



Messiah University
Mosaic

2020 Collaboratory/Engineering Symposium

Engineering and Collaboratory

2020

Force Characterization and Manufacturing of a Dynamic Unilateral Clubfoot Brace

Rebekah L. Forshey

William L. Feczko

Liam P. Lilienthal

Aaron Bashore

Brittney D. Fouse

See next page for additional authors

Follow this and additional works at: <https://mosaic.messiah.edu/engr2020>

 Part of the [Agricultural and Resource Economics Commons](#), [Development Studies Commons](#), [Engineering Commons](#), [Nonprofit Administration and Management Commons](#), and the [Urban Studies and Planning Commons](#)

Permanent URL: <https://mosaic.messiah.edu/engr2020/8>

Sharpening Intellect | Deepening Christian Faith | Inspiring Action

Messiah University is a Christian university of the liberal and applied arts and sciences. Our mission is to educate men and women toward maturity of intellect, character and Christian faith in preparation for lives of service, leadership and reconciliation in church and society.

www.Messiah.edu

One University Ave. | Mechanicsburg PA 17055

Authors

Rebekah L. Forshey, William L. Feczko, Liam P. Lilienthal, Aaron Bashore, Brittney D. Fouse, Michelle Lo, Benjamin J. Mellott, Sam J. Rasinske, Leigha R. Southall, and Jordan M. Witt

FORCE CHARACTERIZATION AND MANUFACTURING OF A DYNAMIC UNILATERAL CLUBFOOT BRACE

2020 COLLABORATORY / ENGINEERING SYMPOSIUM

Aaron Bashore, Brittney Fouse, Michelle Lo, Ben Mellott, Sam Rasinske, Leigha Southall, Jordan Witt

What is Clubfoot?



Clubfoot is a birth defect that affects 1 in every 1000 children worldwide. It is characterized by a baby's foot being twisted inward and upward because the tendons are shorter than usual.



The current treatment for clubfoot is the Ponseti Method, which consists of a corrective phase of five different casts, followed by a maintenance bracing phase.

Maintenance Braces



Boots-and-Bar Brace (Current Method)

- 5 year treatment
- Bilateral (both feet)
- Uncomfortable
- Limits mobility
- Inhibits muscle growth
- Has more social stigma

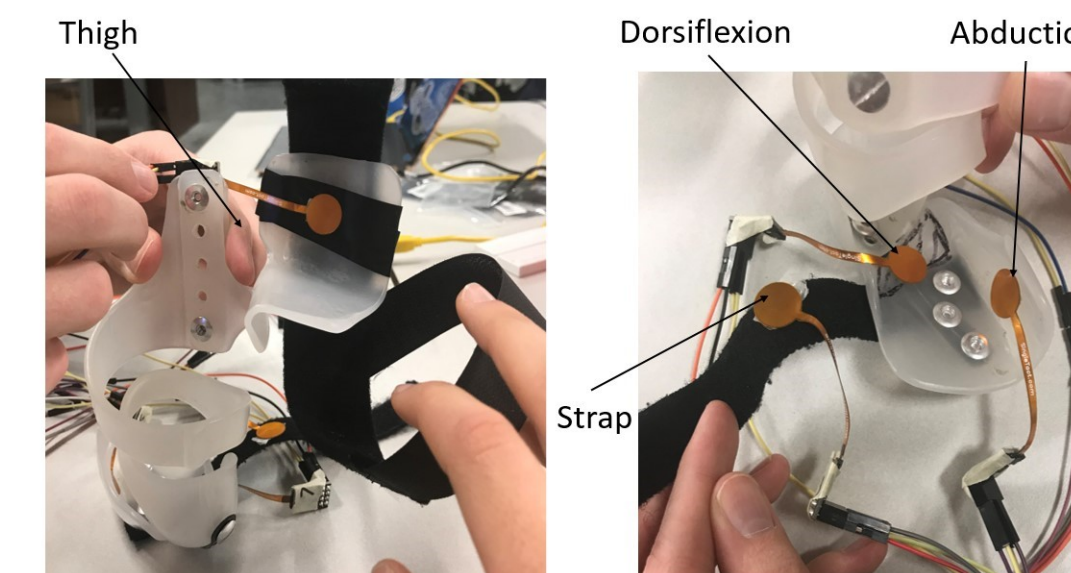
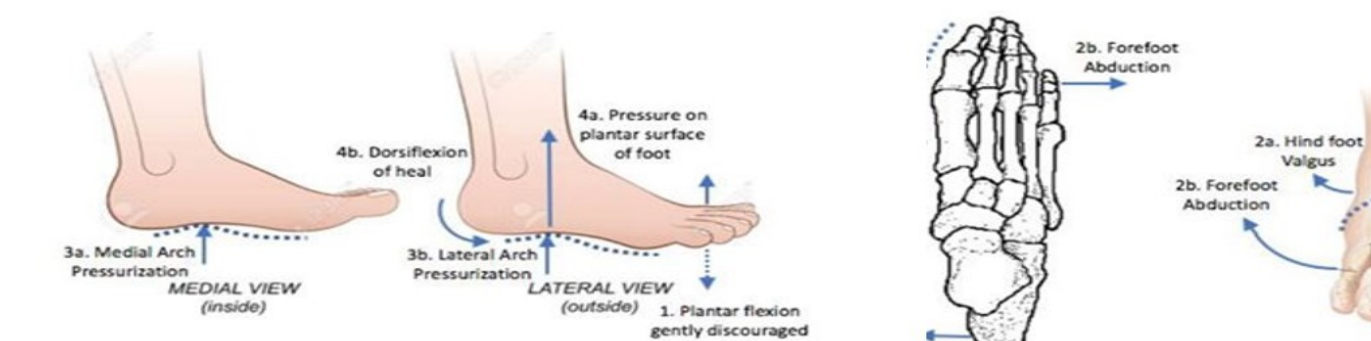
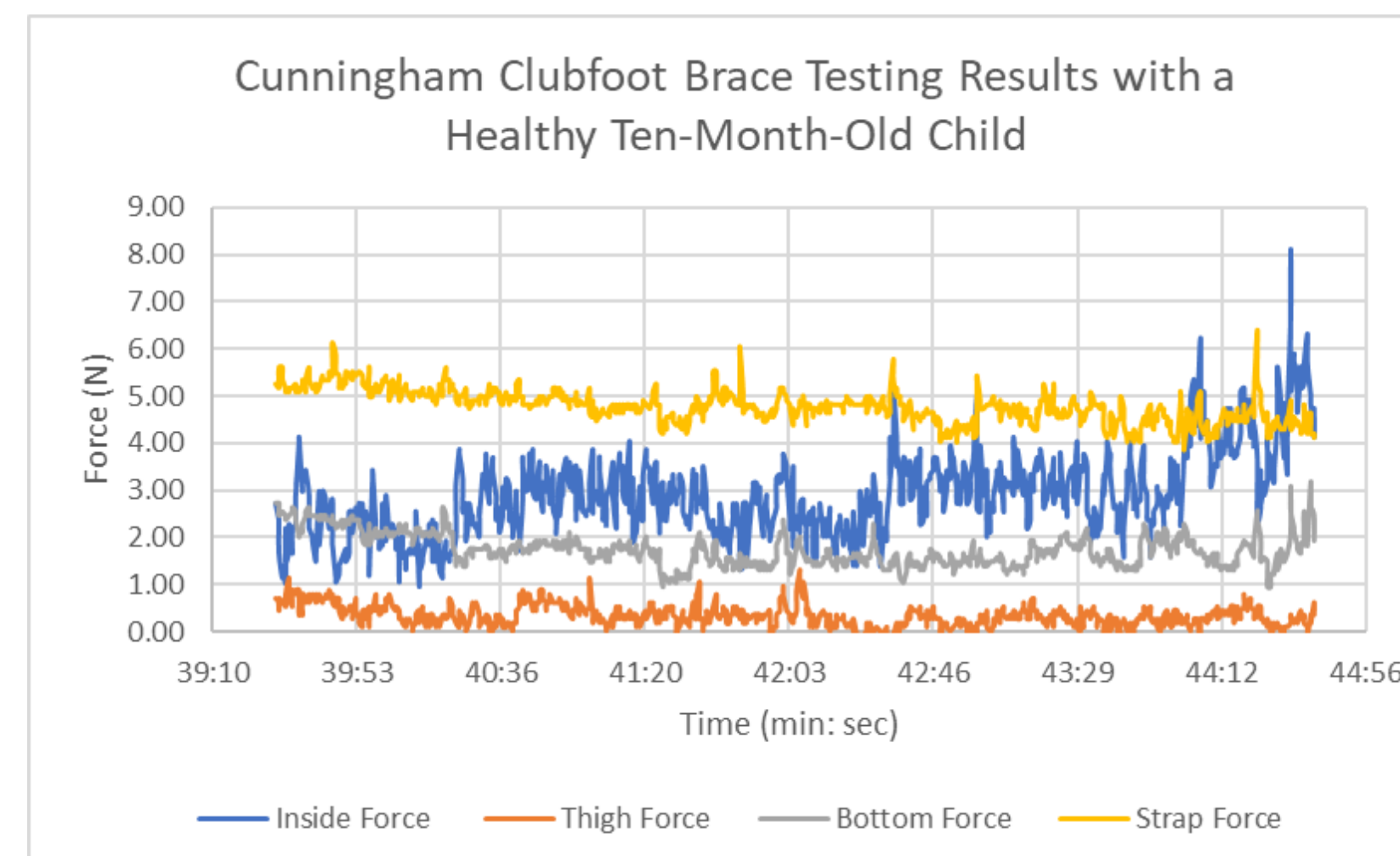
Cunningham Brace

- Replaces the Boots-and-Bar brace
- 2-3 year treatment
- Unilateral (one foot)
- Promotes comfort
- Allows mobility and muscle growth
- Can be hidden to reduce social stigma
- Reports a high compliance (90%)

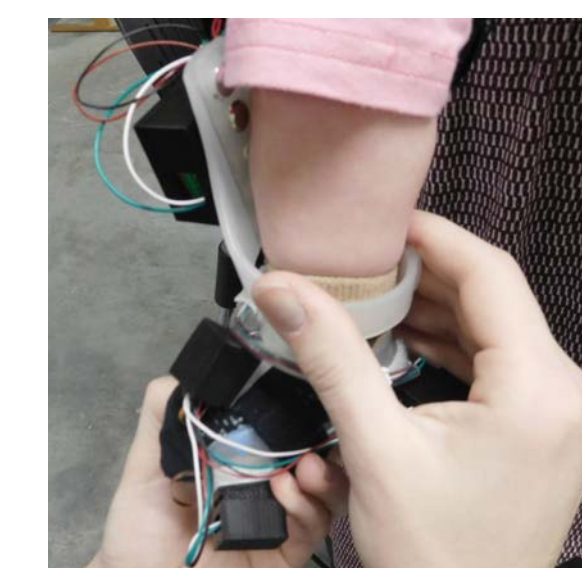


Testing the Forces of the Cunningham Brace

Our goal is to assess the Cunningham Clubfoot Brace and hopefully confirm that it is an effective maintenance brace. To do this, a new and robust testing system was made with capacitance force sensors and was tested with healthy babies.



In one successful system test, a somewhat tight foot strap created a high force, team members creating an abduction force translated to a varying inside force, the bottom force showed dorsiflexion, and the brace did not fit the child as well as anticipated creating a low thigh force.



Manufacturing

The Cunningham Brace is currently manufactured using a lengthy vacuum molding procedure that consumes an entire sheet of plastic. The CCB team is developing a new manufacturing method that will hopefully reduce production time and variability at the CURE International Hospital in Kijabe, Kenya where a clinical study is currently being performed. This year, we prototyped a clay mold for wrapping a flat plastic cutout into the shape of the brace. Next year, we plan to improve the process by 3-D printing a mold.



Creating an Infant Foot Model

Creating an infant foot model will allow us to test the forces the brace exerts on the foot of a child wearing the Cunningham brace.

Step 1: Making the Mold

- Made out of fiberglass casting material
- Reusable



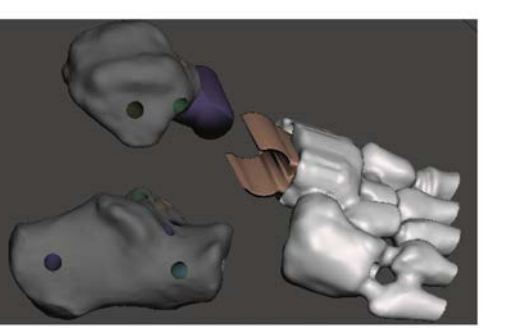
Step 2: Modeling and 3D Printing the Bones

- Bone structure with labelled ligaments added into mold before gel is poured into mold
- Foot is being 3D printed in 3 parts: the forefoot, the midfoot, and the hindfoot



Step 3: Making the Soft Tissue of Foot

- Made out of clear medical grade ballistics gel - a material known for having properties similar to muscle tissue



Current Progress: Revision of Talonavicular Joint Capsule

- With recommendations from Dr. Granger, MD of York, the Talonavicular joint is being remodeled to correctly model the movement of the foot

Conclusion

In the efforts to test the effectiveness of the Cunningham Clubfoot Brace as a clubfoot maintenance brace for CURE International, we have improved our force testing system and manufacturing methods to increase the productivity and repeatability of the brace. Improvements in the infant foot model and testing with healthy children take us one step closer to providing conclusive research. Then, Hope Walks will be able to use the brace as a reliable option for children in their clubfoot treatment process.

Future Directions

Visit to Cunningham Prosthetic Care

- Summer or Fall 2020
- Force Testing with clubfoot patients
- Manufacturing advice from Mr. Cunningham
- Advice and direction from Mr. Cunningham

Fall:

- Testing with healthy and clubfoot children
- Continuation of Manufacturing prototyping and analysis
- Continued refinement of the biomechanical model for laboratory testing
- Updates on clinical study in Kenya
- Updates on Dr. Emily Farrar's clinical analysis

Acknowledgements

- Tim Howell, Dr. Emily Farrar, Andy Erikson, and Dereck Plante for their guidance
- Jerald Cunningham, CPO, Scott Reichenbach, Eric Shoemaker, CPO, and Don Waardenburg for their expert advice and support
- Victoria, Ann, Isaac and the CCK team at CURE International in Kijabe, Kenya
- Bekah Forshey, Liam Lilienthal, and Luke Feczko for their friendships, commitment, and great ideas

