TECHNIQUE

Double-Row Rotator Cuff Repairs: Biomechanical Rationale and Surgical Techniques

Amon T. Ferry, MD, Matthew T. Provencher, MD, Adam Yanke, MS, Nikhil N. Verma, MD, Bernard R. Bach, MD, and Anthony A. Romeo, MD

Division of Sports Medicine
Department of Orthopaedic Surgery
Rush University Medical Center
Chicago, IL

ABSTRACT

Advances in surgical technique and implants for arthroscopic rotator cuff repair have generated an interest in the indications and application of double- and single-row repairs. Recently, a variation of the double-row technique, known as the transosseous equivalent repair, has also been described. Previous reports of unacceptably high failure rates after arthroscopic repair of large and massive rotator cuff tears have led to the scrutiny of both this technique and the implants used. Biomechanically, double-row techniques are superior to single-row with respect to restoring the anatomic footprint, minimizing gap formation, and providing a greater load to failure at time equals zero. Furthermore, the recently described transosseous equivalent fixation technique provides improved footprint restoration, greater contact pressure across the bone-tendon interface, and an increased load to failure when compared to double-row repair. Although the biomechanical data are encouraging, clinical studies are still in progress to assess the efficacy of double-row versus single-row techniques, particularly with regard to tendon healing. The potential advantages may be offset by the added surgical time, required technical expertise, and potential increase in cost. The purpose of this study is to review the biomechanical, histological, and in vivo results of double-row and transosseous equivalent arthroscopic rotator cuff repairs while also discussing our indications and technique for double-row repairs.

Keywords: rotator cuff, double-row, transosseous equivalent, technique, arthroscopic, biomechanics

The goal of rotator cuff repair is to decrease pain, improve function, and restore strength through restoration of a stable bone-tendon construct. Previous literature has shown that improved outcomes, particularly with regard to restoration of strength, are present when the rotator cuff repair is intact.[1–4] Gerber and colleagues[5] suggested that the ideal repair should provide high initial fixation strength, minimize gap formation, and maintain mechanical stability until sufficient healing has occurred. Historically, open techniques have generally employed the use of bone tunnels to provide transosseous fixation. With the advent of arthroscopic techniques for rotator cuff repair, suture anchors have replaced the transosseous tunnel as the primary mode of fixation. As proficiency in arthroscopic rotator cuff repair has improved, so have the fixation techniques. Various methods of arthroscopic rotator cuff footprint restoration have been described, including a double-row repair, which simulates the type of fixation achieved with open and mini-open techniques. For the purposes of this article, a double-row construct consists of 2 rows of suture anchors, all placed within the rotator cuff footprint. A transosseous equivalent construct (TOE) is similar to a double-row anchor repair except that the lateral row fixation integrates the medial sutures to provide compression of the rotator cuff to the tuberosity, similar to an open transosseous suture technique (Fig. 1).

Recent studies have demonstrated that double-row fixation is superior to single-row fixation with regard to contact area and pressures, minimizing gap formation, and increasing load to failure.[6–10] Demirhan et al[11] showed that the strongest biomechanical construct is the combination of medial suture anchors and lateral transosseous bone tunnels, a double-row repair pattern that requires open surgery. However, many surgeons have shifted from open to arthroscopic surgery in order to gain better visualization of the tear pattern, less deltoid disruption, less postoperative morbidity, and an earlier return of motion.[4] Improvement in anchor and suture technology has led to a reduction in implant failures. Currently, with better understanding of optimal techniques for repair based on tear pattern for large and massive tears,[12] the mechanism of failure has shifted to the suture-tendon interface.[13] The arthroscopic TOE repair does not rely on the lateral aspect of the tendon for fixation but rather

Reprints: Anthony A. Romeo, MD, 1725 West Harrison St, Suite 1063, Chicago, IL 60612 (e-mail: shoulderelbowdoc@aol.com).

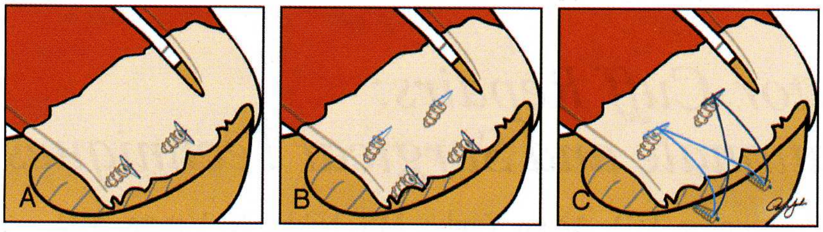

FIGURE 1. Drawing of the proximal humerus depicting the difference between single-row (A), double-row (B), and TOE constructs (C).

creates a load-sharing construct between the medial and lateral points of fixation, which has been shown to reduce the incidence of suture pullout and may provide improved resistance to shear stress during rotational motion.[14]

Arthroscopic rotator cuff repair has become an accepted technique with clinical results that approach the outcomes of open and mini-open techniques. Retear rates for all-arthroscopic repairs have been reported to be between 17% and 50% for 1 and 2 tendon repairs[1,3,4,15] and as high as 94%[16] for large and massive tears. However, these studies have demonstrated that clinical outcome does not necessarily correlate with tendon healing. Therefore, there has been considerable debate regarding the adoption of a more technically demanding, longer, and potentially more expensive double-row all-arthroscopic technique. Current studies are underway to determine if double-row or TOE techniques result in improved results with regard to both clinical outcome and tendon healing to justify the increased complexity and expense.

HISTORICAL PERSPECTIVE

Restoration of the entire footprint is a potentially important factor in cuff repair because it leads to a greater surface area for healing of the tendon. The supraspinatus footprint, on average, measures 12.7 mm (medial to lateral) and 16.3 mm (anterior to posterior) on the superior aspect of the greater tuberosity (Fig. 2).[17] In a cadaver model, Mazzoca et al[18] showed that double-row fixation provides a footprint that is identical to that of the intact supraspinatus. An in vivo study showed that only 47% of the supraspinatus footprint is restored after placement of a single lateral row of suture anchors and confirmed that the entire footprint can be reestablished with the addition of a medial row.[7] Using three-dimensional digitization of the supraspinatus footprint, a significantly greater percentage of native tendon-bone contact area was found after double-row suture anchor fixation (100%) when compared to either single-row suture anchor or simple transosseous suture repairs (46 vs 71%, respectively).[19] In addition, Park and colleagues[20] used contact pressure film to show that a significantly greater portion of the supraspinatus footprint can be restored with a 4-suture bridge TOE technique when compared to double-row suture anchor fixation (77.6% vs 39.6%, respectively).

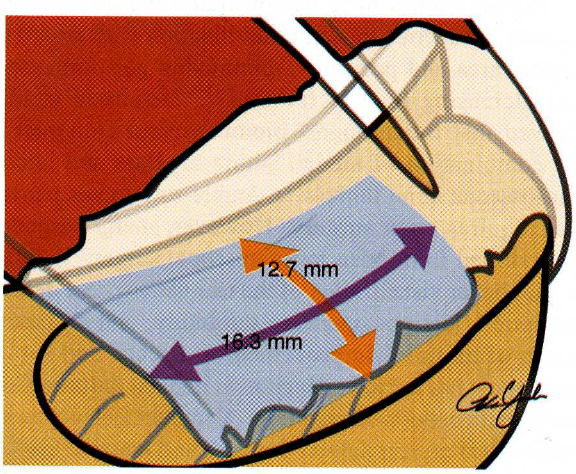

FIGURE 2. Drawing of the proximal humerus depicting the supraspinatus tendon attachment (footprint) with dimensions in millimeters.

Double-row techniques have been shown to have a significantly greater load to failure[10,21] and mean cycles to failure[8] with significantly less gap formation[9,10,21,22] when compared to single-row fixation. Burkhart[23] determined that the maximal contraction force generated by the supraspinatus is equal to approximately 302 N. The actual load that a rotator cuff tendon repair must withstand in vivo, however, may be greater than that predicted by the maximal contraction force generated by the supraspinatus tendon because of the overlap of infraspinatus and supraspinatus tendon fibers on the greater tuberosity.[24] Fortunately, during the early phases of repair, however, rehabilitation is restricted to passive range of motion limiting muscle activity to 10% to 20% and decreasing stress across the repair site.

Early biomechanical studies have demonstrated that 6 simple sutures placed in a single-row has a load to failure of 273 N,[5] and 5 single-loaded suture anchors in a double-row configuration has a load to failure of 336 N.[25] More recently, Park and colleagues[14,26] described a TOE technique that has a load to failure of 443 N. Gap formation, at time equals zero, is significantly reduced with double-row when compared to single row-fixation[9,21] but is similar to that achieved with TOE fixation.[14] The TOE repair technique does, however, provide greater compression of the tendon against the bone[20] and higher load to failure than does double-row fixation with suture anchors.[14] Furthermore, gap formation with shoulder rotation simulating passive motion during the