UPPER EXTREMITY SLING FOR DYNAMIC REHABILITATION FOR TRAUMATIC BRACHIAL PLEXUS INJURY

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1. Abstract

The brachial plexus is a network of nerves that conducts signals to the shoulder, arm, and hand. When these nerves become damaged, loss of motor control and sensory perception can occur[1]. Karen Blaschke, an occupational therapist with UW Hospitals and Clinics, works with patients suffering from brachial plexus injury and has requested a sling that will allow these patients to return to an active lifestyle, mainly running. We aim to create a sling that would adapt to patients at differing levels of rehabilitation. Three designs for the arm portion and two designs for the body anchor were created and evaluated. An arm and anchor design were selected and integrated to create a sling that offered support and allowed proper movement of the arm while running.

2. Introduction

Background

The brachial plexus is a neural network that provides motor control and sensory perception to the upper extremity. Injury to this nerve cluster can result in varying degrees of disability throughout shoulder, upper arm and forearm[2]. The initial healing process, regardless of the necessity of surgical intervention, requires complete support and immobilization of the arm and shoulder area to prevent pain and further injury. Once this phase is completed, there is a need for a dynamic rehabilitation program to stimulate new growth of atrophied muscles[3].

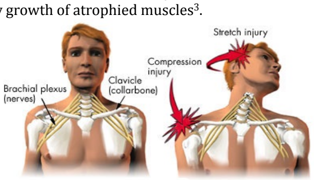

Figure 1. Depiction of a stretch injury. Results from compressive force to the head.

Problem Statement

The goal of this project is to create a sling for use during dynamic rehabilitation for patients with upper extremity injuries such as a brachial plexus tear. The device will effectively support the shoulder and arm to reduce loading of muscles in this area, maintain a ninety degree elbow bend, and facilitate proper angular motion at the shoulder joint during running or other active movements. The sling will be comfortable, lightweight, accommodate motion without causing chaffing.

3. Design Criteria

The dynamic sling for rehabilitation for traumatic brachial plexus injury meet the following requirements:

- Stabilize the shoulder in an anatomically correct position
- Mimics proper arm movement and elbow angle and orientation
- Must be visually appealing, breathable, washable
- Must not cause abrasions, chaffing, or restrict blood flow
- Last the entirety of the patient's therapy
- Adjustable to accommodate different body types
- Easy to assemble

4. Final Design

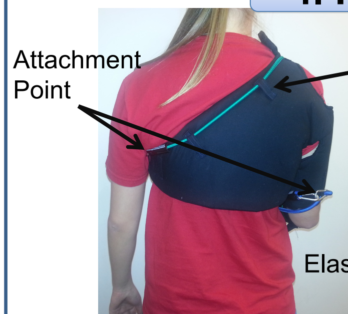

Figure 2. Back view of the sling including vest component, bands, and belt loop holes.

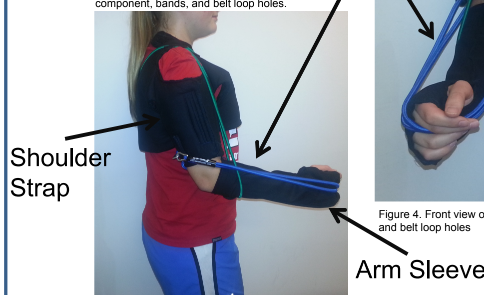

Figure 3. Side view of the sling including shoulder strap, arm sleeve, bands, and attachment points.

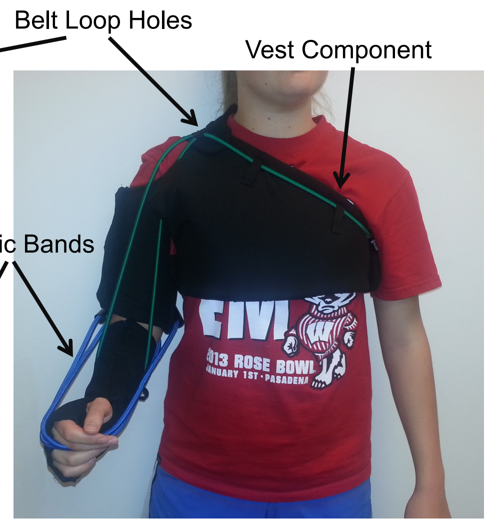

Figure 4. Front view of the sling including vest component, shoulder strap, arm sleeve, bands, and belt loop holes

5. Testing

Elbow Flexion of Patient With and Without the Sling Test

-Assembled treadmill and Kinect, with the Kinect pointing at the treadmill with approximately a 30 degree angle from the front of the treadmill
-Assembled MATLAB code to analyze the angle between two vectors: one from the shoulder to the elbow, and one from the shoulder to the hip
-Ran MATLAB code and SkeletalView for Kinect application to collect data for two trial runs (with and without the sling) of each team member for 15 seconds at a constant speed of 4.5 mph

Reduction of Force With Sling Test

-Assembled hook at hand, and measured force
-Repeated same steps at the mid forearm and elbow

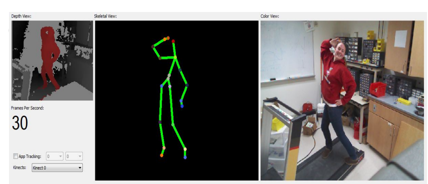

Figure 5. Screen shot of SkeletalView for Kinect for collecting data for trial runs.

6. Analysis

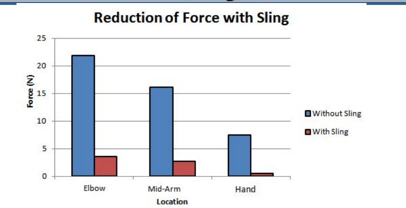

Figure 6. Graph showing the reduction of force when use wearing sling.

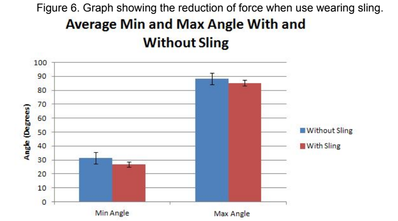

Figure 7. Graph showing the average min and max angle with and without sling. The standard error was lower with the sling.

- Angles were not statistically different ($p<0.05$)
- Trials with sling had lower variances, more consistent running form
- Sling reduced force created on shoulder by more than 80%

7. Future Work

- Universalize the sling sizing
- Variable tension support system
- Material consideration
- Injured subject to determine if shoulder motion is facilitated
- User manual
- Ergonomic testing
- Force distribution analysis of vest

8. Acknowledgements

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- Professor Darryl Thelen
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- Jennifer Kempf
- Christopher Thomas

9. References

[1] Mayo Clinic. 2011. *Brachial plexus injury*. http://www.mayoclinic.com/health/brachial-plexus-injury/DS00897. Accessed March 5, 2013.
[2] Functional Anatomy Blog. 2010. *Anatomy Review: The Brachial Plexus.* http://functionalanatomyblog.com/2010/03/16/anatomy-review-the-brachial-plexus/. Accessed March 5, 2013
[3] Hassan, S and Kay, S. 2003. *Brachial Plexus Injury.* Surgery (Oxford), 21 (10):262-264.