

Robotic task-specific training of the upper extremity in children with Cerebral Palsy

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Abstract

Background: Cerebral Palsy (CP) affects at least 2 in 1,000 children in the United States. The disorder is non-progressive, yet secondary impairments can worsen over time leading to contracture, decreased strength, increased tone and ultimately, impaired mobility and function. Robotic therapy has been found to have positive outcomes for similar impairments in stroke neuro-recovery, suggesting the need for the application of this technology to CP. **Purpose:** The purpose of this study was to investigate whether specific upper extremity (UE) robotic training improves UE function in children with CP. **Methods:** This is an ongoing study currently with 5 children (ages 4-12) with CP that have completed the treatment intervention. Inclusion criteria included a hemiplegic presentation of the UE, a modified Ashworth scale (MAS) score of 2 or less and wrist extension equal to or greater than 0° in the affected arm, and sufficient cognition to attain to a task for 40-60 minutes. Each child participated in 16 total robotic training sessions occurring twice weekly, with each session consisting of 1,040 task-specific reaching movements of the affected arm with real-time impedance control. Pre- and post-testing and a 1-month follow-up were performed for each subject. Clinical outcome measures included active range of motion (AROM), passive range of motion (PROM), manual muscle tests (MMT), and grip strength, in addition to functional tests including the MAS, adaptive Fugl-Meyer scale, and the Pediatric Evaluation of Disability Inventory (PEDI) assessed by parents. Lastly, spatial-temporal control patterns were collected during each session, allowing for a visual assessment of a child's progress in refining UE movement patterns to 16 positions across all quadrants. **Results:** For AROM and PROM, 4 of 5 subjects demonstrated an increase in at least 2 joints by 1-month follow-up. The remaining measurements produced no change or change within the standard error for goniometry ($\pm 5^\circ$), while no decline was noted in any subjects. Pre-test MMT revealed strength measures ranging from 3/5 to 5/5. By 1-month follow-up, 85% of all measurements were 5/5, with the remaining 15% at 4+/5. For grip strength, 3 of 4 subjects (fifth subject unavailable) doubled their strength by 1-month follow-up, with the last demonstrating symmetry with the unaffected limb. Tone, as measured by MAS, did not appear to be a limiting factor as only 1 child displayed any noticeable tone (MAS of 2) across the measured motions. For the Fugl-Meyer, 4 of 5 subjects improved coordination by more than 2 points by 1-month follow-up, while the fifth maintained throughout the study. Parents reported via the PEDI an overall improvement in performing functional tasks for all children during the study, with 4 of 5 subjects improving by 10 or more points. Lastly, spatial-temporal control patterns showed marked improvement for all subjects by 1-month follow-up. **Conclusion:** Early results indicate that the application of robotic training to children with CP improved several clinical measures of the affected limb. This likely resulted in increased use of the affected limb, leading to improved functional performance.