Four different models were developed for simulation and comparison against experimental gait data:

- Model A: a gait model adapted from the Gait2392 OpenSim model
- Model B: a gait model with dissected muscles scaled to represent a cadaver gait study
- Model C: a model adapted from Model A that includes ankle syndesmosis ligaments with estimated ligament properties
- Scaled models: models derived from Model C that include measured force-length values and resting ligament lengths

In this study, two types of models are created: Models A and B are compared against a cadaveric experiment where gait is simulated with lower limb specimens [11]. Model C and the scaled models are used for comparison against an in vivo gait study where fibular motion was measured using fluoroscopy imaging [9,10].

INTRODUCTION

- High ankle sprains are a common injury that disrupts the ankle syndesmosis, a fibrous joint between the tibia and fibula formed by tibiofibular ligaments. These injuries often require surgical repair, meaning the tibia and fibula must be aligned and fixed [1].
- Both fixation and inadvertent misalignment, which occurs in as many as 52% of patients, alter fibular motion in ways that are not yet understood [3-5].
- Computer models can inform fibular motion and how syndrometic injuries are repaired.
- Healthy fibular motion must be understood before attempting to characterize pathological fibular motion.
- In this study, two types of models are created: Models A and B did not use Computed Muscle Control (CMC) since they were compared against the cadaver gait study, which did not involve muscle activations from CMC.
- The only difference between Model C and Model A was the addition of ankle syndesmosis ligaments. This difference alone resulted in substantially different values across all rotations and translations.

METHODS

- Model C fibula rotation and translation values all fell within one standard deviation of the reported experimental values.
- There was no correlation between the direction and magnitude of fibular motion and weight, height, or the interaction of weight and height. However, reported healthy fibular motion does vary substantially across subjects.
- Subject-specific modeling of multiple individuals varying in height and weight to represent the population of subjects in the experiments is crucial for comparison against the experimental subjects.
- Differences in model outputs can be attributed to differences in model properties and experimental design.
  - Different forward dynamic simulations were used for each of the models to represent the reported experimental design.
  - Model A and Model B did not use Computed Muscle Control (CMC) since they were compared against the cadaver gait study, which did not involve muscle activations from CMC.
  - Model C was compared against an in vivo gait study, and therefore used CMC and the final Forward Dynamics (FD) simulation.

RESULTS & DISCUSSION

- High ankle sprains are a common injury that disrupts the ankle syndesmosis, a fibrous joint between the tibia and fibula formed by tibiofibular ligaments. These injuries often require surgical repair, meaning the tibia and fibula must be aligned and fixed [1].
- Both fixation and inadvertent misalignment, which occurs in as many as 52% of patients, alter fibular motion in ways that are not yet understood [3-5].
- Computer models can inform fibular motion and how syndrometic injuries are repaired.
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- The only difference between Model C and Model A was the addition of ankle syndesmosis ligaments. This difference alone resulted in substantially different values across all rotations and translations.

CONCLUSIONS

- OpenSim forward dynamics simulations can be used to quantify fibular translation and rotation during gait.
- Modeling the ankle syndesmosis in a physiologically accurate way results in values that are more precise and accurate compared to experimental gait data.
- Future work will involve improving the modeling of syndrometic ligaments to develop simulations that are more representative of the gait studies.
- Future work will use the musculoskeletal models to examine the effects of ankle syndesmosis injury and repair on fibular motion and ankle biomechanics.

REFERENCES: