ANKLE BRACE

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INTRODUCTION

The focus for this project lies in the musculoskeletal system. The musculoskeletal system comprises of bones and ligaments as well as musculotendinous complexes. Since the Ankle Brace is focused on preventing sprains in athletes, this project focuses on the ligaments in the ankle. The most common sprains occur on the outside of the ankle during lateral movements, which account for 85% of all sprains[1]. The best way to prevent and help recover from these sprains is to either wear a brace or tape the injury via a medical professional. The issue is that most braces are too bulky to wear comfortably with shoes, boots, or cleats. The Ankle Brace project is focused on making a brace that is thinner and more comfortable for the user to wear.

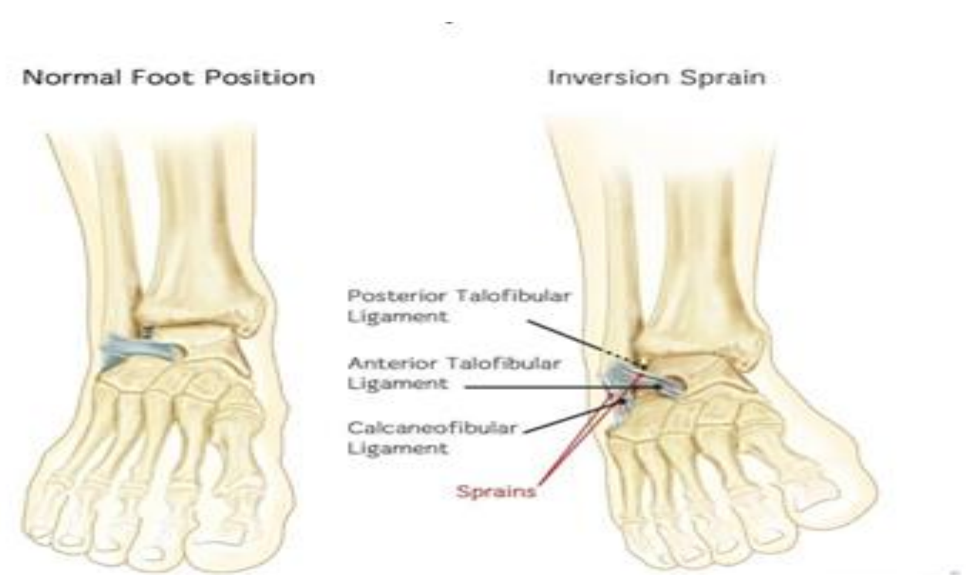

Figure 1: Normal ankle vs Inversion ankle sprain

DESIGN PROCESS

The current braces focus on:

- ❖ Alternate mesh instead of diamonds with extra mesh support in middle
- ❖ Small/Medium/Large sizes for different ankles and people
- ❖ Testing with the ERAU soccer teams to measure inversion/ eversion
- ❖ Testing with current market braces on testing rig
- ❖ Design constraints of 40 degrees of inversion and 10 degrees of eversion to prevent sprains
- ❖ Printing through Ultimaker S5 using thermoplastic polyurethane (TPU)

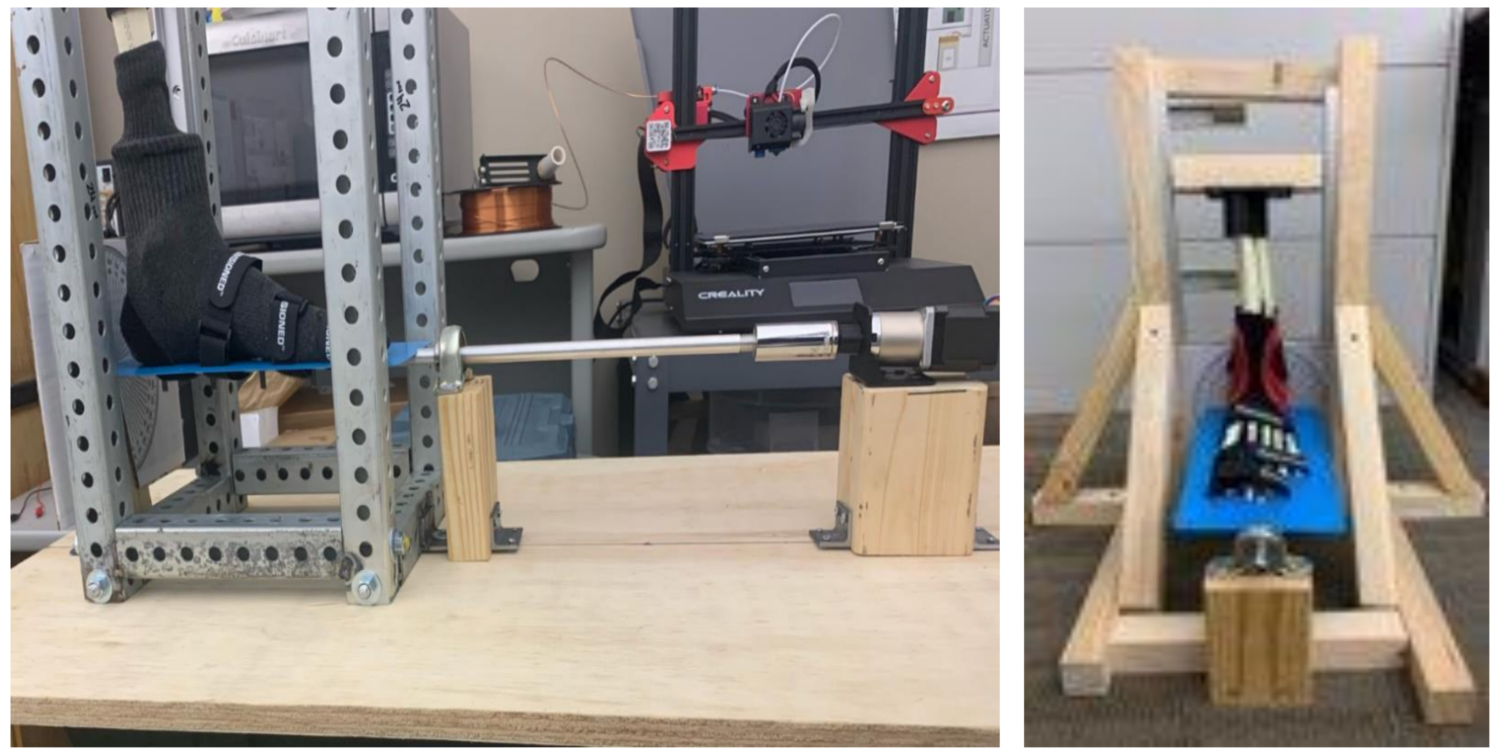

Figure 2: Testing rig

ABSTRACT

Current preventative measures of the market for ankle sprains are ineffective. With the incorporation of thin 3D prints for stability and support combined with compression material, an ankle brace can be produced that is efficient, cost-effective, and reusable. The developed ankle braces vary in design and size modeled using SolidWorks made from thermoplastic polyurethane (TPU) produced by an Ultimaker S5. The team expects to test brace designs to find which braces are more efficient in limiting ankle sprains caused by both excess inversion and eversion while still allowing for natural range of motion. The 3 types of mesh design are solid, triangular, and a 2-layer design that combines both parts. Previous iterations using different mesh proved effective with design considerations incorporated in this session.

Discussion

Design considerations were made to improve on previous diamond pattern and user input. These include:

- ❖ Single piece layered design (top) and solid (left) to improve support and production
- ❖ Triangular mesh (right) to make a stronger shape
- ❖ Improvements to testing rig with new servo motor and drive motor
- ❖ Compression socks vs sleeves
- ❖ Gripper tape stitching on inside to improve friction
- ❖ TPU versus polylactic acid (PLA)

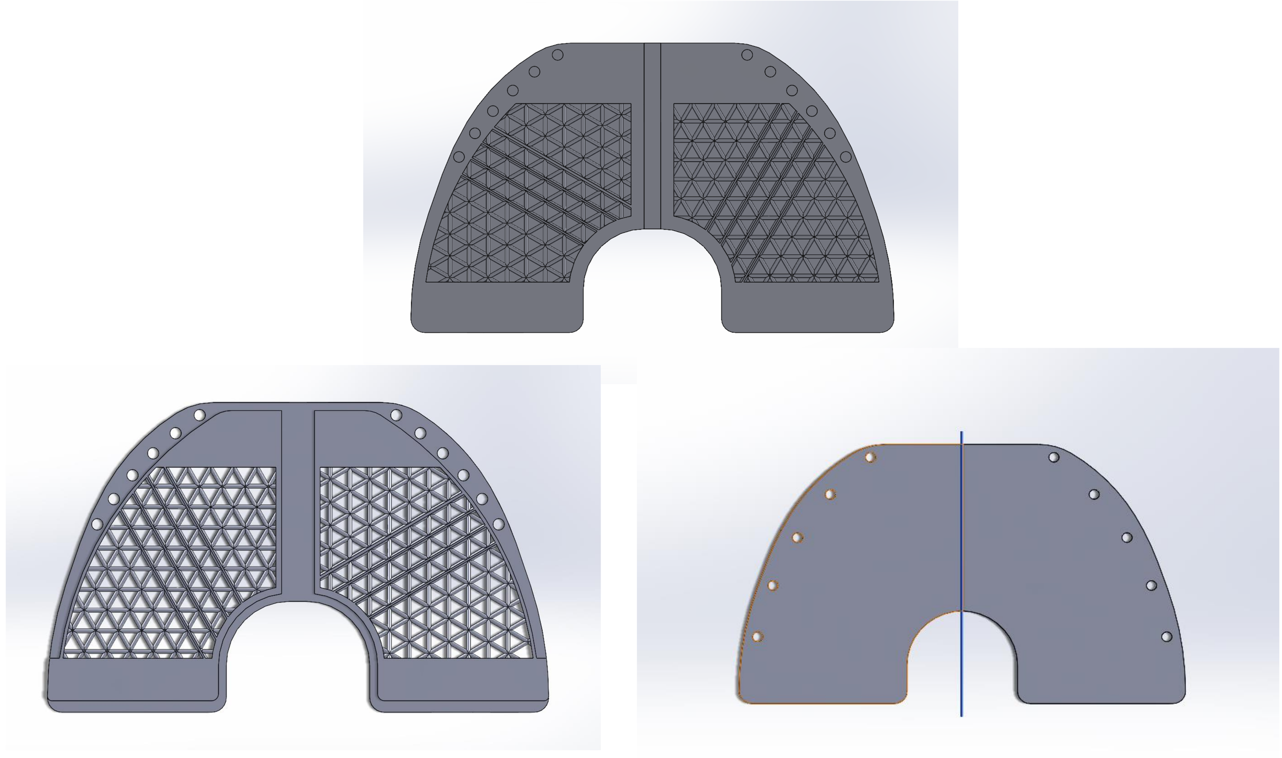

Figure 3: Current TPU Brace Prints

CONCLUSIONS

Based on previous solid braces, the braces that have more material for the mesh should be more stable and less flexible. As such, they should limit motion more and the data will show how much they limit range of motion when tested with the soccer teams. Testing requires IRB approval, coordination with teams without personal identifiers, and multiple types of motions to show maximum variation in strength and flexibility of braces. Possible avenues to explore are the ankle brace team using the braces themselves to gather data with the vicon IMU sensors to show different motions such as lunges and rotations. These would provide ground support and displacement motions. Future projects should Ignite funding come through are additions of more Vicon motion sensors and twin-axis goniometers to collect more data on ankle motions. Possible design improvements include a dial to simplify tying system.

Figure 4: Possible future improvements

REFERENCES

1. Inversion Prevention Methods and Brace Discussion, Daytona Beach, 2020.
2. A, D., H, N., A, N., M, D., & A, A. (2020, October 1). *Bio-numerical analysis of the human ankle-foot model corresponding to neutral standing condition*. Journal of biomedical physics & engineering. Retrieved December 2, 2021, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7557457/.
3. Mondal, S., & Ghosh, R. (2017). A numerical study on stress distribution across the ankle joint: Effects of material distribution of bone, muscle force and ligaments. *Journal of Orthopaedics*, *14*(3), 329–335. https://doi.org/10.1016/j.jor.2017.05.003

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