Chapter

Treatment of Rotator Cuff Tears: New Modalities and Innovations

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Abstract

Although frequently performed, rotator cuff repair carries a not insignificant failure rate. A number of studies including biomechanical and clinical studies have attempted to identify factors affecting rotator cuff repair and healing. Poor prognostic factors likely include age, fatty atrophy of rotator cuff muscles, large tear size, chronicity, and smoking. Recent rotator cuff tear research has been devoted to addressing both biologic and structural concerns of repair. Adjuvant repair techniques aimed at improving biology have emerged, and many are now clinically available and include biologic patch augmentation, bone marrow aspirate, platelet-rich plasma, and utilizing local bone marrow egress. Novel structural techniques have been developed to augment, alter, or replicate the structural properties of rotator cuff, particularly in the setting of irreparable rotator cuff tears. These include subacromial balloon spacers, tendon transfers, superior capsular reconstruction, anterior cable reconstruction, bursal acromial reconstruction, and biologic tuberoplasty. This chapter will examine these novel biological and structural techniques and review available clinical outcomes.

Keywords: rotator cuff repair, patch augmentation, biologics, novel rotator cuff reconstruction techniques, shoulder arthroscopy

1. Introduction

The prevalence of rotator cuff tears within the general population is estimated to be approximately 22.1% [1]. It is the most common source of shoulder pain and disability [2, 3]. As a result, arthroscopic rotator cuff repair is one of the most frequently performed orthopedic procedures [4, 5].

The most common complaint of a patient with a torn rotator cuff is pain [5]. In a study by Itoi et al. 87.9% of patients reported shoulder pain as the reason for the visit, and 10.8% reported pain and muscle weakness [6]. First-line treatments commonly include nonsteroidal anti-inflammatory (NSAIDs), corticosteroid injections, and physical therapy.

Although frequently performed, rotator cuff repair carries a not insignificant failure rate. Retear rates may range from 20% to 70% [7–11]. A number of studies including biomechanical and clinical studies have attempted to identify factors

affecting rotator cuff repair and healing. Poor prognostic factors likely include age, fatty atrophy of rotator cuff muscles, large tear size, chronicity, and smoking.

Recent rotator cuff tear research has been devoted to addressing both biological and structural concerns of repair. Adjuvant repair techniques aimed at improving biology have emerged, and many are now clinically available and include biologic patch augmentation, bone marrow aspirate, platelet-rich plasma, and utilizing local bone marrow egress. Novel structural techniques have been developed to augment, alter, or replicate the structural properties of rotator cuff, particularly in the setting of irreparable rotator cuff tears. These include subacromial balloon spacers, tendon transfers, and superior capsular reconstruction (SCR), anterior cable reconstruction (ACR), bursal acromial reconstruction (BAR), and biologic tuberoplasty. This chapter will examine these novel biological and structural techniques and will review the available clinical outcomes.

2. Biologic augmentation of rotator cuff repair: An evolving field

Primary rotator cuff repair itself continues to evolve. Recent advancements in repair techniques and materials have allowed for continued improvement in time-zero fixation. These include various anchor types, suture materials, stitch configurations, and tissue penetrating devices [12]. However, retear rates after rotator cuff repair remain high, ranging from 20% to 40% at 2 years [11, 13–16]. As such, tendon repair augmentation methods have been proposed to provide a biological scaffold for mechanical stability and long-term incorporation by providing a porous structure onto which collagen can migrate. The utilization of a mechanical augmentation patch dates back to 1986. Ozaki et al. utilized Teflon felt to augment rotator cuff repair [17].

Cuff augmentation can be utilized in several different ways. It can be utilized as a mechanical interposition graft to bridge the gap between the tendon and bone when the tendon does not reach the footprint in the setting of a retracted, irreparable tear [9–11]. Second, an augmentation patch can be applied on the bursal side of the repair in an "on-lay" fashion [18]. Third, biologic grafts can be interposed between the tendon and the bone with the goal of promoting soft tissue integration and subsequent robust healing.

Many types of grafts are available for use in the market currently. These include synthetic, xenograft, allograft, or autograft patches. Several early studies utilized xenograft small intestine submucosal graft, which revealed high rates of repair failure as well as a profound inflammatory response and led to poor clinical outcomes [19, 20]. As such, utilization of small intestine submucosal graft has largely been abandoned. The simple on-lay of reconstituted bovine collagen implant (REGENETEN, Smith, and Nephews) impregnated with growth factors has been shown to significantly increase tendon thickness in the setting of partial thickness rotator cuff tears as seen on MRI at 2 years. These patients also reported improved clinical outcomes. Despite these promising early results on the REGENETEN patch, high-level comparative studies are needed to draw conclusions on its superiority over standard repair or other augmentation methods (**Figure 1**) [21].

A randomized controlled trial of 92 patients utilizing an acellular porcine dermal matrix scaffold in small to medium rotator cuff tears showed improved constant and strength scores compared to the nonbiologically augmented group. This evidence suggests an accelerated return to function without any graft-specific complications [22]. Similar results were seen in a randomized controlled trial of 112 patients with large

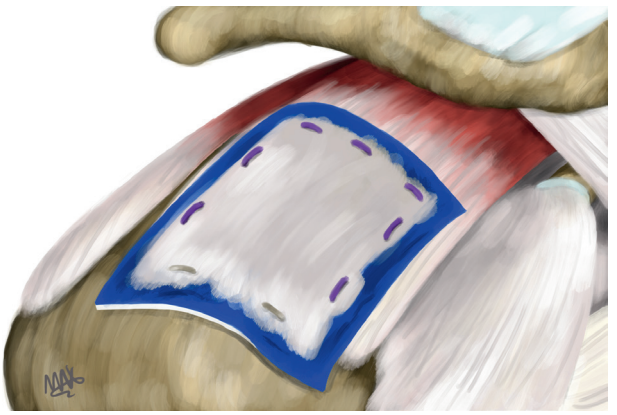

Figure 1.
Schematic of reconstituted bovine collagen implant (REGENETEN, Smith, and Nephews) used in an on-lay fashion to augment rotator cuff repair.

to massive rotator cuff using a synthetic 3D collagen scaffold augmentation. This study showed significantly higher 6-month UCLA and constant scores, suggesting an earlier return to function, although no difference was found at the final follow-up of 28 months [23].

The most utilized form of allograft rotator cuff augmentation is an acellular dermal allograft. This graft is composed of type I collagen processed to remove donor cells while preserving the extracellular matrix. Several acellular dermal allografts are available and have been utilized in orthopedic surgery and plastic surgery for decades. In biomechanical studies, allograft augmentation utilized in an on-lay fashion on top of a repair likely increases the load to failure in rotator cuff tendon repairs [24]. In vivo studies have demonstrated that the removal of cellular components allows infiltration of fibroblasts, tenocytes, and vascular tissues while causing minimal host inflammation [25, 26]. High porosity seen in new generations of "open matrix" dermal allografts may allow for deeper penetration of mesenchymal cells, leading to fibroplasia. Clinically, a prospective randomized study of 42 patients showed higher rates of the intact cuff in the on-lay acellular dermal patch augmentation group compared with the control group (85% vs. 40%) with higher American shoulder and elbow surgeons (ASES) and Constant scores at 2 years [27]. Autograft such as tensor fascia lata has also been utilized for rotator cuff augmentation with superior constant scores compared to partial repairs in a cohort study of 48 patients at minimum 7-year follow-up [28].

The use of biological and structural augmentation is an emerging solution to enhance healing in rotator cuff surgery. Various options are clinically available, and the popularity of these techniques continues to grow. Although promising data is emerging, further high-level comparative studies are necessary to define the indications, efficacy, and value.

3. Superior capsular reconstruction: Indications, techniques, and outcomes

SCR is a surgical procedure performed in the setting of irreparable cuff tears. The goal of SCR is to restore the stability of the shoulder joints, thereby re-establishing the

mechanical fulcrum of the joint to the level of the glenohumeral articulation and potentially improving the force couple of the remaining rotator cuff tendons. Originally, SCR was described using a fascia lata autograft patch [29]. SCR is indicated for patients with a nonarthritic glenohumeral joint and a functional deltoid in the setting of an irreparable rotator cuff tendon (RCT) tear [29]. Patients with an intact subscapularis tendon also show improved outcomes compared to subscapularis deficient shoulders [30]. Ideally, patients should have a repairable or intact subscapularis when undergoing an SCR [30, 31].

The most commonly utilized and studied grafts are fascia lata autograft and extracellular dermal matrix allograft. The procedure can also be performed either arthroscopically or in the open, with sutures and anchors being placed either before or after the placement of the graft [32]. The original SCR technique involves an arthroscopic procedure to be done using a fascia lata autograft that is attached medially to the glenoid using two titanium suture anchors and laterally to the greater tuberosity using double-row techniques and suture bridge. The graft is stabilized with a side-to-side suture posteriorly to the residual infraspinatus and anteriorly to the subscapularis or residual anterior-superior tendon [29].

SCR outcomes are variable. The original authors of the technique involved 24 shoulders who underwent SCR with a fascia lata [29]. Thirty-four months after surgery, patients demonstrated improved active abduction and external rotation as well as improved ASES scores [29]. Denard et al. studied 59 patients who had an SCR and showed improvements in forward flexion, external rotation, VAS, and ASES scores [33]. Unfortunately, 11 (18.6%) of patients in the study underwent a revision procedure, including seven of them undergoing reverse shoulder arthroplasties [9]. More recently, Pennington published outcomes with 86 patients who underwent SCR with a dermal allograft and demonstrated significant improvements in ASES and VAS scores after 16–28 months [34].

The rehabilitation protocol for patients who undergo a SCR is similar to those who also undergo massive rotator cuff repairs. For the first 4 to 6 weeks, postoperatively, patients are placed in a sling with an abduction pillow. Generally, progressive range of motion (ROM) exercises when the wedge is removed at 4–6 weeks postoperatively. Most surgeons then have patients begin strengthening exercises at 12 weeks postoperatively, but a subset starts as early as the 8-week mark (**Figure 2**) [35].

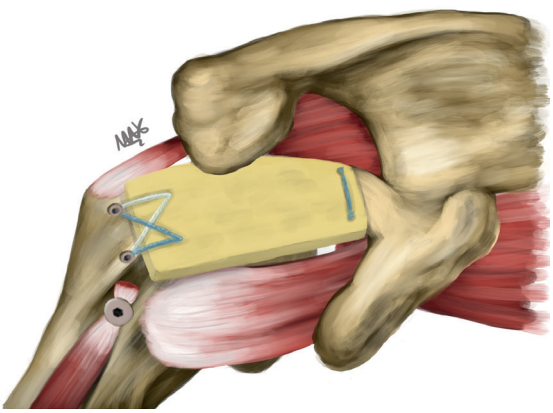

Figure 2.
Schematic of a SCR done using dermal cellular allograft fixed using suture anchors (note: long head of biceps tenodesed).

4. The subacromial balloon spacer for irreparable rotator cuff tears

Approximately half of all patients diagnosed with a torn rotator cuff undergo a surgical repair [36]. A subset of these patients are found either preoperatively or intraoperatively to have tears that are too large and retracted to perform a primary repair. As stated earlier, graft augmentation or SCR may be considered by both to be technically difficult to perform and may not be the ideal choice for lower-demand individuals. Also, there is some evidence that procedures that utilize grafts may negatively affect the outcomes of subsequent reverse shoulder arthroplasty (RSA) [37]. In lieu of this, the InSpace subacromial balloon (Stryker, USA) spacer was developed in 2010 [37] and was food and drug administration (FDA)-approved in 2021. The device consists of a saline-filled biodegradable balloon which is inserted between the humeral head and the acromion [38]. After arthroscopic insertion in the subacromial space, the InSpace balloon is insufflated with a recommended volume of saline proportional to the implant size selected. The outer material of the balloon is made of a copolymer designed to degrade in 12 months 7. It is theorized that a pseudocapsule remains after it degrades to help maintain the balloon effect. Currently, it is indicated in patients with massive (>5 cm) irreparable tears involving two or more tendons with a functional deltoid, little to no glenohumeral joint osteoarthritis, and preserved passive range of motion on examination. Similar SCR, the goal of the subacromial balloon is to restore the acromio-humeral interval and thereby re-establishing the normal mechanic of the shoulder during elevation. A theoretical advantage is that it may also reduce friction between tissue planes and potentially result in less early postoperative pain [38, 39].

While the InSpace subacromial balloon spacer is a novel device, it has already been implanted in approximately 29,000 patients internationally. However, current research is limited, and further studies are needed to evaluate its efficacy and safety. Nevertheless, the InSpace subacromial balloon spacer holds great promise in the management of irreparable rotator cuff tears, particularly in patients who are not suitable for more complex procedures (**Figure 3**).

Given earlier availability of the implant in Europe, international studies provide more data on postoperative outcomes of the surgical procedure. Gervasi et al. [40] showed that pain score improvement was found as early as 1 week postoperatively,

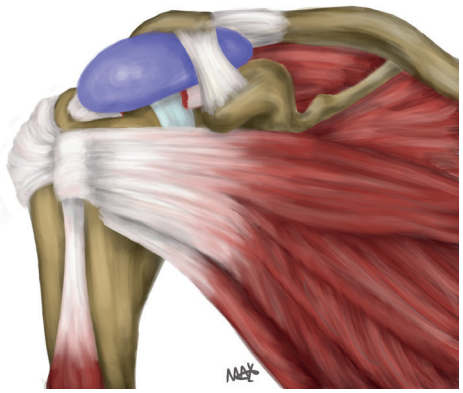

Figure 3.
Schematic diagram of InSPACE balloon inserted in the subacromial space.

and strength improvement 18 months postoperatively. Constant scores increased from 31.9 to 69.8 at 1 year follow-ups, demonstrating improvements in function, and mobility. More recently, a level 1 randomized controlled study emerged from the United States to evaluate the balloon over the course of 2 years. Participants underwent a partial tendon repair or an InSpace balloon insertion. ASES scores improved for both groups; however, a larger increase was noted for the InSpace group (46.22 vs. 42.53) [41]. InSpace implants also demonstrated functional and patient-reported outcomes comparable to partial repair of irreparable massive rotator cuff tears with intact subscapularis [41]. The InSpace device group demonstrated an earlier recovery based on improvements in ASES, WORC, and constant scores [41]. The range of motion measurements was also superior [41]. After the degradation of the implant, a 2-year follow-up demonstrated maintained clinical improvement.

Although the results of Hazra et al. are promising, other studies challenge this. A multicenter double-blinded randomized controlled trial (START:REACTS) in the United Kingdom showed less desirable outcomes [42]. This study randomized patients to debridement alone vs. debridement and subacromial balloon spacer insertion. This study was prematurely halted due to statistically greater improvement in the debridement alone group. While considered one of the emerging techniques for massive irreparable rotator cuff tears, the technique is considered controversial due to the conflicting data from the two high-level randomized controlled trials. Although approved for use by the FDA, further high-quality research is necessary to establish the role of the subacromial balloon spacer in treating irreparable rotator cuff tears.

Relative indications for use:

1. Irreparable symptomatic full-thickness massive rotator cuff tear:
    a. Measuring 5 cm or greater in diameter
    b. Involving two or more tendons
3. Functional deltoid muscle and preserved passive range of motion on physical examination
4. Absence of severe glenohumeral arthritis (Hamada grade 3 or greater)
5. Absence of pseudoparalysis, axillary nerve palsy
6. Absence of irreparable subscapularis tendon tear

5. Tendon transfers for massive irreparable rotator cuff tears: A review of latissimus dorsi transfer (LDT) and lower trapezius transfer (LTT)

Tendon transfers are another option for massive, irreparable rotator cuff tears. Patients with low-grade rotator cuff arthropathy (Hamada I or II) and a maintained glenohumeral joint with pseudoparalysis are potential candidates. Tendon transfers have been utilized to restore motion, strength, and function via force coupling. From a biomechanical point of view, the transferred tendons are thought to act as humeral head depression and concavity compression (compression of the

articulation). They can improve external rotation via a transfer force vector [43]. Latissimus dorsi transfer (LDT) and LTT are both options and can be performed open or with arthroscopic assistance. Indications for LDT and LTT include a relatively young, active patient with a massive irreparable rotator cuff tear, intact deltoid function, without subscapularis deficiency and/or anterior-superior escape of the humerus. The ability to comply with a long rehabilitation protocol is a favorable patient characteristic as well.

LDT was first described by L'Episcopo [44] in the setting of obstetric brachial plexopathy and later adopted by Gerber et al. [45] (**Figures 4** and **5**) for the management of irreparable posterosuperior rotator cuff tears. A level IV study by Gerber et al. studied long-term results of LDT at 10 years follow-up in 46 shoulders. Improvements in flexion, abduction, and external rotation as well as abduction strength were demonstrated. Inferior outcomes were demonstrated in those with subscapularis insufficiency and teres minor atrophy [46]. A recent randomized prospective evaluation of

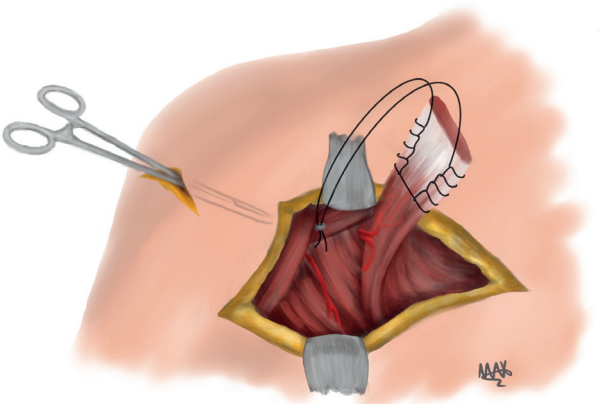

Figure 4.
Through a posterior-based incision, the latisimuss dorsi is harvested from its attachment on the humerus. Nonabsorbable sutures secure the tendon using a locking Krackow technique. The graft is then tunneled through a separate incision deep to deltoid and superficial to infraspinatous.

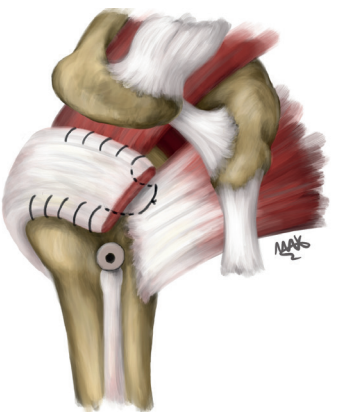

Figure 5.
The lateral edge of the graft is secured on to the greater tuberosity via preferred technique. Remnant supraspinatous can be attached to the medial border of the graft and the distal edge of the graft is secured to upper border of subscapularis (note: long head of biceps tenodesed).

LDT vs. SCR demonstrated that LDT provides statistically significant improvements in range of motion and patient-reported outcomes, although more favorable outcomes in ASES and constant scores were seen in the SCR group [47]. LDT has also been described as option for treatment of subscapularis deficiency with improved function, pain scores, as well as internal rotation in retrospective case series studies [48, 49].

Compared to LDT, LTT offers a better in-line pull similar to the infraspinatus, and biomechanical studies have shown improved external rotation force compared with LDT [50]. Due to the short length of the tendon of the lower trapezius, a bridging graft is necessary. Achilles tendon allograft and semi-tendinosis autograft have both been described in the literature [51, 52]. In either case, the lower trapezius is isolated and harvested from its insertion on the inferomedial scapular spine. Care should be taken not to violate the neurovascular pedicle, including the spinal accessory nerve and transverse cervical artery, which lie medial to the scapula on the undersurface of the muscle. The graft is tunneled through the infraspinatus fascia and under the deltoid and affixed to the greater tuberosity via bone tunnels or suture anchors. The transfer is tensioned with the arm abducted to 90 and in maximal external rotation [52]. Significant improvements in functional scores and active range of motion have been reported across multiple studies [53, 54]. Elhassan et al. reported on 41 patients with irreparable posterior superior rotator cuff tears treated with arthroscopically assisted LTT. They reported significant improvements in visual analog scale, SSV, and disabilities of the arm, shoulder and hand (DASH) scores in 37 of their patients at a mean follow-up of 14 months. Unlike LDT, subscapularis insufficiency was not correlated to inferior outcomes in LTT [53]. A level III retrospective cross-over study comparing LDT with LTT demonstrated greater active external rotation as well as post-operative ASES score. A maintained acromiohumeral distance and a lower progression of arthritis in LTT also revealed that it might be the preferred tendon transfer option for irreparable posterosuperior rotator cuff tears [55]. Rehabilitation after the tendon transfer procedures typically involves 6 weeks of full immobilization in an externally rotated and abducted position, followed by an additional 6 weeks of limited internal or external rotation to protect the transfer.

Although outcomes are suboptimal compared to primary RTC repair, LDT and LTT can serve as attractive options for younger patients with massive, irreparable rotator cuff tears (**Figure 6**).

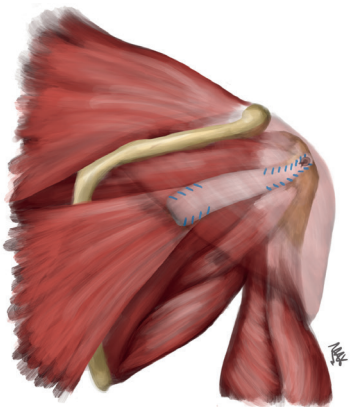

Figure 6.
LTT with utilization of bridging achilles tendon autograft to allow insertion onto greater tuberosity.

6. Anterior cable reconstruction with long head of biceps tendon: A novel technique for rotator cuff repair

The rotator cable is a semi-circular thickening that interweaves with the supraspinatus and infraspinatus tendons. It runs perpendicular to the tendon fibers and blends anteriorly with subscapularis. The analogy of the rotator cable acting as a load-bearing suspension bridge is described by Burkhart et al. [56]. Anatomically, the rotator cable is about 2.59 times thicker than the rotator crescent and provides a stress shielding effect to the thinner tissue of the rotator crescent, where the rotator cuff is inherently prone to tearing [56]. Being a critical structure in biomechanical functioning of the rotator cuff, there have been efforts to address this surgically during the repair of a torn rotator cuff tendon.

ACR with a long head of biceps tendon (LHBT) was described by Park et al. in 2018 [57]. The LHBT is a good graft option for several reasons. It has a proximal attachment on the glenoid, close to the native capsule, and does not require fixation of graft on to the glenoid. The LHBT is often tenotomized, and the proximal stump of tissue is discarded. Thus, it represents a local, expendable, and autologous source of tissue, obviating donor site morbidity as well as foreign body reaction and inflammation associated with nonautologous sources of tissue.

After arthroscopic evaluation of the LHBT, the subacromial space is entered using a standard posterior viewing portal and lateral working portal, and a tuberosity footprint is prepared. A posterolateral viewing portal is made at the posterior edge of a torn tendon in the subacromial space. A triple-loaded medial anchor is then placed at the anterior border of infraspinatus on the cartilage junction. A biceps tenodesis is performed at the site of this anchor. The arm is externally rotated to reduce the strain that may restrict the range of motion. One suture knot is made anterior and one posterior to the tendon and suture remnants after tenodesis as well. A pair of strands that have not been used are then passed through the rotator cuff tendon which are utilized for side-to-side repair over the tenodesis biceps tendon (**Figure 7**). A lateral anchor is then inserted where the anteriorly moved infraspinatus and distal portion of LHBT tendon can lie together. Each of the paired strands is passed through the LHBT and rotator cuff and tied. A biceps tenotomy is then performed (**Figure 7**) [58].

Biomechanically, this has been shown to decrease superior translation of the humeral head and normalize subacromial contact pressures without limiting the range of motion. Clinically, a level III retrospective study of 41 arthroscopic rotator cuff repairs with ACR and 84 without ACR in patients was performed in rotator cable deficient full-thickness supraspinatous tendon tear >2 cm. This demonstrated equivalent VAS, ASES, and ROM but statistically significantly improved acromiohumeral distance and retear rates (4.9% vs. 7.1%) at minimum follow-up of 12 months [58].

Multiple variations of ACR have been described such as a LHBT rerouting procedure [58, 59]. In this procedure, LHBT is mobilized from surrounding soft tissue. A groove is created more laterally on the tuberosity and biceps tenodesis performed in the rerouted position. The rotator cuff repair is completed with the LHBT interposed between the rotator cuff and humeral head (**Figure 7**) [60]. A case series of 80 patients with a large rotator cuff tear and a follow-up of 21 months demonstrated statistically significant improvement in ASES, Korean Shoulder Score, active ROM, and acromiohumeral distance compared with preoperative scores [60].

ACR is an emerging novel technique utilized with good success in a limited number of preliminary studies. There is an increasing level of interest in such techniques,

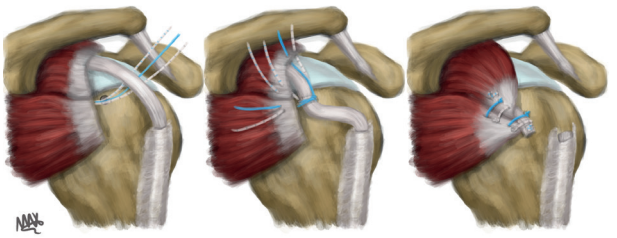

Figure 7.
Schematic depiction of ACR using long head of biceps autograft.

but higher-level comparative studies are lacking and are needed to define the role of ACR in irreparable rotator cuff tears (**Figure 7**).

7. Bursal acromial reconstruction

The evolution of arthroscopic techniques led to the creation of methods such as superior capsule reconstruction, which utilize allografts [61]. However, the SCR is time-consuming, potentially complex, and expensive. This led to the evolution of the BAR, a technique that provides an interposition allograft graft preventing contact between the humerus and acromion [62]. Potential advantage of BAR is lower cost, lower post-operative rehab demands, and anesthesia time compared with techniques such as SCR, tendon transfers, and reverse total shoulder arthroplasty.

Patients are prepared for the surgery by being placed in the beach chair position or the lateral decubitus, ensuring that the acromioclavicular joint (ACJ) is within the surgical field [62]. A bursectomy, minimal acromioplasty, and a lateral clavicle excision is performed with the intention of providing a flat surface for graft insertion and tying around the acromion [62]. The acromial surface area is then measured, and the allograft is trimmed to that measurement. A crossed suture tape configuration with a lasso-loop knot is then created at each corner by passing a high tensile nonabsorbable suture from corner to corner [62]. A suture tape retriever is then placed through the Neviaser portal, and a suture manipulator is placed through the mid-ACJ port [62]. The tape from the posteromedial graft corner is then introduced into a cannula and passed off to the retriever within the Neviaser portal. After insertion of the tape into the anteromedial corner of the graft in the subacromial space, the graft is passed into the waiting tape retriever within the ACJ portal. After all three sutures are inserted, the graft can now be inserted within the subacromial space. After insertion of the graft under the acromion, the three lateral sutures are to be passed via a needle in outside-in-technique [62]. After the passage of all six sutures in the bursa, the corresponding tails are then retrieved for tying [62].

BAR is best indicated for patients with complex rotator cuff tears who are older than 75 years of age and do not show any osteoarthritis [62]. While older

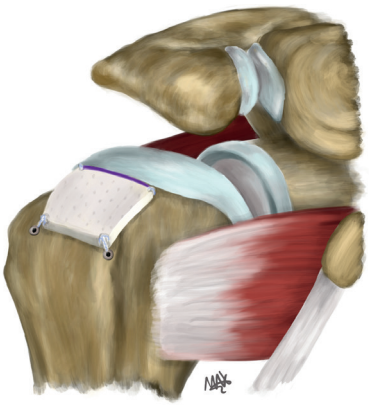

Figure 8.
Arthroscopic view of a dermal allograft affixed to the greater tuberosity.

osteoarthritic patients, or older patients with a torn rotator cuff typically undergo a RSA some can qualify to possibly undergo a BAR [63]. RSA has shown excellent clinical outcomes in patients who undergo the procedures, but not all patients who undergo an RSA may be good candidates [63, 64]. This can include comorbidities or desire to not undergo an arthroplasty [64]. In the case of irreparable rotator cuffs in the elderly, BAR can also be an alternative within those cases. With BAR being a very new procedure, little information on long-term patient outcomes is available. One study, however, released mid-term outcomes for patients undergoing BAR. Patients demonstrated significantly improved Western Ontario Rotator cuff score, and the disabilities of the arm, shoulder, and hand improved, with 92% and 74% of patients meeting clinical differences for the scores respectively (**Figure 8**) [65].

8. Biologic tuberoplasty: A novel option for massive irreparable rotator cuff tears in low-demand patients

For patients with significant comorbidities who are unable to undergo an extensive procedure to treat massive irreparable rotator cuff tears, surgical treatment options are limited. Biologic tuberoplasty is a novel procedure that provides a quicker, bone-sparing option for massive, irreparable rotator cuff tears in low-demand patients. Ideally, patients have little to no glenohumeral joint arthritis [66, 67]. Coverage of tuberosity with an acellular dermal allograft is thought to act as interpositional tissue and prevent bone-on-bone contact between the undersurface of the acromion and the tuberosity, leading to pain relief. The phenomenon of "biologic tuberoplasty" was first described by Mirzayan et al. They noted that patients who had undergone SCR, and had a graft failure, still had equivalent visual analog scale scores and functional outcome scores as patients with intact graft. It was postulated that the residual graft left on the greater tuberosity was preventing bone-on-bone contact with the acromion. In a case series study of 10 patients, there was a significant improvement in ASES, SANE, and VAS scores at a mean follow-up of 21 months with magnetic resonance imaging evidence of healed graft onto the tuberosity in all cases [68]. This novel technique does not, however, restore normal glenohumeral joint kinematics and is intended solely for pain relief. The clinical benefits of this novel technique have yet

to be proven with high-level comparative studies. Further comparative data is needed to understand short and long-term outcomes.

Advantages:

1. Lower cost relative to prosthetic replacement.

2. Decreased time under anesthesia for high-risk patients.

3. Avoidance of complications of prosthetic replacement.

4. Low-demand postoperative rehabilitation.

5. Does not increase the difficulty of prosthetic replacement at a later time.

Disadvantages/risks and/or limitations:

1. Cost of dermal allograft.

2. Use of implant, technical risk of foreign body reaction.

3. Does not restore normal glenohumeral joint kinematicsis intended solely as a pain reliever (**Figure 9**).

9. Platelet-rich plasma: An emerging supplementation in rotator cuff repair

The use of platelet-rich product (PRP) supplementation is a particular area of interest in orthopedic surgery. PRP is a biologically active concentrate produced by centrifuging of whole blood. PRP has been utilized in an attempt to improve biologic healing environment as a standalone treatment and adjunct supplementation at the time of rotator cuff repair surgery. Four types of PRP exist depending on preparation: pure platelet-rich plasma (P-PRP), leukocyte- and platelet-rich plasma (L-PRP), pure

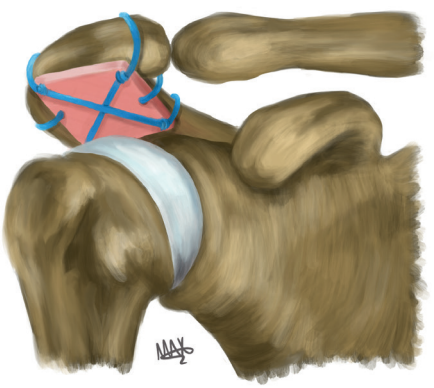

Figure 9.
Schematic of a BAR.

platelet-rich fibrin (P-PRF), and leukocyte- and platelet-rich fibrin (L-PRF) [69]. It contains numerous growth factors important for tissue repair and wound healing such as transforming growth factor B1, platelet-derived growth factor, vascular endothelial growth factor, epithelial growth factor, and insulin-like growth factors [70–72]. There have been extensive research on clinical utility of PRP at time of rotator cuff repair, with mixed results [73, 74]. Recent meta-analysis of randomized controlled trials by Ryan et al. in 2021. This study included 17 level I or II randomized controlled trials comparing 553 patients treated with PRP to 551 control patients with varying size and severity of rotator cuff tears [75]. This study demonstrated favorable results for using PRP in conjunction with rotator cuff repair with lower retear rates. It improved constant scores SST scores, and VAS scores compared to the control group, with P-PRP appearing to be the most effective formulation. Other biologics such as bone marrow aspirate concentrate and stem cells are under investigation; however, clinical data in the setting of rotator cuff repair surgery is lacking.

10. Conclusion

Despite arthroscopic rotator cuff repair being one of the most frequently performed orthopedic procedures, it carries a significant failure rate.

Recent research has focused on addressing both biological and structural concerns of repair, with the emergence of adjuvant repair techniques aimed at improving biology and novel structural techniques developed to augment or replicate the structural properties of rotator cuff. These techniques include biologic patch augmentation, subacromial balloon spacers, tendon transfers, SCR, ACR, BAR, and biologic tuberoplasty.

Further studies are needed to evaluate the efficacy and safety of these emerging techniques. However, the currently available clinical outcomes are encouraging, and these techniques hold great promise in improving the management of rotator cuff tears, especially in the setting of irreparable rotator cuff tears.

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