Achilles Tendon Rupture: A Biomechanical Evaluation of Varying the Number of Loops in a Physiological Model

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Our disclosure is in the Final AOFAS Program Book. None of the authors have any potential conflicts with this presentation.
Introduction

Achilles tendon Ruptures

The Achilles tendon is the most frequently ruptured tendon in the body despite being the largest and strongest.

Management tends to be controversial and decided on a case by case basis.

Treatment methods include:

- Non-operative
- Percutaneous methods
- Open repair – Krackow technique

Krackow Repair

Previous studies have shown that an augmented Krackow repair with an epitendinous weave both more resistant to gapping and stronger than percutaneous methods.

Risk of wound complication, with reports up to 21%, due to the poor blood supply to the skin overlying the incision site.

There is controversy over the number of loops that should be placed.
Purpose of Study

To create a physiologic model representative of Achilles tendon ruptures seen clinically - not done in prior studies

Biomechanical study to see how the number of Krackow loops alters the repairs resistance to gapping and overall strength.

See if the physiologic model changes the strength of repair when compared to the model used in previous studies

Creating the Physiologic Model

- 32 Fresh frozen Bovine Achilles tendons
- Transected with scalpel 5cm from calcaneal tuberosity
- To create fraying we:
  - Made 2 cm long longitudinal cuts perpendicular to the original transection
  - Incisions were spaced 2mm apart

Creating the Physiologic Model
Tendons were repaired using Krackow technique with Orthocord No#2

2 sutures were used with varying number of loops based on group assignment

Augmentation weave with Ethibond 2.0

Pitch of 1cm³
Three Phases of Biomechanical Testing

Cyclic Loading (Adopted from Lee et al., 2009)

- 1000 cycles oscillating between 20N and 100N
- 1000 cycles oscillating between 20N and 190N
- Gap formation was measured after each phase
- If repair failed, specimen would not advance to next phase
- Repair failure set as gapping of 15mm

Load to Failure (if sample did not fail on cyclic loading)
# of failures after cyclical loading

<table>
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<th>0</th>
<th>1</th>
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<tbody>
<tr>
<td>Phase 2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
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Discussion

Gapping/Max Load

Increasing the number of loops did not statistically change the overall strength of the repair

- Agrees with McKeon et al., 2006,

Increasing the number of loops lead to a decrease in gapping

Frayed vs Unfrayed

- Group 1 and 2 both had 3 loops in healthy, unfrayed tendon
- There was no significant difference in load to failure
- Group 2 was more prone to gapping
- We believe that the frayed ends forces the surgeon to put the load bearing loops further from both the rupture site and knot and may decrease the repair’s gap resistance
Clinical Relevance

The current trend is to accelerate rehabilitation protocol after Achilles tendon repairs (shorter immobilization, return to sports sooner)

Repair gapping leads to tendon elongation and delayed healing

Need for repairs that are more gap resistant to the cyclic stressing that would be seen in rehabilitation

Limitations

- Bovine tendons
- Small sample size
- In-vitro nature only accounts for suture strength and not biological healing
- Frayed ends were created with the use of a scalpel instead of by tendon rupture – different biomechanical stresses
Conclusion and Future Studies

Increasing the number of loops did not increase overall load to failure but did increase resistance to gapping.

Repairs with more loops requiring larger incisions may not necessarily lead to stronger repairs.

Further studies with more loops to see if this trend continues.

References


