CUNNINGHAM CLUBFOOT BRACE

SCHOOL OF SCIENCE, ENGINEERING, AND HEALTH SYMPOSIUM 2019

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What is Clubfoot?

Clubfoot is a birth defect that affects 1 in every 1000 children worldwide. [1] 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 [2], which consists of a corrective phase of five different casts, followed by a maintenance bracing phase.

1. Ansar, Adnan et al. "Systematic review and meta-analysis of global birth prevalence of clubfoot: a study protocol." *BMJ open* vol. 8,3 e019246. 6 Mar. 2018, doi:10.1136/bmjopen-2017-019246
2. Radler, Christof. "The Ponseti method for the treatment of congenital club foot: review of the current literature and treatment recommendations." *International orthopaedics* vol. 37,9 (2013): 1747-53. doi:10.1007/s00264-013-2031-1

The Cunningham Clubfoot Brace

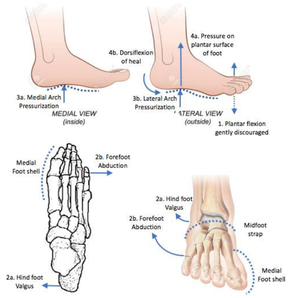
Boots-and-Bar Brace
(Current Method)
- 5 – year treatment
- Bilateral (both feet)
- Uncomfortable
- Limits mobility
- Prevents muscle growth
- Has more social stigma

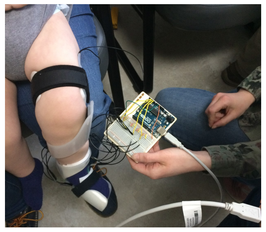
Cunningham Maintenance Brace
- Replaces the Boots-and-Bar brace
- 2-3 year treatment
- Unilateral
- Promotes comfort
- Allows mobility and muscle growth
- Can be hidden to reduce social stigma
- Reports a high compliance (86-95%) [4]

4. Cunningham, Jerald, SBIR Phase I Final Report: Dynamic Torsional KAFO for Lower Extremity Deformities, National Science Foundation Proposal # 0418277

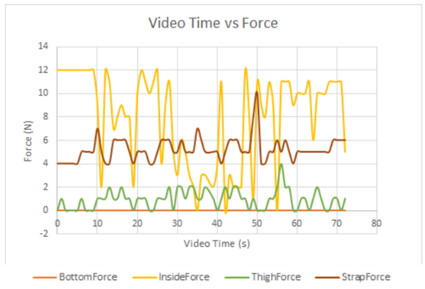
Testing the Forces of the Cunningham Brace

Our goal is to validate the Cunningham Clubfoot Brace and help confirm that it is an effective maintenance brace. In order to do this, we are testing the forces exerted on the foot in four different areas on the brace: inside the foot piece, on the bottom of the foot piece, under the strap, and inside the thigh piece.



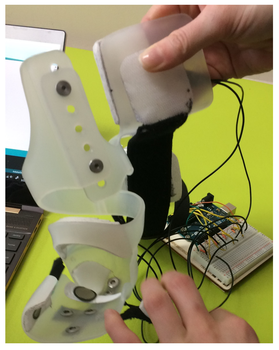


We did a pilot test in Cunningham's clinic in Maine in order to get preliminary data regarding the forces.



The data showed that the inside force, which is responsible for abduction, had the largest value. The strap and thigh forces work together to counteract this force. The bottom force, which contributes to dorsiflexion, was very small.

Force Sensor Sock



We are working on developing a force sensor sock in order to eliminate the need to move the force sensors to each individual patient brace. This sock will be Bluetooth activated and will have four sensors in the correct position for testing. The sock will slide on the foot and then the brace will be put on the child.

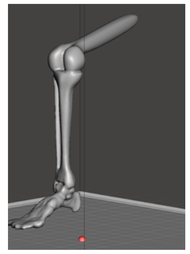
Creating an Infant Foot Model

We hypothesize that we will be able to utilize the method created by a team at Carnegie Mellon University for an *adult* model of clubfoot [3] to create an *infant* biomechanical model of clubfoot. This will allow us to test the forces without having a real clubfoot patient. There are three steps to creating the foot model.

Step 1: Making the Mold
- Made out of fiberglass casting material
- Can be reused

Step 2: Making the Foot
- Made with clear medical grade ballistics gel - a material known for having properties similar to muscle tissue

Step 3: Modeling and 3D Printing the Bones
- Ballistics gel leg is missing needed bone structure
- Bone skeleton provides structure in foot
- Foot is being 3D printed in 3 parts: the fore-foot, the mid-foot, and the hind-foot



3. Wu et al. A Patient-Specific Flexible 3D Printed Orthopedic Model for Training and Teaching of Clubfoot Correction Surgery. 3D printing and additive manufacturing (2016).

Conclusion

In our effort to test the effectiveness of the Cunningham Clubfoot Brace as a quality maintenance brace for CURE International, we have made major progress in developing a force testing plan and creating an infant foot model. As we continue to test the forces on patients and develop our foot model, we will be one step closer to validating the Cunningham Brace. Then, Hope Walks in Kijabe, Kenya, and others around the world, will be able to use the brace as a reliable option for children in the clubfoot treatment process.

Future Directions

Kenya Site Team Trip, May 2019:
- Continue to build relationships with the CURE Clubfoot Kenya (CCK) team and be updated on the clinical study
- Continue to pilot the force sensor and talk with parents about their Cunningham Clubfoot Brace experience

Fall:
- Expand development of the infant foot model and force testing analysis

Future Years:
- Clinical study in Kenya
- Dr. Emily Farrar and Mr. Jerald Cunningham's patient data study

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