STAT-B: Eccentric Loading as a Treatment for Achilles Tendonitis

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Introduction

Achilles tendonitis occurs in 6-18% of athletes with 1 million cases per year.

Symptoms:
- Inflammation
- Soreness
- Stiffness

Causes:
- Overuse of tendon from intensive training
- Obesity
- Flat arching foot
- High blood pressure

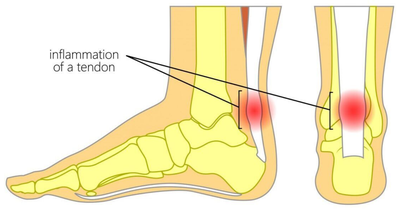

Figure 1: Achilles tendon diagram

Two Types:
Insertional - swelling/breakdown of fibers in lower portion of heel
Non-insertional - swelling/breakdown of fibers in middle portion of heel

Clinical Need

Needs Statement

Design a low form factor, comfortable, therapeutic ankle brace that provides passive eccentric loading to promote proper healing and pain reduction of Achilles tendonitis throughout the therapy process, specifically in athlete populations.

Current Treatment Methods

1. **RICE Method**
   a. **Rest, Ice, Compress, Elevate**
2. **Orthotic Braces**
   a. Wearable articles provide support and pressure to the ankle (Fig 2)
   b. Ex: Heel inserts, supportive shoes, walking boots, ankle splints
3. **Physical Therapy**
   a. Stretching and flexibility exercises to regain strength
4. **Kinesiology Tape**
   a. Lightweight material designed to relieve tendon and muscle pain.

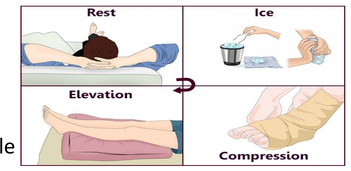

Figure 2: RICE method illustration


Figure 3: KT tape

Problems
- Lack of standard treatment method
- Braces are bulky and inflexible
- Kinesiology tape not enough support
- Braces cannot be used during daily activity


Figure 4: Orthotic brace

Solution Profile
- Eccentric loading
- Low form factor
- Flexible
- Ease of usage
- Wearable during everyday activities

Proposed Solution


Figure 5: Final ankle brace design

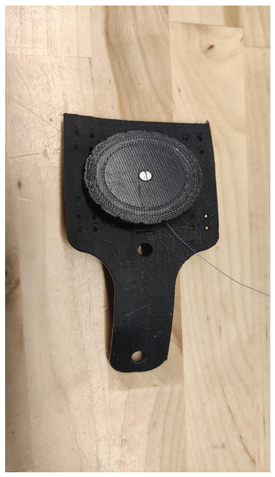
Figure 6: Ratcheting Mechanism final design

Our solution utilizes applied tension in order to induce plantar flexion and improve recovery for patients.

Mechanism & Design:
- Lightweight neoprene sock - does not place pressure on the achilles tendon
- 3D printed ratcheting mechanism
- Strong wire + elastic bands to control force applied on the foot

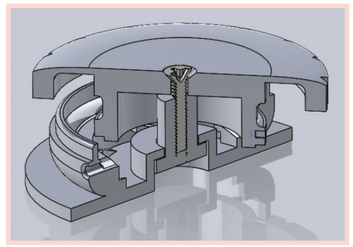
Figure 7: Pictures of the ratcheting mechanism

Testing

- Stress & strain with tensile testing rig
- The break index for the nylon cable was found to be 12 lbs, which is much greater than forces created by ankle flexion. This was also increased greatly due to how we twisted the fishing line.

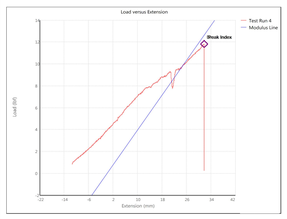

Figure 8. Nylon Thread Stress Strain Curve

Click #	Force Reading (N)
1	0.34
2	0.59
3	0.88
4	1.03
5	1.62
6	2.06
7	2.55
8	2.99
9	3.34
10	3.87

Figure 9. Raw Force Data

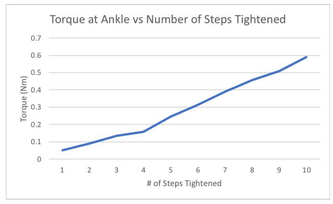

Figure 10. Tension Results from Testing Rig

- Using a fabricated test rig, the tension applied by the brace to the patient's ankle was measured.
- As seen in Figure 9 the brace applied a range of .3 to 4 Newtons as the apparatus was tightened.
- It was also determined that each turn of the knob applied an average of .06 Nm of torque on the ankle. The fishing line shortens 0.4 mm with each knob turn.

Conclusions & Future Work

Conclusions
- Eccentric loading is a vital component of tendonitis rehabilitation
- Our brace fills an important market gap in the treatment of achilles tendonitis
- Our brace can be utilized by both clinicians and researchers to better understand and treat the condition
- Our brace can be readily modified based on the results of exploratory research

Next steps
- Durability testing of our brace
  - how does it hold up during intense activity?
  - is more support needed?
  - common abrasion points?
- Comparing different treatment methods
  - Conventional: higher loads at shorter, discrete intervals
  - Novel: lighter loads for extended durations
- Quantifying optimal loading tension for patients
  - will differ for discrete PT sessions vs prolonged use
  - likely dependent on tendon and tibia length

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