**ADDITIVE MANUFACTURING OF DYNAMIC ANKLE BRACE**

**ABSTRACT**

Engineered for athletes, by athletes, an ankle brace (SIQ Ankle Brace) was designed specifically for soccer players to limit inversion and eversion ankle sprains but allow natural range of motion. The current prevention methods are ineffective due to bulkiness, restriction, and lack of comfort. Motions greater than 40° inversion and 10° eversion can cause lateral and medial ankle sprains. The purpose of this project is to further develop and improve the SIQ Ankle Brace which is strategically designed to be thin and purposely allows natural range and movement while wearing soccer cleats. The idea is to test the ankle brace on humans as well use a physical ankle model with ligaments. The human testing will involve athletes mimicking soccer movements while wearing the 3D printed brace. During the testing with the physical ankle model - a brace will be applied to simulate twisting an ankle. The data collected will include the angles and forces applied to the ankle model with and without the SIQ Ankle Brace. With this data, improvements to the ankle brace can be made through alterations of thickness, materials, and dimensions to meet design requirements.

**BACKGROUND**

Ankle sprains are the most common injury in soccer for youth and professional players. Sprains account for 85% of all sprains [1]. Sprains can potentially weaken ligaments and muscles, however, with a proper brace, prevention can be enhanced by creating stability within the ankle joint. Current ankle sprain prevention methods such as ankle braces and athletic ankle taping are ineffective due to bulkiness, restriction, and lack of comfort.

![Prototype of ankle brace on subject's foot.](image)

![Ankle model in testing rig before and after torque is applied.](image)

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**RESULTS**

- An updated prototype was developed with a brace thickness of 0.175 cm, weight of 30.5 grams, and it was customized to conform to the subject’s foot.
- The brace uses the diamond mesh geometric layout made from TPU that provides a restoring force due to material properties to protect the ankle from over-inversion.
- The brace provides holes around the distal malleoli for ergonomics and comfort purposes. Assembled using a zipper in the back to enable user-friendly application.
- The lateral side has a horizontal diamond mesh geometry and the medial has a vertical diamond mesh geometry to restrict range of motion.
- The brace fits comfortably inside a soccer cleat and is easy to don and doff.

**VALIDATING EXPERIMENTS**

To validate the design of the ankle brace, a testing rig has been built to simulate the forces applied on an ankle’s motion of twist. A physical ankle model will be used to replicate an ankle sprain as a torque sensor will be applying forces to the system. The test will be performed both with and without the SIQ ankle brace along with commercial market braces. The data collected will be comparing the angles of inversion and eversion of the model. Additionally, the test will record the amount of torque applied to the system.

Applying a steady torque to the testing rig with an ankle model, the following results were concluded.

As seen in Figure 5, inversion and eversion resistance testing where the SIQ ankle brace is compared to other braces currently on the market indicates that the SIQ brace, for the torques applied, resists comparatively with the ones on the market.

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**REFERENCES**

