Technical Note

Compressed Biceps Autograft Augmentation of Arthroscopic Rotator Cuff Repair

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Abstract: Rotator cuff repair failure rates continue to be a challenging problem. Various methods of biological and structural augmentation of the rotator cuff have been explored to improve tendon healing after repair. We describe a technique in which biceps tendon autograft is harvested after tenodesis. The biceps tendon is then compressed into a patch that is placed over the repaired rotator cuff tendon. Repurposing the portion of the tendon that is otherwise discarded offers several advantages over other augmentations that have been used, including the biological potential of live autograft tenocytes in the patch, lower cost, and no donor-site morbidity.

Rotator cuff disorders are among the most common causes of shoulder pain and dysfunction with a negative impact on quality of life.[1,2] Performing rotator cuff repair to address tears that fail to improve with conservative treatment has become an increasingly common treatment for rotator cuff pathology.[3,4] Despite the increasing incidence of repairs, failure due to retear continues to present a significant challenge, with reported rates ranging from 11% to 94%.[5,6] Many factors have been identified as affecting retear rates, including patient age, tear size, preoperative fatty infiltration, muscle atrophy, smoking, and diabetes.[7-11] Retears are concerning because long-term maintenance of good outcomes has been shown to be contingent on tendon-bone interface healing.[12,13] Increasingly, tendon biology is being evaluated as a modifiable risk factor for retear.

In the early 2000s, reports on the use of patch augmentation in rotator cuff repair showed promising results.[12,14] Since those reports, there has been an increase in techniques using patch augmentation to improve rotator cuff healing.[15] Various patches have been used, including xenograft intestine mucosa, xenograft dermal grafts, synthetic grafts, and allografts.[13,16-28] Additionally, autografts have been used, including humeral periosteum and tensor fascia lata autografts.[29,30]

An additional augmentation for rotator cuff repair is biceps tendon autograft. Neviaser[31] originally described using the biceps tendon for large defects with retraction for which anatomic reduction was not possible. Veen et al.[32] reported on the use of biceps autograft augmentation with varying techniques for rotator cuff repair. The current literature shows varying results with

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The authors report the following potential conflicts of interest or sources of funding: J.M.T. receives grants or contracts from Arthrex, outside the submitted work; receives royalties or licenses and consulting fees from Arthrex; and has a leadership or fiduciary role in the AANA board, outside the submitted work. P.J.D. receives grants or contracts from Arthrex, outside the submitted work; receives royalties or licenses and consulting fees from Arthrex; is a committee member of AANA and American Shoulder and Elbow Surgeons, outside the submitted work; and owns stock or stock options in Stryker, Kaliber Labs, and PT Genie, outside the submitted work. J.J.M. receives grants or contracts from Samaritan Biologics, Integra LifeSciences, and Stryker Spine and receives consulting fees from Samaritan Biologics. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

Received May 2, 2022; revised manuscript received July 6, 2022; accepted August 5, 2022.

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2212-6287/22603
https://doi.org/10.1016/j.eats.2022.08.011

previously used techniques of repair augmentation using the biceps tendon.[33-36] These grafts have used a section of the biceps or occasionally have split it along its axis to cover a defect.

Recently, Colbath et al.[37] described the use of a biceps tendon autograft as a biological augmentation, expanding it into a patch through the use of a skin graft preparation technique. They showed that tenocytes could remain viable and this could initiate stem cell differentiation into mature tenocytes. The current technique expands on this knowledge, and in this article, we describe a method in which the biceps is harvested and compressed into an autologous patch that can be placed as an onlay over a rotator cuff repair. After arthroscopic suprapectoral biceps tenodesis, the proximal remnant of the biceps tendon is harvested and compressed into a flat patch, allowing it to be secured over the bursal side of the repaired tendon. This technique has several advantages over alternative patch techniques, including autologous tenocyte delivery to the site of pathology, lower cost compared with allograft, and avoidance of potential reactions present with other patches. Finally, because the proximal biceps is often discarded after tenodesis in cases of rotator cuff repair, this technique produces no additional donor-site morbidity.

Preoperative Decision Making

Standard preoperative shoulder radiographs with anteroposterior, internal rotation, and axillary views are obtained preoperatively. A magnetic resonance imaging scan is obtained to evaluate the rotator cuff for tear size, retraction, and fatty atrophy and to rule out additional non—cuff-related pathology. A diagnostic arthroscopy is performed, providing confirmation of both a rotator cuff warranting repair and biceps pathology being addressed with a tenodesis.

Surgical Technique

The patient is positioned in the lateral decubitus position on a beanbag with the use of a padded arm sleeve (Arthrex, Naples, FL). Range of motion is assessed to evaluate for preoperative stiffness. Standard portals are created, and a diagnostic arthroscopy is performed. The articular side of the rotator cuff is assessed. The biceps is tenotomized at its glenoid insertion. The arthroscope is then moved into the subacromial space. A standard bursectomy with subacromial decompression is completed to allow for visualization of the bursal side of the rotator cuff. The rotator cuff tear is then repaired in standard fashion. For this particular technique, the rotator cuff can be repaired in any fashion and with any type of fixation.

Attention is then turned to the biceps tenodesis. Multiple techniques may be used for this specific procedure providing that they allow harvest of at least the proximal 40 mm of the biceps. The preferred technique of the senior author (J.M.T.) is to perform a suprapectoral arthroscopic tenodesis (Video 1). The arthroscope is placed into a lateral portal routinely used for rotator cuff repair and directed to the anterior subdeltoid space. Once the space has been entered, the anterosuperior portal is used to introduce a shaver into the same space. Care is taken to avoid entering the intra-articular shoulder through this incision as the desire is to remain in the subacromial and/or subdeltoid space. The biceps tendon is then identified just proximal to the falciform ligament, distal to the beginning of the bicipital groove, with debridement of bursal tissue as needed to allow for visualization (Fig 1). A third portal (the "falciform portal") is then established using a spinal needle for localization (Fig 1). The portal is distal and slightly lateral to the anterosuperior portal and should be centered directly over the biceps tendon to allow for eventual anchor placement.

The bicipital sheath is entered with electrocautery, and the tendon is identified. The bony surface where the biceps tendon lies is then prepared with a rasp until there is bleeding bone. The biceps tendon is delivered from the suprapectoral and subdeltoid space, removing it from the intra-articular shoulder. A locking grasper is placed on the tendon through the anterosuperior portal, and tension is pulled to ensure that a tensioned tenodesis is performed. An all-suture anchor (FiberTak; Arthrex) is then placed into the humerus. One limb of the anchor is passed through the biceps tendon twice in a locking figure-of-8 fashion, which provides excellent fixation in the tendon. A knot is then tied using the other limb as a post to reduce the biceps tendon to the humerus (Video 1). The biceps is cut proximal to the fixation point, with the residual biceps tendon removed from the shoulder.

The residual tendon is formed into a patch on the back table. The tendon is measured and cut to a length of 27 mm by removing 10 mm from the origin and any additional length distally. The cut tendon is placed into a tray (Biceps Autograft Tissue Compression Plate; Arthrex) for compression. The tray is composed of 2 plates that provide a space for the biceps and allow for compression of the tendon with expansion into a 27-mm-long by 22-mm-wide patch. The plates are then placed into a taper assembly press (Arthrex). The device has a gauge for tension, and compression is applied until the gauge is centered between minimum and maximum and held for 4 minutes.

The compression force is then removed. The biceps now fills the 27-mm × 22-mm recessed space of the plates (Fig 2, Video 1). At this point, 4 sets of sutures are passed through the biceps patch at the corners to prepare for shuttling. The sutures limbs are attached to a collapsible insertion device (Graft Spreader; Arthrex) that can be placed through an arthroscopic portal. As shown in Fig 3, the patch is inserted in a compressed

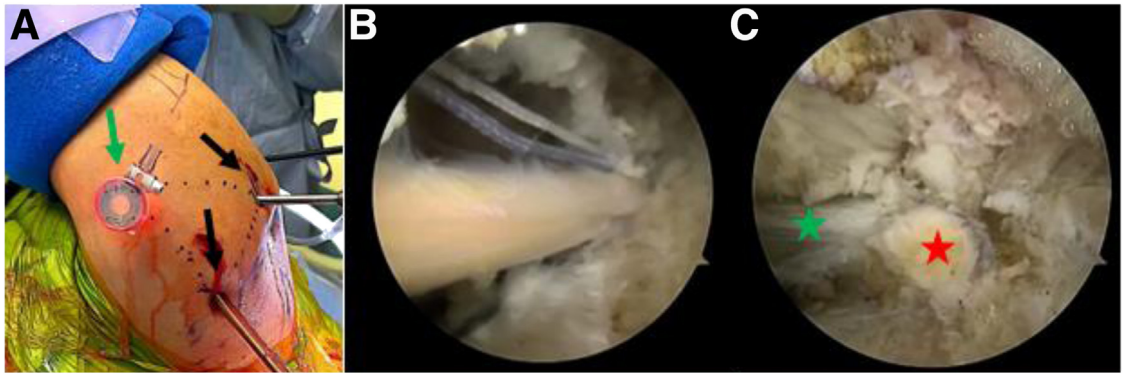

Fig 1. Suprapectoral biceps harvest in right shoulder with patient in lateral decubitus position. (A) A triangle is drawn between the lateral midline portal and the anterosuperior portal (black arrows). A cannula is placed in the falciform portal (green arrow), which is established using a spinal needle for localization starting at the tip of the drawn triangle (dotted lines). The falciform portal overlies the bicipital groove. (B) Biceps tendon after tenodesis, with sutures coming from placed anchor. The cannula shown (sutures passing through) is the falciform portal. (C) Tenotomized biceps (red star) and intact falciform ligament (green star).

fashion and then opened on tension to cover the repaired rotator cuff.

In our technique, the patch is fixed to the repaired rotator cuff using a rotator cuff augmentation system (CuffMend; Arthrex) (Video 1). The medial aspect of the patch is fixed to the rotator cuff muscle and tendon using absorbable suture tendon anchors (TissueTak; Arthrex). Once secured medially with 2 to 3 points of fixation, the 2 medial sutures are removed and the graft insertion device is withdrawn. Care is taken to fix the anterior and posterior aspects of the patch as well (Fig 4). The 2 remaining lateral sutures are then secured into the lateral aspect of the greater tuberosity with 2 knotless anchors (3.5-mm PushLock; Arthrex). The shoulder is taken through a range of motion while the surgeon visualizes that the patch is stable on the rotator cuff. The patch is well fixed to the rotator cuff and should glide freely under the acromion without catching or a change in tension (Fig 5, Video 1).

Postoperative Protocol

The patient follows a standard rotator cuff repair protocol. The senior author's protocol is as follows: The patient generally remains in a sling for 6 weeks. During this period of immobilization, Codman pendulums are allowed together with passive motion under the supervision of a physical therapist. Supine motion is started at 2 weeks, with progression to full passive range of motion by 6 weeks. Active motion begins at 6 weeks, advancing from supine to standing. Light resistance training is started at 10 weeks, with weight lifting beginning at 12 weeks. Overhead activities are minimized until 4 months. The patient is cleared to resume overhead activities (tennis, pickleball, and so

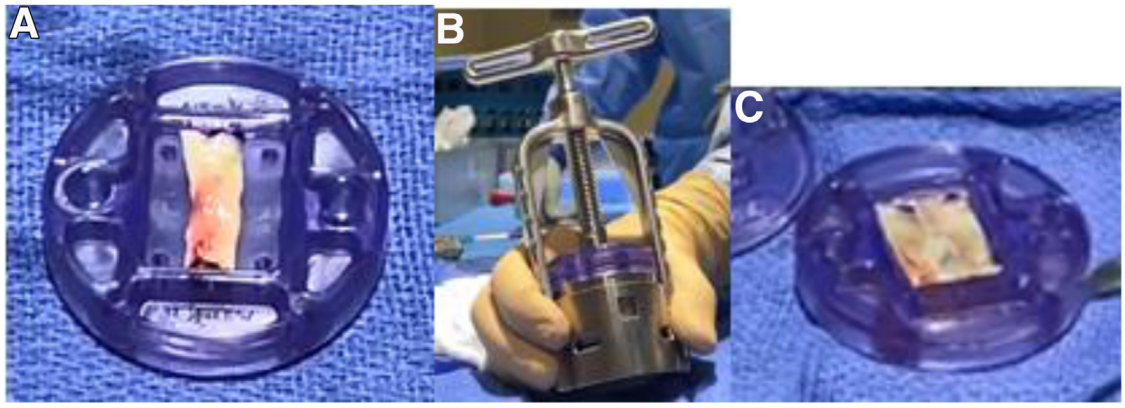

Fig 2. Biceps patch. (A) Twenty-seven millimeters of normal biceps tendon taken from biceps after tenodesis. The tendon is centered in the compressive plate device. It should be noted that the plate has an inset space for the tendon. (B) Compressive device with maximal compression placed. Once the desired compression has been obtained, the tendon is left under compression for 3 minutes. (C) Newly created patch. It should be noted that the tendon has been flattened to fill the entirety of the recessed space and measures approximately 25 mm in width.

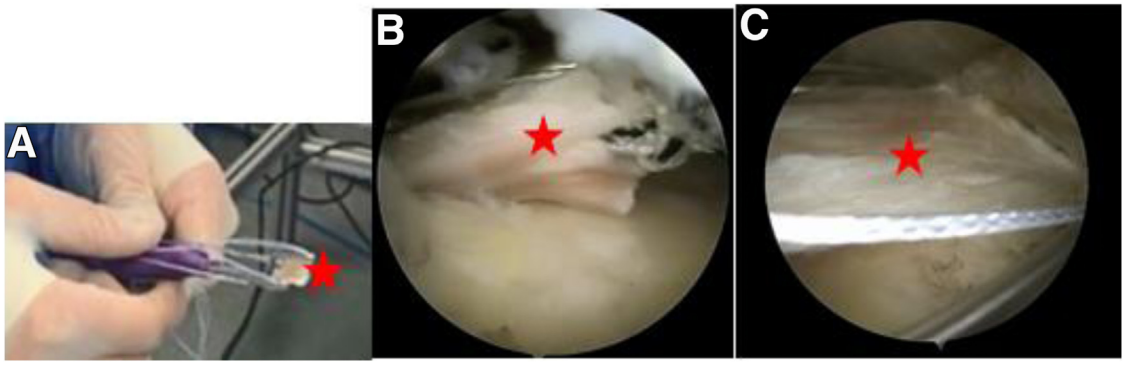

Fig 3. Insertion of patch (red stars) in right shoulder with patient in lateral decubitus position. (A) Proprietary device. (B) Appearance of patch when first introduced with device rollers compressed together. (C) Once the patch is appropriately placed medial to lateral, the device is expanded and the patch is spread out on tension over the rotator cuff. The star represents the center of the patch, and lateral is to the left of the photo.

on) at 5 to 6 months. Table 1 lists pearls and pitfalls of our technique, and Table 2 presents advantages and disadvantages.

Discussion

This article outlines a technique to use the biceps tendon remnant after tenodesis as a patch to augment a rotator cuff repair. Originally reported by Neviaser,[31] the use of the biceps tendon to mechanically bridge rotator cuff repairs has been described. Sano et al.[38] and Pavlidis et al.[39] both reported similar techniques. However, all 3 of the aforementioned studies reported on the use of the biceps as a patch between the greater tuberosity and an irreparable rotator cuff tear.

Other materials have been used to augment rotator cuff repairs. Gilot et al.[40] used an extracellular matrix augmentation (ArthroFlex; Arthrex) of rotator cuff repairs of large to massive tears. They found that, at a mean 24.9-month follow-up, the retear rate was significantly lower in the patch group (10%) than in the control group (26%). Along with the decreased retear rate, an improvement in patient outcome scores was reported. Gilot et al. recommended use of the patch for augmentation in any complicated case in which a significant failure rate was anticipated. Barber et al.[14] noted a similar decrease in the retear rate with the use of an acellular human dermal matrix allograft patch (GraftJacket; Wright Medical, Arlington, TN) (15% with augmentation vs 60% without augmentation). They also noted no increase in complications or adverse events related to the human dermal matrix. Although the use of acellular human dermal allograft has shown promising results, there is significant cost associated with the implant.[41]

The current technique uses an autologous biceps tendon as a biological augmentation and involves repurposing the normally discarded proximal biceps tendon by compressing it into a patch and applying it over the repaired tendon as a biological augmentation. The surgical technique is similar to onlay approaches that have been described using both bovine and dermal allografts. The biceps tendon, through the compressive device, is able to be sized sufficiently to function in a similar manner with coverage of the repaired rotator cuff tendon. One significant advantage is the avoidance of allograft patches. Cook et al.[42] reported on the difficulty with allograft patch use given that there are over 20 different patches cleared for use in the United States, with few to no data reported on the specific patches. Furthermore, they noted that there is a significant cost

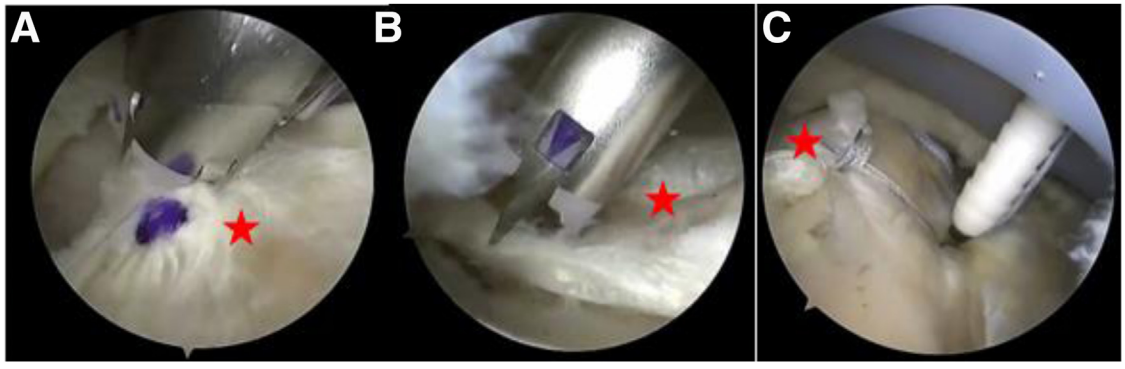

Fig 4. Fixation of biceps patch (red stars) in right shoulder with patient in lateral decubitus position. (A) Placement of first suture staple (purple), with stapler in place to fix second staple. (B) Fixation of anterior aspect of patch.

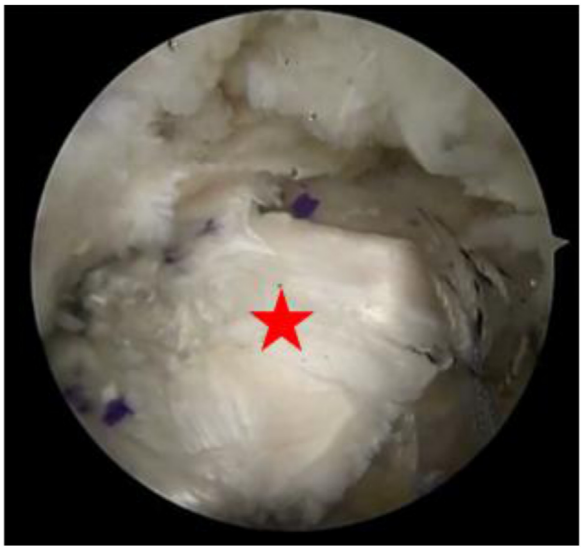

Fig 5. Final construct in right shoulder with patient in lateral decubitus position with viewing through lateral portal. The patch (red star) is shown in its final configuration. The patch is able to move as a unit with the repaired rotator cuff.

associated with the use of allograft patch. In our technique, the biceps is readily available, with no additional implant charge given that the tissue is traditionally discarded after the case.

The described technique is not without challenges and limitations. One weakness of the technique is the lack of literature on the biology of the biceps tendon following the compressive force to form the tendon into a patch. Whereas Colbath et al.[37] showed that tenocyte viability was partially retained using a Skin graft meshing device, tenocyte viability and the biological effects of compression on tendon healing have not been evaluated for the current technique. An additional limitation is the size of biceps patch available. The current design allows for a 27-mm × 22-mm patch, but the rotator cuff might have a larger area at risk after repair. There is also risk when placing additional anchors into the greater tuberosity to fix the patch. It is possible to interfere with the previously placed anchors for cuff repair, compromising the patch fixation as well as the tear. Despite the need for further research into its efficacy, the current technique is relatively simple to perform, avoids implant-related costs, and uses autograft tissue that is generally discarded. Further study is warranted to determine the biological augmentative effects of this patch on rotator cuff repair.

Table 1. Pearls and Pitfalls

Pearls
Thorough subacromial decompression should be performed to ensure adequate visualization.
Medial patch fixation should be performed through a portal immediately off the lateral acromion to achieve the optimal angle.
The lateral fixation sutures should be preloaded prior to insertion of the patch into the subacromial space.
The cannula should be placed in the lateral portal for graft passage.
Pitfalls
Intra-articular biceps tenodesis yields insufficient tendon for a patch.
Excessive traction on the lateral patch while placing anchors can cause tearing and loss of fixation.
Convergence with rotator cuff repair fixation can compromise the repair.
The patch can become twisted in the subacromial space during insertion without adequate control.

Table 2. Advantages and Disadvantages

Advantages
Autograft tissue with no graft cost
Addition of autograft tenocytes to repair site
No donor-site morbidity
Disadvantages
Additional implant cost for anchor fixation
Additional procedure with prolonged operative time and learning curve
Inability to perform intra-articular tenodesis because of inadequate tendon length

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