Wearing a Myoelectric Elbow-Wrist-Hand Orthosis Reduces Upper Extremity Impairment in Chronic Stroke

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INTRODUCTION
Most stroke survivors exhibit upper extremity (UE) hemiparesis that undermines function and quality of life (Broeks et al., 1999). While a small proportion of these survivors exhibit active movement in the distal areas of their paretic UEs, the vast majority exhibit little to no active movement in their wrists and fingers (Wolf et al., 1983). These limitations severely diminish response to rehabilitative therapies and participation in daily activities. Thus, there remains a significant gap, centering on the need to develop devices that increase function in this rapidly-expanding group of moderately impaired stroke survivors.

Myoelectric wrist and hand orthoses (MEWHOs) bridge this gap by utilizing EMG sensors to provide powered assistance for elbow flexion and extension and gross grasp motions. While this technology has shown promising results, no study has directly investigated the effect of wearing a MEWHO on UE impairment, gross manual dexterity and functional task performance.

Accordingly, the purpose of this study was to determine the immediate impact of a MEWHO on paretic UE outcomes in chronic, stable, moderately impaired stroke survivors.

METHOD
Subjects: 18 chronic, moderately impaired stroke survivors were included (median age: 56 ± 11.8, 11 males, 28% Medicare Age, 16 right hand dominant, median Fugl-Meyer: 18.6±6.1)

Apparatus: The MyoPro Motion-G (Myomo Inc., Cambridge, MA, USA) is a MEWHO that provides powered assistance for elbow flexion and extension and gross grasp motions. Outcome measures included: (a) the Fugl-Meyer Scale (a measure of UE impairment), (b) The Box & Block Test (a measure of gross manual dexterity) and (c) a battery of functional tasks (to measure functional task performance).

Procedures: Subjects were administered the aforementioned measures with no orthosis. They then donned the MEWHO and were again tested on the same battery of measures.

Data Analysis: We used a paired t-test to test our primary hypothesis that there would be a significant difference in FM score when using the MEWHO as compared to not using the MEWHO. We utilized the Wilcoxon signed-ranks test to test our secondary hypotheses that there would be a significant difference in scores on the Box & Block Test and the Battery of Functional Tasks when wearing versus not wearing the MEWHO.

RESULTS
Subjects exhibited significantly reduced UE impairment while wearing the MEWHO (FM: t (17) = 8.56, p < .0001), and increased quality in performing functional tasks while wearing the MEWHO (Feeding {grasp}: Z=2.251, p=.024; Drinking {grasp}: Z=2.966, p=.003; Drinking {elbow}: Z=2.966, p=.003). Additionally, subjects showed significant decreases in time taken to grasp a cup (Z=1.286, p=.016) and increased gross manual dexterity while wearing a MEWHO (BB: Z =3.42, p < .001).

DISCUSSION
While post-stroke ambulation and gait kinematics are increased when wearing an orthosis (Sheffer et al., 2013; Esquenazi et al. 2009), this is the first study to compare the effects of a myoelectric orthosis to no orthosis in the paretic UE. Results suggest that UE impairment is significantly reduced when donning a MEWHO. Further, utilization of a MEWHO significantly increased gross manual dexterity and performance of certain functional tasks. More MEWHO training is needed for subjects to be able to perform multi-joint functional movements in order to attain consistent functional changes, which will be incorporated into future work.

CONCLUSION
MEWHO use significantly reduces UE impairment and increases performance of certain functional tasks in chronic, moderately impaired stroke.

CLINICAL APPLICATIONS
With little to no training, subjects were able to utilize the MEWHO to perform daily tasks. As such, a MEWHO may constitute an additional device option for stroke survivors exhibiting moderate UE hemiparesis; a crucial finding, given the paucity of therapeutic options available to this group.

REFERENCES
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