Technical Note

Rotator Cuff Repair Augmented With a Reinforced Bioabsorbable Autobiologic Matrix

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Abstract: Rotator cuff tears are one of the most common shoulder pathologies in the adult population, present in approximately 25% of individuals in their 60s and 50% in individuals in their 80s. With several techniques and technological advances in repairing symptomatic rotator cuff tears, the rate of retear rates remains elevated. Synthetic grafts have been developed to aid with rotator cuff repair by providing biomechanical advantage, improved healing at bone tendon interface, while also remaining a cost-effective option when compared with costly revision rates. BioCharge Autobiologic Matrix is a synthetic scaffold approved by the Food and Drug Administration and developed to augment rotator cuff repairs by improving the ultimate load to failure rate while also providing improved enthesis architecture at the tendon-bone interface when observed at a microscopic level. The goal of this Technical Note is to describe the technique of rotator cuff repair with BioCharge augmentation.

Rotator cuff tears are one of the most common shoulder pathologies in the adult population, seen in approximately 25% of individuals in their 60s and 50% in individuals in their 80s.[1] Although tears can present as asymptomatic, approximately 50% of patients older than 65 years of age can have a contralateral symptomatic tear. Asymptomatic tears can progress to symptomatic in 2 to 3 years.[1] Rotator cuff repair has become the standard of care in full-thickness symptomatic tears and tears that are unresponsive to nonoperative management. However, retear rates remain elevated—between 20% and 90%—depending on the size of the tear and the technique used in the repair.[2] Synthetic grafts have been developed to aid in the management of rotator cuff repairs. These grafts have been shown to have similar maximal load to failure and stiffness as the rotator cuff tendon.[3,4] By augmenting rotator cuff repairs with synthetic grafts, this provides a biomechanical advantage by increasing the ultimate load to failure.[4]

The BioCharge Autobiologic Matrix (Atreon Orthopedics, Dublin, OH) is a synthetic scaffold approved by the Food and Drug Administration and developed to be used in conjunction with suture anchors to help healing of rotator cuff repairs on the bursal side by hindering suture cut-out while improving tissue quality. This synthetic scaffold improves the ultimate load to failure rate while providing improved enthesis architecture at the tendon-bone interface when observed at a microscopic level.[5] The BioCharge Autobiologic Matrix graft provides an alternative solution to rotator cuff repair augmentation with promising results. The purpose of this Technical Note is to describe our technique for using this synthetic scaffold on the bursal aspect of the rotator cuff in the setting of arthroscopic rotator cuff repair.

Surgical Technique

This technique is performed with the patient under general anesthesia, positioned in the beach-chair position; however, this can be performed in the lateral position as well. Before the procedure, our patients receive an interscalene block by the Department of Anesthesia.

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Standard arthroscopic portals are marked with the patient in the beach-chair position. The shoulder joint is first accessed through the posterior portal, and a standard diagnostic arthroscopy is performed by visualizing the Southern California Orthopedic Institute 15-point system.[6] Pathology within the glenohumeral joint is addressed at the surgeon's discretion. Next, the subacromial space is entered where appropriate bursectomy and subacromial decompression is performed, allowing for visualization of the supraspinatus and infraspinatus tendons and their tear pattern. The rotator cuff footprint is prepared with a shaver until adequate bone bleeding is achieved as shown in Figure 1. Next, one double-loaded medial-row anchor is placed, and the 4 suture limbs are independently passed using a suture passer through the torn tendon. The suture limbs are then tied in a horizontal mattress fashion using a modified SMC knot, followed by alternating half-hitches, on the basis of the preference of the surgeon. Similarly, the technique can be applied to knotless suture anchors, as demonstrated in Video 1. Once the rotator cuff footprint is prepared, 2 medial-row knotless suture anchors are deployed in the posteromedial and anteromedial area. These are passed sequentially with a suture passer, EXPRESSEW (DePuy Mitek, Raynham, MA), through the rotator cuff to establish the medial row. The knotless suture mechanism does not require tying knots to the medial row.

Rotator Cuff Repair With Augment

Once the medial row is established and passed through the tendon, the anterior suture limb from the anteromedial row is loaded into the snare of the BioCharge suture tunnel. This same step can also be completed with a knotless construct. The BioCharge is then introduced into the shoulder by sliding it down through the cannula with a knot pusher or arthroscopic grasper (Arthrex, Naples, FL). It can be manipulated if necessary to make sure it lays flat on the rotator cuff using an arthroscopic grasper. A suture bridge technique is then used to establish the first anterolateral row using a lateral anchor. These steps are demonstrated sequentially in Figure 2. Next, another BioCharge augment is loaded in a similar fashion on the posterior suture limb. The BioCharge is again introduced inside the shoulder through the cannula and then laid flat on the rotator cuff and the posterolateral row is then established. The rotator cuff is now repaired with a double-row suture bridge technique with BioCharge augment, which allows for increase in the footprint and compression of the rotator cuff repair in addition to wicking the local biology to the implant. Pearls and pitfalls of this technique are demonstrated in Table 1, and advantages and disadvantages are listed in Table 2.

Discussion

The prevalence of rotator cuff pathology has compelled orthopaedic surgeons to develop several arthroscopic techniques for rotator cuff repair. However, high retear rates and variable healing potential of the repairs remain a challenge to achieving successful patient outcomes, especially in larger rotator

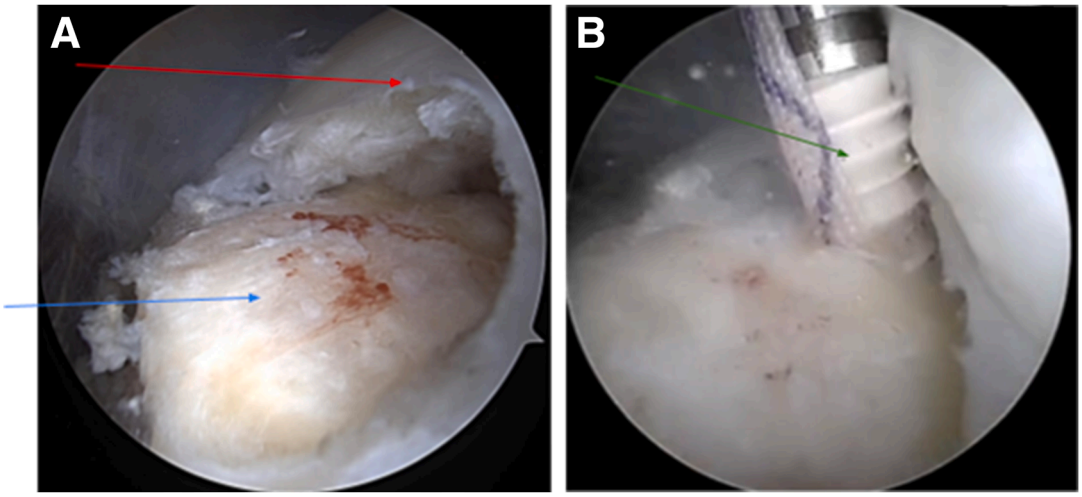

Fig 1. Intraoperative photo from the posterior arthroscopic portal demonstrating the rotator cuff tear pattern (red arrow) after bursal debridement, decompression, and supraspinatus footprint preparation with a burr until subchondral bleeding is visualized on the humerus (blue arrow) (A). The medial row (green arrow) is established with preloaded sutures as shown in the intraoperative image on the right (B). The medial row can be established with a double loaded suture anchor or with 2 knotless suture anchors as demonstrated in Video 1. The patient is positioned supine in a beach-chair position approaching the left shoulder. Standard and accessory arthroscopic portals are used as determined by surgeon preferences.

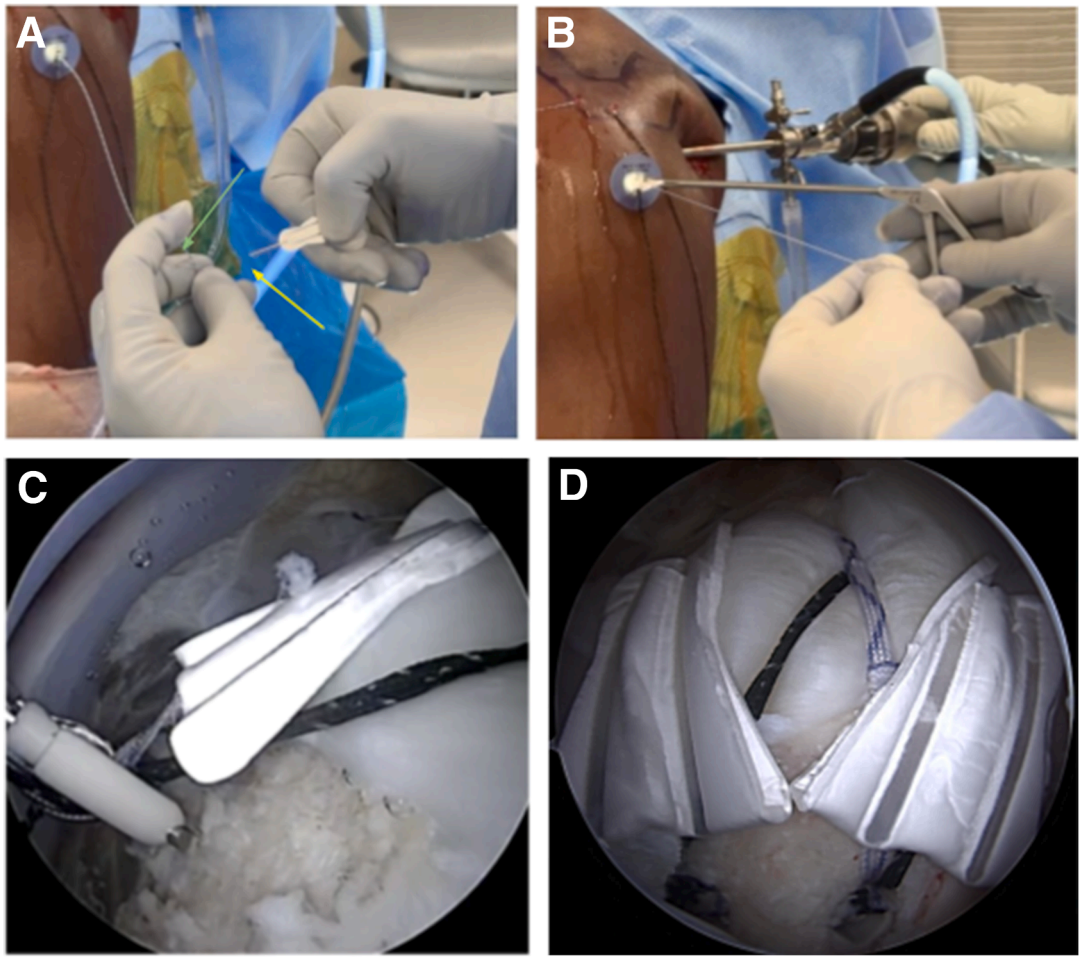

Fig 2. The posterior suture limb (green arrow) is loaded onto the snare of the BioCharge (yellow arrow) (A) and an arthroscopic grasper is used to slide the BioCharge down the suture limb through the portal (B). The BioCharge is then laid flat onto the rotator cuff using appropriate tension on the suture limb and using the grasper to lay it flat. Next, the suture limb with the BioCharge and another suture limb from the anteromedial row is then loaded onto an anchor and the posterolateral row is then established (C). These steps are repeated again, where the BioCharge is loaded onto a suture limb from the anteromedial row and the anterolateral row is established to create a rotator cuff repair in SpeedBridge (Arthrex) technique with BioCharge scaffold augmentation (D). Patient positioned on a beach chair approaching the left shoulder.

cuff tears. The retear rates can be multifactorial, depending on the size of the tear, patient age, muscle atrophy, muscle fatty degeneration, and chronicity.[7] Moreover, one study found that the failure of the repair tends to occur during the first 12 weeks post-operatively in approximately 80% of patients, which correlates to the timeline established by multiple studies in which repair failure occurs by 3 to 6 months postoperatively.[8]

To mitigate these challenges, there has been an increased propensity for rotator cuff repair with augmentation. In a systematic review, Ferguson et al.[9] analyzed several studies exploring the augmentation of rotator cuff repairs with allograft, xenograft, and

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Make sure to take "deep bites" with the suture passer in order for the augment to lay on the rotator cuff.	Ensure that the graft passes freely through the cannula and avoid any wrinkling of the graft.
Take into consideration the graft measures 1.2 cm width by 2 cm in length.	
Lay the graft flat on each limb over the rotator cuff before establishing the lateral row.	Avoid passing the sutures too close to the edge of the tear.

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Simple and replicable technique.	No comparison with rotator cuff repair alone in RCTs.
Fully synthetic graft resorbed in 4-6 months.	Lack of long term outcomes when compared with other synthetic grafts.
Low-profile graft: 1.7 mm thickness.	
Improved biological healing at bone-tendon interface.	

RCT, randomized controlled trial.

synthetic grafts. In this review, they found that augmentation with allograft or synthetic graft showed lower retear rates and promising results when compared with xenografts, which showed inferior outcomes and greater retear rates. Similarly, Imbergamo et al.[10] reported in a meta-analysis that rotator cuff repair with graft augmentation in cadaveric studies significantly increased ultimate load to failure with no influence on gap formation or stiffness. In addition, Ciampi et al.[7] found that the augmentation of rotator cuff repairs with synthetic graft significantly improved the 36-month outcome in terms of function, strength, and retear rate.

In addition to clinical benefits, it is essential to assess the cost-effectiveness of graft augmentation and its long-term financial impact on both the health care system and patient outcomes. In the United States, failed rotator cuff repairs are estimated at roughly $200 million annually, with direct and indirect costs included.[11,12] These costs primarily arise from revision surgeries, extended rehabilitation, and subsequent procedures such as the conversion to arthroplasty. Initial rotator cuff repairs in the United States are approximately $7,500 to $13,000, whereas revision procedures—including office visits, physical therapy, imaging and prolonged recovery—have a price ranging from $7,500 to $13,600, increasing the cost burden.[11] Cuff augmentation, however, reduces rates of tears by approximately 17.8%, leading to reduced postoperative costs.[11-13] Quigley et al.[12] conducted a decision tree analysis and concluded that the use of extracellular matrix augmentation during primary repair was cost-effective, with an incremental cost-effectiveness ratio of $14,000, assuming an institutional graft cost of $3,500. On the basis of previous studies, interventions are considered cost-effective if its incremental cost-effectiveness ratio is less than $50,000 per quality-adjusted life year.[12-14] Ultimately, graft augmentation has shown to not only improve clinical outcomes but also is cost-effective by reducing retear rates and minimizing the need for costly revisions or arthroplasty.

The Rotium BioCharge Autobiologic Matrix was developed to address these concerns by providing an alternative solution to rotator cuff repair augmentation. It is composed of poly glycolic acid and poly lactide co-caprolactone microfiber matrix. The poly glycolic acid is degradable within the first several days of implantation and allows for a prohealing response instead of a fibrotic scar formation.[5] The poly lactide co-caprolactone has a longer resorption time and acts as a scaffold during the repair process by transitioning mechanical forces to the newly deposited tissue.[5] This autobiologic matrix is replaced with neonative tissue in 3 to 4 months, which creates a final appearance similar to the collagen-based extracellular matrix. Figure 3 demonstrates an ultrasound scan of the rotator cuff repair with BioCharge, which is almost fully absorbed at 4 months postoperatively. This will ultimately aid in increasing the repair footprint, providing additional support to the repair site at the tendon-bone interface while also mitigating the acute postoperative inflammatory response.

In addition to similarities in biomechanical properties between synthetic grafts and rotator cuff tendons, synthetic grafts provide a lower risk for disease transmission to the host, graft rejection, or acute inflammatory reactions.[15] However, there is still limited information regarding the type of synthetic graft while

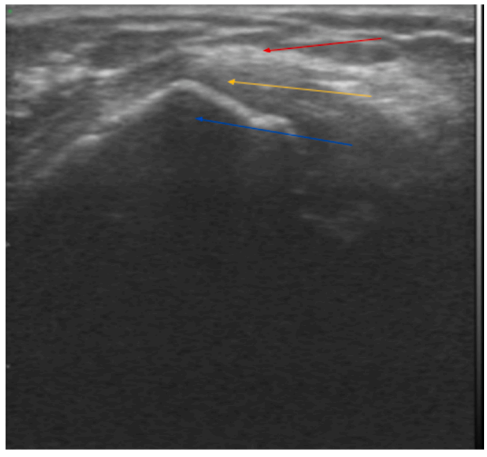

Fig 3. Postoperative ultrasound scan of the rotator cuff tear repaired with BioCharge augmentation. This was obtained in the office at the 4 month postoperative visit using an ultrasound view from the lateral aspect of the left shoulder. The BioCharge scaffold appears to be almost fully reabsorbed (red arrow). The rotator cuff repair appears to be intact and fully healed (yellow arrow) as visualized by the continuous rotator cuff fibers inserting onto the footprint of the humeral head (blue arrow).

considering other graft options. Besides the advantages of synthetic grafts, there are no established guidelines when to consider the use of grafts in rotator cuff repair. The use of grafts remains at the surgeon's discretion and their relevant experience. In addition, the surgeon should remain aware of the cost-effectiveness when choosing primary repair versus repair with augmentation of any graft type. The BioCharge Autobiologic Matrix is a viable option for rotator cuff repair augmentation with a user-friendly technique and promising results.

Disclosures

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: B.L.B. reports consulting or advisory and equity or stocks from Enovis Corporation and Atreon Orthopedics; consulting or advisory and funding grants from Anika Therapeutics; consulting or advisory with Tigon Medical; and funding grants from Zimmer Biomet. D.M. reports consulting or advisory and funding grants from Stryker Orthopaedics and consulting or advisory with Atreon Orthopedics. S. K.B. reports consulting or advisory with Johnson and Johnson, Shoulder Innovations, ConMed Corporation, Stryker Orthopaedics, Smith & Nephew, Bard, and Pacira BioSciences; consulting or advisory and equity or stocks from with Atreon Orthopedics, Kaliber Labs, Precision OS, Suture Tech, and Sparta Biomedical; and equity or stocks from Trice Medical and Ocean Orthopedics. All other authors (R.D., S.L., B.G.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Video 1. Rotator cuff repair augmented with BioCharge Autobiologic Matrix. Arthroscopy is performed with the patient in the beach-chair position and using standard arthroscopic portals in the left shoulder. Subacromial decompression and the rotator cuff footprint is prepared with a shaver until bleeding bone is visualized. Two medial-row anchors are placed and sutures are passed through the rotator cuff. The anterior suture limb of the anteromedial anchor is loaded onto the snare of the BioCharge, and it is passed through the portal using an arthroscopic grasper until it is laid flat onto the rotator cuff. The most anterior suture limb from the posteromedial anchor and the BioCharge suture limb are then loaded onto an anchor and the anterolateral row is established. These steps are repeated again loading the BioCharge on the posterior suture limb from the posteromedial anchor, which is then loaded with the remaining suture from the anteromedial row onto an anchor to establish the posterolateral row. The final repair demonstrates double-row rotator cuff repair with BioCharge augmentation on the bursal surface of the rotator cuff.