A NEW METHOD FOR HUMAN DIGITAL PULLEY RECONSTRUCTION USING EXPANDED POLYTETRAFLOUROETHYLENE (ePTFE) AND A TRANSOSSEOUS TECHNIQUE FOR FIXATION

Giuffrida, Ylenia[1]; Owens, Patrick[1]; Baria, Dinah[2,3]; Milne, Edward[2]; Latta, LL[1,2,3]

1. Orthopaedic and Rehabilitation, University of Miami, Miami, FL

2. Max Biedermann Institute for Biomechanics, Mount Sinai Medical Center, Miami Beach, FL

3. University of Miami, Miami & Coral Gables Campuses, FL

M.B.I.

Max–Biedermann–Institute for Biomechanics

M.B.I.

Max–Biedermann–Institute for Biomechanics

INTRODUCTION:

Current techniques of pulley reconstruction have marginal success because of high complication rates.[1] A new technique utilizing expanded polytetrafluoroethylene (ePTFE) and a unique titanium plate is described and tested for pullout strength. The authors hypothesize that this technique is as strong as current techniques and native pulleys.

METHODS:

Cadaver digital rays were dissected leaving the flexor tendons and A2 pulleys intact.

The load to failure and resistance to volar translation (stiffness) of each A2 pulley were measured using a hook pulled at a constant rate of 10 cm/min, similar to that of previously published methods,[2] (FIGURE 1). Testing was performed on an MTS Minibionix Model 858 machine. Failure mechanisms were noted and photographed and load – displacement data recorded. Peak load was reported as failure and the slope of the linear portion of the load-displacement graph was reported as stiffness.

Next, A2 pulley reconstructions were performed using ePTFE with a transosseous technique of fixation in combination with a unique titanium plate. The ePTFE material has a very low coefficient of friction, so the titanium plate was fashioned to reinforce the grip on the ePTFE. The ePTFE was "sandwiched" between the bone surface and the plate. Sutures were placed through the holes in the plate, through the ePTFE and the bone, thus compressing the roughened under surface of the plate into the edges of the ePTFE increasing the area and the frictional resistance of the grip on the ePTFE. Four different suture configurations were compared: 1) a single wrap Fiber Wire®, 2) a double wrap Fiber WIre®, 3) a double wrap 22 gauge stainless steel wire, and 4) a triple wrap 22 gauge stainless steel wire, (FIGURE 2).

Mean and standard deviation values of load to failure and stiffness were calculated and compared to measurements of the intact pulleys and values published for native A2 pulleys. Published A2 pulley pullout strength ranges from <220N-407N and repair techniques range from 27-220N. ANOVA test for multiple comparisons was used for statistical analysis.

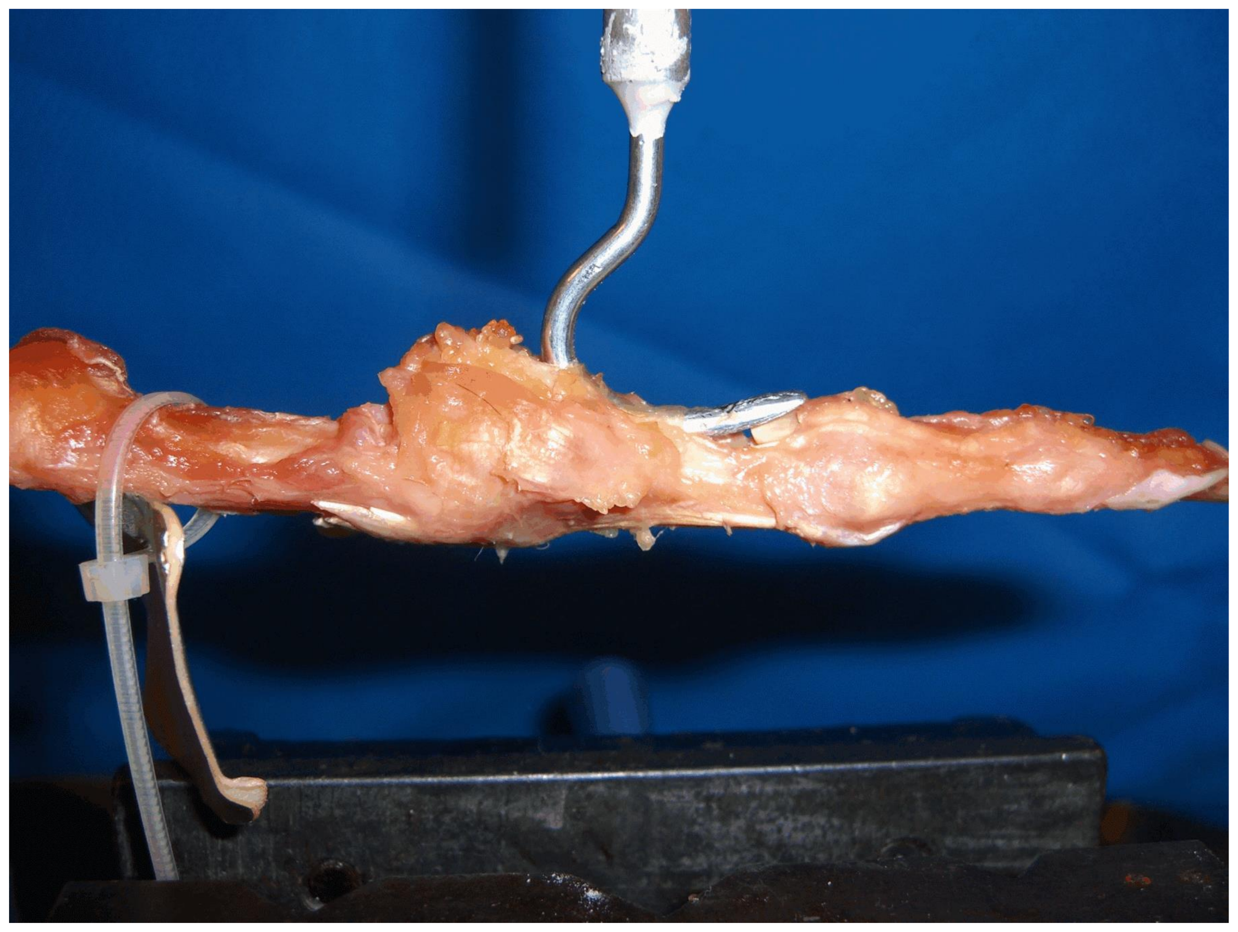

FIGURE 1 – Test fixture before clamping

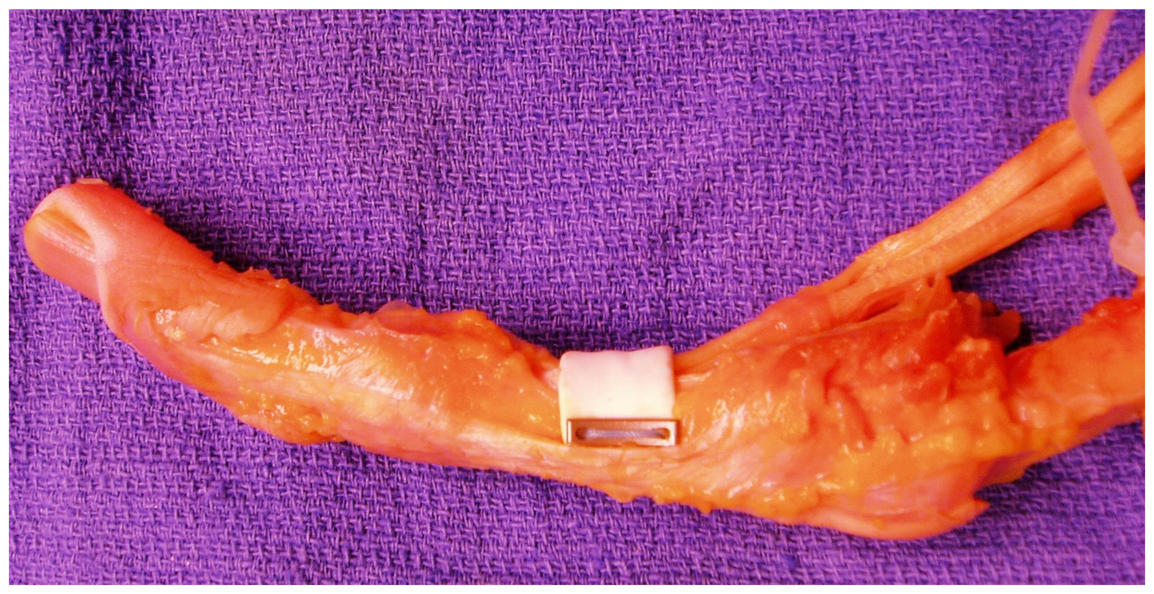

FIGURE 2 – Repaired pulley

Table 1 – Failure Load of Pulley Repair

Repair Type	No.	Mean, in N	S.D.
Intact A2 pulleys	24	248.74	96.83
Single wrap FiberWire®	6	73.15	21.06
Double wrap FiberWire®	4	176.25	21.74
Double wrap SS wire	4	191.31	17.36
Triple wrap SS wire	5	273.46	105.88

Table 2 – Stiffness of Pulley Repair

Repair Type	No.	Mean, in N/mm	S.D.
Intact A2 pulleys	24	66.70	19.65
Single wrap FiberWire®	6	12.56	5.78
Double wrap FiberWire®	4	58.98	26.13
Double wrap SS wire	4	21.72	10.61
Triple wrap SS wire	5	19.23	3.81

RESULTS:

Means for peak strength and stiffness can be found in Tables 1 and 2 respectively. Failure mechanisms were suture cutout (tearing) through or tensile failure of ePTFE in most reconstructions, with sporadic FiberWire® knot failure (2), phalanx fracture (1), and PIPJ hyperextension failure(1). The single FiberWire® repair was statistically significantly weaker than all SS repairs and intact A2's (2 SS wire, $P < 0.4$; 3 SS wire, $P < 0.0001$; and intact A2's, $P < 0.0001$). The double FiberWire® repairs were stronger than the single repairs, but the difference was not statistically significant, $P < 0.067$. There was no statistical difference in stiffness between any of the repair techniques.

DISCUSSION:

ePTFE is an ideal material for pulley reconstruction because it is biologically inert. ePTFE has an adequate amount of tensile strength to serve as a human digital pulley, and is limited by its suture cutout or tear properties. An implant such as the metal prosthesis described in this study is necessary to augment tear properties of ePTFE. A transosseous technique of fixation is ideal in that it does not disrupt the extensor compartment, and allows for facile tensioning of the pulley graft. Both FiberWire® suture and 22G stainless steel wire are adequately strong methods of fixation, with a small rate of knot failure in the Fiberwire® group. Other commercially available formulations of ePTFE may have improved tear strength and should be evaluated.

REFERENCES:

1). Lin, GT, et al., J Hand Surg [Am} 1990. 15-4:429-34

2). Lin, GT, et al., J Hand Surg [Br] 1989. 14-3:278-82

ACKNOWLEGEMENTS:

This study was performed at the University of Miami's Orthopaedic Biomechanics Lab at Mount Sinai Medical Center, Miami Beach, FL.