Use of a Myoelectric Arm Orthoses to Improve Therapeutic and Functional Value for Patients with Severe Arm Dysfunction

Jonathan Naft, CPO

Abstract

This presentation will thoroughly discuss the findings resulting from 20 patients that currently wear a myoelectric orthoses that uses EMG/myoelectric control for an otherwise impaired upper extremity. The custom orthoses uses an electrode on the biceps and triceps in order to read EMG. Different from FES, the EMG signal is filtered and amplified to control flexion and extension for patients that lack power and range of motion (ROM) in the affected arm. Static hand sections on the orthoses are used to position the hand for functional tasks.

Patients that wear the elbow wrist hand orthoses (EWHO) benefit from therapeutic and functional benefits. The orthoses was able to provide assistance to increase ROM when compared to ROM without the orthoses. The findings also suggest that patients with spasticity can learn volitional control of their tone. Different from FES, myoelectric control utilizes the patient’s own control. This may mean that patients recovering from diagnoses such as CVA will have a new method to help regain strength, ROM, and function in their disabled arm at a faster rate than without the orthoses.

Introduction

The number of patients recovering from neuromuscular arm weakness is a large population in the US. Every 40 seconds, someone in the United States has a stroke (CDC, 2012). The orthotic community can help patients restore arm function by developing a myoelectric orthoses that uses myoelectric control, from a patient’s biceps and triceps, to control an elbow wrist hand orthoses. The brace is a portable, lightweight functional arm brace that restores movement to a weakened arm as a result of neuromuscular damage. The custom orthoses incorporates a noninvasive myoelectric platform technology in a wearable device that enables a person to initiate-and-control their own motion when they would otherwise not be able to fully move an affected arm. The arm brace has been proven effective in assisting people in their daily living activities in the home and facilitating functional repetitive task practices during therapy. The technology does not use electrical impulses or stimulation. It reads weak muscle signals and sends it to the device’s signal processor which allows a person to move their affected arm. The patient self initiates and achieves natural movement patterns by their own muscular signals that indicate intention to move. The system senses even a very weak EMG muscle signal and then processes data to a motor on the device that enables desired motion.

The brace is indicated for use to (1) facilitate muscle re-education and (2) maintain or increase range of motion.

Methods

The Orthoses

A novel custom EWHO was designed (Fig. 1). Three rigid sections control the arm in the sagittal, coronal, and transverse planes. A motor is mounted laterally at the elbow to provide lift assist. Electrodes are moveable with Velcro, and they are located in the humeral section in order to read EMG from the biceps and triceps. A battery is thermoformed into the lateral humeral section to power the orthoses. Wires are routed internally to allow the
input signals to be converted by an on-board microprocessor. The orthoses is fabricated from an impression of the patient’s affected arm.

Data Collection

To measure success from wearing the orthoses, the following data was be collected:

- Joint ROM, at the elbow, measured actively without the orthoses
- Joint ROM, at the elbow, measured with the orthoses in place

Results
Twenty patients were tested with the orthoses. Diagnoses included CVA, ALS, and SCI. The following results were obtained:

Patients showed an increase in their ROM and overall movement of their impaired arm. Without the orthoses, patients achieved less ROM when compared to a higher ROM/ less movement with the orthoses in place.

The presentation will show results, on video, of patients using the device.

**Conclusion**

Patients can benefit from wearing a myoelectric EWHO that assists in powering an otherwise dysfunctional arm. Elbow joint ROM increases as a result of wearing the orthoses. Patients can utilize their minimal EMG signals to control a powered orthoses.
Discussion

The concept of a powered arm orthoses is encouraging, and one might infer other findings that were anecdotally witnessed during the data collection:

Patients with tone, from CVA, seemed to be able to control, volitionally, the spasticity in their affected arm. During the eight week period that patients were observed, most of the patients with tone were able to use the orthoses as a means to help overcome their tone. For example, patients with flexure tone were able to learn to relax their biceps resulting in extension from the orthoses. Further study from this topic may reveal a new method to help patients lessen spasticity.

Patients also reported that they were able to increase their level of function while wearing the orthoses. For example, as a result in increased arm movement, patients reported using the orthoses for assistance in the following ways:

- Carrying objects – patients reported that use of the orthoses assisted in carrying purses, groceries, and other small items that had handles. They reported this was significantly better with the orthoses than without.
- Sit to stand – patients reported less difficulty mobilizing from sit to stand while wearing the orthoses. By utilizing the motor’s extension, the patients described being able to use both arms to assist in standing when otherwise they may use only the non-affected arm.
- Some patients used the hand’s terminal device to assist with eating. In most cases, patients used the fork attachment to stabilize food in order to cut the food with the sound side. Without the orthoses and fork attachment, they reported not being able to cut their food. This suggests that other terminal devices may be of use for a wider variety of ADL’s.
- Regarding the patient’s with CVA, some reported an increase in overall arm strength and ROM. Patients that were both actively involved in therapy programs as well as patients that were long removed from therapy reported, anecdotally, they felt the powered orthoses helped them achieve a faster recovery than treatments without using the brace.

The above listed observations imply further study is needed to examine the usefulness of a myoelectric controlled orthoses. Perhaps these observations could inspire future research to quantitatively measure other successes as we learn more about this orthoses.

Clinical Applications

At the conclusion of this presentation, the audience will gain knowledge that will be useful for identifying patients that can be fit with a myoelectric orthoses. As well, clinicians will be inspired for a new method to help patients regain function lost from neuromuscular impairments.

References


Taub E, Uswatte G, King DK, Morris D, Crago JE, Chatterjee A. A placebo-controlled trial of


D. Effect of Constraint-Induced Movement Therapy on Upper Extremity Function 3 to 9 Months After Stroke: The EXCITE Randomized Clinical Trial *JAMA,* November 1, 2006; 296: 2095 — 2104.


