Technical Note

Arthroscopic Rotator Cuff Augmentation: Surgical Technique Using Bovine Collagen Bioinductive Implant

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Abstract: Symptomatic partial-thickness rotator cuff tears and full-thickness tears with poor tissue quality often pose a dilemma for orthopaedic surgeons. Despite advances in repair techniques and fixation devices, retear rates remain high. Progression of partial-thickness tears has been noted to be over 50%, with remaining fibers seeing increased strain. Patch augmentation that induces a healing response while decreasing peak strain of adjacent tissue is becoming more popular among orthopaedic surgeons. Therefore, we present an all-arthroscopic technique guide for application of a Food and Drug Administration–approved bovine bioinductive patch (Rotation Medical, Plymouth, MN).

The incidence of partial-thickness rotator cuff tears has been shown to be between 4% and 26% depending on the age of the patient.[1] Most of these tears are articular sided and have poor healing potential because of hypovascularity and decreased tensile strength. Unfortunately, partial tendon lesions are often much more painful than full-thickness tears, showing higher levels of pain mediators such as substance P.[2] With progression of tears shown to be over 50% in some studies, the orthopaedic surgeon faces a dilemma, especially because the recovery is quite different with simple debridement versus repair.[3] One viable option is a bovine collagen bioinductive patch by Rotation Medical (Plymouth, MN), which has been shown to induce tissue formation and provide load sharing, decreasing the peak strain of the adjacent tissue and creating an environment more conducive to healing. In addition, the patient can return to activity as tolerated after cuff augmentation surgery, following a standard decompression protocol. A study of the Rotation Medical bioinductive implant in sheep showed that the device had the ability to induce the formation of tendinous tissue without histologic evidence of a foreign body or inflammatory response.[4] An additional study showed that this scaffold was effective in augmenting full-thickness rotator cuff tear repairs, inducing tissue formation in all patients by 3 months, and resulted in clinical improvement and structural integrity at 2 years' follow-up.[3] We offer this presentation to guide surgeons through a stepwise approach in preparation, deployment, and fixation of the graft.

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Surgical Technique

Surgical Setup

A cadaveric specimen was used in Video 1; however, the presented steps describe our typical approach to this clinical scenario. General anesthesia is administered, and the patient is placed in the lateral decubitus position, although the beach-chair position may be used. The arm is prepared and draped in the standard fashion, and balanced inline traction is applied with the arm at 30° of abduction. A standard arthroscopic posterior viewing portal is made, and a diagnostic arthroscopy is performed. The anterior edge of the supraspinatus tendon is approximated by the placement of 2 parallel percutaneous needles. The external landmark for this placement is roughly the anterior-lateral corner of the acromion. These tendon markers

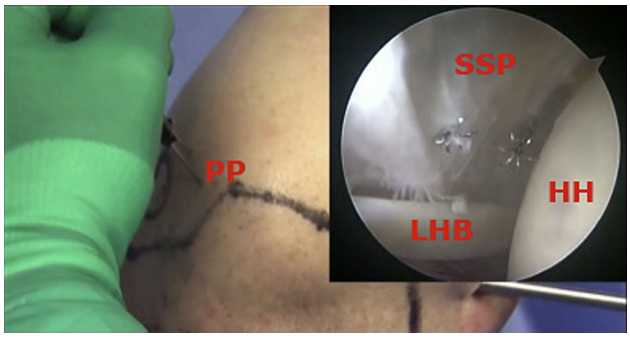

Fig 1. Arthroscopic view from the posterior portal (PP) of a right shoulder, viewing anteriorly. Spinal needles are placed parallel to the biceps tendon; when viewed in a bursal manner, this serves as a reference for the anterior border of the supraspinatus (SSP) tendon and, therefore, the patch anterior border. (HH, humeral head; LHB, long head of biceps.)

are placed percutaneously just posterior to the biceps tendon (Fig 1).

The subacromial space is then entered, and a complete bursectomy is performed to achieve optimal visualization of the rotator cuff by use of a standard lateral portal. We will typically use an 8-mm cannula (Arthrex, Naples, FL) to ensure ease of passage without soft-tissue interference.

Graft Insertion

From the lateral portal, a 5-mm guidewire is placed at the lateral edge of the rotator cuff footprint (Fig 2), which will serve to guide the center line of the patch. It is lightly tapped into the bone. The delivery system is then prepared. The system consists of a triggered delivery tube resembling a gun (Fig 3). The end of the barrel contains the bovine collagen graft, which is loaded within a clear plastic tube, pre-tensioned with metal spring-loaded arms. This will allow for delivery of the graft within the tube, and with retraction of the tube, the spring-loaded arms deploy to evenly spread the graft along the surface of the native rotator cuff.

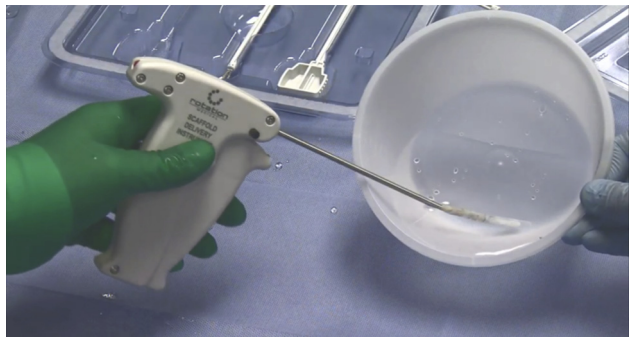

Fig 3. The triggered graft delivery instrumentation is shown. The graft is hydrated while still in the delivery system to allow ease of passage.

The preassembled patch delivery system is hydrated (Fig 3) and loaded along the pre-placed guidewire. The graft is introduced into the lateral working portal along the wire. The graft is inserted medially until the red-button indicator becomes prominent (this indicates that the graft is in the appropriate medial-to-lateral position based on the guidewire placement) (Fig 4). At this time, the safety—represented by the black push button on the side of the insertion device—is released. The trigger is then slowly squeezed, which retracts the clear plastic tube and allows for the graft to be deployed (Fig 5).

Fixation of Graft

Two additional cannulas are included in the patch system (Rotation Medical). They are thin and clear, and they assist in inserting the staples into the graft. The first is placed adjacent to the lateral border of the acromion to allow a perpendicular angle of insertion of the staple. The absorbable staples are loaded individually on the

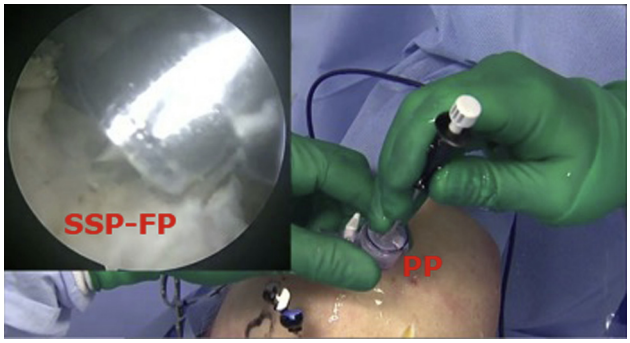

Fig 2. Arthroscopic view of the subacromial space of a right shoulder, viewing from the posterior portal (PP). A 5-mm guide pin is placed into the lateral aspect of the supraspinatus footprint (SSP-FP). This accurately provides positioning of the implant medially to laterally.

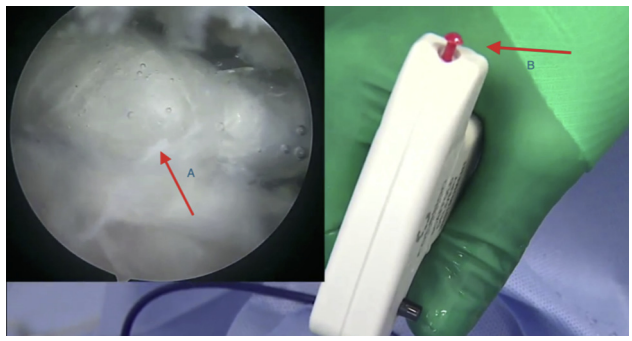

Fig 4. Arthroscopic view of the subacromial space of a right shoulder, viewing from the posterior portal, showing full insertion of the bovine collagen patch into the subacromial space. Arrow A shows the collagen patch being deployed, and arrow B shows the prominent red button signifying that the delivery tube has been fully retracted.

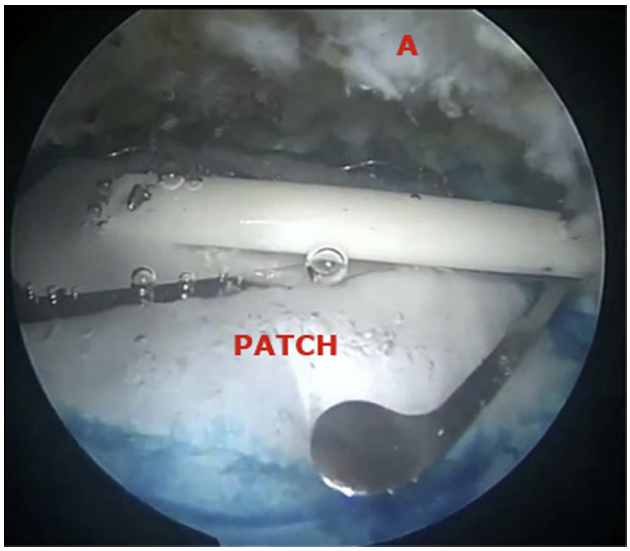

Fig 5. Arthroscopic view of the subacromial space of a right shoulder, viewing from the posterior portal, showing deployment of the graft in the subacromial space. (A, acromion.)

staple inserter. This is a metal-pronged device that allows for the staple to be recessed within it. The metal staple delivery instrument is then placed through the clear cannula, and the position for fixation is selected. The metal prongs are inserted through the bovine collagen patch and into the underlying rotator cuff tendon. The insertion trigger is depressed and the staple is deployed, fixing the patch to the underlying rotator cuff (Fig 6). This process is repeated until the medial, anterior, and posterior edges of the patch are attached. A total of 5 to 8 staples are typically used. The tendon markers are then removed.

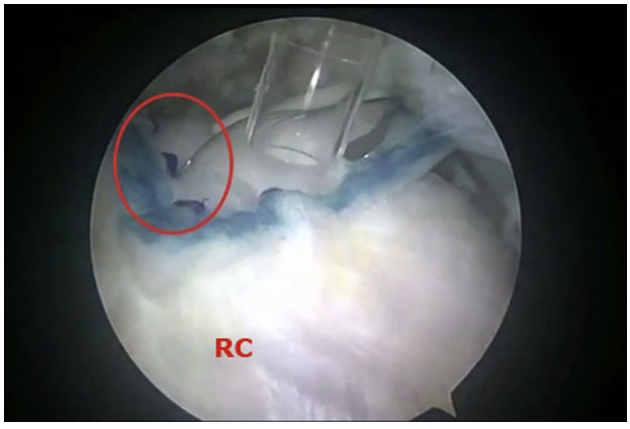

Fig 6. Arthroscopic view of the subacromial space of a right shoulder, viewing from the posterior portal. Through an accessory medial portal, polylactic acid staples (red oval) are placed into the tendon side of the graft. Five to 8 staples are usually required to fixate the graft to the underlying rotator cuff (RC).

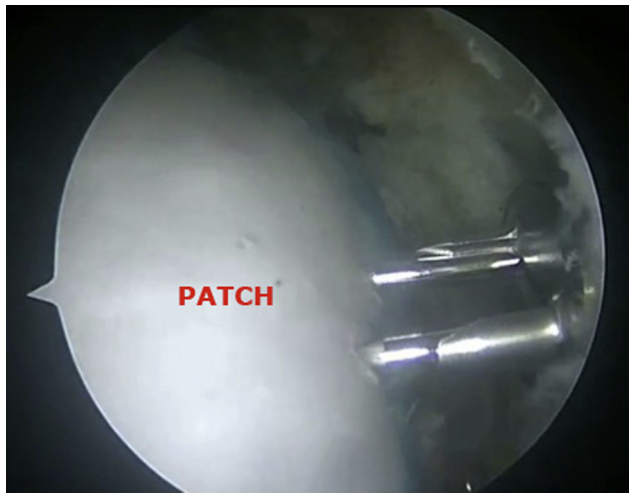

Fig 7. Arthroscopic view of the subacromial space of a right shoulder, viewing from the posterior portal. The lateral staple guide captures and positions the graft.

The lateral edge of the patch is fixed to the greater tuberosity with bone staples. The bone stapler introducer is brought into the subacromial space through the previously placed lateral portal, with or without the cannula in place. The bone stapler introducer is designed similarly to the medial stapler, but the metal prongs are longer and stiffer to allow pilot holes to be established into the bone of the greater tuberosity. There is a central plastic obturator that extends beyond the metal tongs to allow a smooth introduction of the stapler into the subacromial space. The obturator is removed and replaced by a pronged bone awl. The prongs are inserted through the patch tissue and then lateralized to slightly tension the graft laterally (Fig 7). Once in position, a mallet is used to tap the prongs into the bone as pilot holes. The

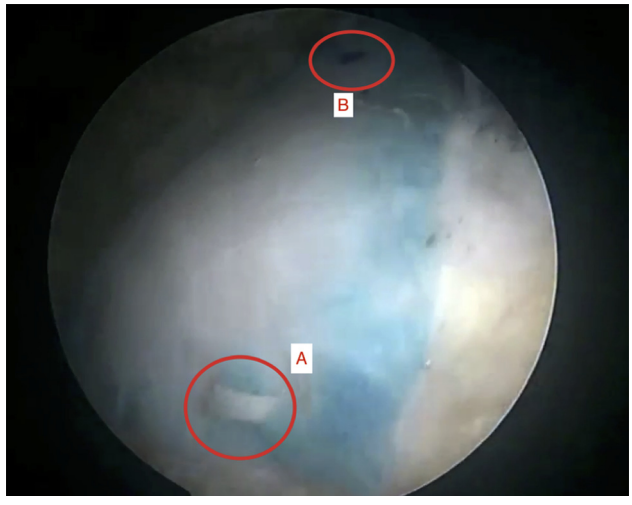

Fig 8. Finished construct, viewing from the lateral portal: lateral fixation (oval A) and medial fixation (oval B) of graft.

Table 1. Indications and Contraindications for Bovine Bioinductive Patch Augmentation

Indications
Symptomatic partial-thickness tears
Unable to comply with protection after cuff repair
Demanding lifestyle that will not allow for extended time off
Contraindications
May not be viable for larger rotator cuff tears involving more than one muscle
Active infection
Poor humeral bone quality
Allergy to polylactic acid

pronged bone awl is removed without moving the staple inserter.

PEEK (polyether ether ketone) bone staples (Fig 8) are loaded into the introducer and placed into the previously tapped pilot holes in the greater tuberosity; they are initially advanced by hand to ensure they are in the pilot holes correctly and are then tamped until flush with the edge of the patch. Typically, 2 to 3 staples are needed. The stability and placement of the graft are then checked with a probe, with staples being added if necessary, and the graft is viewed in its completed form to ensure medial and lateral fixation spans the patch (Fig 8). The instruments are removed and the wounds closed in the usual fashion.

For partial-thickness tears, the postoperative protocol is immediate range of motion as tolerated, with the patient using a sling for comfort. Strengthening can begin once full range of motion has returned.

Discussion

For symptomatic partial-thickness rotator cuff tears (Table 1), especially in a patient who is not able to comply with extended therapy, the described patch may allow for a quicker return to activity while inducing a healing response with tendon-like tissue. The deployment system for the graft, as well as the bone and tissue staples, is easy to use and provides excellent initial fixation. As with all patches, there is a risk of inducing an inflammatory response (Table 2), but clinical data to date have not shown this complication. Meticulous surgical technique including visualization before deployment is crucial for success. Pearls and pitfalls of the surgical technique are outlined in Table 3. Surgical steps are listed in Table 4.

Table 2. Risks and Limitations for Bovine Bioinductive Patch Augmentation Procedure

Risks
Immune response
Dislodgement of implants
Structural failure
Infection
Limitations
The technique has not been proved in a human model.
Previous bovine scaffolds have had limited success.

Table 3. Surgical Pearls and Pitfalls

Pearls
Ensure the needles are parallel to the biceps tendon.
Perform a thorough bursectomy to secure visualization.
Ensure the initial guide pin is in the correct position on the greater tuberosity.
Moisten the graft patch for ease of passage.
Fully insert the implant to confirm adequate deployment of the patch into the space.
Confirm patch deployment with a slow and steady withdrawal of the delivery tube.
Make an accessory portal just off the acromion edge for perpendicular delivery of medial staples.
Abduct the arm for optimal visualization of the lateral staples.
Maintain a steady grip on the pilot hole guide laterally to ensure optimal delivery of lateral staples.
Pitfalls
Poor patient selection (e.g., rotator cuff structural compromise) can lead to poor results.
There may be an inadequate view of the subacromial space.
Nonparallel placement of the spinal needles can affect graft orientation.
Poor accessory portal placement can lead to staple misfire.

Table 4. Surgical Steps in Arthroscopic Bioinductive Patch Augmentation

1. Diagnostic arthroscopy is performed.
2. Tendon markers along the anterior edge of the supraspinatus are placed in a percutaneous fashion.
3. Entry is made into the subacromial space, and bursectomy is performed through a standard lateral portal.
4. A 5-mm guidewire is placed at the lateral edge of the rotator cuff footprint.
5. The graft is hydrated for 1 minute.
6. The graft is loaded into the delivery instrument.
7. The graft is introduced until the red button becomes prominent.
8. The graft is deployed.
9. A second lateral cannula is placed just off the lateral edge of the acromion.
10. Soft-tissue staples are placed through the graft into the underlying rotator cuff.
11. The tendon markers are removed.
12. A bone stapler awl is used to tension the graft from the lateral portal.
13. The bone staples are placed.
14. The instruments are removed, and the wounds are closed.

NOTE. The equipment required comprises standard arthroscopic equipment, the Bovine Bioinductive Patch System (Rotation Medical), and an 8-mm cannula (Arthrex).

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