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Biomechanical evaluation of the simple cinch stitch for arthroscopic rotator cuff repair☆

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ABSTRACT

Background: The tissue-suture interface is described as the most vulnerable and susceptible area in the muscle–tendon–bone construction of arthroscopic rotator cuff repair. Various stitching techniques have been described to enhance the strength, fixation and stability of the repair, but technical and biomechanical challenges remain. Purpose was to examine the biomechanical properties of the simple cinch stitch in comparison to other stitches commonly used for rotator cuff repair.

Methods: Infraspinatus tendons were harvested from sheep and split in half. The tendons were randomized into five different stitch configuration groups for biomechanical testing: simple stitch; horizontal stitch; FiberChain®; simple cinch stitch; and modified Mason-Allen stitch. Each specimen was first cyclically loaded on a universal materials testing machine under force control from 5 to 30 N at 0.25 Hz for twenty cycles. Then, each specimen was loaded to failure under displacement control at a rate of 1 mm/s. Cyclic elongation, peak-to-peak displacement and ultimate tensile load were measured. The type of failure was recorded.

Findings: No differences in cyclic elongation or peak-to-peak displacement were seen between stitch configurations. In the load-to-failure test, the simple cinch stitch demonstrated significantly higher ultimate load than the simple and the horizontal stitch configurations. The comparison to the FiberChain® Suture revealed no statistical significant differences.

The FiberChain® Suture demonstrated significantly higher ultimate load than the simple stitch. No statistical significance could be demonstrated in comparison to the horizontal stitch or the simple cinch stitch.

The ultimate tensile load of the modified Mason-Allen stitch was significantly higher than that of the other stitch configurations.

Interpretation: The simple cinch stitch has an ultimate tensile load comparable to the FiberChain® suture and is superior to the simple stitch and the horizontal stitch. The major advantage of the simple cinch technique is that it is possible to perform the stitch entirely arthroscopically, without the need to perforate the tissue a second time or to use special suture materials.

Study design: Controlled laboratory study.

1. Introduction

Following improvements in technique, instrumentation and implant design, the popularity of arthroscopic rotator cuff reconstruction has increased (Wilson et al., 2002; Severud et al., 2003; Liu & Baker, 1994; Burkhart et al., 2001; Yamaguchi et al., 2003). Nevertheless, many technical challenges remain unsolved. Specifically, the tissue-suture interface is described as the most vulnerable and susceptible area in the muscle-tendon-bone construction. High failure rates after rotator cuff repair have been described in the literature and emphasize the importance of tissue healing (Liu & Baker, 1994; Galatz et al., 2004).

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To improve the outcome of rotator cuff reconstruction, various stitching techniques have been described to enhance the strength, fixation and stability of the repair. Some of these techniques require the use of additional material; include complicated steps; are not always feasible to perform; or have a significant learning curve. In addition, not every technique can be implemented in arthroscopic procedures. The arthroscopic rotator cuff repair is often limited to simple or horizontal stitch forms, given that the biomechanically stronger modified Mason–Allen stitch is more complex and more difficult to perform (Schneeberger et al., 2002; Gerber et al., 1994, 1999). Other suture configurations that are currently in use are the simple stitch, the horizontal mattress-type and the massive cuff stitch (Ma et al., 2004; MacGillivray & Ma, 2004). The lasso-loop, lasso-mattress, and double-cinch stitches represent self-cinching stitches, which can also be performed arthroscopically (Ma et al., 2004; Ponce et al., 2011; Lafosse et al., 2006).

In the current study, we aimed to compare the biomechanical properties of a previously described self-cinching stitch to other commonly used stitch configurations for arthroscopic rotator cuff repair, stabilization and biceps tenodesis. This simple cinch stitch is based on a combination of a simple stitch and a cow hitch (Hawi et al., 2015). In this technique, the mid-portion of the suture is passed through the tissue, creating a loop that allows both suture ends to pass (Figs. 1, 2). We showed before that it is possible to perform this stitch entirely arthroscopically, without the need to perforate the tissue more than one time, in combination with knotless suture anchors (Hawi et al., 2015).

The hypothesis of the study was that the strength of the simple cinch stitch would be comparable to that of the FiberChain® and superior to the strength of the simple stitch and of the horizontal stitch.

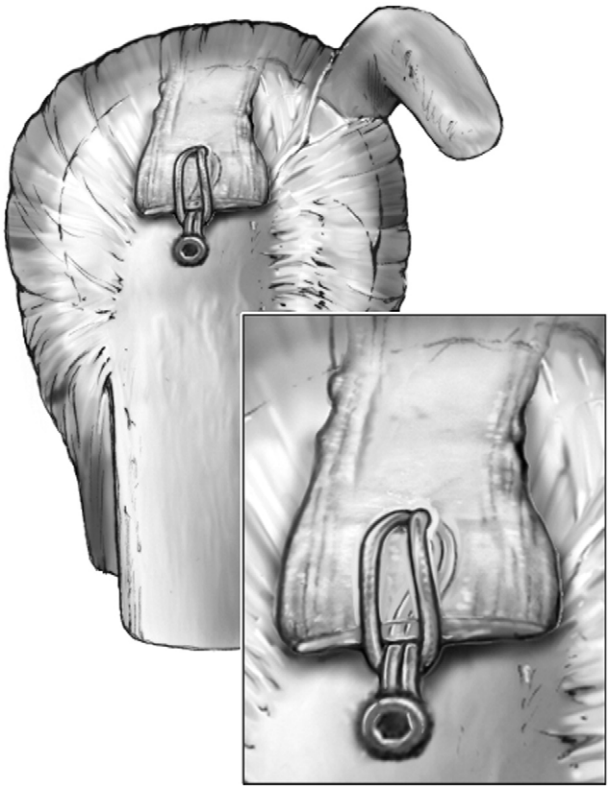

Fig. 2. Application of the simple cinch stitch.

2. Methods

Forty tendons were randomly assigned to a suture group, for a total of eight tendons tested with each stitch configuration.

The design of this study was modeled after the methodology described in previous published research comparing the biomechanical properties of different suture types using sheep infraspinatus tendon grafts (Ma et al., 2004; Ponce et al., 2011). The infraspinatus tendons were sharply dissected from the muscle tissue and split longitudinally in half. All tendons were visually inspected for gross abnormalities; none had to be excluded. The tendons were kept frozen until one day prior to the testing sequence, when they were thawed at room temperature overnight. Five different suture configurations were tested (Fig. 3): simple stitch, horizontal stitch, FiberChain®, simple cinch stitch and the modified Mason-Allen. Number-2 FiberWire® (Arthrex GmbH, Munich, Germany), a polyester braid and long-chain polyethylene suture, was used for all stitch configurations.

2.1. Technique

The simple cinch stitch is a self-cinching stitch that combines a simple stitch with a cow hitch (Hawi et al., 2015). The midportion of the

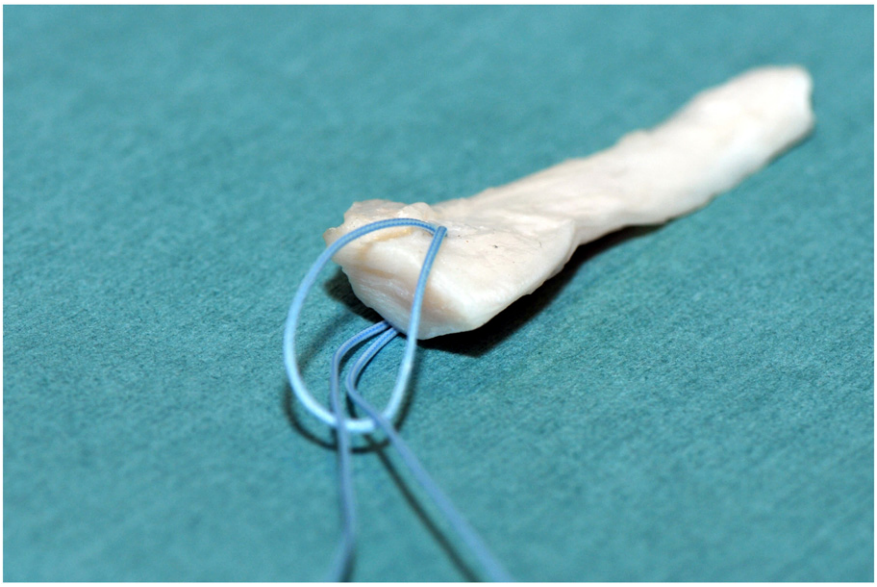

Fig. 1. The simple cinch stitch performed in a sheep tendon.