Suture Purchase Length: A Biomechanical Study of Flexor Tendon Repair in Newborn Lambs

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Purpose We aimed to determine the effect of core suture purchase on repair strength of flexor tendon lacerations in newborn lambs as a model for pediatric tendon repairs. The dimensions of flexor tendons in these lambs are similar to those of children younger than 2 years.

Methods Thirty-six flexor tendons were harvested from newborn lambs. The tendons were cut transversely and repaired using a single figure-of-eight core suture using 5-0 polypropylene. The 36 tendons were divided into 9 groups (n = 4 tendons in each group) according to the length of the core suture purchase: 2, 3, 4, 5, 6, 7, 8, 9, or 10 mm. The initial gap force and ultimate strength of the repairs were studied using a computerized tensometer.

Results There were no significant differences between core suture purchase lengths 2, 3, 4, and 5 mm for both initial gap and ultimate strength. Similarly, there were no significant differences between purchase lengths 6, 7, 8, 9, and 10 mm for both initial gap and ultimate strength. However, there was a significant difference between the former and the latter groups.

Conclusions The optimal core suture purchase length in flexor tendon repair of newborn lambs was 6 mm. However, this length may be too much of a purchase when applied clinically in children younger than 2 years. *(J Hand Surg 2013;38A:62–65. Copyright © 2013 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Tendon purchase, flexor tendon, tensile strength, children.

Compared with adults and older children, flexor tendon injury in children younger than 2 years has many unique features.[1] First, the size of the tendon is smaller in both width and thickness, and it is therefore difficult to place core sutures. Second, the rupture rate following flexor tendon repair is highest in the age group regardless of the tendon repair technique.[2] Finally, rupture of repaired flexor tendons in children younger than 2 years can still occur while the hand is completely immobilized.[2] This may reflect noncompliance in young children, and it indicates that the tensile strength of repaired flexor tendons in very young children is weak. However, previous experiments on the tensile strength of repaired flexor tendons have been performed on adult and not pediatric tendons.

Numerous biomechanical studies have also been conducted on adult tendons to investigate the core suture purchase length in flexor tendon repairs, and the studies determined that the optimal length of purchase is between 7 and 10 mm.[3–7] Once again, no experimental data are available for pediatric tendons with regard to optimal core suture purchase length. Clinically, pediatric hand surgeons have noted that the core suture purchase in flexor tendon repair in very young children should be 1 to 2 mm longer than the width of the tendon[1] or 1.5 to 2.0 times the tendon width.[8] The width of the flexor tendons in children younger than 2 years[1]

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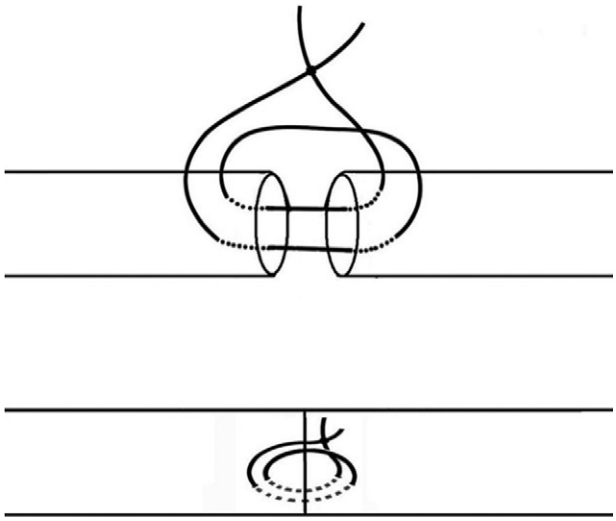

FIGURE 1: Top: the configuration of the figure-of-eight suture. Bottom: the appearance of the tied figure-of-eight suture.

is similar to that of newborn lambs; therefore, we chose to use the newborn lamb as a model for pediatric flexor tendon repair.

The purpose of this study was to assess how the length of core suture purchase affected the repair strength of transversely cut digital flexor tendons of newborn lambs (1–2 wk old) using a figure-of-eight core suture technique.

MATERIALS AND METHODS

The study was approved by the Research Committee at the Department of Surgery. A total of 36 fresh digital flexor tendons of newborn lambs (1–2 wk old) were used. Dimensions of the tendons were 1 to 2 mm wide and 0.5 to 1.0 mm thick. These dimensions are similar to the dimensions of flexor tendons in children younger than 2 years.[1,9] All 36 tendons were harvested, cut transversely, and repaired using a single figure-of-eight suture using 5-0 polypropylene sutures. The technique of the figure-of-eight suturing[10] is shown in Figure 1. The suture grasps the full-thickness substance of the tendon on each side, and the knot is tied on the tendon surface. The 36 tendons were divided into 9 groups (4 tendons in each group) according to the length of the suture purchase (ie, the length of the entry point of the core suture from the cut tendon edge on each side): 2-, 3-, 4-, 5-, 6-, 7-, 8-, 9-, and 10-mm purchase lengths. The purchase length was measured using a caliper (Martin Caliper; Nex Gen Ergonomics Inc., Quebec). All repairs were tested to single-cycle tensile failure using a computerized tensometer (Instron Canada Ltd; Burlington, Ontario). The preload was set at 1.0 N, and the sutured tendons were pulled at a constant speed of 20 mm/min. The initial gap force (the force that produced a visible gap between the 2 tendon ends at the repair side) and the ultimate strength of the repairs (the peak force recorded during testing, which appeared just before failure of the repair) were recorded. Data were analyzed statistically using 1-way analysis of variance. When the analysis indicated significance ($P < .05$), multiple comparisons were done using the Dunnett T3 post-hoc test for initial gap force data and Scheffe post-hoc test for ultimate strength data. Further analysis was done using a Student *t*-test for independent groups.

TABLE 1. Measured Force of Initial Gap Formation and Ultimate Strength

Tendon Purchase Length (mm)	Initial Gap Force in Newtons (Mean ± SD)	Ultimate Strength Force in Newtons (Mean ± SD)
2	3.2 ± 0.3	4.3 ± 0.5
3	3.5 ± 0.2	5.5 ± 1.0
4	3.5 ± 0.5	4.5 ± 0.6
5	3.2 ± 0.5	4.5 ± 0.6
6	5.3 ± 0.1	7.5 ± 0.6
7	5.6 ± 0.3	7.5 ± 0.6
8	5.7 ± 0.9	7.8 ± 1.0
9	5.4 ± 0.5	8.0 ± 1.4
10	5.8 ± 0.7	7.8 ± 0.5

RESULTS

The results for both initial gap forces and ultimate strengths are shown in Table 1. Using 1-way analysis of variance, there was a significant difference between the groups for both initial gap force ($P < .001$) and ultimate strength ($P < .001$). Using the post-hoc tests for multiple comparisons, there were no significant differences between purchase lengths 2, 3, 4, and 5 mm for both initial gap and ultimate strength; and there were no significant differences between purchase lengths 6, 7, 8, 9, and 10 mm for both initial gap and ultimate strength. However, lengths of 6 mm or more were significantly stronger ($P < .05$) than lengths of 5 mm or less for both gap force and ultimate strength. We then rearranged the data into 2 groups (Table 2). Group I included 2-, 3-, 4-, and 5-mm purchase lengths, and group II included 6-, 7-, 8-, 9-, and 10-mm purchase lengths. Using the Student *t*-test for independent groups, the difference between the 2 groups was significant ($P < .001$) for both initial gap force and ultimate strength.