The Journal of Foot & Ankle Surgery 56 (2017) 3–7

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Original Research

Comparison of Suture-Based Anchors and Traditional Bioabsorbable Anchors in Foot and Ankle Surgery

W. Chad Hembree, MD [1], Michael A. Tsai, BS [2], Brent G. Parks, MSc [2], Stuart D. Miller, MD [1]

[1] Department of Orthopaedic Surgery, MedStar Union Memorial Hospital, Baltimore, MD
[2] Engineer, Department of Orthopaedic Surgery, MedStar Union Memorial Hospital, Baltimore, MD

ARTICLE INFO

Level of Clinical Evidence: 5

Keywords:
Achilles tendinitis
ankle instability
bone mineral density
Broström procedure
calcaneus
fibula
load to failure

ABSTRACT

We compared the pullout strength of a suture-based anchor versus a bioabsorbable anchor in the distal fibula and calcaneus and evaluated the relationship between bone mineral density and peak load to failure. Eight paired cadaveric specimens underwent a modified Broström procedure and Achilles tendon reattachment. The fibula and calcaneus in the paired specimens received either a suture-based anchor or a bioabsorbable suture anchor. The fibular and calcaneal specimens were loaded to failure, defined as a substantial decrease in the applied load or pullout from the bone. In the fibula, the peak load to failure was significantly greater with the suture-based versus the bioabsorbable anchors (133.3 ± 41.8 N versus 76.8 ± 35.3 N; $p = .002$). No significant difference in load with 5 mm of displacement was found between the 2 groups. In the calcaneus, no difference in the peak load to failure was found between the 2 groups, and the peak load to failure with 5 mm of displacement was significantly lower with the suture-based than with the bioabsorbable anchors (52.2 ± 9.8 N versus 75.9 ± 12.4 N; $p = .003$). Bone mineral density and peak load to failure were significantly correlated in the fibula with the suture-based anchor. An innovative suture-based anchor had a greater peak load to failure compared with a bioabsorbable anchor in the fibula. In the calcaneus, the load at 5 mm of displacement was significantly lower in the suture-based than in the bioabsorbable group. The correlation findings might indicate the need for a cortical bone shelf with the suture-based anchor. Suture-based anchors could be a viable alternative to bioabsorbable anchors for certain foot and ankle procedures.

Two of the most common applications of suture anchors in foot and ankle surgery are in the distal fibula for lateral ankle ligament reconstruction (1–4) and in the calcaneus for Achilles tendon reattachment after debridement procedures for insertional tendinitis (5,6). The suture-based anchor (JuggerKnot; Zimmer Biomet, Warsaw, IN) uses suture alone to secure the suture arms to the bone, obviating the need for a metal or plastic anchor. Using a suture-based anchor provides several potential benefits. If magnetic resonance imaging of a nearby joint is indicated after the procedure, suture-based anchors will not cause the amount of image distortion typically seen with metal anchors. The use of a suture-based anchor in the shoulder could help to prevent the failures seen with metal or plastic anchors that lead to intra-articular chondral injury or synovitis (7–9). An anchor composed entirely of suture would theoretically limit foreign body reactions and decrease the risk of chondral injury in the event of a pullout. Also, a suture-based anchor could potentially minimize treatment challenges during revision surgery. Revision procedures can be complicated by the attempt to avoid previous metal and plastic anchors, which can compromise the strength of the repair.

Bioabsorbable anchors were used for comparison in the present study because they are commonly used in foot and ankle surgery and were readily available from the manufacturer. The bioabsorbable anchors were meant to be representative of other solid-type anchors (metal or plastic). The bioabsorbable anchors used in the present his study are composed of poly-D,L-lactide from L-lactide and D-lactide, which has been shown to remain present in bone for ≥1 year after implantation (10), thereby creating the potential for pullout and damage to the surrounding joints and tissues. The all-suture–based anchors potentially offer advantages over the bioabsorbable anchors for other reasons as well. Bioabsorbable screws, for example, could have an increased risk of breakage, associated joint effusions, and tunnel widening compared with metal screws when used in anterior cruciate ligament reconstruction (11). Bioabsorbable implants have

Financial Disclosure: Zimmer Biomet (Warsaw, IN) donated 1.4-mm and 2.9-mm JuggerKnot anchors for this study. Arthrex (Naples, FL) donated 2.4-mm Mini Bio-Suture Tak and 4.5-mm Bio-Corkscrew anchors.

Conflict of Interest: B. G. Parks is a consultant for Arthrex. S. D. Miller is a consultant for Zimmer Biomet.

Address correspondence to: Stuart D. Miller, MD, c/o Lyn Camire, Editor, Department of Orthopaedic Surgery, MedStar Union Memorial Hospital, 3333 North Calvert Street, Suite 400, Baltimore, MD 21218.

E-mail address: lyn.camire@medstar.net (S.D. Miller).

1067-2516/$ - see front matter © 2016 by the American College of Foot and Ankle Surgeons. All rights reserved.
http://dx.doi.org/10.1053/j.jfas.2016.10.011

also been shown to cause inflammatory reactions (12), cyst formation in bone (13), and foreign body reactions (14). Suture-based anchors theoretically avoid some of the possible complications associated with bioabsorbable anchors.

Much of the published data on suture anchor pullout strength pertains to shoulder surgery, with suture-based anchors showing pullout strength similar to that of traditional solid anchors (15,16). Anchor implantation in the glenoid takes advantage of a strong rim of cortical bone, which might not always be present in foot and ankle applications. The strength of suture-based anchors in foot and ankle surgery has not been fully evaluated. Multiple studies support the use of traditional suture anchors for the modified Broström procedure and for reattaching the Achilles tendon back to bone (1–6). Only limited findings are available on the use of suture-based anchors in foot and ankle surgery. In a cadaveric biomechanical study, the strength of suture-based anchors was not different from that of an all-soft tissue repair in the modified Broström procedure (17). More work is needed to assess the strength of an all suture-based anchor in foot and ankle surgery.

The purpose of the present study was to compare pullout strength of an all suture-based anchor versus standard bioabsorbable anchors at the distal fibula and calcaneal tuberosity. A secondary purpose was to determine whether the bone mineral density (BMD) correlated with the pullout strength. We hypothesized that no difference in pullout strength would exist between the suture-based and bioabsorbable anchors and that no correlation would exist between the BMD and the load to failure.

Materials and Methods

Eight matched cadaveric specimens (16 specimens) were used (average age 49 [range 36 to 55] years; 6 male and 2 female pairs). Based on the power analysis, 8 specimens were needed per group for 80% power to identify a significant difference in pullout strength, the primary aim, at the $p = .05$ level.

Dual-energy x-ray absorptiometry scanning was used to measure the BMD of the calcaneus in each specimen of the 8 pairs.

For the fibula site, a standard longitudinal approach for the modified Broström was performed by a fellowship-trained foot and ankle surgeon. The inferior extensor retinaculum was elevated away from the tip of the fibula as 1 layer. The anterior talofibular ligament (ATFL) and calcaneofibular ligament were sharply released off the bone. A periosteal flap was elevated from distally to proximally off the lateral border of the fibula. A 3-mm rongeur was used to create a 3-mm trough along the distal fibula, extending from the proximal origin of the ATFL to the most distal origin of the calcaneofibular ligament, such as is typically done in vivo to promote healing of the ligamentous tissue. The length of the trough varied according to the anatomy of each specimen. Using the manufacturer's suggested technique, anchors were placed within the trough at the anatomic site of the ATFL, with 1 specimen in each pair receiving a 1.4-mm suture-based anchor (1.4-mm drill, no. 1 MaxBraid suture; JuggerKnot; Zimmer Biomet, Warsaw, IN) and 1 specimen receiving the 2.4-mm bioabsorbable anchor (1.8-mm drill, no. 2-0 FiberWire; Mini Bio-Suture Tak; Arthrex, Naples, FL). The direction of anchor insertion into the fibula in the present study was consistent with currently used surgical techniques. Most techniques describe anchor insertion from a distal to proximal direction, almost in line with the direction of the pulling force of the ATFL (1,2,4). Although not ideal from a biomechanical standpoint, this direction of anchor insertion has been shown to have excellent clinical outcomes and therefore is presumed to be strong enough to hold the ligamentous tissue until it heals (1,4). Furthermore, the distal fibula can be thin in the lateral to medial direction, which limits the ability to place anchors from laterally to medially because of the potential risk of penetrating the lateral gutter of the ankle joint. The fibula bone was then skeletonized and secured in a polyvinyl chloride pot using Kirschner wires and polyester resin. The specimens were mounted separately, and the suture arms were attached directly to the cross-head of an electromechanical load frame (MTS Q-Test; MTS Systems, Eden Prairie, MN; Fig. 1). The direction of pull was orthogonal to the cortical surface of the bone (Fig. 2). The specimens were loaded at 5 mm/min until failure, defined as a substantial decrease in the applied load or anchor pullout from bone. The load at 5 mm of frame cross-head extension and the peak load to failure were measured.

For the calcaneal site, a standard midline approach was used. The skin and paratenon were elevated medially and laterally away from the Achilles tendon as 1 layer. The tendon was split midline and elevated away from the underlying calcaneus medially and laterally. A microsagittal saw was used to remove the enthesophyte and Haglund's deformity, as is typically performed in vivo, leaving a flat cancellous bone bed. Resection of Haglund's deformity and the enthesophyte left no cortical bone at the site of anchor insertion in the calcaneus. The size of the exposed cancellous surface varied according to the different anatomy of each specimen. Imaging was not performed to quantify the decortication. Using the manufacturer's suggested technique, anchors were placed at the reattachment site of the Achilles tendon, with 1 specimen in each pair receiving either a 2.9-mm suture-based anchor (2.9-mm drill, no. 2 MaxBraid; JuggerKnot; Zimmer Biomet) or a 4.5-mm bioabsorbable anchor (3.5-mm drill, no. 2 FiberWire; Bio-Corkscrew, Arthrex). The anchors were inserted nearly perpendicular to the direction of the pulling force (Fig. 2). This is consistent with multiple described techniques and the shape of the calcaneal surface after removal of the enthesophyte and Haglund's deformity (6,18). The specimens were then mounted using transversely placed Steinman pins into the electromechanical load frame. The suture arms were attached directly to the cross-head of the

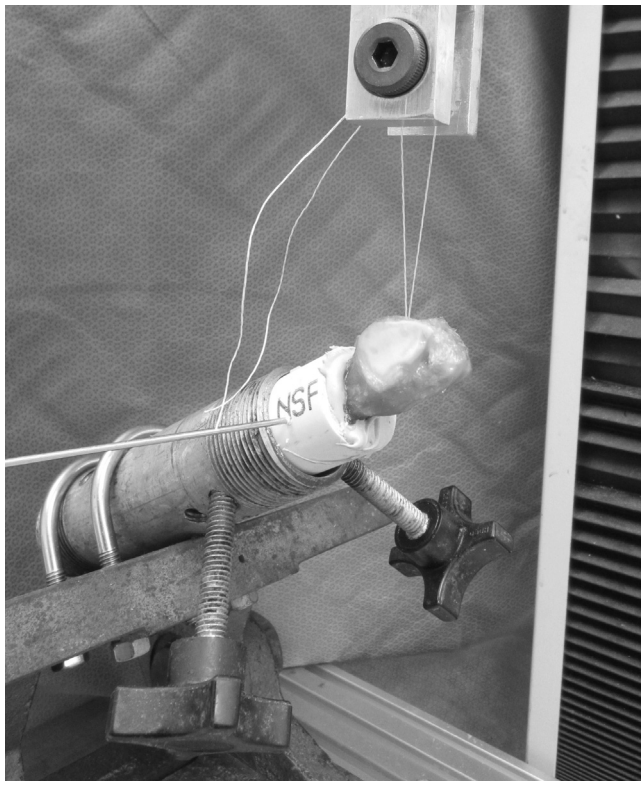

Fig. 1. Fibula specimen mounted on load frame.