

Project Title: *Rehabilitation of Finger Extension in Chronic Hemiplegia*

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Project Description

Studies of cortical reorganization following infarcts and preliminary results from studies using robots in therapeutic training suggest that devices which assist in the active production of repetitive movements may prove beneficial in restoring function. We have found that individuals with chronic hemiplegia subsequent to stroke have directionally dependent weakness, such that finger extension is impaired to a greater extent than finger flexion. Thus, we have developed two devices to assist finger extension when needed: a portable, body-powered orthosis (BPO) and a pneumatically-powered orthosis (PPO).

Progress to Date

*Body-powered orthosis*¹: This is a cable-driven orthosis attached to the dorsal side of the hand (see Fig. 1). It is actuated by the subject through either bicipital abduction and glenohumeral flexion of the shoulders or elbow



Fig. 1: BPO

extension using basic prosthetics technology. A miniature force transducer (Sensotec, Honeywell) in series with the cabling allows measurement of the amount of force required to assist finger extension. This information is available to the user and the therapist as an audio signal. Similarly, EMG information about muscle activity can be fed back to the user and therapist in an aural modality.

*Pneumatically-powered orthosis*²: This device uses air pressure applied to the palmar surface of the hand to force the fingers into extension (see Fig. 2). Electrogoniometers on the dorsal side of the glove provide feedback of actual joint angles; assistance is



Fig. 2: PPO with head-mounted

only provided when joint angle measurements detect difficulty with extension. EMG measurements of extensor activity are again available.

We have initiated a pilot study to assess the performance and efficacy of the devices³. By the end of the calendar year, 15 subjects will have completed 6 weeks of rehabilitative training consisting of 3 one-hour sessions per week. During each session the subjects attempt to grasp and release either virtual objects (generated through the PC Glasstron® head-mounted display, PLM-S700, SONY Electronics, Inc) or real objects. Five subjects will have received extension assistance from the body-powered orthosis, another 5 will have used the pneumatic orthosis, and the final 5 will not have received any external assistance.

Presentations and Publications

1. Luo X, Kenyon RV, Kline T, Waldinger HC, Kamper DG. In *IEEE International Conference on Rehabilitation Robotics*. (Chicago, IL, 2005, 329-332).
2. Kline T, Kamper D, Schmit B. In *IEEE International Conference on Rehabilitation Robotics*. (Chicago, IL, 2005, 78-81).
3. Luo X, Kline T, Fischer HC, Stubblefield KA, Kenyon RV, Kamper DG. In *27th International Conference of the IEEE Engineering in Medicine and Biology Society*. (Shanghai, China, 2005).
4. Waldinger, H. and Stubblefield, K. Hand Rehabilitation Following Stroke: Limitations of Current Interventions and New Evidence-Based Approaches. American Occupational Therapy Conference (Long Beach, CA, May 14, 2005).
5. Waldinger, H. Hand Rehabilitation Using Mechatronics in a Virtual Environment. 18th Annual Midwest Deans' Occupational Therapy Research Conference, College of Health Sciences, Rush University (Chicago IL, March 4, 2005).