Biomechanical Evaluation of SpeedBridge Bridge Configurations for Rotator Cuff Tendon Repair

Christian Tacogue, Yiwen Zhao, Chunfeng Zhao

Mayo Clinic, Rochester, MN

Email of Presenting Author: Tacogue.Christian@mayo.edu, christiantacogue@gmail.com

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INTRODUCTION: Rotator cuff tears are a common injury that often requires surgical intervention arthroscopically for pain relief and functional recovery. However, retear following surgery remains problematic due to high stress placed on the repair relative to its holding strength. Consequently, many surgical technologies have been designed and clinically trialed to increase repair strength. The double-row two-anchor SpeedBridge configuration is the most widely accepted suture technique in clinical practice; however, a comparison between a two-anchor and three-anchor SpeedBridge technique has not been researched. The purpose of this study was to evaluate the biomechanical peak force and stiffness of five double-row configurations and to determine which technique would best reduce the risk of retear.

METHODS: Thirty subscapularis tendons were harvested from cadaver pig shoulders and divided into five groups (n = 6 per group). Each tendon was detached from its native bony attachment and repaired using one of the double-row SpeedBridge suture configuration: (1) two-anchor knotless, (2) two-anchor knotted, (3) two-anchor with a suture bridge, (4) three-anchor knotless, and (5) three-anchor knotted with a suture bridge. All specimens underwent biomechanical testing to failure. In addition to recording the peak force and stiffness, the failure mode was observed. Biomechanical properties among all groups were compared using the one-way analysis of variance (ANOVA) test, with statistical significance set at $p < 0.05$.

RESULTS: The average peak force for the three-anchor knotted with a suture bridge was significantly higher than all two-anchor suture configurations. The three-anchor knotted with a suture bridge configuration had the highest average peak force (85.1 N) compared to the three-anchor knotless (72.0 N), two-anchor knotless (52.7 N), two-anchor knotted (64.0 N), and two-anchor knotted with a suture bridge (69.3 N) configuration. Significant differences were also found between the two-anchor knotless and two-anchor knotted with suture bridge configurations in peak force. The average stiffness for both the three-anchor knotless and three-anchor knotted with a suture bridge configurations were significantly higher than all two-anchor suture configurations. The three-anchor knotted with a suture bridge configuration had the highest average stiffness (18.2 N/mm) compared to the three-anchor knotless (16.2 N/mm), two-anchor knotless (4.8 N/mm), two-anchor knotted (7.6 N/mm), and two-anchor knotted with a suture bridge (7.6 N/mm) configuration. The failure mode of nearly all subscapularis tendons in each group was the suture cutting through the tendon. Exceptions include one tendon rupture for both the two-anchor knotless and knotted configurations and two tendon ruptures for the two-anchor knotted with a suture bridge configuration.

DISCUSSION: This study compares the biomechanical properties of various double-row SpeedBridge configurations in a pig rotator cuff repair model. The use of a subscapularis tendon is to mimic geriatric patients or patients with a weak rotator cuff tendon due to its thin low cell and tissue density. The results showed that the three-anchor knotted with a suture bridge configuration had significantly better peak force and stiffness compared to all two-anchor configurations. Moreover, the three-anchor knotless configuration had significantly better peak force and stiffness compared to all two-anchor configurations. However, there was no significance in peak force with the three-anchor knotless configuration compared to all two-anchor configurations. Significance in peak force was also found between the two-anchor knotless and two-anchor knotted with a suture bridge. With the failure mode of subscapular tendons from nearly all groups being the suture cutting through the tendon, there was no statistical significance among all the groups. Based on these findings, the three-anchor knotted with a suture bridge configuration demonstrated superior biomechanical performance compared to the other four suture configurations.

SIGNIFICANCE/CLINICAL REVELANCE: The three-anchor knotted with a suture bridge technique could improve the rate of retear in clinical practice.

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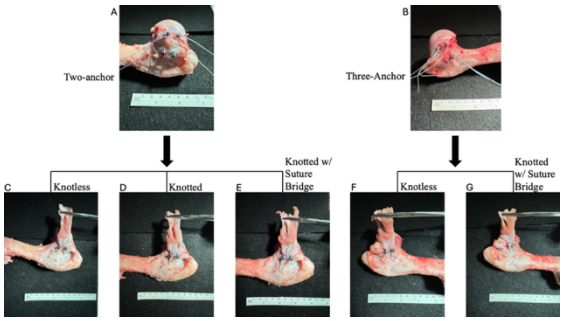

Figure 1. Preparation of each suture configuration. Figure 1A and 1B display the two-anchor and three-anchor set up on the humeral head before the subscapularis tendon is reattached with size 2 Fiberwire. The Fiberwire from each anchor is threaded through the unattached subscapularis tendon, as show in in Figure 1C, 1D, 1E, 1F, and 1G. For each knotless and knotted with a suture bridge configuration (1C, 1E, 1F, and 1G), the ends of the Fiberwire penetrates the tendon through the same hole posteriorly. For the knotted configuration (1D), each end of the Fiberwire penetrates the tendon separately through two holes posteriorly. After passing through the tendon, each end of the Fiberwire is tied to the two lower anchors to create the knotless configuration (1C and 1F). For the knotted configuration (1D), each end of the Fiberwire is knotted three times before being tied to the two lower anchors. In the knotted with a suture bridge configuration (1E and 1G), three knots are made between one end of each outer anchor to form a suture bridge; subsequently, all ends of the Fiberwire are tied to the lower anchors.

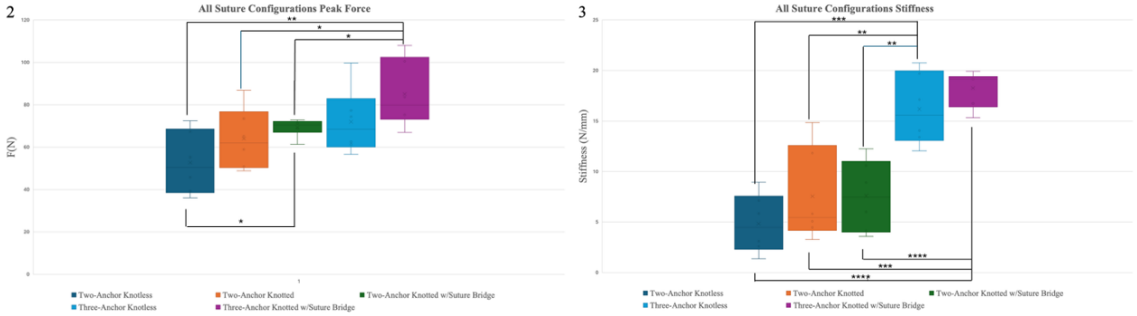

Figure 2-3. Comparison of testing peak force (2) and stiffness (3) for five groups (mean ± SD). * denotes $p < 0.05$, ** denotes $p < 0.005$, *** denotes $p < 0.0005$, and **** denotes $p << 0.0001$.