THERAPEUTIC SPIDER CAGE

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ABSTRACT

Cerebral palsy is a disorder that affects gross motor function. The disease is usually acquired prenatally and caused by abnormal brain development in regions associated with movement such as the motor cortex and pyramidal tracts. There is no cure for cerebral palsy but treatment options include surgery, medication, and therapy. Matt Jahnke is the adult program director for United Cerebral Palsy (UCP) of Greater Dane County and he has tasked the team with creating a spider cage to aid in physical therapy. Spider cages are structures used in physical therapy to help motor impaired individuals gain strength, muscle control, balance, and independence. The team fabricated a spider cage out of 80/20 Inc. aluminum based on a panels design that contains a wire-mesh caging for harness attachment points. After assembly, slip testing was performed using five subjects in three different test setups. Deflection at each carabiner was measured using a dial indicator and statistical analyses were run on the data. Data from the heavier test subjects showed that carabiners attached closer to the beams led to less deflection while data from the lighter subjects were not as significant. UCP will be able to use the spider cage for therapy needs within its facility.

BACKGROUND

Cerebral palsy is a group of non-progressive, non-contagious motor conditions caused by a delay in physical development [1]. There is no cure, but there are treatments to improve the lives of those affected.

Effects of Cerebral Palsy:
- Lack of motor control with voluntary movements.
- Stiff or tight muscles and exaggerated reflexes.
- Disturbances in sensation, perception, communication, and behavior [1].

Treatment:
- Surgery, medication, and therapy.
- Spider cage enhances physical therapy to improve control of gross motor functions [2].

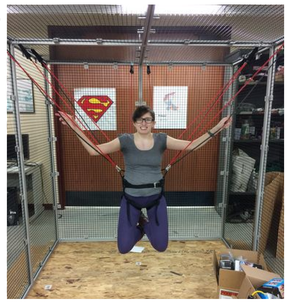

Figure 1: Spider cage with resistance bands supporting test subject's full body weight.

MOTIVATION

UCP does not currently have a spider cage therapy unit within its facility and commercially available units are expensive and difficult to transport. Fabricating a relatively inexpensive and portable model that has the same level of functionality as a commercial model is desirable to UCP.

DESIGN CRITERIA

- The cage should be able withstand a load of 300lbs from any point on the top of the frame.
- A therapist should be able to connect resistance bands to virtually any point on the top and sides of the cage between the framing members.
- The cage must be able to function with any size patient.
- The cage must be relatively lightweight, transportable in sections, and able to fit onto a noncommercial trailer.
- Assembly of the cage should require between 2-4 people.

FINAL DESIGN

Design Considerations:
- Angled members provide added support to top face of cage.
- Members are connected with anchors torqued into other members for stability.
- The cage is designed to be broken down into smaller panels for portability.
- Slots on bottom members provide attachment to a base platform for stabilization.
- Mesh provides ample connection locations on each face.

Specifications:
- A 6.5' x 6.5' x 6.5' cage with an open face.
- Wire mesh encloses three sides of the cage and the top to allow for attachments.
- Total weight: 240 lbs.

Figure 2: The final design for UCP's spider cage which has a frame made of 80/20, wire mesh for resistance band attachments, and padded flooring.

Cage Materials:
- Aluminum extruded 80/20,1515-LS series of various lengths.
- 80/20 Anchor fasteners
- 12 gauge thermoplastic coated wire mesh with 1" x 1" openings.
- Wire mesh retainers.

Additional Materials:
- 4'x 8' OSB board (QTY: 2)
- Latex resistance bands with multiple elasticities (QTY: 4)
- Foam flooring
- Pool noodles
- Full body harness

TESTING PROTOCOL

Goal: Determine if mesh deflection at carabiner locations between three test setups is significantly different.

Hypothesis: Test setups with carabiner attachment locations further from the extrusion will yield greater deflections than those closer to the extrusion.

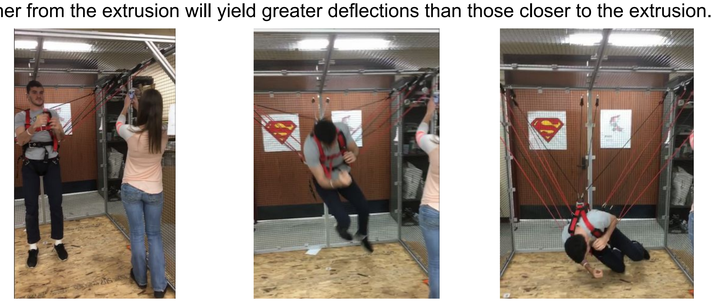

Figure 3: Test subject performing slip test. Subject was to stand and thrust weight forward to simulate slip while deflection was recorded using a dial indicator.

RESULTS & DISCUSSION

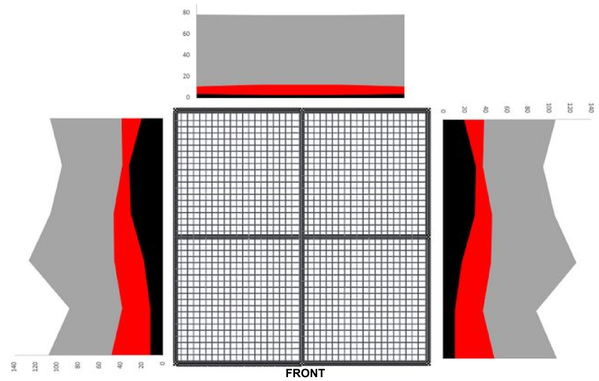

Figure 4: Top view deflection visual of one test subject from test setups 1 (black), 2 (red), and 3 (grey) on the scale of thousandths of an inch.

Table 1: Heavier group ANOVA p-values for variation in each test setup (top). Lighter group ANOVA p-values for variation in each test setup (bottom). Red values indicate significant difference and blue values indicate no significant difference between test setups.

Location	Carabiner 1	Carabiner 2	Carabiner 3	Carabiner 4	Carabiner 5	Carabiner 6	Carabiner 7	Carabiner 8
P-value	0.00026	0.00023	0.00155	0.0071	0.00042	0.001	0.0932	0.00126

Location	Carabiner 1	Carabiner 2	Carabiner 3	Carabiner 4	Carabiner 5	Carabiner 6	Carabiner 7	Carabiner 8
P-value	0.0752	0.285	0.0231	0.0161	0.0687	0.14	0.0928	0.0156

- Deflection was lowest when the carabiners were attached near the extrusions and greatest when attached farther away from the extrusions
- Prior testing indicated that permanent deformation of the mesh occurred at a deflection of 1.25 inches

FUTURE WORK

- Research non-latex resistance bands
- Research harnesses better fit for specific clients and their needs
- Research carabiners that are easier for the client to use and help reduce wear on the cage
- Transport and setup cage at Continuum Therapy

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[1] A. Colver, C. Fairhurst, and P. O. D. Pharoah, "Cerebral palsy," (in English), *The Lancet,* vol. 383, no. 9924, pp. 1240-9, 2014 Apr 05 2015-02-07 2014.
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