In Situ Comparison of a New Flexor Tendon Repair using Multifilament Stainless Steel Suture with the Savage Technique

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INTRODUCTION:

Over the past decades flexor tendons have been repaired using many repair configurations and suture types. The result of the repair depends on the method of attachment of the suture to the tendon[4], as well as the characteristics of the suture itself[2]. Both the ultimate tensile strength of the repair and the force needed to produce a 2mm gap at the repair site are important[3]. Ultimate tensile strength and gap formation depend on the number of strands crossing the repair site as well as the charachteristics of the suture material[1; 6]. Sutures that are stiffer will allow less gap formation for the same applied force[6]. The repair also depends on the ability of the suture to hold knots because sutures fail most frequently at the site of the knots either because the knots untie or the suture is weakened at these points. The ideal combination is a suture technique that provides a strong attachment to the tendon, with a suture that does not elongate and is strong. Combined with these features the method should also be relatively simple to perform, with suture that is manageable and easy to tie secure knots.

With these characteristics in mind, the purpose of this study was to compare the in-situ biomechanical performance of a new multifilament stainless steel suture material for flexor tendon repairs. Using a cadaver model, the mechanical competence of a simplified 6-strand locking technique with the new stainless steel suture material was compared to a modified 6-strand modified Savage technique with 3-0 Ethibond (Fig.1). The Savage technique has been previously shown to have excellent strength[4], but it is technically challenging and requires advanced surgical skills. Our hypothesis is that the new stainless steel suture material will allow surgeons to achieve this high strength with a simplified stitching technique.

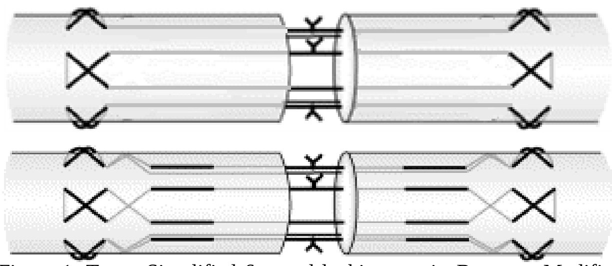

Figure 1. Top – Simplified 6-strand locking repair. Bottom - Modified Savage repair. Image modified from Viinikainen 2004[5]

METHODS:

Twelve flexor tendons were harvested from fresh frozen cadaveric hands. As the tendons were harvested they were wrapped in gauze and kept moist with physiological saline solution. A tendon laceration was simulated by making a sharp transverse cut through the tendon. The tendons were then repaired with either a 6-strand simplified locking (SS) repair using multifilament stainless steel suture (49 strands of 0.023" diameter 316L wire, Fort Wayne Metals, Fort Wayne, IN) or a 6-strand modified Savage (MS) technique using 3-0 Ethibond on paired tendons (e.g. SS on left index profundus, MS on right index profundus) (Fig. 1). This ensured equal tendon quality and size between comparison groups. Both repairs were followed by an epitendonous stitch using 5-0 Nylon. All repairs were performed by a single trained orthopaedic surgeon.

Tendons were tested immediately following the repair. The tendon ends were wrapped in gauze and hydrated with physiological saline solution while clamped in a custom clamp (Fig. 1). The tendons were cyclically loaded 10 times from 5 to 10 N, then immediately tested to failure at 1 mm/second using a servo-hydraulic testing machine (MTS Mini-Bionix 858). Gap formation at the repair site was recorded using a digital video camera at 30 frames/ sec. Additionally, displacement data was measured using a 3d motion tracking system (Optotrak 3020, Northern Digital, Inc). Force data was recorded using a load cell (INTERFACE SSM-500).

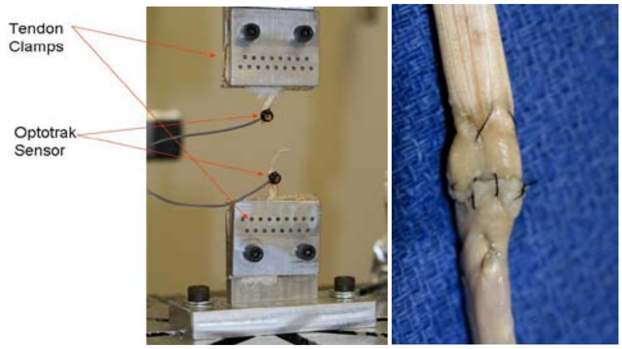

Figure 2. Left - Tendon specimen in custom tendon clamps mounted to servo-hydraulic testing machine after test. Right - Flexor tendon repaired with the simplified locking technique and epitendinous stitch, using multifilament stainless steel suture and 5-0 Nylon respectively.

RESULTS:

The simplified locking repair with multifilament stainless steel suture showed a higher ultimate load than the modified Savage technique with Ethibond. The average force to produce a 2mm gap was 23.4 N higher with the stainless steel suture, although this difference was not statistically significant.

Table 1: Results from biomechanical testing of flexor tendons repaired with 2 different techniques. N= 6 pairs of specimens.

	Force to Produce 2mm Gap (N)	Ultimate Load (N)	OptoTrak Displacement at Failure (mm)
Simplified Locking Stainless Steel 4-0	85.1±12.2	98.6±3.14	7.0±2.25
Modified Savage Ethibond 3-0	61.7±18.1	71.9±14.6	7.8±5.57
p-value (paired t-test)	0.08	0.003	0.65

DISCUSSION:

The simplified locking repair with multifilament stainless steel suture demonstrated a significantly higher ultimate load than the modified Savage repair with Ethibond. The force required to produce a 2mm gap was not statistically significantly different for the two repairs ($p = 0.08$), however it is anticipated significant differences will be seen with higher sample sizes. Previous studies have shown the 6 strand Savage repair to be one of the strongest configurations for flexor tendon repair, however this repair is difficult to complete and requires advanced surgical skills[5]. By using the multifilament stainless steel suture, a comparable repair was shown to be achievable with an easier, more widely used technique. Future work will include increasing the sample size of the comparison groups.

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