Comparison of Flexor Tendon Suture Techniques Including 1 Using 10 Strands

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Purpose To compare mechanical properties of a multistrand suture technique for flexor tendon repair with those of conventional suture methods through biomechanical and clinical studies.

Methods We describe a multistrand suture technique that is readily expandable from 6 to 10 strands of core suture. For biomechanical evaluation, 60 porcine flexor tendons were repaired using 1 of the following 6 suture techniques: Kessler (2-strand), locking cruciate (4-strand), Lim/Tsai's 6-strand, and our modified techniques (6-, 8-, or 10-strand). Structural properties of each tenorrhaphy were determined through tensile testing (ultimate failure load and force at 2-mm gap formation). Clinically we repaired 25 flexor tendons using the described 10-strand technique in zones I and II. Final follow-up results were evaluated according to the criteria of Strickland and Glogovac.

Results In the biomechanical study, tensile properties were strongly affected by repair technique; tendons in the 10-strand group had approximately 106%, 66%, and 39% increased ultimate load to failure (average, 87 N) compared with those in the 4-, 6-, and 8-strand groups, respectively. Tendons in the 10-strand group withstood higher 2-mm gap formation forces (average, 41 N) than those with other suture methods (4-strand, 26 N; 6-strand, 27 N; and 8-strand, 33 N). Clinically, we obtained 21 excellent, 2 good, and 2 fair outcomes after a mean of 16 months (range, 6–53 mo) of follow-up. No patients experienced poor results or rupture.

Conclusions The 10-strand suture repair technique not only increased ultimate strength and force at the 2-mm gap formation compared with conventional suture methods, it also showed good clinical outcomes. This multistrand suture technique can greatly increase the gap resistance of surgical repair, facilitating early mobilization of the affected digit. *(J Hand Surg Am. 2015;40(7):1369–1376.*

Type of study/level of evidence Therapeutic IV.

Key words Core suture, biomechanical study, flexor tendon, porcine, tenorrhaphy.

Additional material is available online.

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No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

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EARLY MOBILIZATION AFTER FLEXOR tendon repair, which is essential to prevent peritendinous adhesions and for better healing,[1] requires an efficient suture method that is sufficiently strong to resist repair-site gapping and rupture. Suture integrity is affected by multiple factors such as the number of strands of core suture, caliber of the core suture, suture material, length of suture purchase, locking configuration, and number of anchor points.[2,3] The strength of the repair especially depends on the number of strands crossing the repair site, because strength

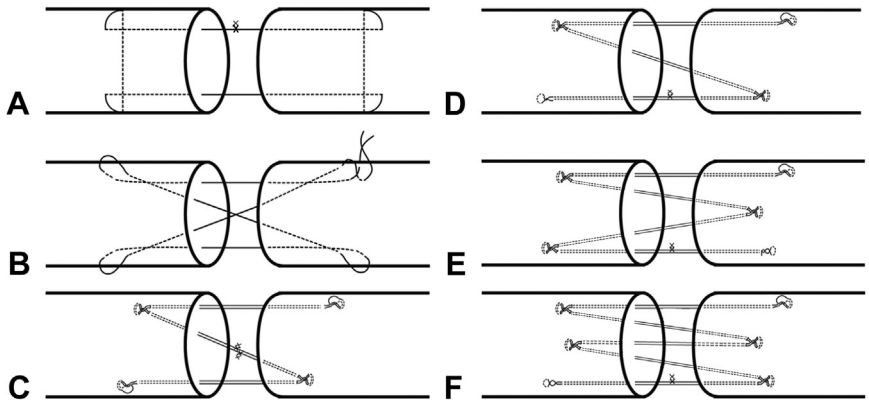

FIGURE 1: Various suture techniques used for mechanical testing: **A** 2-strand modified Kessler; **B** 4-strand locking cruciate; **C** 6-strand Lim–Tsai technique; **D** modified 6-strand; **E** modified 8-strand; and **F** modified 10-strand.

is increased with an increase in the number of core strands.[4–7]

A multitude of tendon repair techniques have been described to achieve strong repairs.[3–14] We focused on developing a technique that would be not only strong enough to allow early active motion but also simple to perform quickly. Among various proposed suture techniques, the 6-strand suture method using looped sutures (the Lim/Tsai technique) introduced by Gill et al[6] was especially attractive because the technique is relatively simple compared with other 6-strand techniques. However, this method has shortcomings such as requiring 2 looped sutures and the formation of 2 intratendinous knots, which might disturb healing.[15] To improve the 6-strand Lim/Tsai technique, we modified it and used just one looped suture. This modified technique is freely expandable from 6 to 10 strands to increase repair strength with minimal additional surgical time.

The purpose of the current study was to determine whether a modified multistrand suture technique using up to 10 strands could be applied as a reliable repair method to ensure early mobilization of the affected digit. We demonstrated the mechanical properties of the double-loop 10-strand suture method compared with conventional method through biomechanical testing, and report clinical outcomes.

MATERIALS AND METHODS

Tendon harvest and repair for biomechanical study

We chose porcine flexor tendons for biomechanical study because their structure and diameter are similar to those of human flexor tendons.[16,17] A total of 60 porcine flexor digitorum profundus tendons were harvested from adult pigs. A single experienced hand surgeon performed all of the repairs to improve consistency of the technique. The suture–tendon junction and level at which the tendon would be transversely cut were predetermined and marked, as were the entering points of the core and peripheral sutures.

The modified techniques (6-strand, 8-strand, and 10-strand [6-S, 8-S, and 10-S, respectively]) were compared with 3 conventional methods (a modified Kessler 2-strand technique [2-K], a locking cruciate 5-strand technique [4-L], and the 6-strand technique of Lim and Tsai[6] [6-LT]). All suture materials used for the core and peripheral sutures were nylon (Ailee, Pusan, South Korea). The 60 tendons were randomly divided into 6 groups so that each repair configuration had 10 samples. Figure 1 summarizes the repair methods. The 2-K and 4-L techniques were performed using a 4-0 nylon suture. The 6-LT method used 2 double-loop 4-0 nylon sutures (Ailee). The details of this technique have been previously described.[6] We also used a looped 4-0 nylon suture for the core suture in our 6-S, 8-S, and 10-S techniques (Fig. 2). Although we have described only the modified 6-strand technique here for brevity, the method is expandable to 8- and 10-strand sutures. Details of the technique are shown in Figure 3. For the 8- and 10-strand suture techniques, the configuration requires minor changes, as outlined in Figure 1E and F. Two or 4 strands could be added before the final cutting of one suture limb (Fig. 3D). Each anchor point was designed to avoid locking anchors on the same level of the tendon surface (Fig. 4). In the case of 10-strand sutures, the first locking anchor was placed 12 mm from the cut end, followed by the second and third anchors at 8 and 10 mm, respectively (Fig. 4). It is important to provide proper tensioning in the first locking loop