Technical Note

Arthroscopic Rotator Cuff Repair Technique Using a Bio-Composite Scaffold for Tissue Augmentation

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Abstract: The use of biologics and rotator cuff augmentation have seen significant growth in interest to combat complications of rotator cuff retear after arthroscopic rotator cuff repair. Bio-inductive implants are used to induce new tissue formation; however, they lack structural strength at the time of implantation. Conversely, dermal allografts are used to provide structural strength at implantation, but they do not allow for sufficient tissue incorporation and carry inherent risks of allograft tissue. The BioBrace™ (Biorez, New Haven, CT) is a bio-inductive scaffold composed of highly porous type I collagen and bio-resorbable poly (L-lactide) microfilaments developed to combat the latter drawbacks. The unique bio-composite properties provide the ability to combine the benefits of bio-induction and strength into a single implant. We propose a successful, reproducible technique for the implantation of BioBrace for rotator cuff augmentation.

Rotator cuff tears often occur as a result of repetitive use and wear, with an increasing prevalence as patients age. Although some patients are asymptomatic, many symptomatic full-thickness tears often require surgical repair.[1] Rotator cuff repairs (RCRs) are among the most common arthroscopic orthopedic procedures performed worldwide, with an annual incidence >460,000 per year.[1] The aim of an RCR is to re-attach the injured tendon back to its native footprint to restore dynamic stability and function. Despite operative fixation, it is not uncommon for patients to experience a retear. It has been well reported in the literature that the most common mechanism for RCR failure is suture "pull-through" at the suture–tendon interface. As a result, the use of biologics and rotator cuff augmentations have seen significant growth in interest to combat this complication.

The use of a type I bovine, bio-inductive implant has shown promising results in both partial- and full-thickness rotator cuff repairs through the induction of new tendon-like tissue.[2,3] Although they are biologically successful at the induction of new tissue, bio-inductive implants lacks structural strength, which is integral at time 0 of implantation to provide additional strength to the repair. Conversely, dermal allografts (acellular dermal matrices [ADMs]), when used to reinforce rotator cuff repairs, increase the load to failure across the construct at time 0 of implantation, but drawbacks exist, including increased time to tissue incorporation, cost, technical difficulty with implantation, and the inherent risks of allograft tissue.[4]

The BioBrace™ (Biorez, New Haven, CT) is a bio-inductive scaffold composed of highly porous type I collagen and bio-resorbable poly (L-lactide) (PLLA) microfilaments developed to combat the latter drawbacks. The unique bio-composite properties provide the ability to combine the benefits of biology and strength into a single implant (Fig. 1). The bio-inductive scaffold allows for induction, maturation, and remodeling of new host tissue while providing load sharing strength (141 N) at time 0 of implantation.[5] The structural integrity of the scaffold can act as rebar for the sutures to prevent suture-tendon pull-through. These characteristics may lend

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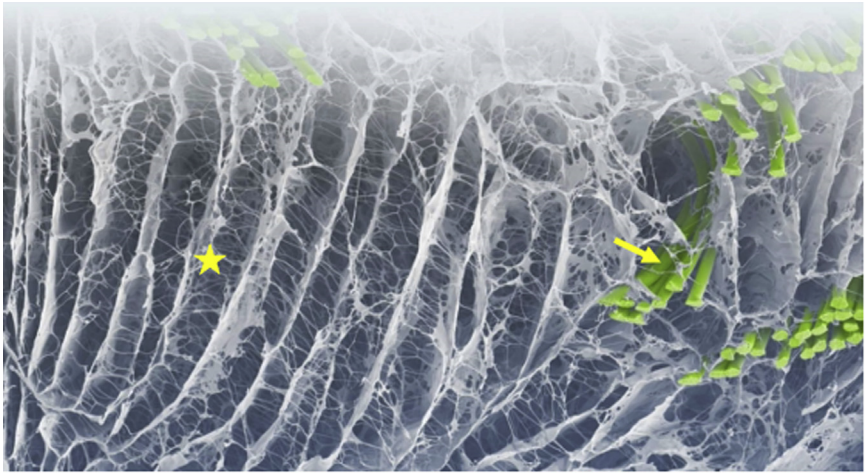

Fig 1. Microscope view of the BioBrace bio-composite scaffold, demonstrating 80% porous (star) with poly (L-lactide) microfilament reinforcement (arrow) to allow for induction of host tissue, maturation, and strength.

themselves to enhanced healing incorporation for the graft and repair while decreasing the risk of native suture–tendon failure. In turn, potentially, this can lead to enhanced rehabilitation protocols and decreased failures.[4] The aim of this article is to propose a reproducible, successful technique for the implantation of the BioBrace bio-composite scaffold for rotator cuff augmentation.

Surgical Technique

Our surgical technique uses the BioBrace bioinductive scaffold from Biorez for augmentation during RCR. Indications and contraindications for the use of BioBrace in RCR augmentation are outlined in Table 1.

We prefer to use an interscalene nerve block in the patient, followed by general anesthesia. The procedure can be performed with the patient in the beach-chair or lateral decubitus position. We prefer the lateral decubitus position with an axillary roll placed under the contralateral axilla. The operative extremity is attached to a 10-lb. (4.5-kg) weight for balanced suspension with the arm in flexion and abduction. The operative extremity is then prepped and draped in a sterile manner.

Viewing through a standard posterior portal and working through a high rotator interval portal, the surgeon performs a systematic standard diagnostic arthroscopy. The articular rotator cuff is carefully inspected. Tendon fraying may be debrided with a mechanical shaver. Mechanical shaving or electrocautery may be used to perform a lysis of adhesions of the rotator interval if clinically warranted. The arthroscope is then redirected to the subacromial space, and preparation of the specialized portion of the case may begin (Video 1).

Subacromial Space Preparation and Inspection of Rotator Cuff

1. A lateral portal is established, and a thorough bursectomy is performed to enhance visualization.
2. An acromioplasty may be performed as needed.
3. Inspection of the rotator cuff is performed to determine tissue quality and mobility and to measure the rotator cuff defect.

Preparation of BioBrace Bio-Composite Scaffold

1. Once the decision is made to use the BioBrace bio-composite scaffold, it is prepared on the back table.
2. The BioBrace can be trimmed if needed to allow for appropriate rotator cuff coverage based on measurements obtained during inspection.
3. The BioBrace is marked with a sterile marking pen to assist in orientation of the anterior/posterior and medial/lateral aspects (Fig. 2).
4. The BioBrace is then hydrated with 5cc of autologous blood, autologous platelet-rich plasma (PRP), autologous bone marrow aspirate concentrate (BMAC), or sterile saline (Fig. 3).

Table 1. Indications and contraindications

Indications
• Revision full-thickness rotator cuff repair
• Large (>3 cm) rotator cuff tear
• Massive (>5 cm) rotator cuff tear
• Chronic full-thickness rotator cuff tear with Goutier classification grade 3 or 4 fatty infiltration
• Full-thickness rotator cuff tear in patients with multiple medical comorbidities (smoking, diabetes, etc.)
Contraindications
• Replacement of acellular dermal matrix sheet in superior capsular reconstructions

Fig 2. BioBrace marked with marking pen to allow for proper orientation during arthroscopic placement.

5. Once the BioBrace is prepared, it will remain soaking in the liquid medium of choice while attention turns to preparing the rotator cuff.

Preparation of Rotator Cuff and Greater Tuberosity

1. A straight basket is used to debride the edges of the rotator cuff to remove atrophic tissue and maximize tissue-to-bone healing.
2. Shaving and electrocautery may be used to perform a more thorough rotator interval release and free soft tissue as needed for better excursion of the rotator cuff.

Fig 3. BioBrace hydrated with autologous blood.

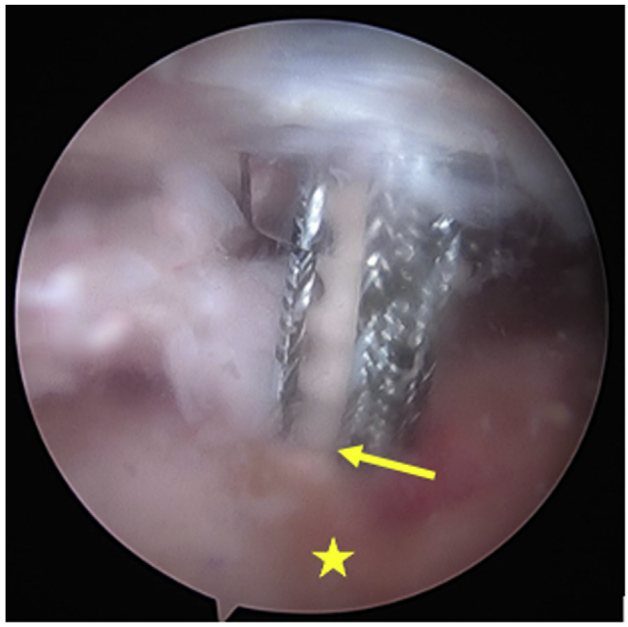

Fig 4. Posterior portal visualization of the medial margin of the greater tuberosity (star) within the subacromial space, demonstrating a 4.75-mm anchor equipped with self-tensioning tapes and standard #2 sutures being anchored into place (arrow).

3. A high-speed bur is used to decorticate the greater tuberosity to facilitate tissue-to-bone healing.

Double-Row Rotator Cuff Repair with Preparation of Sutures for Scaffold Fixation

1. Two separate 4.75-mm anchors, each equipped with self-tensioning tapes and standard #2 sutures, are placed percutaneously along the medial margin of the greater tuberosity (Fig. 4).
2. Both limbs of tape of the anterior anchor are passed up, as a unit, through the rotator cuff using a looped suture passer and a passing gun (e.g., EXPRESSEW®, SCORPION™).
3. The previous step is then repeated for both limbs of tape of the posterior anchor.
4. Attention turns to preparation of #2 sutures for the BioBrace.
5. Two of the sutures on the anterior anchor are individually passed through the rotator cuff, posterior to the anterior anchor tapes.
6. Two of the sutures on the posterior anchor are individually passed through the rotator cuff, anterior to the posterior anchor tapes.
7. All 4 limbs of the sutures are visually confirmed to be evenly spaced between the anterior and posterior anchor tapes.
8. Using a rotator cuff grasper to reduce the tendon, the anterior two sutures are tied down together for

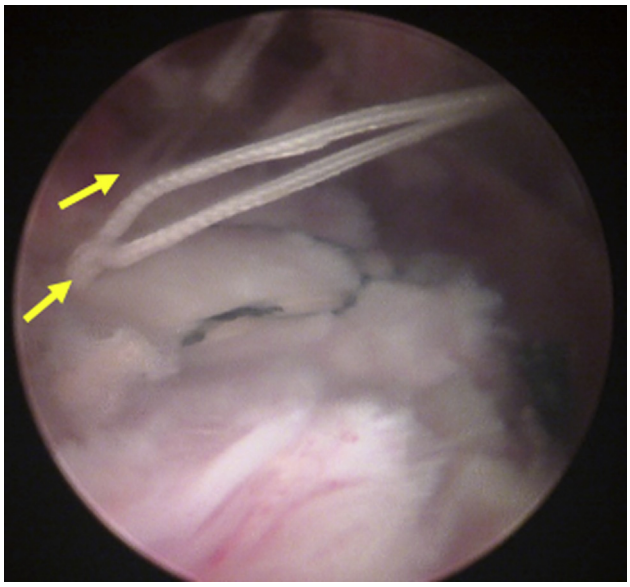

Fig 5. Posterior portal visualization of #2 FiberWire sutures being tied down for medial compression (arrows) and saved for later during passage of BioBrace.

medial compression and saved for later passage through the BioBrace (Fig. 5).

9. The previous step is then repeated for the posterior two sutures.
10. Attention turns back to the anchor tapes to achieve the double-row rotator cuff repair.
11. One limb on the anterior tape and 1 limb of the posterior tape are brought laterally to the articular margin in a criss-cross configuration and secured using a 5.5-mm anchor in a Suture-Bridge manner.
12. The previous step is then repeated for the other anterior tape and other posterior tape, completing the double-row repair.

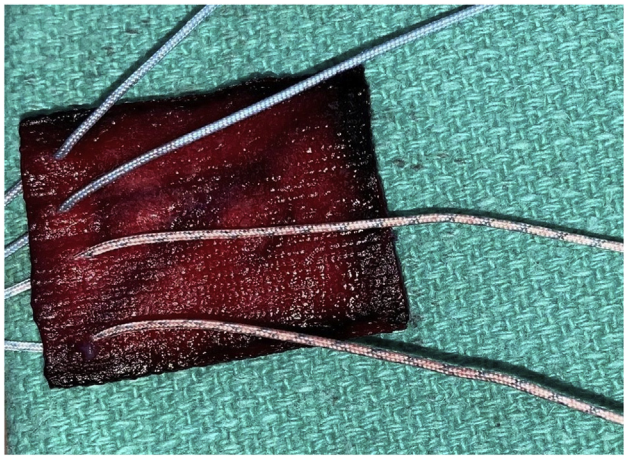

Fig 6. All four #2 sutures evenly passed along the medial margin of BioBrace, outside of the body.

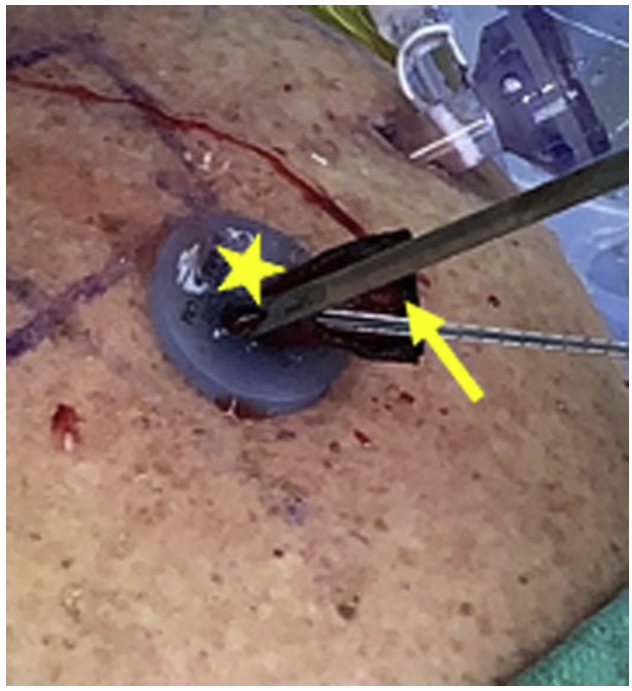

Fig 7. The BioBrace (arrow) is shuttled into the subacromial space with a standard non-traumatic rotator cuff grasper (star) via a lateral portal.

Incorporation of BioBrace

1. The four #2 sutures are brought outside the body, laterally, through the lateral portal. The authors use a 10- or 12-mm PassPort cannula to facilitate graft entry without damaging the implant. A 4-quadrant cannula divider is recommended for suture management through the lateral portal.
2. Each suture is evenly passed along the medial margin of the BioBrace, outside of the body, with passing guns or a simple 18G spinal needle and passing wire (CHIA®) to facilitate suture passage through the scaffold (Fig. 6).
3. The cannula divider is removed, and the BioBrace is shuttled into the subacromial space by using a "back grasper" or any standard nontraumatic rotator cuff grasper, with special attention paid to suture management to ensure the BioBrace and sutures are correctly oriented (Figs. 7 and 8).
4. The 2 limbs of the anterior sutures going through the BioBrace are tied down for compression and medial stability with a simple double half-hitch.
5. The previous step is then repeated for the 2 limbs of the posterior sutures going through the BioBrace.
6. One limb of the anterior suture and 1 limb of the posterior suture are then brought out laterally in a criss-cross configuration and secured to a third row using a 2.9-mm knotless anchor in a Suture-Bridge manner. Care is taken to ensure this is not over-tensioned (Fig. 9).

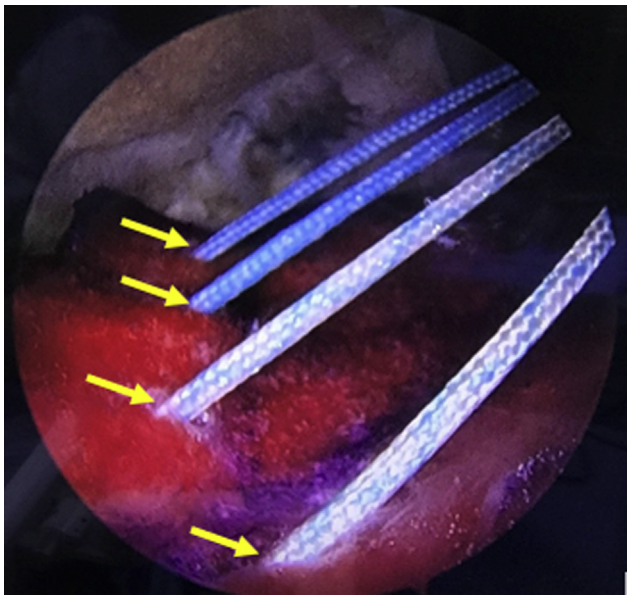

Fig 8. Arthroscopic confirmation via posterior portal that the BioBrace is properly shuttled into the subacromial space with no tangles in the #2 suture (arrows).

7. The previous step is then repeated for the other remaining 2 sutures, completing the triple-row repair.
8. A final survey of the BioBrace is completed with the arthroscopic camera via the anterior and lateral portals to ensure adequate range of motion, proper scaffold placement, and that all edges of the scaffold are properly secured (Fig. 10).

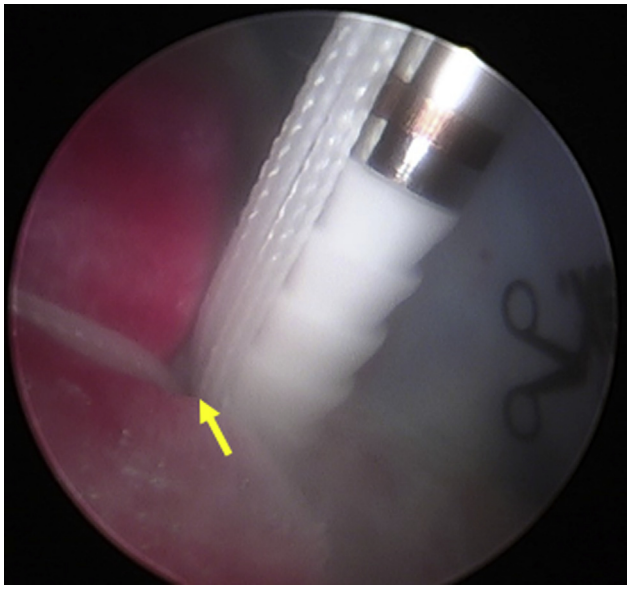

Fig 9. Posterior portal visualization of sutures being brought laterally in a crisscross configuration and secured to third row using 2.9-mm anchor in SutureBridge manner (arrow).

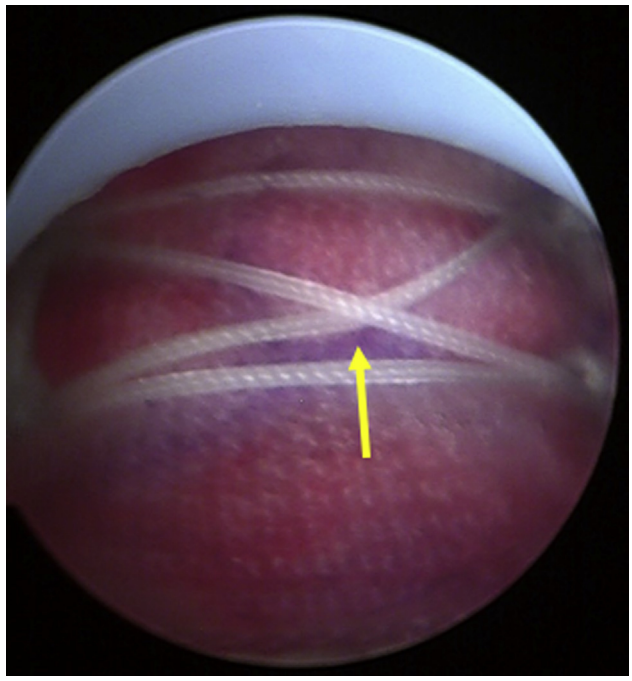

Fig 10. Survey of BioBrace via lateral portal with proper placement in a crisscross configuration (arrow) in a SutureBridge manner.

Discussion

Arthroscopic treatment of large to massive rotator cuff tears, as well as revision rotator cuff tears, remain a challenge to the orthopaedic surgeon owing to the risk of failure at the suture–tendon interface. With increasing awareness of this problem, surgeons have often moved to augmenting RCRs through the addition of either a bio-inductive implant or a dermal allograft. Although each option contains obvious benefits, neither provides a perfect solution.

The use of a bio-inductive scaffold (BioBrace) provides an opportunity to optimize healing potential through the combination of bio-induction and strength. This is particularly attractive in the setting of poor tissue quality, often seen in revision or large to massive rotator cuff tears. The BioBrace allows for a resorbable rotator cuff augmentation that can provide strength at time 0, rapid incorporation, and ultimate resorption of the implant while new native tissue remains.[5] This implant has the potential to prevent tissue gapping or retears by increasing the thickness of the tendon, which, combined with the strength of the implant, can act as a rebar for suture, helping to decrease the risk of suture–tendon pull-through.

The advantages of this implant are exciting, but the limitations must be considered (Table 2). There is concern for the induction of a mild, local inflammatory response to a foreign body due to the PLLA microfilaments, which in theory could also increase the risk for a surgical site infection. However, this risk is small owing

Table 2. Advantages and disadvantages

Advantages
• This technique allows ease of technique reproducibility.
• Procedure may be performed in beach chair or lateral position without changing technique.
• BioBrace allows for restorable rotator cuff augmentation, which also provides structural support at time 0 of implantation.
• BioBrace may prevent tissue gapping or retears.
• The process enhances rehabilitation protocols while potentially decreasing failure rates.
• BioBrace may be trimmed to size if needed.
Disadvantages
• Low risk of mild, local inflammatory response to foreign body, raising concern for surgical site infection.
• Technical difficulty of incorporating into surgeons' standard shoulder arthroscopy.
• High cost

to the relatively low total mass and size of PLLA within the scaffold itself, which in previous studies has been shown not to lead to negative outcomes.[6] Another potential concern is for the technical difficulty of incorporating this implant into a surgeon's standard shoulder arthroscopy for a rotator cuff tear. The surgical technique in this paper aims to minimize those concerns. We have found this technique to be efficient and reproducible on a variety of challenging rotator cuff tears. Lastly, consideration of cost may be a concern; however, compared with the combined risks of prolonged rehabilitation and reoperation for retears, we believe the cost benefits outweigh the risks when considering this implant for the correct surgical indications mentioned earlier. The understanding of this surgical technique, as described, and the use of the surgical pearls will allow for rapid acclimation to the procedure and optimization of patient outcomes (Table 3).

Table 3. Surgical pearls for arthroscopic preparation and placement

• BioBrace Bio-Composite scaffold comes available as a 23-mm-wide by 30-mm-long implant with 3 mm of thickness; however, it can be trimmed to allow for appropriate rotator cuff coverage if desired.
• To decrease suture friction, BioBrace Bio-Composite Scaffold should be wet with autologous blood, platelet-rich plasma, bone marrow aspirate concentrate, or sterile saline before passing sutures through it.
• After placement of the BioBrace Bio-Composite Scaffold, the shoulder should be taken through a range of motion while viewing arthroscopically to ensure there is no subacromial impingement on the graft. If so, a subacromial decompression should be carefully undertaken.
• During the passing of the #2 sutures through the BioBrace Bio-Composite scaffold, an inspection of the sutures should be conducted during each pass of #2 to ensure there are no tangles.

In summary, the addition of this bio-composite scaffold for arthroscopic treatment of revision and large to massive rotator cuff tears may improve postoperative outcomes while decreasing failure rates. Further work is needed to better quantify the results. The application of a reproducible surgical technique is paramount for ensuring optimization of the implant. This bio-composite scaffold offers the surgeon an option for dealing with high-risk rotator cuff pathology.

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