Project Title: *Robotic Therapy for Force Training of the Upper Extremity in Chronic Hemiparetic Stroke*

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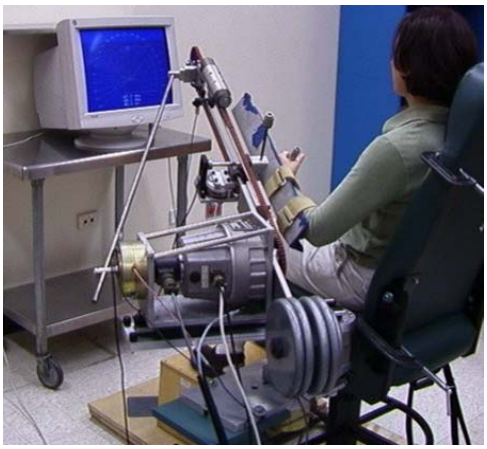
Project description

The goal of this project is to use a novel robotic therapy device, the ARM Guide, to improve recovery of upper extremity function after stroke. We have already demonstrated in an initial pilot study that the device can improve movement recovery following chronic stroke. However, the results from our study, combined with evidence from other recent studies of robotic therapy, suggest that robotic therapy might be substantially enhanced by specifically targeting abnormal force generation after stroke, a therapeutic paradigm in which subjects will use biofeedback of arm forces to consciously direct their movements towards a desired target. The current project implements this novel form of robotic therapy, called "guided force training", and tests whether this therapy can improve recovery beyond previous forms of robotic and conventional therapy.

We are examining 48 stroke survivors who are at least six months post-injury with unilateral lesion. Subjects participate in one of three therapy programs across 24 one-hour sessions in eight weeks. The first program, free reaching therapy, involves subjects practicing unsupported reaching movements with the affected arm to an array of targets throughout the workspace. A second group participates in conventional therapy during one-on-one sessions with an occupational therapist. The strategies employed by the therapist concentrate on scapular and shoulder alignment, passive and active assisted range of motion, and reeducation using a task-oriented approach. Finally, the robotic therapy group engages in reaching therapy with the device. As the subject attempts to make reaching movements while holding onto a handpiece along a linear track (see figure at right), a force sensor in the handpiece records the direction of forces generated by the user. If impaired coordination causes the user to push the handpiece in a direction other than towards the intended target, the motor will halt movement and the user will be given graphical feedback showing them how to correct their reach. This punishment-reward system (proper endpoint force rewarded by allowing smooth, unimpeded movement) trains users to consciously aim hand movements toward the desired target. Additionally, we have expanded the protocol to include a fourth group that participates in all three modes of training, as they might if these tools were available in the clinic.



Progress to date

We have enrolled 41 subjects who have all completed the training program. Four of these individuals have completed the mixed-mode training. Current results indicate that the guided force training is a feasible paradigm for improving hemiparetic upper extremity function as this training group has demonstrated statistically significant gains in nearly all outcomes after eight weeks of training. Significant improvements have been seen in all groups, although currently no difference in the magnitude of the improvements is detectable between the groups. The mixed mode appears to be as effective, on average, as the best of the other three groups in each outcome measure.