The Effect of Sequential Flexor Tendon Pulley Sectioning and Reconstruction of Joint Range of Motion and Tendon Load

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Introduction

- The A2 and A4 flexor pulleys are important in maintaining proper finger biomechanics.
- Injury to the A2 and A4 pulleys following sharp lacerations or crush/iatrogenic injury results in tendon bowstringing.
- It is unclear how deficient tendon pulleys and subsequent reconstructions at different wrist positions can affect actual flexor tendon loads in addition to joint range of motion (ROM).
- We conducted a study to characterize the effects of sequential A2 and A4 pulley sectioning and reconstruction on joint ROM and flexor tendon load.

Methods

14 digits (index, long, ring fingers) from 5 freshly frozen cadaveric hands (3 Females, 2 Males; mean age=71.8 years) were tested

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A novel *in-vitro* finger motion simulator was designed and used to achieve full simulated active finger flexion/extension under load control at different wrist positions (wrist neutral, 30° wrist flexed, 30° wrist extended

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Protocol
Intact ➞ 25% A2 cuts(until 100%) ➞ A2 Rec ➞ A2 release ➞ 50% A4 cuts(until 100%) ➞ A4 Rec ➞ A4 release ➞ A2 Rec + A4 100% ➞ A2 100% + A4 Rec ➞ Full A2 + A4 Rec

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2-way Repeated Measures ANOVA tests were conducted

Results

FDP Load

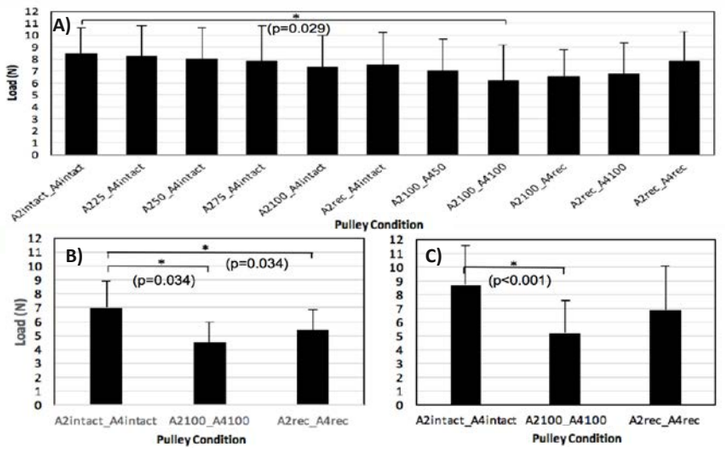

Fig 1: A2 and A4 Pulley Sectioning/ Reconstruction in A) Wrist Neutral, B) Wrist 30° Flexed, C) Wrist 30° Extended

MCP ROM

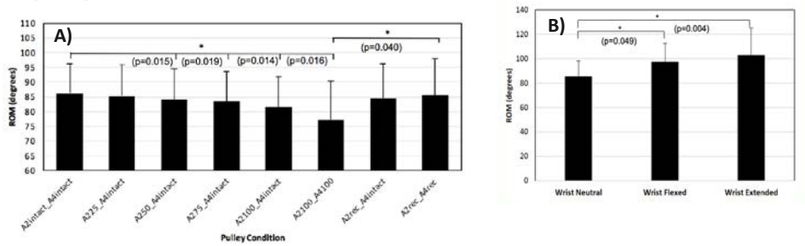

Fig 2: A) Pulley Sectioning/Reconstruction in Wrist Neutral, B) Pulley Reconstruction: ROM vs. Wrist Position

- With wrist in neutral, full sectioning of both pulleys reduced MCP ROM and FDP tendon load by 9.1±7.1 N and 2.3±1.9 N respectively.
- With the wrist flexed, cutting both pulleys reduced FDP by 3.6±3.5 N and restored to within 0.5 N of the intact state by reconstruction.
- With the wrist extended, cutting both pulleys reduced FDP by 3.5±1.7 N.
- When both pulleys were fully reconstructed, there was a loss of 12±16° in MCP ROM in wrist neutral compared to wrist flexed, as well as a 17.5±16° loss in MCP ROM in wrist neutral compared to wrist extended.

Figure 3 A) **B)**

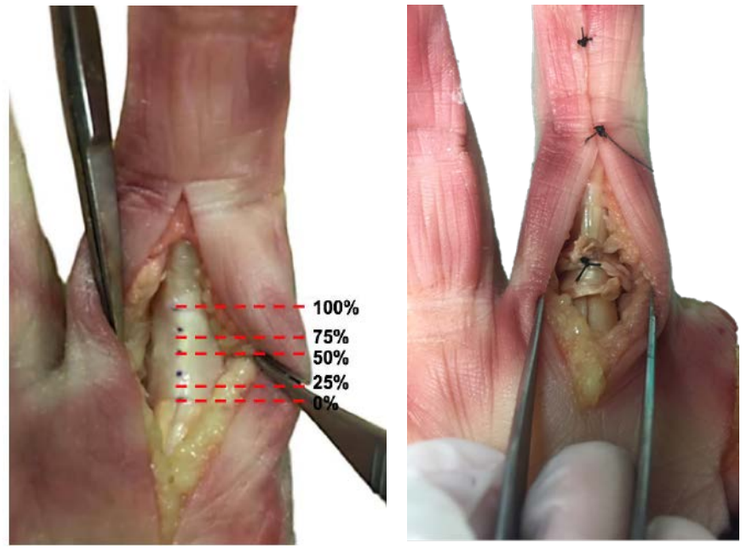

Fig 3: A2 Flexor Pulley post A) Sequential 25% increment labels B) Reconstruction

Conclusions

- Sectioning of the A2 and A4 pulleys in all wrist positions showed statistically significant effects on reducing MCP ROM and FDP tendon loads.
- Pulley reconstructions restored metrics with no significant difference compared to the intact state, reinforcing their utility by reducing bowstringing and restoring natural joint biomechanics and tendon loads.
- The new simulator's capability to measure in-line tendon loads has provided additional tendon load information that compliments the state of knowledge on joint ROM in the context of pulley reconstructions.