

Comparison of the efficacy of surgical and non-surgical interventions for acute Achilles tendon rupture - an innovative mouse model

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Introduction: Acute Achilles tendon rupture is a common and significant injury in sports medicine. Clinical studies have demonstrated that both surgical and nonsurgical interventions can yield satisfactory results; however, the optimal treatment approach for this injury remains debated. Currently, most animal studies on acute Achilles tendon rupture lack clinical relevance due to insufficient ankle external fixation. To address this issue, we developed a mouse model of acute Achilles tendon rupture repair that simulates the clinical setting by incorporating ankle immobilization as an adjunct therapy. This study aimed to evaluate and compare the efficacy of surgical and nonsurgical treatments for acute Achilles tendon rupture, as well as the impact of different ankle fixation angles on tendon repair, providing valuable clinical insights.

Methods: This study involved 162 male C57BL/6 mice and 30 Scx-CreERT2 tdTomato transgenic mice. The surgical group underwent Achilles tenotomy followed by Kessler suture repair, while the nonsurgical group had only the Achilles tenotomy. The ankle was immobilized at 160° of plantar flexion and at 90° of neutral position. Specimens were collected at 2 and 4 weeks postoperatively for biomechanical, histological, and qRT-PCR analyses, including Scx+ stem cell tracing.

Results: Four weeks post-surgery, biomechanical analysis showed no statistically significant differences in ultimate load and stiffness at maximal plantar flexion (160°) between the surgical and nonsurgical groups ($p > 0.05$). Both groups exhibited significantly higher ultimate load and stiffness at 160° compared to 90° ($p < 0.01$). Histological analysis revealed better collagen fiber organization and increased COL1 expression in the surgical group. qRT-PCR analyses showed heightened expression of tendon repair-related genes (Scx, Tnmd, and TGF- β 1) in the surgical group, whereas the nonsurgical group exhibited increased expression of inflammatory factors (IL-1 β and IL-6). Tracing of Scx+ tendon stem cells revealed a greater quantity and more uniform distribution of these stem cells in the surgical group.

Discussion: Experimental investigations into acute Achilles tendon rupture have demonstrated that maintaining the ankle in a plantar flexion position during healing can achieve satisfactory outcomes, regardless of the treatment approach. However, histological evaluations indicate that the tendon tissue and collagen structure in the surgical repair group are superior to those in the non-surgical group. External fixation in the maximum plantar flexion position may also reduce tension at the repair site and promote healing. This study advocates for surgical intervention in acute Achilles tendon ruptures, highlighting its potential to enhance tendon repair quality.

Significance/Clinical Relevance: Both surgical and nonsurgical treatments for acute Achilles tendon rupture produce satisfactory tendon repair outcomes when the ankle joint is maintained in maximal plantar immobilization. However, surgical treatment demonstrates superior histological outcomes in tendon repair.

