Tensile Strength of a New Suture for Fixation of Tendon Grafts When Using a Weave Technique

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Purpose: To evaluate a new corner stitch construct for tendon graft or tendon transfer fixation and compare the tensile strength with a conventional central cross-suture design in human cadaver tendons.

Methods: Flexor digitorum profundus tendons of the index, middle, and ring fingers (48 total) were used as recipients and palmaris longus, extensor indicis proprius, and extensor digitorum communis tendons of the index finger (48 total) were used as grafts from 16 fresh-frozen human cadaver hands. We compared the cross-stitch technique with a new corner stitch technique in tendon repairs made with 1, 2, or 3 weaves (8 per group). Tendons were sutured at each weave with either 2 full-thickness cross-stitches or 4 partial-thickness corner stitches of 4-0 nylon. Mattress sutures also were placed through the free tendon end for each repair type. The tensile strength of the tendon–graft composite was measured with a materials testing machine.

Results: The tensile strength of the repairs increased significantly with the number of weaves. When 2 or 3 weaves were used with the corner stitch or when 3 weaves were used with the cross-stitch, the repairs were significantly stronger. Although no significant difference in strength to failure was noted when comparing cross and corner stitches with equivalent numbers of weaves, qualitatively there was a difference in mode of failure with the 3-weave corner stitches failing primarily by intrasubstance tendon failure and the 3-weave cross-stitch repairs failing by tendon pullout.

Conclusions: The corner stitch is as strong as conventional cross-stitch repairs and its superficial placement may be more favorable to tendon blood supply. This repair may be advantageous for clinical applications. (J Hand Surg 2006;31A:982–986. Copyright © 2006 by the American Society for Surgery of the Hand.)

Key words: Human, *in vitro*, suture, tendon graft, tensile strength.

Tendon grafting is an uncommonly performed but still clinically important procedure that is used both to reconstruct damaged tendons and to lengthen tendons for tendon transfer.[1–3] Although the fixation of the distal attachment to bone has been well studied,[4–7] the proximal weave repair of the graft to the host tendon has not been examined in great detail, with only a single citation in Medline when searching with the key words *tendon*, *suture*, and *weave*.[8] By using other sources we were able to identify 1 other report[9] that measured the tensile strength of such repairs. Although the available literature suggests that these proximal weaves are very strong, failure of the proximal weave repair does occur clinically,[3,10–13] with 1 series reporting a 7% rate of complications at the proximal end.[10,11,13]

Typically the proximal host–donor repair begins with weaving the 2 tendons together and fixing the weave ends and juncture points with sutures.[9,11] Usually a cross-stitch[8] or horizontal mattress stitch[11] is used at the center of each weave, with the cross-stitch having significantly greater strength in a cadaver study.[8] Both of these stitches grasp the full thickness of the tendon weave. Gelberman et al[14,15] showed the

importance of longitudinal intratendinous vessels to the revascularization of tendon grafts. Although the horizontal mattress stitch runs parallel to these vessels, the cross-stitch transfixes them. We believe that it is possible that the transfixing cross-stitch may compromise longitudinal vascularity of the motor tendon. This could result in weakening of the proximal weave over time and could explain the existence of failure at what otherwise should be an extremely strong and reliable connection. In this study we evaluated an alternative suture design for the weave technique that does not penetrate into the depth of the tendon and therefore may pose less of a risk to the tendon vascularity. In this method a more superficially placed horizontal mattress suture is made in each of the 4 corners of each weave, avoiding the center of either tendon. This study compared the tensile strength of the conventional cross-stitch with the corner stitch constructs in human cadaver tendons.

Materials and Methods

A total of 48 human flexor digitorum profundus (FDP) tendons of the index, middle, and ring fingers were used as recipient host tendons and a total of 48 palmaris longus, extensor indicis proprius, and extensor digitorum communis tendons were used as donor grafts. The tendons were obtained from 16 fresh-frozen human cadaver hands.

Suture Techniques

After creating a small slit in the FDP tendon at the palm level with a scalpel, the graft tendon was drawn through the slit to produce 1 interlacing weave. The slit length was roughly 1.5 times the FDP tendon width. There was an equal distance of approximately 5 mm between weaves. During suturing, the tendons were kept under tension with a 200-g weight.[16] Tendons were repaired with either 2 horizontal mattress cross-stitches centered on the weave intersection that were oriented at 90° to each other and overlapping, each with a 5-mm bite, to form a cross or X shape as described by Gabuzda et al[8] (Fig. 1A) or they were repaired with 4 horizontal mattress corner stitches with a 3-mm bite at each of the 4 corners of each weave (Fig. 1B). Figure 1B shows 2 stitches on the surface, but there are 2 more stitches on the other side. All sutures consisted of 4-0 nylon (Ethilon; Ethicon, Inc., Somerville, NJ). The cross-stitches each went through the center of both the motor and graft tendons (Fig. 2), whereas the corner stitches went through the periphery of the graft and motor tendons (Fig. 3). Two horizontal mattress sutures were used to secure the motor and graft tendon free ends for each repair type, as is performed clinically (Fig. 1). These mattress sutures were placed at both edges of the free tendon end so as not to obstruct the revascularization at the center of the tendon. For each suture technique, the tendon repairs were made with 1, 2, or 3 weaves (8 per group). For multiple weaves, a slit was made in the FDP tendon and the graft tendon was pulled through the slit with a small tendon passer or hemostat. Another slit then was made in the FDP at 90° to the original cut, again as is performed clinically, and the graft tendon again was passed.

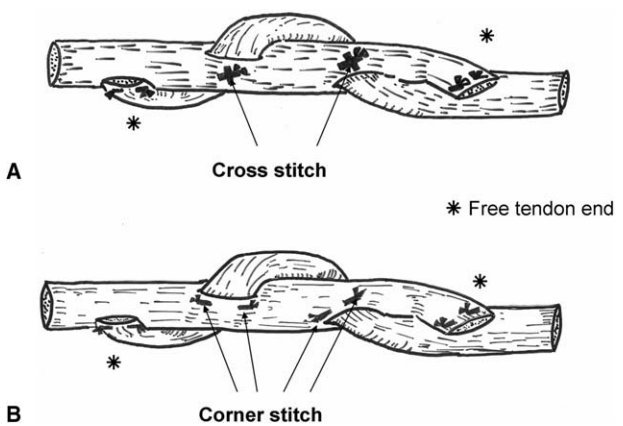

Figure 1. (A) Corner and (B) cross-stitch repair techniques with 2 weaves.

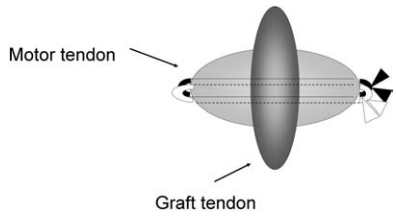

Figure 2. Cross-stitch repair technique: the central portion of both the motor and graft tendons are transfixed.

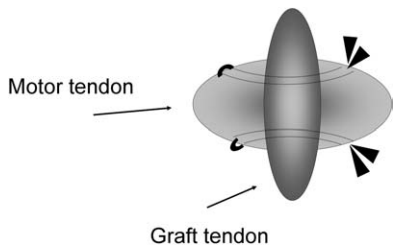

Figure 3. Corner-stitch repair technique: the central portions of the motor and graft tendons are not crossed by the sutures.