Approaches for Tendon Structure and Function Assessment

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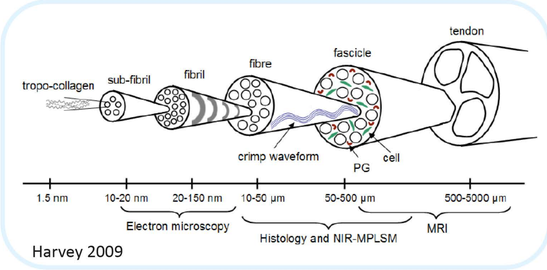
Introduction

- Tendons serve a critical role, facilitating joint movement by transmitting load from muscle to bone.
- Tendon injuries are extremely common, accounting for 30% of all musculoskeletal consultations.[1]
- Despite the high prevalence of tendon injury, treatment options are limited with variable efficacy.
- Improving our understanding of the progression of tendon injury and healing is a critical first step in reducing the clinical burden of tendon injury.
- **Investigations of tendon rely on assessment of structural and functional properties to elucidate mechanisms of tendon homeostasis and healing.**

Structure

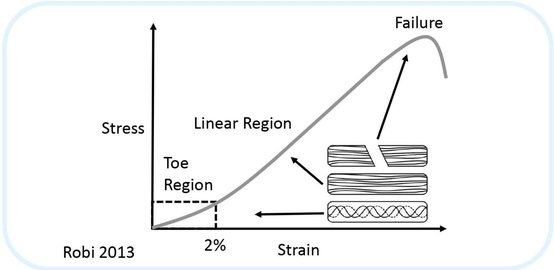
- Tendon has a hierarchical structure, primarily composed of highly-aligned, collagen I fibers.



Harvey 2009

Function

- Tendon exhibits characteristic viscoelastic mechanical behavior.



Robi 2013

Structure: Histological Assessment

Objective

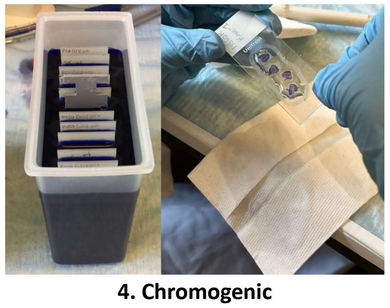
This approach aims to characterize tendon structure by depicting cell and extracellular matrix morphology.

Methods

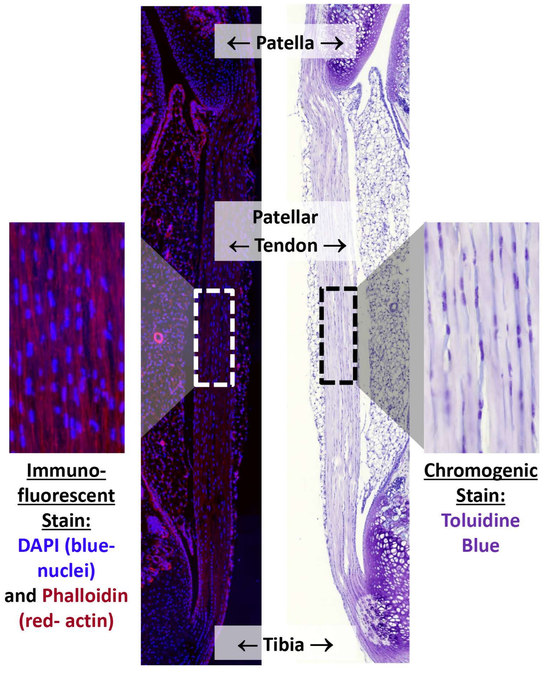

1. Sample Fixation and Embedding


2. Tissue Sectioning (LEICA CM1520, Leica Biosystems)


3. Immunofluorescent Staining


4. Chromogenic Staining

Results



Immuno-fluorescent Stain: DAPI (blue-nuclei) and Phalloidin (red- actin)

Chromogenic Stain: Toluidine Blue

Function: Mechanical Assessment

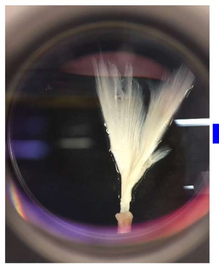
Objective

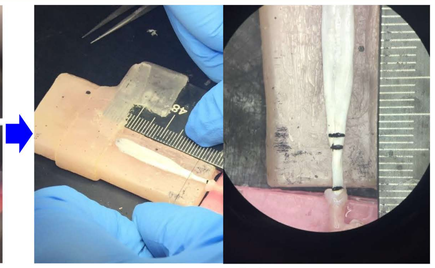
This study seeks to define mechanical properties of the Achilles tendon according to hydration state.

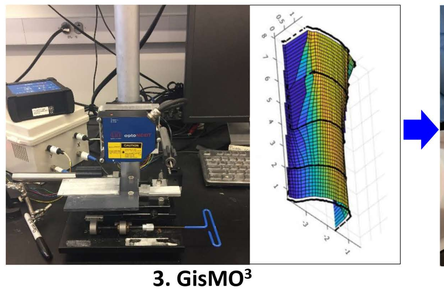
Hypothesis

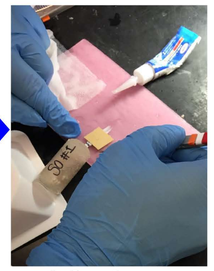
Mechanical properties will be superior in the hydrated state, which is similar to *in vivo* conditions.

Materials and Methods[2]

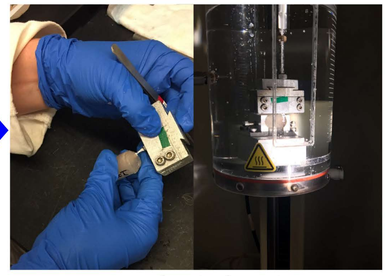

1. Dissection

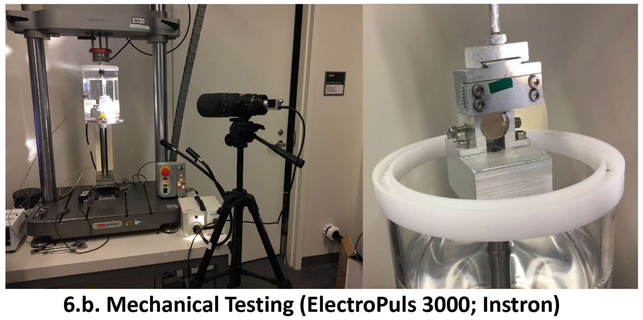

2. Staining


3. GisMO[3]

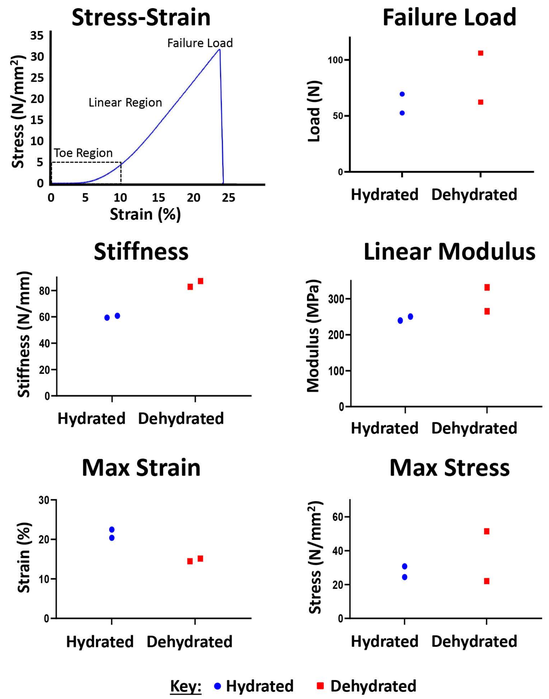

4. Sandpaper


5. Potting


6.a. Mechanical Testing


6.b. Mechanical Testing (ElectroPuls 3000; Instron)

Results



Discussion

- Histological and mechanical assessment work synergistically to yield insights about tendon structure and function.
- Different histological staining techniques can be leveraged to visualize aspects of cells and extracellular matrix important to tendon structure.
- Consistent with previous findings,[4] hydration status impacts elastic mechanical properties of tendon.
  - Conclusions are limited by small sample size, inconsistent freeze-thaw cycle number, and difficulty standardizing dehydration status.
- While the present assays are powerful tools for assessment of tendon, they are limited to *ex vivo* investigations. Future work should investigate approaches to advance *in vivo* tendon analysis.
- Strategies for evaluation of tendon *in vivo* could include advanced imaging modalities, such as magnetic resonance imaging and live fluorescence imaging of transgenic mouse models.[5]

References/Acknowledgements

1. Lipman et al., Drug Des Devel Ther., 2018 2. Leahy et al., Am J Sports Med, 2022 3. Favata M, PhD Thesis, 2006 4. Dabrowska et al., Materials (Basel), 2022. 5. Morris et al., Dev. Biol, 2018 Funding was provided by the OER Summer Internship Program. The author would like to thank the Soslowsky Lab and McKay Orthopaedic Research Laboratories for the support.