Examination of Biaxial Mechanical Properties of Tendon-Bone Insertion

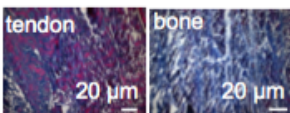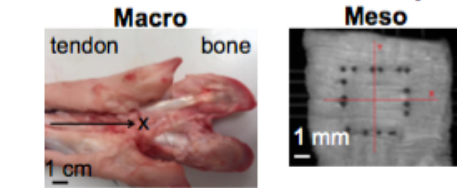Ashley Saltzman and Dr. Hsiao-Ying Shadow Huang

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Introduction and Background

Current Knowledge

- High strain-rate stretching along the direction of fibers can damage the tendon-bone insertion irreversibly.

Macro

tendon   bone

1 cm

Meso

1 mm

tendon   bone

20 μm   20 μm

Micro-structure of collagen fibers are related to the mechanical property

Current Limitations

- How stretching the tendon-bone insertion biaxially affects its properties is currently unknown.

Objectives and Approaches

- Properties of longitudinal cross section tissue samples will be tested via a Biotester 5000 (CellScale, Waterloo, CAN).
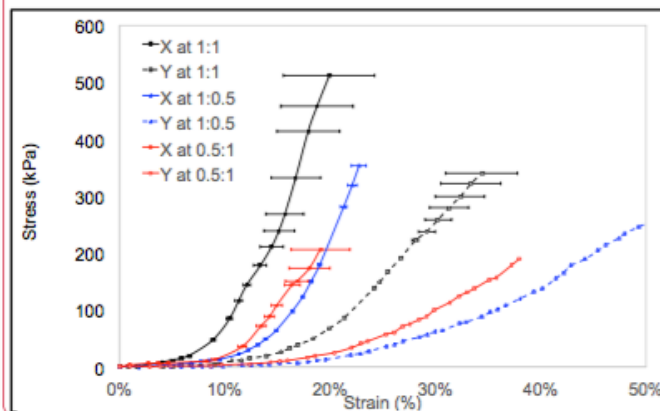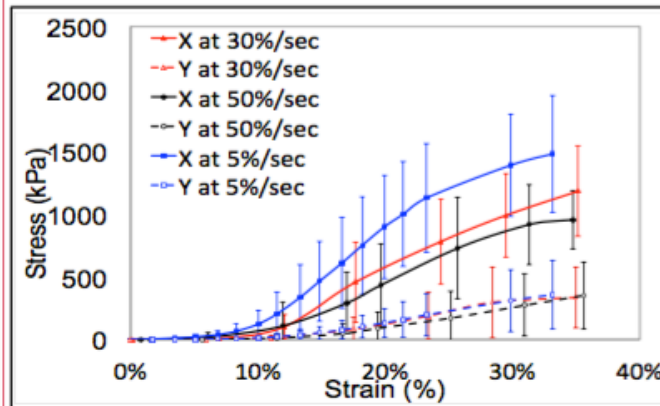
  * Design a mounting system for the machine to test the stiffer tendon-bone insertion sections

  * Draw comparisons between mid tendon and tendon-bone insertion properties.

CDD camera
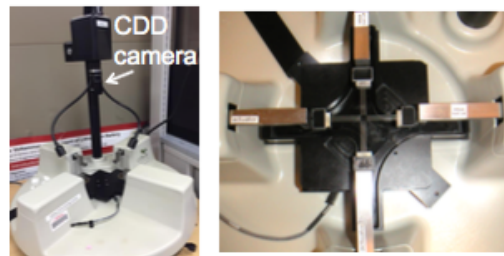
Methods and Results

### Biaxial Stretching using Displacement and Force Control

- Porcine tendon specimens (5mm X 5mm) are immersed in HBSS at 37ºC and biaxially stretched by a biaxial tester under different strain levels. (X: Longitudinal; Y: Circumferential).

- Specimens undergo 12 cycles of prestreching at 2%/sec strain.

- Mid tendon results suggest biaxial stretching can help protect the tendon from breaking

Stress (kPa) vs Strain (%)
- X at 30%/sec
- Y at 30%/sec
- X at 50%/sec
- Y at 50%/sec
- X at 5%/sec
- Y at 5%/sec

Stress (kPa) vs Strain (%)
- X at 1:1
- Y at 1:1
- X at 1:0.5
- Y at 1:0.5
- X at 0.5:1
- Y at 0.5:1

Gripping Design and Fabrication

Clamp Design and Ongoing Results

- A mount for the clamp was designed and 3D printed using an ABS polymer material.

  * Alligator clips are used to hold the 2 mm X 2mm tendon-bone insertion tissue.

  - Clamps grip onto the tissue and stretch without slip.

1 mm
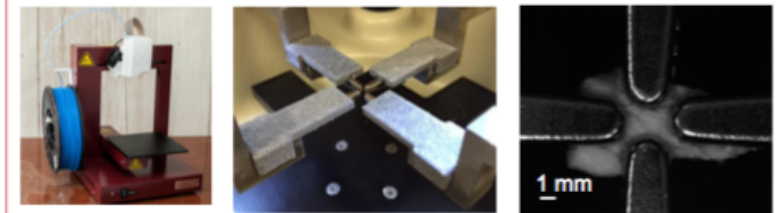
- Relationships between the longitudinal and radial direction are discovered:

  * Stress in the longitudinal direction is greater than the circumferential direction

  * Stretching biaxially protects the tissue from breaking

  * The study is ongoing and the mid tendon results will be compared to the tendon-bone insertion data

Tendon-Bone Insertion — Stress (kPa) vs Strain (%)
- X at 1:1
- Y at 1:1
- X at 1:0.5
- Y at 1:0.5
- X at 0.5:1
- Y at 0.5:1