In Vitro Analysis of Rotator Cuff Repairs: A Comparison of Arthroscopically Inserted Tacks or Anchors With Open Transosseous Repairs

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Purpose: The purpose of this study was to employ a cyclic loading protocol to compare rotator cuff repair strengths of arthroscopically inserted cuff tacks and suture anchors with the traditional open transosseous suture repair. **Type of Study:** In vitro cadaveric analysis. **Methods:** Full-thickness 1 × 3-cm rotator cuff defects were created in 25 fresh-frozen cadaveric shoulders, and were randomized to 1 of 4 repair groups: (1) open repair with transosseous sutures, (2) arthroscopic repair with 2 singly loaded suture anchors, (3) arthroscopic repair with 2 doubly loaded suture anchors, and (4) arthroscopic repair with cuff tacks. All repairs were cyclically loaded from 10 to 180 N, and the numbers of cycles to 50% (5-mm gap) and 100% (10-mm gap) failure were recorded. **Results:** The number of cycles to 100% failure was significantly higher for the arthroscopic doubly loaded suture anchor repairs when compared with the (1) open transosseous suture repair ($P = .009$), (2) arthroscopic cuff tack repair ($P = .003$), and (3) arthroscopic singly loaded suture anchor repair ($P = .02$). Additionally, the number of cycles to 50% failure was significantly higher for all anchors versus open or tack repair ($P = .03$ for both). **Conclusions:** Immediate postoperative fixation of rotator cuff repairs with doubly loaded suture anchors was more stable than that provided by the open transosseous suture repairs, arthroscopic singly loaded suture anchors, or cuff tacks. However, additional evaluation is needed to examine the effects on the sustained strength of the repair throughout the healing process. **Clinical Relevance:** These in vitro results indicate that superior immediate postoperative fixation of rotator cuff repairs may be achieved with the doubly loaded suture anchors. However, additional evaluation is needed to examine the effects on the sustained strength of the repair throughout the healing process. **Key Words:** Rotator cuff tears—Absorbable anchors—Absorbable tacks—Cyclic loading—Cadaveric model.

Traditionally, the gold standard for rotator cuff repairs has been the open transosseous suture repair. More recently, arthroscopic and arthroscopically assisted mini-open techniques of rotator cuff repair have become more popular. Accompanying this increase in popularity, several new arthroscopic rotator cuff repair devices have been designed and marketed.

Since the introduction of the suture anchor in 1985 by Goble et al.,[1] numerous permutations of the device have been developed. Among the most widely used rotator cuff repair devices currently available are cuff tacks and suture anchors. Ideally, these devices should be easy to insert, provide strength of repair equivalent to the open transosseous repair, and maintain repair strength throughout the healing process.[2]

Many studies have looked at the initial ultimate tensile strength of rotator cuff repairs using suture anchors[3-6] as well as anchor pull-out strength.[3-8] More

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0749-8063/05/2103-3971$30.00/0
doi:10.1016/j.arthro.2004.11.018

recently, Burkhart et al.[9,10] published several articles advocating the use of cyclic testing to determine rotator cuff repair strength, because these tests provide a better simulation of the in vivo mechanism of rotator cuff repair failure. Using such a cyclic loading protocol, several studies have shown that bioabsorbable suture anchors and tack fixation are less prone to failure than transosseous suture fixation.[11,12] In neither of these studies, however, were the repair devices inserted arthroscopically. To our knowledge, there are no published reports of studies that used arthroscopic insertion of rotator cuff repair devices into intact cadaver shoulders to determine repair strength. Arthroscopic knot tying is potentially more difficult than open knot tying and, as such, may affect the strength of repair. We believe that inserting the devices arthroscopically into intact cadaver shoulders best simulates how the devices will work in real clinical situations.

The purpose of this study was to compare the rotator cuff repair strengths after cyclic loading of arthroscopically inserted bioabsorbable suture anchors with singly and doubly loaded suture anchors, arthroscopically inserted bioabsorbable cuff tacks, and open repairs with the traditional transosseous suture technique. We hypothesized that the doubly loaded suture anchors would show repair strength superior to the open repair, the singly loaded suture anchors, and the bioabsorbable cuff tacks.

METHODS

Twenty-eight fresh-frozen cadaver shoulders (mean age, 79 years) were obtained and stored at −20°C. Each of the 28 specimens was then thawed at room temperature for 24 hours, and randomized to 1 of 4 treatment groups: (1) open technique repaired with transosseous sutures, (2) arthroscopic repair with 2 singly loaded 5-mm Twin-fix suture anchors (Smith & Nephew Endoscopy, Mansfield, MA), (3) arthroscopic repair with 2 doubly loaded 5-mm Twin-fix suture anchors, and (4) arthroscopic repair with Mitek cuff tacks (Mitek Surgical Products, Westwood, MA). A standard mini-open incision was made and a standard crescent-shaped full-thickness defect (30 mm anterior-to-posterior and 10 mm medial-to-lateral) was then created in the supraspinatus and infraspinatus tendons of each of the shoulders as was previously described by Burkhart et al.[9,10] Three shoulders already had existing cuff tears that were extended to resemble the created rotator cuff tears. Four specimens were excluded from the study: 2 from group 1 (1 with a massive, irreparable rotator cuff tear, and 1 with a degenerative tear with dimensions that were not consistent with our created defects), 1 from group 2, and 1 from group 3. In the excluded specimens in group 2 and group 3, very poor tissue quality was noted at the time the tears were created and the tissue was deemed inadequate for repair. The open repairs were performed by an orthopaedic sports fellowship–trained physician who performs mini-open repairs in a clinical setting, and the arthroscopic repairs were performed by an orthopaedic sports fellowship–trained physician who routinely uses arthroscopic repairs in his practice. Company representatives were present to ensure appropriate placement and use of the devices.

For group 1, the repair was performed through the standard mini-open incision, and with groups 2, 3, and 4, a layered closure of the incision needed to create the initial cuff defect was performed prior to arthroscopic repair of the cuff. In group 1 (n = 5), each rotator cuff defect was repaired with two No. 2 Ethibond transosseous sutures (Ethicon, Somerville, NJ) using a Mason-Allen stitch technique.[4] These sutures were placed through 3 drill holes that were spaced 10 mm apart and 30 mm distal to the tip of the greater tuberosity.[13] For the arthroscopic repairs (groups 2, 3, and 4), standard posterior, anterior-superior, and lateral portals were used. A bursectomy was performed for visualization and soft tissue was removed from the greater tuberosity with a shaver. An accessory anterolateral portal was created for insertion of anchors and cuff tacks. In group 2 (n = 6), each defect was repaired with 2 Twin-fix singly loaded suture anchors using No. 2 braided polyester sutures. One of the 2 sutures from each anchor was removed. The sutures were placed at a 45° angle (the "deadman's angle") in the greater tuberosity. The sutures were placed approximately 1 cm medial to the leading edge of the cuff tear using standard arthroscopic suture passing instruments, creating a simple stitch. A lockable sliding knot backed with 3 reverse half-hitches on alternating posts was used for each suture.[14] The technique for group 3 (n = 6) was identical to group 2 except that both sutures from each Twin-fix anchor was utilized for the repair (doubly loaded suture anchors). In group 4 (n = 7), each defect was repaired with two smooth bioabsorbable Mitek cuff tacks by mobilizing the leading edges of the tears to close the defect. The tacks were inserted (according to the manufacturer's instrumentation and guidelines) through the tendon 5 mm from its free end and into a predrilled hole in the greater tuberosity.

The specimens were dissected, leaving only the intact rotator cuff, humeral head, and proximal 15 cm