



Jan 16, 2025

Innovative and Customized Protocol for Simplified Biological Analysis of Tendon Tissue Samples

DOI

<https://dx.doi.org/10.17504/protocols.io.j8nlk96bxv5r/v1>

Dongwook Yang¹

¹Baylor College of Medicine



Dongwook Yang

Baylor College of Medicine

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Protocol Citation: Dongwook Yang 2025. Innovative and Customized Protocol for Simplified Biological Analysis of Tendon Tissue Samples. **protocols.io** <https://dx.doi.org/10.17504/protocols.io.j8nlk96bxv5r/v1>

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Protocol status: Working

We use this protocol and it's working

Created: January 10, 2025

Last Modified: January 16, 2025

Protocol Integer ID: 118101

Keywords: Mechanical properties, Biological tissues, Tendon, Stiffness, mechanical properties of tendon tissue, biomechanical properties of small tissue sample, tendon tissue sample, tendon tissue, mechanical properties of biological tissue, tensile testing, biomechanical property, achilles tendon, traditional mechanical testing equipment, tendon, flexible biological sample, equipment for biological tissue, uniaxial material testing system, small physical dimensions of most tissue sample, small tissue sample, customized uniaxial material testing system, most tissue sample, mechanical property, controlled strain rate, strain rate, key mechanical parameter, key mechanical parameters such as ultimate load, biological tissue, film paper grip, tissue, rigid material, precise measurement, stiffness

Abstract

Analyzing the mechanical properties of biological tissues presents unique challenges due to the inherent limitations of using living cells and the small physical dimensions of most tissue samples. Traditional mechanical testing equipment designed for larger, more rigid materials often proves unsuitable for such analyses. In this study, we present an innovative and simplified protocol for evaluating the mechanical properties of tendon tissues. Using a customized uniaxial material testing system, we modified existing methods to accommodate the specific needs of small and flexible biological samples. Tendon specimens, including patella and Achilles tendons, were prepared and mounted with film paper grips, enabling secure fixation and precise measurement. The samples were subjected to tensile testing at controlled strain rates (25–35 mm/sec), and key mechanical parameters such as ultimate load and stiffness were determined from the load-displacement curve. By optimizing testing conditions and adapting equipment for biological tissues, this protocol provides a more accessible and reproducible approach to studying the biomechanical properties of small tissue samples.

Guidelines

This simplified protocol provides a reliable and efficient method for bio-mechanical testing of small tendon samples. By modifying conventional strength testing techniques, the approach ensures that researchers can obtain accurate and reproducible measurements tailored to the needs of biological research.



Materials

Testing Apparatus:

Digital force gauge: FG-3000 series (SEALS USA INC)

Customized uniaxial materials testing system with a 500 N load cell

Motor: 50 Hz stepper motor (constant frequency)

Screw Options:

M3 screw with a standard coarse pitch of 0.5 mm/revolution

M4 screw with a standard coarse pitch of 0.7 mm/revolution

Grips: Film paper grip (G1008, Mark-10)

Measuring Tools: Calipers for specimen size measurements

Specimen preparation

- 1 Entire tendon units are utilized, with specific examples including:
Patella tendon: Extends from the apex of the patella bone to the tibial tuberosity.
Achilles tendon: Extends from the calcaneus to the muscle-tendon junction of the gastrocnemius muscle.
- 2 Both ends of each tendon sample are securely clamped using film paper grips to minimize slippage during testing.
- 3 The initial dimensions (length, width, and thickness) of the tendon samples are measured using calipers immediately after fixation in the clamps.

Testing Setup

- 4 Mount the tendon sample on the uniaxial materials testing system, ensuring alignment with the force axis.
- 5 Configure the motor and screw mechanism to achieve the desired strain rate, based on the selected screw:
M3 screw: Provides a strain rate of 25 mm/sec (pitch = 0.5 mm/revolution).
M4 screw: Provides a strain rate of 35 mm/sec (pitch = 0.7 mm/revolution).
- 6 Determine the linear movement speed ("strain rate") using the formula.

Tensile Testing

- 7 Apply uniaxial tensile loading to the specimen at the configured strain rate.
- 8 Continue loading until the tendon fails, ensuring constant strain rate throughout the test.

Data Collection and Analysis

- 9 Record load-displacement data during testing.
- 10 Derive the following mechanical properties from the load-displacement curve:

Ultimate Load: The maximum force sustained by the tendon before failure.

Stiffness: The slope of the linear region of the load-displacement curve, representing elastic behavior.

Protocol references

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