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Patch Augmentation and Patch Extension for Complex Rotator Cuff Tears

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The successful management of large to massive rotator cuff tears is challenging. Multiple factors to include poor tendon quality with fatty degeneration lead to high retear rates despite improved arthroscopic and open repair techniques. Patch augmentation and patch interposition with various grafts have been studied in an effort to both reinforce and bridge massive rotator cuff repairs, and provide an optimal biologic and mechanical environment at the tendon-bone interface. The purpose of this review is to present the current indications, surgical techniques, and outcomes of patch augmentation and patch interposition (extension) for large and massive rotator cuff tears.

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Introduction

Advanced rotator cuff pathology can represent a disabling condition with significant associated shoulder pain, weakness, and dysfunction.[1] Successful surgical treatment of large and massive rotator cuff tears can be challenging. Patient age, medical comorbidities, tear size and tear chronicity, and poor tissue quality may contribute to high rates of failure and poor healing after primary repair.[2-9] Although studies report retear rates of 40%-90% in large to massive rotator cuff repairs, good outcomes and consistent pain relief can be achieved.[6,10] However, retearing has been correlated with worse pain and functional outcomes postoperatively.[6,10-12] Therefore, investigators have sought to develop techniques to optimize biologic incorporation of large and massive rotator cuff repairs to prevent structural failure.

Multiple surgical procedures have been described for the treatment of large or massive rotator cuff tears, including rotator cuff tear debridement and decompression,[13] partial repair (with or without footprint medialization),[14] primary arthroscopic or open repair,[2,6,15] superior capsular reconstruction,[16] latissimus dorsi tendon transfer,[17] and ultimately, reverse total shoulder arthroplasty.[18] The reparability of tears is an important distinguishing feature in the diagnostic algorithm. Recently, rotator cuff patch augmentation has been evaluated as a viable surgical option for repairable tears. The goals of this approach are to reduce retear rates by improving biologic healing, protecting the suture and supporting the repair, and ultimately improving postoperative pain and function. By definition, patch augmentation refers to onlaying a graft over a repaired rotator cuff tear, whereas an "interpositional" or "extension" graft creates a bridge from the residual irreparable rotator cuff tendon to the humeral footprint. Generally, the graft functions as mechanical augmentation and an extracellular matrix (ECM) scaffold to allow organized tissue in-growth and optimize healing potential. Since Neviaser et al's[19] first use of interposition allograft for rotator cuff repair, graft options for this technique have expanded and include synthetic polymers, allograft, autograft, and xenograft materials. Current studies are also investigating the role of additional biologic augmentation with platelet-rich plasma, mesenchymal cells, and growth factors; however, this is outside of the focus of this discussion.[20,21] The purpose of this review is to present the current indications, surgical techniques, and outcomes of patch augmentation and patch extension for large and massive rotator cuff tears.

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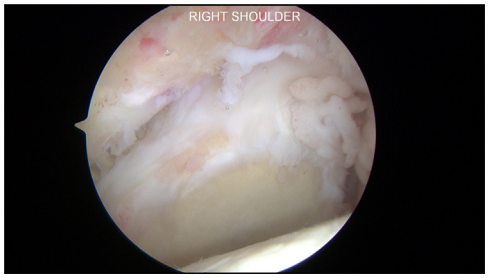

Figure 1 Lateral subacromial view of a right shoulder with a massive, 3-tendon retracted rotator cuff tear with diminished tissue quality. (Color version of figure is available online.)

Surgical Indications

Indications for Patch Augmentation and Patch Interposition (Extension)

(1) Persistent pain and shoulder dysfunction despite at least 6-months of conservative treatment with physical therapy, oral medication, or periarticular injection treatment.
(2) A symptomatic large to massive rotator cuff tear documented by preoperative imaging and intraoperative assessment (Fig. 1).
(3) A repairable tear demonstrated by intraoperative assessment (*patch augmentation*).
    (a) an irreparable tear would indicate the need for *patch interposition.*
(4) Reliable patient able to participate in postoperative rehabilitation regimen.

Contraindications

(1) Glenohumeral arthritis or inflammatory arthropathy.
(2) Active infection.
(3) Patient not likely or unwilling to be compliant with rehabilitation protocols.

Outcomes of Patch Augmentation Techniques

Allograft

Multiple studies have evaluated the outcomes of both allograft augmentation and interposition for massive rotator cuff tears. This section will focus on those investigations in which patients underwent allograft augmentation of a repairable tear. Multiple acellular human dermal matrices are currently commercially available, although 1 patch option (GraftJacket; Wright Medical Technology, Arlington, TN) has received the most widespread focus in the literature. Other preliminary studies have investigated an alternative acellular human dermal matrix product, including the Arthroflex patch (Arthrex, Naples, FL); however, results are limited and larger studies are warranted.[22] The human dermal tissue forms an acellular collagen ECM scaffold to provide an organized framework for host cell infiltration, vascular ingrowth, and later tissue remodeling.[23] Barber et al performed a randomized, multicenter prospective level II clinical trial comparing arthroscopic GraftJacket augmentation ($n = 22$) of chronic 2-tendon rotator cuff tears with a group receiving arthroscopic repair alone ($n = 20$). Arthrogram-enhanced magnetic resonance imaging (MRI) at 12-months follow up showed intact cuffs in 85% of the augmented group and only 40% of the nonaugmented repairs. Also, American Shoulder and Elbow Society and Constant scores improved significantly from preoperatively to postoperatively, and no adverse reactions were recorded.[23] Burkhead et al followed 17 consecutive patients who underwent open massive rotator cuff repair with GraftJacket augmentation, and found similar results.[24]

Xenograft

The premise behind xenograft technology for augmentation of rotator cuff repairs is that the acellularized ECM will serve as a scaffold to stimulate host inflammatory response and collagen deposition, thus strengthening tendon healing. Multiple products have been studied over the past decade with variable results. The most well-studied device is the porcine small intestine submucosa (Restore Orthobiologic Implant; DePuy, Warsaw, Indiana). Iannotti et al[25] performed a level II, randomized controlled trial to determine the comparative effectiveness of the porcine small intestine submucosal patch augmentation vs a control group without augmentation in 30 shoulders with chronic 2-tendon rotator cuff tears. Patients were followed up for 1-year and underwent an MRI arthrogram to assess the integrity of the repair. The rotator cuff healed in only 4 of the 15 shoulders in the open augmentation group as compared to 9 of the 15 in the control group ($P = 0.11$). Additionally, clinical outcome scores were inferior in the augmentation group. In summary, the authors did not recommend using this patch for chronic massive rotator cuff tears, and attribute the failure rate to the adverse mechanical environment in the immediate postoperative period as the patch undergoes resorption. Walton et al[26] performed a similar prospective study and confirmed these findings (Fig. 2).

Porcine dermal collagen patches are another xenograft which has previously been evaluated. These grafts have the advantage of increased strength compared to porcine submucosa, which may be owing to the presence of collagen cross-linking.[27] Furthermore, acellular dermal collagen patches have not elicited the same inflammatory reaction seen in repairs augmented with porcine small intestine submucosa grafts.[25,26] However, the lack of well-performed level I and II studies with porcine dermal collagen patch augmentation makes it difficult to interpret the results. More recently, bovine collagen grafts have emerged as another option for patch augmentation. Table 1 lists the published case series evaluating the outcomes of rotator cuff repair patch augmentation with xenograft.[25,26,28-32]