The Effect of Number of Knots Per Throw, Knot Technique, and Suture Type on Strength Properties of Suspensory Fixation Button Surgical Procedures

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INTRODUCTION: Previous studies of the cortical suspensory button (CSB) implant have analyzed fixation strength as a function of suture type and surgical technique, but knot configuration remains an area of interest. This study investigates four-strand knot configurations in CSB suspensory fixation, specifically comparing the use of two separate knots with a single knot. We hypothesize that using two knots on the distal side with #2 suture will yield stronger and stiffer suspensory fixation.

METHODS: Two types of knot configurations were compared: a centralized, single knot with all four suture strands versus two independent knots with two suture strands each. They were tested using #2 or 2-0 suture, and distal or proximal knot positions. Mechanical testing on the Instron measured ultimate failure load, elongation at failure, and stiffness. Statistical analyses (Shapiro-Wilk, unpaired Student t-tests, and Chi-square tests) assessed differences in strength, stiffness, elongation, and failure mode between knot configurations within each CSB construct combination.

RESULTS: With #2 suture, two knots across the CSB resulted in higher load to failure compared to one knot in both proximal (467.00 N vs. 554.66 N, p=0.026) and distal (395.18 N vs. 526.51 N, p<0.001) configurations. Furthermore, two knots provided higher stiffness than one knot in both proximal (53.24 N/mm vs. 67.89 N/mm, p<0.001) and distal (47.08 N/mm vs. 56.73 N/mm, p<0.041) knot locations. However, using 2-0 suture showed no significant differences in failure load and stiffness, regardless of knot location. Elongation at failure did not vary significantly between constructs. Regarding failure mode, the top strand showed no particular pattern of failure at either the opposite side, same side, or at the location of the knot, whereas the bottom strand almost always failed at the location of the knot.

DISCUSSION: Using #2 suture, tying two independent knots across the CSB increased load to failure and stiffness compared to using only one knot, regardless of knot position. However, with 2-0 suture, the number of knots did not impact construct strength. Thus, tying two knots with #2 suture is recommended to enhance construct strength. Knot position did not significantly affect the strength or stiffness of the CSB construct, emphasizing the importance of considering knot prominence and surgical approach for determining knot location.

CLINICAL RELEVANCE: This study guides clinicians on the optimal knot configurations when using a CSB. Optimizing knot configurations and considering knot prominence can enhance surgical techniques and reduce the risk of implant failure and complications.

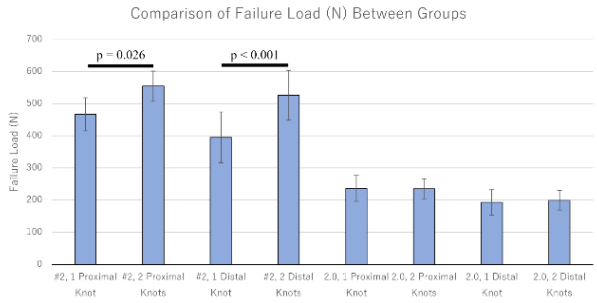

Figure 1. Failure load of CSB constructs with one or two-knot configurations, proximal or distal knot location, and with #2 or 2-0 suture.

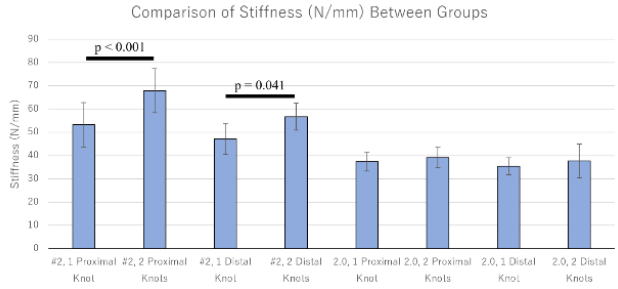

Figure 2. Stiffness of CSB constructs.

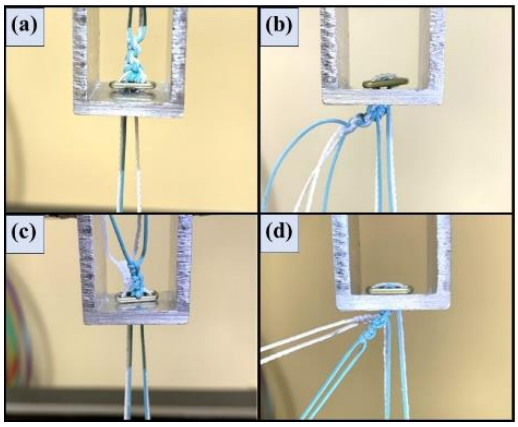

Figure 3. CSB constructs: 1 distal knot (a); 1 proximal knot (b); 2 distal knots (c); 2 proximal knots (d)