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Strain Rate Effects on the Muscle-Tendon-Bone Tissues

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Introduction and Background

Current Knowledge

- Tendons are responsible for transmitting contractile loads from the muscles to the bones, and are subjected to physiologic loading daily.
- Often, excessive physiologic loading is the cause of irreversible damage to these specialized tissues.

Current Limitations

- Tendons failure are strain-rate dependent and have an effect on the Young's modulus of the tissue.

Objectives and Approaches

- The approach aims to understand the effect of localized stress-strain states on the tendons and surrounding tissues.
  - Porcine muscle-tendon bone samples were extracted from the deep digital flexor tendon.
  - A series of uniaxial tension tests were conducted at various strain rates (0.1%, 1%, 5%, 10%) to evaluate the effect of an increasing strain rate on the failure properties of the tendons.
  - The study closely followed and referenced a similar study using chicken tendons [1].

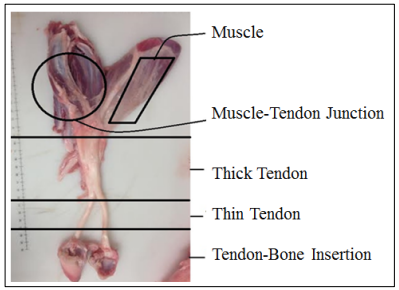
References

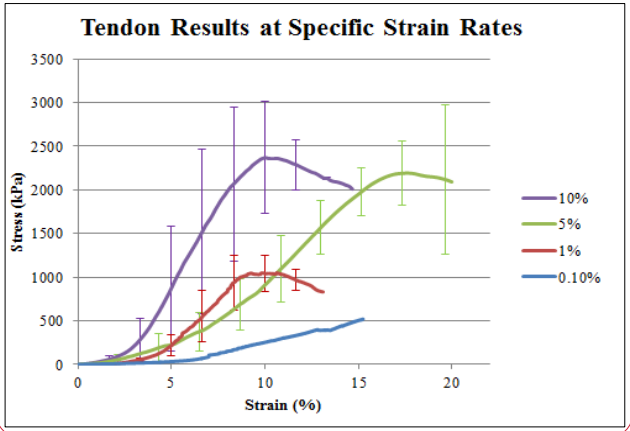
[1] Ng, B., Chou, S., Lim, B., & Chong, A. (2004). Strain rate effect on the failure properties of tendons. *Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine,* 203-206.

Methods and Results

Uniaxial Testing at Increasing Strain Rates

- The deep digital flexor tendon can be divided into five regions: tendon-bone insertion, thin tendon, thick tendon, muscle-tendon junction and muscle.
- A uniaxial tension test was conducted on the thin tendon regions using an Instron 4400R. The samples were tested until failure at increasing strain rates. BlueHill software output data in the form of a load and displacement array. The cross-sectional area of each thin tendon sample was assumed to be an ellipse.
- The tendons appeared to fail at higher loads as the strain rate was increased.

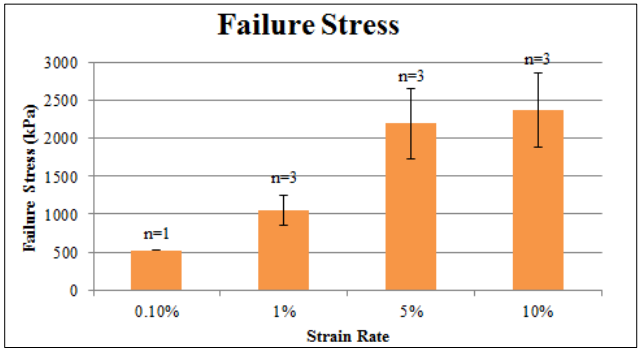




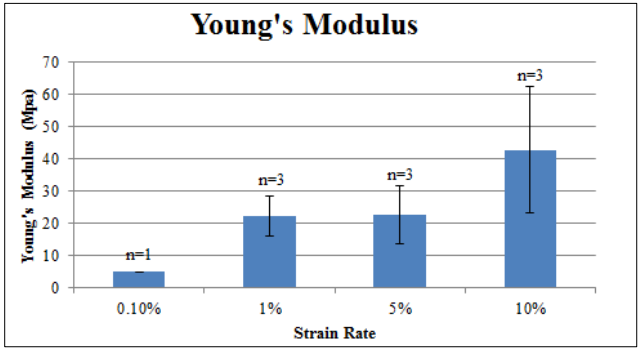
Discussion and Conclusion

Effect of Strain Rate on the Mechanical Failure Properties of Tendons

- As the strain rate increased, the failure stress increased as well.
- The failure stress is dependent on the rate at which the material is elongated.



- The elastic modulus increased with increasing strain rate. Though only a small increase was observed between the 1% and 5% strain rates, a larger sample size would likely further separate the results. The data values obtained are smaller than those found in the related study, however this my be due to the difference in species.
- The data suggests that the Young's modulus is dependent on strain rate.



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