

Clinical Study

A Simplified Approach for Arthroscopic Repair of Rotator Cuff Tear with Dermal Patch Augmentation

Anthony C. Levenda and Natalie R. Sanders

Lakeshore Bone and Joint Institute, 601 Gateway Boulevard, Chesterton, IN 46304, USA

Correspondence should be addressed to Anthony C. Levenda; alevenda@yahoo.com

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Here, we describe an arthroscopic method specifically developed to augment rotator cuff repair using a flexible acellular dermal patch (ADP). In this method, an apparently complex technique is simplified by utilizing specific steps to augment a rotator cuff repair. In this method, using a revised arthroscopic technique, rotator cuff repair was performed. This technique allowed easy passage of the graft, excellent visualization, minimal soft tissue trauma, and full four-corner fixation of an ADP. Twelve patients underwent rotator cuff repair with augmentation using the combination of this method and ADP. Due to the technique and biomechanical characteristics of the material, the repairs have been stable and with high patient satisfaction.

1. Introduction

Rotator cuff tears primarily affect the older segment of the population which is increasingly growing in size and activity level [1]. It is estimated that more than 40% of those over 60 years of age suffer from a rotator cuff tear [2]. In treating this condition, it is estimated that, for 2010 in the United States alone, there were a total of 81,000 major (≥ 3 cm tear) rotator cuff repairs performed and 24,600 of these used some kind of augmentation [1]. By 2014, the number of major procedures is expected to rise to 109,100 [1]. For treatment, many patients with partial-thickness tears look first to noninvasive treatment options which can include icing the affected area and anti-inflammatory injections such as cortisone and physical therapy. If the injury does not heal, is painful, or is too severe (full-thickness, large, or massive tear), for those patients who wish to proceed with surgery and are willing to accept the risks and the demands of postoperative physical therapy, arthroscopic surgery can be advantageous. Since no two rotator cuff tears are alike, the way the tears are addressed is different for each case. Primary rotator cuff repair using standard arthroscopic technique is often not optimal in patients with large to massive tears [1]. In addition to the tear type, there are differences in tissue quality, patients' comorbidities (diabetic,

smoker, etc.), revision tears, and chronic tears. All of these factors must be taken into consideration when evaluating a patient for possible arthroscopic rotator cuff repair.

When surgery is indicated, large to massive rotator cuff tears may be augmented using a material with biomechanical integrity. Failed rotator cuff repairs can sometimes occur due to knot tying or anchor fixation; however, this should not be a concern for a skilled arthroscopist. Even for a skilled surgeon, challenges remain in repairing rotator cuffs arthroscopically. Several studies have shown high imaging test (MRI, ultrasound) failure rates for nonaugmented repairs with failure defined by a nonintact rotator cuff [3–5]. Recognizing this, surgeons choosing augmented repair with either an allograft, a xenograft, or a synthetic graft, over just sutures, made up about 30% of all major rotator cuff repairs in 2010 [1]. This percentage is estimated to increase to as much as 37% by 2014 [1]. One option for difficult repairs is augmentation with biological scaffolds.

Biological scaffolds commonly used to augment rotator cuff repair include xenografts and allografts. Common xenograft tissues are typically collagen-based sheets such as equine pericardium, bovine dermis, or porcine small intestinal submucosa. Repairs using xenografts counted for slightly less than half of all augmented repairs in 2010 [1]. The other

major category of biological scaffold augment material is decellularized human skin allografts which made up slightly more than half of the augmented repair market in 2010 and this number is expected to increase [1] as surgeons choose allografts over both xenografts and nonaugmented repairs. Decellularized human skin allografts have been used for a variety of medical procedures, primarily wound healing, soft tissue reconstruction, and sports medicine applications [6–24]. In theory, decellularization serves to remove potentially immunogenic material and also provides a clean scaffold for host cellular and vascular ingrowth [25]. Augmentation in repair of rotator cuff tears is among reported clinical applications for decellularized human dermis [9, 11, 13, 21, 24, 26]. During these procedures, the dermal matrix is typically used to augment a repair procedure in order to provide biomechanical strength and support directed healing.

Here, we describe arthroscopic rotator cuff augmentation using a method specifically tailored to the use of flexible of a human ADP.

2. Technique

The criteria used for selecting patients included patients with large to massive rotator cuff tears and those who needed revision repairs. Tears with poor tissue quality or having poor mobilization of tissue were prime candidates for augmented repair. Finally, patients who exhibited comorbidities such as smoking or diabetes could greatly benefit from ADP.

Patients consented to participation in the study and the surgical extremity was marked. Most patients received interscalene block in the preoperative area by an anesthesiologist. General anesthesia was induced and the patient was placed in the lateral decubitus position on a bean bag using an axillary roll and padding all bony prominences. The extremity was prepped and draped and the arm was placed in traction at 15 degrees of forward flexion and 60 degrees of abduction. A rolled towel was placed in the axillary pouch. Bony landmarks were outlined. A standard posterior portal was made and arthroscope was introduced. Intra-articular exam was performed and an anterior portal was made from an outside-in technique using a spinal needle. Any intra-articular pathology was addressed. The camera was then redirected to the subacromial space.

Once in the subacromial space, a spinal needle was introduced laterally for proper positioning of the lateral portal. Once in proper position, a stab incision was made and a complete bursectomy was performed using a shaver and electrocautery. If a subacromial decompression or distal clavicle extension was to be performed this was done at this time. Next, the rotator cuff was inspected by evaluating mobilization, size of tear, and tendon quality (Figure 1). If repairable, the footprint was prepared. Soft tissue releases (anterior and posterior slides) were performed if necessary. Next, Arthrex BioCorkscrews, double loaded (Arthrex, Naples, FL), were implanted at the edge of the articular surface (Figure 2). Visualization was from the lateral portal. Using Arthrex Lassos, Arthrex FiberWire (Arthrex, Naples, FL) was passed from the corkscrew through the rotator cuff

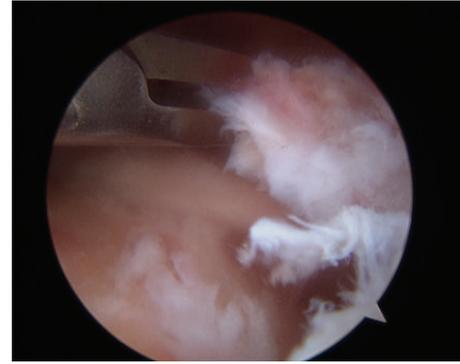


FIGURE 1: Identify rotator cuff tear pattern.

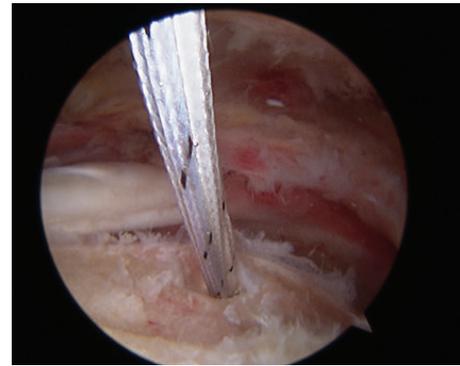


FIGURE 2: 5.5 BioCorkscrew anchor loaded with double FiberWire.



FIGURE 3: Pass sutures in mattress fashion through cuff utilizing Arthrex Lasso.

tear in a mattress type fashion carefully not to over-tension the repair (Figure 3). The sutures were tied arthroscopically and excess material was cut (Figure 4).

In patients with poor tissue quality, revision surgery, or combination of both, an allograft was used. Using a calibrated probe, the area that needs augmentation was measured. It is important to measure the area from anterior to posterior and from medial to lateral. A lateral cannula was placed at this point for suture management. Three FiberWires were placed medially to the sutures tied in the cuff repair. These should be placed in the anterior position, the midline position, and posterior position. This was done with an Arthrex Lasso.

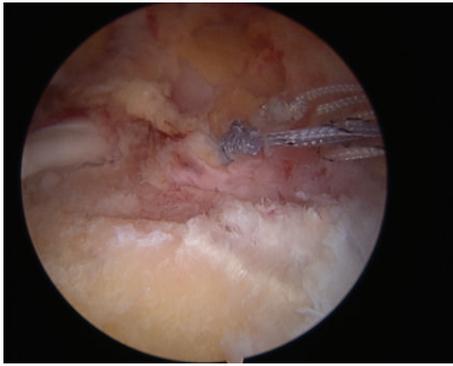


FIGURE 4: Repaired cuff to medial edge of footprint. As noted, entire footprint is prepared for placement of the ArthroFlex dermal patch.

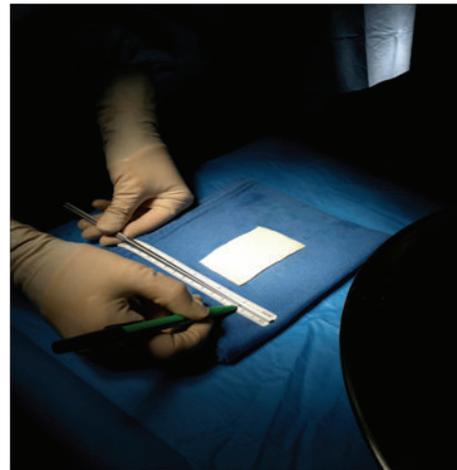


FIGURE 7: Arthroscopically the defect to be filled is measured with a probe. The measurements taken are anterior to posterior and medial to lateral.



FIGURE 5: Three medial FiberWires for the ADP are passed through lateral cannula. Cannula is used to keep sutures from crossing.



FIGURE 8: Two to three fiber cinches are placed on the lateral side for lateral fixation and stabilization.



FIGURE 6: With assistance, the sutures are kept separate as the cannula is removed.

The sutures were not tied. It is advisable to use alternating colored FiberWire to assist in suture management. The camera was placed in the posterior portal and the sutures were grasped individually through the lateral cannula using caution not to cross sutures. Then, they were tagged with hemostats (Figure 5). With assistance, the cannula was carefully removed while keeping the sutures separated (Figure 6). The graft passed easier through skin incision versus a cannula.

Once the cannula was removed and the sutures were kept separated and tagged, attention was turned to the graft. Using the measurements obtained, the ADP (ArthroFlex, LifeNet Health, Virginia Beach, VA) was prepared (Figure 7). The graft was slightly undersized due to the need to place tension on the graft during the augmentation. Next, three Arthroflex FiberLinks (Arthroflex, Naples, FL) were passed through the lateral edge of the graft (Figure 8). These were used for ease of graft passage and for double row fixation.

The graft was then placed on the arm laterally to the lateral portal with the correct side up. One arm of each suture previously passed through the cuff was then passed through the anterior, midline, and posterior sides of the graft (Figures 9 and 10).

The graft was carefully passed through the lateral incision alternating a knot pusher over each anterior and posterior suture as they were passed. A mulberry knot can be used on the medial midline suture to help advance the graft into position. During this step, an assistant held slight tension on the lateral Cinch sutures to aid in passing the graft (Figure 11). Once the graft was in position, the sutures were each tied medially (Figure 12). After the medial edge was down,



FIGURE 9: The three medial FiberWires are passed through the medial side of the ADP in a simple fashion.



FIGURE 10: All medial and lateral sutures were passed through ADP.

the graft was further stabilized with tension laterally in a double row fashion using a combination of the medial sutures and lateral FiberLinks.

Additional small stab incisions can be made laterally to obtain optimal points of fixation for the double row (Figures 13(a) and 13(b)). A spinal needle can be used to obtain these positions. It is easier to stabilize the midline lateral FiberLink first. The repair was then evaluated and additional fixation was performed as needed on the anterior and posterior edges using a lasso and additional free FiberWires to allow further tensioning (Figure 14).

The technique described allowed ease of passage of the graft, excellent visualization, and minimal soft tissue trauma. Generally, the only cannula utilized was the small orange cannula from Arthrex and only during suture management of the ADP.

Postoperative protocol was patient dependent but began with true protected passive ROM for the first 6–8 weeks. An abductor sling was worn for the first 6–8 weeks except for hygiene and therapy. At 6–8 weeks, general active motion was started. Resistance or strengthening was not begun until the fourth month.

3. Results

Thus far, ADP has been used in 12 patients with 2–4 cm tears using the technique described here (Table 1). The patients ranged in age from 52 to 71 years with a mean age of 61.8



FIGURE 11: Utilizing a knot pusher and viewing arthroscopically the graft is passed into the subacromial space. Note the tension placed by the assistant on the lateral sutures. The knot pusher is alternated on the medial fiberwire sutures passing through the graft.



FIGURE 12: The three medial FiberWire sutures are tied arthroscopically to stabilize the graft.

years and had an equal male to female ratio. Two patients had type II diabetes and one patient had type I diabetes. Three of the patients presented with revision tears, unrelated to the augment patch.

Patients were evaluated at 2 weeks, 6 weeks, 12 weeks, 16 weeks, 6 months, and 1 year following the procedure. Patients showed both an increased range of motion and increased strength. They also experienced a significant decrease in pain when graded on the VAS Numeric Pain Distress Scale. The preoperative average score of 9 was greatly reduced to a postoperative average of 3 following surgery using this technique. The results of several studies [13, 21, 26] have suggested the clinical outcomes of rotator cuff repairs might not be dependent or even correlated with cuff integrity determined by MRI. In light of these findings, the additional expense of MRI scanning was deemed unnecessary if the patient demonstrated clinical success, pain relief, and satisfaction with the repair.

As a case example, a 66-year-old female underwent primary arthroscopic rotator cuff repair without ADP augmentation in June, 2011. She had an uneventful postoperative course for 6 weeks and then she sustained a fall. She then began to have increased pain in her shoulder. A repeated MRI without contrast revealed re-tear of rotator cuff

TABLE 1: Patient demographics and outcomes.

Patient	Age y.o.	Gender	Present w/revision	Tear size (cm)	Pre-op VAS*	Post-op VAS	Increase in strength	Successful repair
1	58	M	No	4 × 4	7	0	Yes	Yes
2	66	F	Yes	3 × 2	10	2	Yes	Yes
3	52	F	Yes	2.5 × 3	10	5	Yes	Yes
4	59	F	No	2 × 2	8	2	Yes	Yes
5	71	F	No	3 × 3	8	4	Yes	Yes
6	55	M	No	3 × 3	10	4	Yes	Yes
7	67	M	No	2.7 × 2.7	10	5	Yes	Yes
8	67	F	No	2 × 2	9	1	Yes	Yes
9	57	M	Yes	3 × 3	7	0	Yes	Yes
10	67	M	No	2 × 2	10	2	Yes	Yes
11	62	F	No	2.5 × 2.5	10	0	Yes	Yes
12	62	M	No	2 × 3	9	2	Yes	Yes

*Visual Analog Numeric Pain Distress Scale.

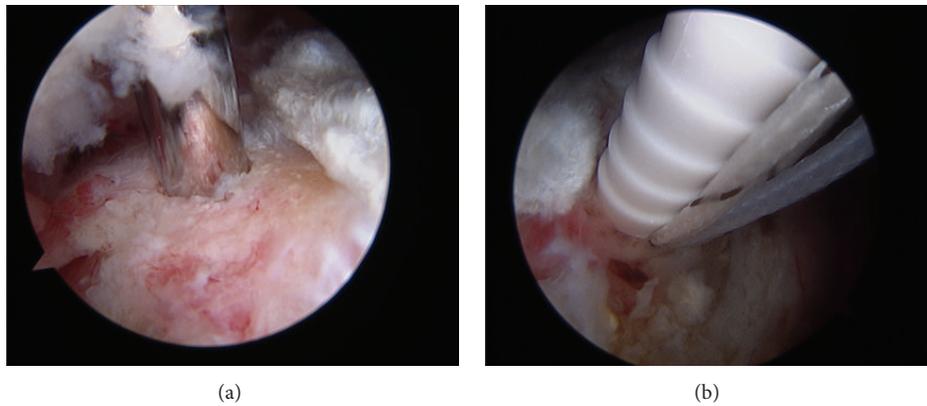


FIGURE 13: (a) Push locks are used laterally to perform a double row repair and stabilize the graft laterally. (b) Push lock is used laterally for double row fixation.



FIGURE 14: Final repair viewed from lateral portal.

(Figure 15(a)). She went on to have an arthroscopic revision rotator cuff repair augmented with the allograft. Another MRI was ordered seven months after operation which demonstrated healed rotator cuff repair with ADP augmentation (Figure 15(b)).

There were no complications due to infection, adhesions, or neurological injuries. However, two failures of ADP

augmentation occurred due to postoperative falls resulting in retear of their rotator cuff. Both patients went on to have reverse total shoulder arthroplasty. Of note, during reverse total shoulder arthroplasty the graft and tissue were evaluated. The retear had occurred medial to the graft. The graft and the footprint were intact.

4. Discussion

Using this simplified approach to graft augmentation of arthroscopic rotator cuff repair has resulted in high quality surgical fixation. This is in large part due to the improved visualization for graft augmentation, when compared to a mini-open technique, as well as the ease of ADP handling and the favorable biomechanical characteristics of the graft. The advantage of improved visualization from using an arthroscopic technique may be offset by the benefit of a potentially stronger fixation at the suture-tendon interface provided by a mini-open or open repair [3, 26]. However, the use of an allograft to augment the arthroscopic repair can increase the strength of the suture-tendon interface, thus minimizing the advantage of an open repair, while also benefitting

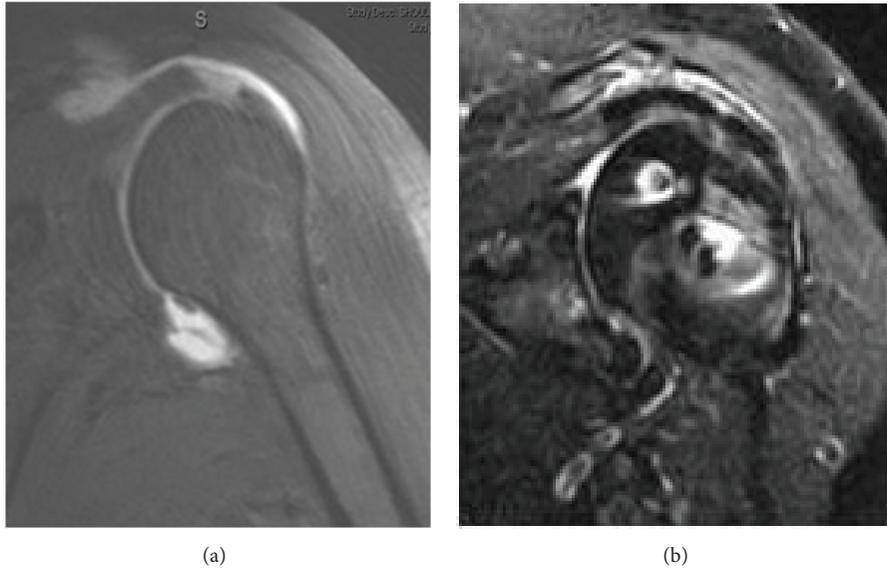


FIGURE 15: Retear rotator cuff two months after original repair (a) and seven months after RCR with ADP augmentation (b).

the patient with decreased wound morbidity and pain. Using our arthroscopic method, follow-up through one year after operation has demonstrated high patient satisfaction. The ADP was very manageable to use in performing arthroscopic graft augmentation despite the average graft size being 3 cm by 3 cm. In addition, the graft exhibited superior strength since it did not tear and resisted pull out with tension of the sutures. However, these clinical results should be considered with the limitations of an informal case series. Our intent was to focus on this innovative augmentation technique and we only provided the initial clinical results as an interest of note.

5. Conclusion

This surgical technique demonstrates a new method to arthroscopically augment a standard rotator cuff repair with a graft which is provided ready to use. Patients exhibited a significant decrease in postoperative pain. While further long-term study and the larger patient base are necessary to have significance, these short-term results demonstrate favorable outcomes especially in patients with an increased risk of failure.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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