method, was then used to classify subjects into subgroups based on similar trends in recovery pattern of slope over time, and Random Coefficient Regression (RCR) was used to model the recovery patterns within each subgroup. All groups showed significant reductions in both reflex and intrinsic slope over time, but subjects in classes with higher baseline values of the slope showed larger improvements over the four weeks of training. These findings suggest that LOKOMAT training may also be useful for reducing the abnormal modulation of neuromuscular properties that arises as secondary effects after SCI. This can advise clinicians as to which patients can benefit the most from LOKOMAT training prior to beginning the training. Further, this study shows that system identification and GMM/RCR can serve as powerful tools to quantify and track spasticity over time in the SCI population.