A Biomechanical Comparison of an Open and Three Minimally Invasive Percutaneous Achilles Repair Techniques During a Simulated Rehabilitation Protocol

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**Introduction:** In the case of Achilles tendon rupture, many options exist ranging from non-operative treatment to open surgical repair. While non-operative management is a viable option, surgical repair is preferred in young and athletic populations. Recently, minimally invasive percutaneous repair methods have been developed. Despite similarly reported satisfactory clinical outcomes, neither open nor percutaneous techniques are without limitations. The purpose of the present study was to biomechanically analyze three commercially available percutaneous techniques and an open Achilles repair during a simulated progressive rehabilitation program.

**Methods:** Thirty-three fresh frozen ankle specimens with no previous history of Achilles injury were used. Following a simulated mid-substance Achilles rupture created 6 cm proximal to the calcaneal insertion, specimens were randomly assigned to each of the following repair techniques: (1) Open repair, (2) Achillon® Achilles Tendon Suture System (Integra LifeSciences Corporation, Plainsboro NJ), (3) PARS Achilles Jig System (Arthrex Inc., Naples FL), or (4) Achilles SpeedBridge™ variation (Arthrex Inc., Naples FL). Repairs were subjected to a cyclic loading protocol representative of progressive postoperative rehabilitation: 250 cycles (@ 1 Hz) for each loading range: (1) 20-100 N, (2) 20-200 N, (3) 20-300 N, (4) 20-400 N.

**Results:** After the first loading stage, the open repair technique had an average (± SD) elongation of 5.2 ± 1.1 mm which was significantly lower compared to all percutaneous repair methods. No significant differences were observed between the Achillon, PARS Achilles Jig System, or SpeedBridge with displacements of 9.9 ± 2.2 mm, 12.2 ± 4.4 mm, and 10.0 ± 3.9 mm, respectively. When examined over smaller cyclic intervals, the majority of elongation, regardless of repair, occurred within the first 10 cycles. Within the first ten cycles, the open repair achieved 71.1% of the total elongation observed at 250 cycles. Corresponding values for the Achillon, PARS Achilles Jig System, and SpeedBridge repairs were 81.8%, 77.8 %, and 69.0%, respectively. No significant differences were observed in the mechanism of or total number of cycles to failure. However, it should be noted that several percutaneous repairs insufficiently captured the tendon and were excluded from final analysis. Most notably, 6/12 tendons repaired with the Achillon device failed to capture the tendon, missing anteriorly, while 1/7 PARS Jig System Repair missed the tendon anteriorly.

**Discussion:** Differences in early repair elongation during simulated progressive rehabilitation suggest that surgical repair technique should be considered when prescribing postoperative rehabilitation. Reduced early elongation of open repairs suggests that patients treated with this technique may be able to progress through an earlier and/or more aggressive postoperative protocol without the risk of early irrevocable repair elongation or gapping about the repair site. However, in cases where cosmesis or
wound healing complications are of significant concern, percutaneous techniques provide a biomechanically reasonable alternative based on the repair strengths (cycles to failure) demonstrated in the present study. Based on the findings of this study, percutaneous repairs should be protected longer postoperatively to allow for biologic healing and avoid early repair elongation and potential gapping between the healing tendon ends.