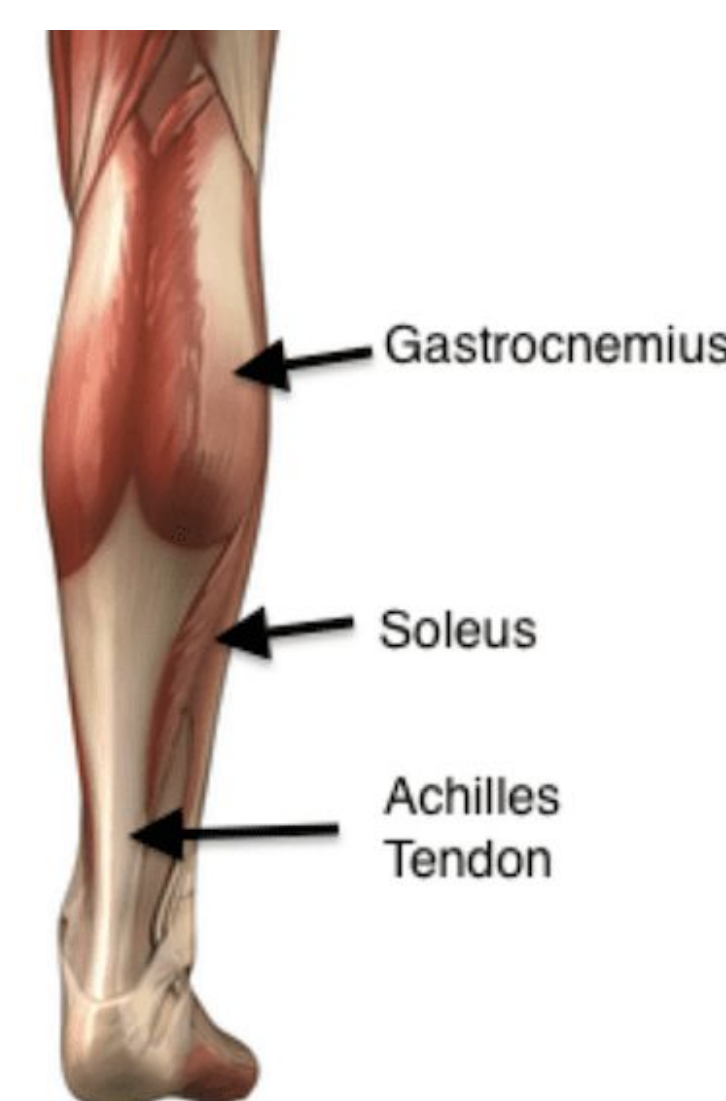


Introduction

- The Achilles Tendon (AT) connects gastrocnemius and soleus muscles (calf) and the calcaneus bone (heel)
- **Achilles Tendon ruptures**
 - 7-40 patients per 100,000 patient population annually [5] with peak age of 30-40 [1]
 - More common in males than females
 - Most often caused by sudden, forceful motions, commonly seen in athletes and mid-aged individuals



Existing solutions:

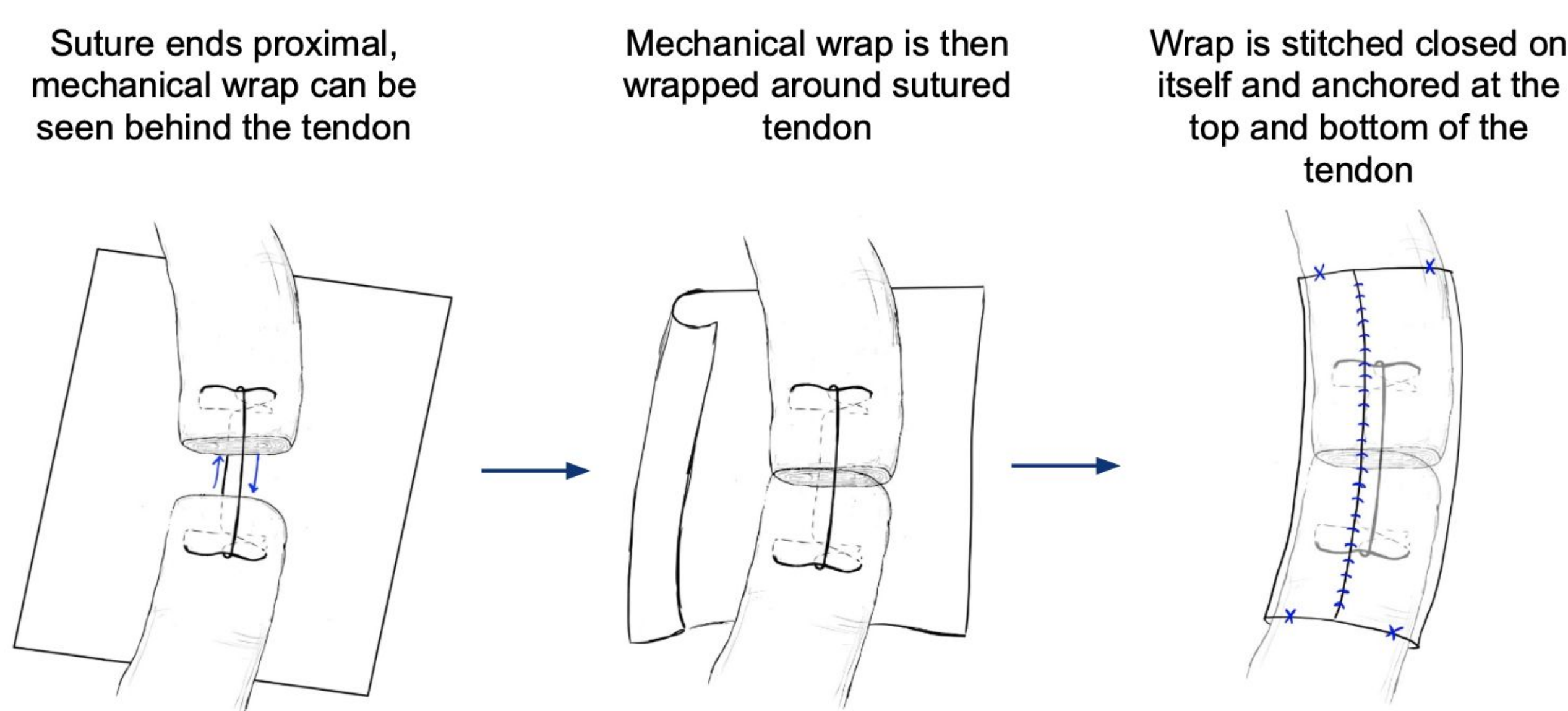
- Non-invasive solution [3]: Bracing or casting in resting equinus (ankle bent downward)
- Invasive Solution [3]: Suture torn ends of the ruptured tendon together using Krackow or modified Mason Allen technique

Objectives of Project:

- Create solution to increase mechanical stability of Achilles repair or decrease recovery time
 - Prove design concept works using mechanical testing
- Determine which textile pattern yields the most success in providing mechanical stability

Design Specifications and Application

- Synthetic Nylon Wrap in addition to suture of ruptured tendon proximal ends improves the long-term outcomes of Achilles tendon repairs.
- Use of Modified Mason-Allen instead of Krackow suture provides a **less invasive** approach.
- Synthetic Nylon Wrap **mimics function of the Achilles Tendon** while the suture helps further promote healing.
- Additionally, the Synthetic Nylon Wrap **degrades overtime** and function is replaced with the fully healed, bridged Achilles tendon.
- **The objective of this project is to develop a novel method to increase mechanical stability of Achilles tendon repair.**



Experimental Groups

1. Weave
2. Braid
3. Knit

Requirements

Achilles Tendon:

At maximum load, the proximal ends distance should be 0.5mm < 1mm.

Mechanical Properties:

Ultimate tensile strength should be greater than accepted standard of 11.3 MPa. [6]

Elastic Modulus should be greater than accepted standard of 400-600 MPa. [6]

Surgery Time:

The suture and wrap should be applicable within 30 min \geq 1 hour

Constraints

Anatomical Dimensions of Achilles Tendon:

The synthetic biomaterial wrap should cover circumference of 28.6-31.5 mm.

Wrap should encompass the Achilles tendon length of 90-100 mm, width of 13-14 mm, thickness of 4-5 mm, and cross-sectional area of 5-6 mm.

Limitations of Existing Solutions

- Locking loop suture pattern
 - Complex
 - Invasive to healthy tendons away from repair site
 - Increases risk for tissue tearing
- Poor resistance to gap formation
 - Increased risk of re-rupture
- Low repair tensile strength
 - ~245 N

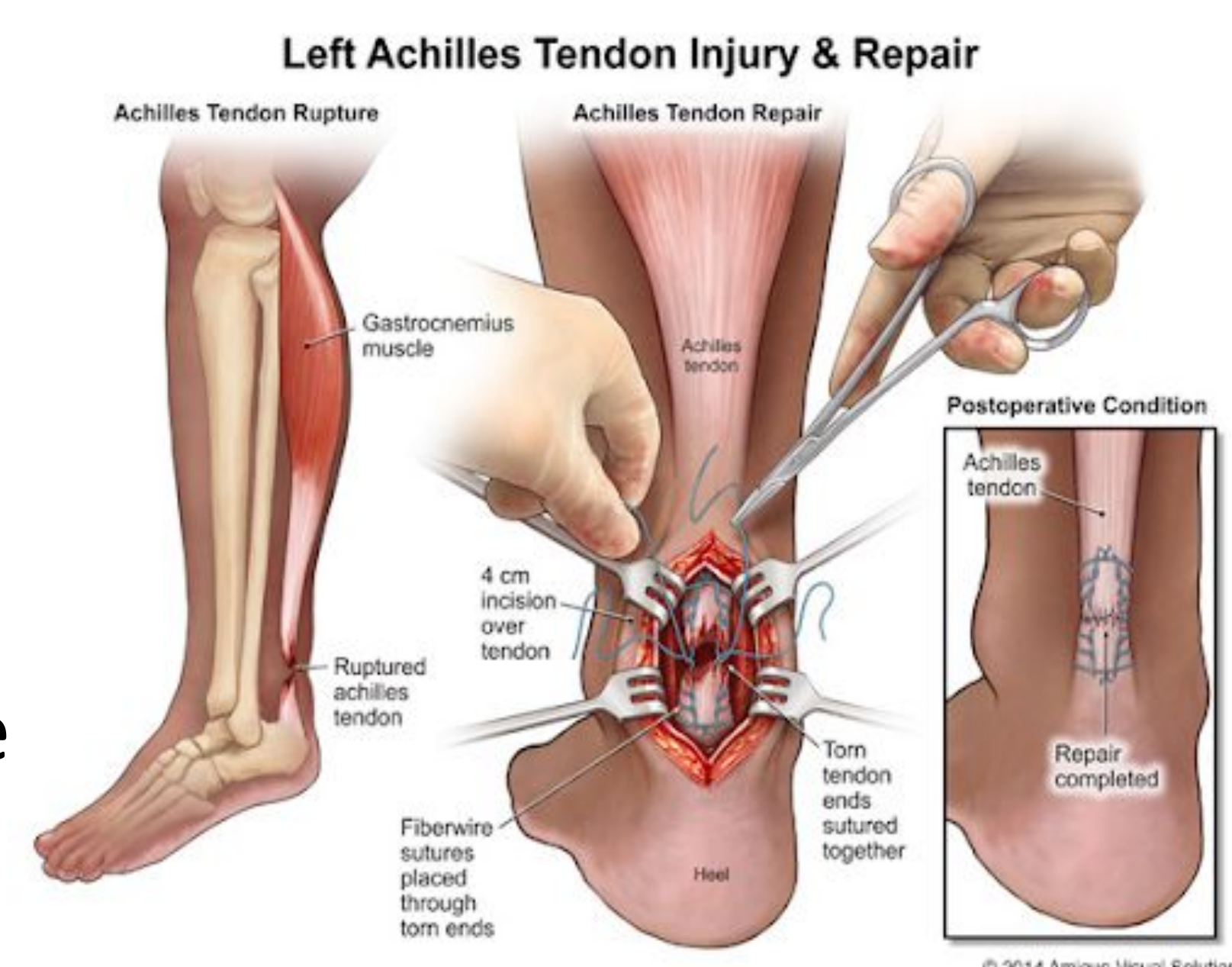


Figure 1: Krackow Suture Technique

Impact

- The Krackow suture technique is often used to repair Achilles' tendons yet its disadvantages include risk of re-rupture [4]
 - Re-rupture rate after surgery = **3.7%** [2]
 - Re-rupture causes long-term **functional deficits** [8]
- Annual valuation of Achilles' tendon repair sector = **\$46 million** - a conservative estimate
 - Based on an incidence rate of 2.1 cases per 100,000 person-years (6,888 surgeries performed annually) [5]
 - American population of 328 million
 - Average cost of surgery (Medicare data) = \$6,722. Patient pays \$1,344 [7]
- Device will improve patient outcomes, decrease chance of re-rupture, and save millions annually in preventable healthcare spending
- May be applied to other long tendons and ligaments

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