Feasibility Testing Report – Lower Attachment Stage 1

Team: P15001: Active Ankle Foot Orthotic
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Test Date: 10/16/2014

Related System: ABBBB: Raise Foot, AAA: Secure Foot

The reason for this test is to find:

a) Where on the lower base should the McKibben muscle be attached?
b) How much force does it take to lift the foot with an ankle brace?
c) How should the Mckibben muscle extender be attached to the lower base?
d) Does the brace remain comfortable when a force is applied? Are there any specific ways that the force is applied that causes the brace to be uncomfortable or constrict blood flow?

Supplies:

1.) Mueller Adjustable Ankle Stabilizer
2.) Adjustable Velcro straps
3.) 60lb fishing line
4.) 20lb spring force gage
5.) Large safety pins
6.) Ruler

Setup:

During this test, 2 different test setups were used (Figure 1 and Figure 2).

Setup 1: In this setup, the volunteer is wearing an ankle brace with a piece of fishing line sewed into the end of the brace. The volunteer's leg is held to the base of a table using 2 Velcro straps, one placed right above the volunteer's ankle and another placed around the mid calf region. This ensures that the volunteer's leg remains still during the test in order to obtain the most accurate force values.

Setup 2: In this setup, the volunteer is also wearing an ankle brace with a piece of fishing line sewed into the end of the brace; however, the force is not applied on the brace directly. The fishing line on the brace is tied to a rigid Velcro strap that is wrap around the

volunteer's foot, near the toes. Another piece of fishing line is tied to the Velcro strap and will be used to apply a force. Similar to setup 1, the volunteer's leg is tied to the base of a table using 2 Velcro straps, one placed above the volunteer's ankle and another placed around the mid calf region. This ensures that the volunteer's leg will remain still during the test in order to obtain the most accurate force values.

Figure 1: Setup #1, fishing line attached at end of brace (see circled area).

Figure 2: Setup #2, fishing line attached to the Velcro strap that is tied to the ankle brace (see circled area).

Procedure:

Two separate setups were utilized yielding a total of two tests. However, both setups followed the same test procedure, which is outlined below:

1. Using a spring force gage, a team member will lift the volunteer's foot
2. Volunteer announces when their foot is at a 90 degree angle and team member will stop applying a force.
3. The team member will read aloud the resulting force from the force gage
4. The test volunteer will record the results

Results:

Setup 1: The collected results for setup 1 are displayed in table 1, below.

Observations:

1.) Brace is crimping because most of the force absorbed by brace
2.) First 1.5lbs of force is transmitted to brace
3.) Moment arm at start of test: 4.75inches, Moment arm at end of test: 2.9inches

Table 1: Setup 1 Results

Trial	Force (lbs)
1	7.5
2	8.0
3	8.5
Average	8.0
Note: The volunteer indicated that their foot was only lifted approximately 60% of the way. An angle of 90 degrees was NOT obtained during this test.	

Setup 2: The collected results for setup 2 are displayed in table 2, below.

Table 2: Setup 2 Results

Trial	Force (lbs)
1	7.0
2	6.75
3	7.0
Average	6.91
Note: the volunteer noticed that during this particular setup, the foot was lifted to 90 degree angle	

Conclusion:

In conclusion, it was determined that the brace was too elastic to withstand an applied force. Overall, when a force was applied directly to the brace, the brace crimped and decreased the desired moment arm by approximately 50%. This resulted in an increased amount of force needed to lift the foot. However, when the setup was altered to include a more rigid attachment point, the Velcro strap, it was clear that the ability to lift the foot was easier and more effective. Therefore, this tells us that our team will need to incorporate a more rigid attachment point. Also, the results also indicate that the force will need to be applied close to the toes (approximately 1 inch away).

a.) Where on the lower base should the McKibben muscle be attached?
On top of foot, near the toes (approximately 1 inch away)

b.) How much force does it take to lift the foot with an ankle brace?
According to our results, it will take approximately 8lbs of force to lift the force. From previous tests, we believe that the necessary applied force can be lowered. Our follow-up test will be addressing this question.

c.) How should the Mckibben muscle extender be attached to the lower base?
The muscle extender should rest on the top of the base/brace and strung through inelastic loop holes in order to avoid contact with a user's shoe.

d.) Does the brace remain comfortable when a force is applied? Are there any specific ways that the force is applied that causes the brace to be uncomfortable or constrict blood flow?
In this test, the brace was not comfortable because it was very tight. It needed to be wrapped tight in order to withstand the necessary applied forces. This issue will be addressed in a follow up test, outlined below.

Next Steps:

The next step is to complete a follow up test that addresses the issues discovered by this test. Specifically, the follow up test will need to include a more rigid attachment point since it was determined that the brace is too elastic to withstand the necessary applied force.