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Muscle-tendon morphomechanical properties of non-surgically treated Achilles tendon 1-year post-rupture

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INTRODUCTION

Achilles tendon rupture (ATR) leads to long-term deficits in muscle strength, which persist for several years regardless of the treatment approach and seem to be permanent [1].After rupture, Achilles tendons (AT) seem to be longer, thicker, and have lower stiffness acutely [1,2]. Increased AT length and immobilization after rupture stimulate changes in plantar flexor muscles, e.g. shorter and more pennate medial gastrocnemius (MG) fascicles [3]. The majority of long-term follow-ups are done after surgical treatment. **STUDY AIM:** to evaluate mechanical and structural properties of non-surgically treated muscle-tendon units 1-year post-rupture.

METHODS

- 24 patients (20 M, 4 F) measured 1-year ± 3.5 months after rupture, all treated non-surgically [3].
- During ramp maximum voluntary contractions (MVC) MG muscle-tendon junction displacement was quantified using ultrasound imaging to assess stiffness (Figure 1).
- Tendon elongation and force recordings were synchronized. In the injured limb, polynomial fit to find stiffness was usually only applied up to a maximum of 80% of MVC (Figure 2).
- Achilles tendon rupture score (0 = no impairment, 100 = high functional impairment).

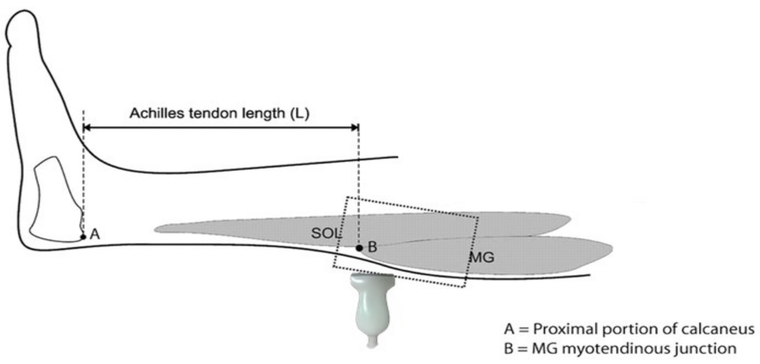

Figure 1. B-mode ultrasound images of the MG muscle-tendon junction (A) at rest and (B) during MVC. Circles indicate the position of the tracked muscle-tendon junction.

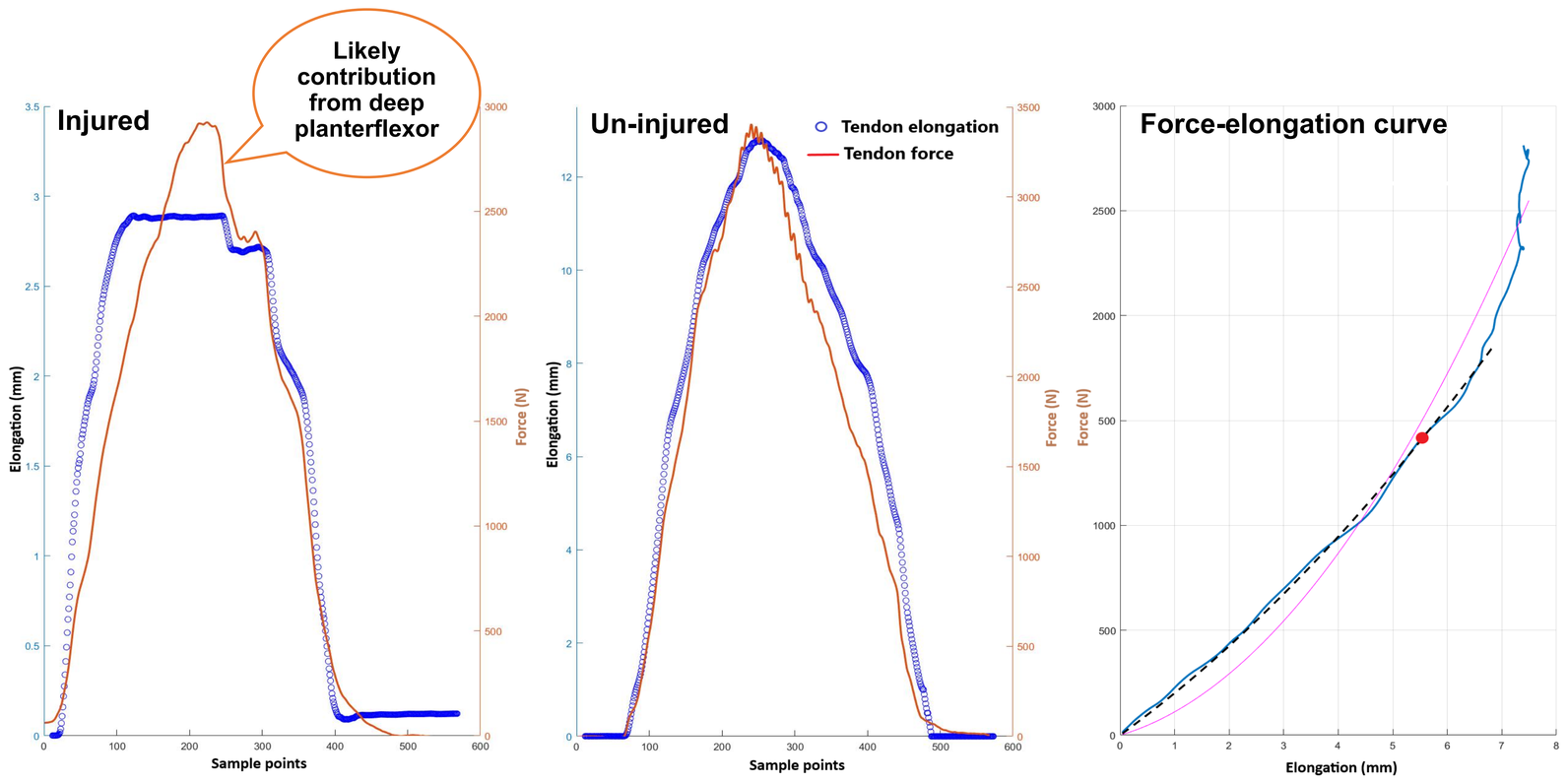

Figure 2. Example of synchronized raw tendon force and elongation data for both limbs of one subject. In the injured limb, AT elongation reached a plateau while force was still increasing. This was seen in several subjects, and causes the force-elongation curve to rise vertically at high forces, leading to a poor polynomial fit (solid pink line). In this case, a polynomial fit to 80% of MVC (black dashed line) yielded a better curve fit. Stiffness was defined as the slope of the fitted curve at 50% MVC of the injured limb (red dot).

RESULTS

Injured tendons were longer with a mean difference of 1.8 cm (95%CI: 0.5-1.9 cm; P<0.001), and thicker: 0.2 mm (0.2–0.3 mm; P<0.01). There was no difference between injured and uninjured AT stiffness 1-year post-rupture (mean difference: 29.8 N/mm, -7.7–67.3 N/m; P=0.170) (Figure 3). The injured tendon showed 1.8 mm (1.2–2.4 mm; P<0.01) lower AT elongation during MVCs. Patient-reported functional outcome was related to AT resting length (β=0.68, r(10)=4.079, P=0.002). Inter-limb differences in MG fascicle length were related to inter-limb differences in MVC (β=1.17, r(14)=2.808, P=0.014).

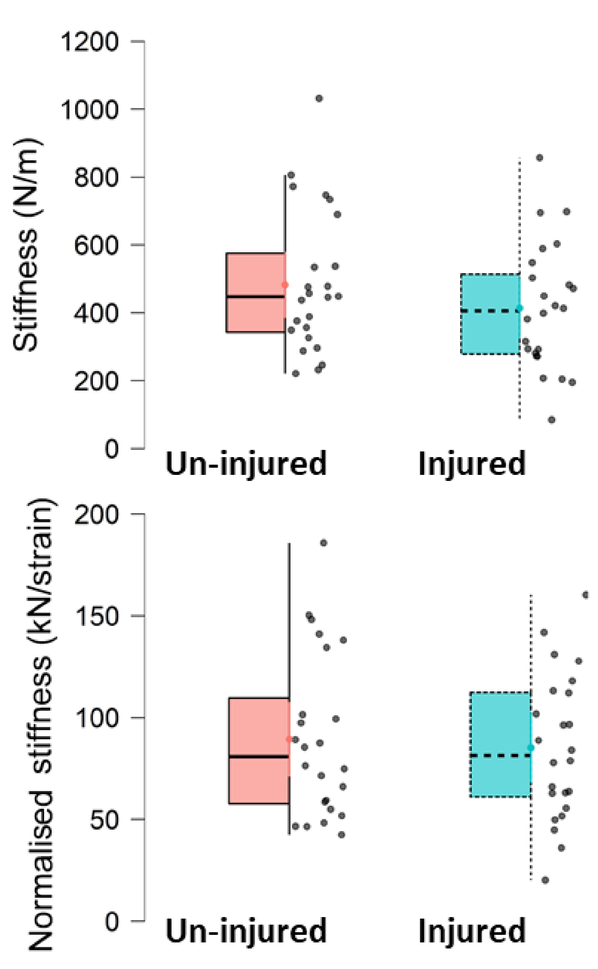

Figure 3. Box plots illustrating estimated means ± SD for AT mechanical properties during MVC for both limbs.

CONCLUSIONS

- Longer AT resting length was associated with poorer self-evaluated function.
- Although stiffness was similar 1-year post rupture between limbs, plantar flexion strength deficit was present, possibly due to shorter MG fascicles.
- AT rupture may lead to irreversible deficits, hindering participation in some pre-injury activities.

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For more data, use the QR code.

REFERENCES

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