Technical Note

Dermal Tuberoplasty for Irreparable Supraspinatus Tears Using Self-Punching, Knotless Fixation

Tal S. David, M.D., John A. Grotting, M.D., and Shane Bass, B.A.

Abstract: Superior capsular reconstruction has become an accepted treatment option for the irreparable rotator cuff tear in the nonarthritic shoulder. Widespread adoption of this technique has been limited, however, because of the technical difficulty of performing this procedure. Recently, allograft interpositional grafting of the greater tuberosity has gained popularity as a simpler alternative to superior capsular reconstruction and provides similar joint preservation advantages. We describe a technique for allograft interpositional tuberoplasty that simplifies graft delivery, graft fixation, and suture management by using a graft inserter and self-punching, knotless soft anchors.

In patients with irreparable supraspinatus tears and minimal glenohumeral arthritis, arthroscopic superior capsular reconstruction (SCR) has become accepted as a procedure that can effectively reduce pain and provide improved glenohumeral joint kinematics.[1-4] Widespread adoption of this procedure, however, has been mitigated by several technical challenges including issues regarding superior glenoid anchor fixation and optimal graft tensioning, as well as technically demanding suture management. Recently, several techniques have attempted to address some of these challenges by modifying the SCR procedure to eliminate the need for glenoid fixation and graft tensioning.[5,6] These so-called tuberoplasty procedures place dermal allograft over the exposed greater tuberosity, creating an interpositional graft between the acromion and the humerus, and eliminate the need for glenoid fixation. Despite this simplification, these techniques still require meticulous suture management as sutures are passed through the graft external to the shoulder, which ultimately requires simultaneous delivery of graft and sutures into the subacromial space. This step remains a difficult obstacle for even the most experienced arthroscopic surgeon. The tuberoplasty technique described in this article simplifies graft delivery and suture management by using a graft inserter and a self-punching, knotless technique of graft fixation (Video 1).

Surgical Technique

After the patient has undergone an interscalene block and induction of anesthesia, an examination of the involved shoulder is performed with the patient in the supine position. Passive range of motion and stability testing in all planes are assessed. The patient is then positioned in the lateral decubitus position with the operative arm slightly abducted and flexed with 10 lb of arthroscopic suspension. After the standard preparation, draping, and time-out protocols, a posterior viewing portal is established 2 cm distal and 1 cm medial to the posterolateral acromial edge and a diagnostic arthroscopy is completed. If concomitant glenohumeral pathology (e.g., long head of the biceps pathology, loose bodies, capsular constriction, or labral tearing) is encountered, it is addressed before proceeding. In an effort to maintain the shoulder's force couples, tears of the subscapularis and/or infraspinatus tendons are repaired whenever possible.

The arthroscope is then redirected into the subacromial space, and a second inflow small-bore cannula is inserted via an anterior portal. We prefer to use dual gravity inflow for shoulder arthroscopy; however, the
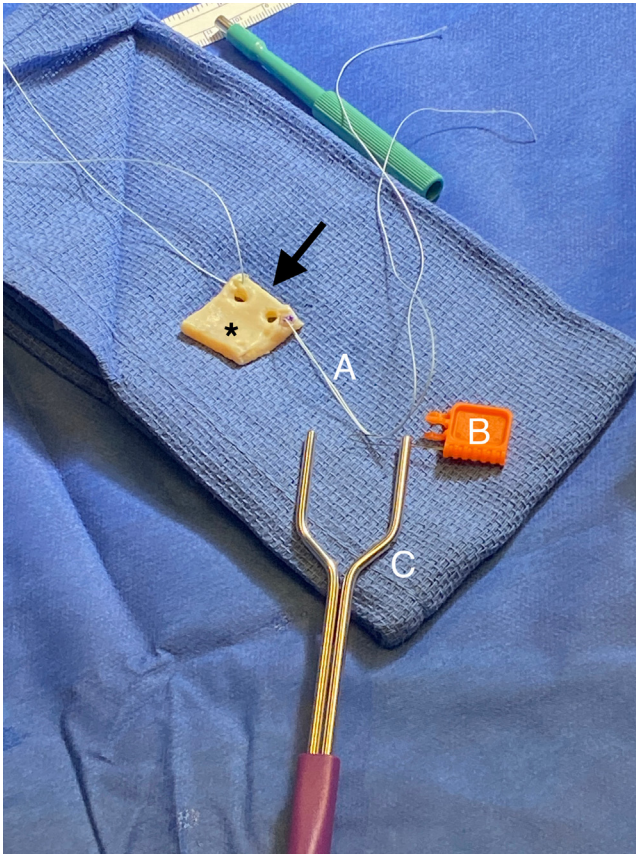
Fig 1. A 3-mm-thick dermal allograft (asterisk) is prepared for loading onto a retractable graft inserter (C). The arrow indicates the medial edge of the graft, which has been prepared by pre-punching 2 holes and loading a No. 0 FiberWire (A) through each of its medial corners. A closed-loop suture passer (B) can be used to help pass the No. 0 FiberWire through the holes at the distal end of the graft inserter.

Fig 2. The 3-mm-thick dermal allograft (asterisk) is assembled on the graft inserter. The No. 0 FiberWire sutures (arrowhead) are crossed over the front of the inserter and cleated onto the opposite-side handle slot to maintain tension and control of the graft as it is inserted into the subacromial space.

use of a mechanical pump to maintain intra-articular pressure eliminates the need for a second inflow. A low-lateral portal is established as a working portal, subacromial bursal tissue is debrided with a 5.5-mm shaver, and a partial acromioplasty is performed if necessary. The reparability of the supraspinatus is assessed at this point. Once it is determined that the superior rotator cuff is not anatomically reparable, bone preparation can begin. The shaver is used to debride the native supraspinatus footprint to promote graft adherence. Because the interposed graft is intended to maintain space between the acromion and the greater tuberosity throughout range of motion, medializing the graft to the articular margin is an important step so that the medial graft edge is not lateral to the acromial edge in full adduction. Anteriorly, the bone is debrided to the bicipital groove; posteriorly, to the superior edge of the infraspinatus. A 10-mm-diameter flexible button cannula (PassPort; Arthrex, Naples, FL) is placed through the lateral portal.

A 3-mm-thick dermal graft is prepared on the back table and cut to cover the exposed supraspinatus footprint. Because of the elastic properties of the dermal graft, we have found that a 20 × 25−mm dimension is adequate. A sharp, round instrument (we prefer a 3.5-mm bone punch) is used to dilate 2 holes in the medial edge of the graft approximately 4 mm from the edge. A 3.0-mm biopsy punch can also be used to create these holes in the graft. These pre-punched holes will allow for easier passage of the self-punching medial implants. A marking pen is used to mark the holes so that they can be easily identified once the graft is positioned in the subacromial space. A No. 0 FiberWire suture (Arthrex) is passed through the medial corners of the graft in a simple configuration, and these corner sutures
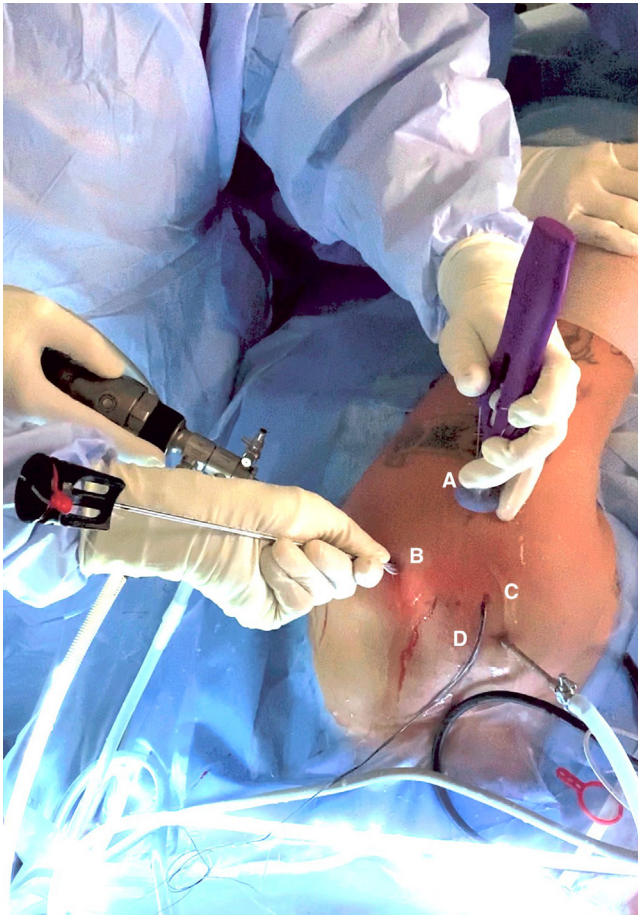
impeded. Adduction and rotation of the arm can help prevent skiving medially. A knotless, transtendinous soft anchor (SP 2.6 FiberTak RC Soft Anchor; Arthrex) is then introduced through the percutaneous access (Fig 3). This anchor allows for direct insertion into bone because it is self-punching and may be used with or without a guide. We have found that using a guide may widen the aperture of the bone, particularly if the guide is inadvertently countersunk as the anchor is malleted. This can affect anchor pullout; therefore, we do not routinely use a guide when inserting the medial anchors through the graft. With the graft stabilized by the graft spreader, the anchor is placed through the pre-punched hole at the posteromedial corner of the graft and then punched into the humerus to the appropriate depth indicated by the thick laser line on the inserter (Fig 4). The inserter is withdrawn, and the anchor is set beneath the bone surface by gentle pulling back on all the sutures. An anteromedial anchor is inserted following the same steps through a separate percutaneous portal.

Once the medial anchors have been placed, the graft spreader can be removed (Fig 5). This is accomplished by holding the graft spreader in place, uncleating the No. 0 FiberWire, and cutting 1 limb at the aperture of the lateral cannula. Pulling on the uncut limb will disengage the graft from the spreader. With both No. 0 sutures removed, the graft spreader arm is folded, and the device can be removed.

The joined tails on the anchor's 1.7-mm FiberTape suture (Arthrex) are cut, and 1 FiberTape tail from each

Fig 3. Left shoulder in lateral decubitus position. Dermal allograft is inserted through a 10-mm flexible cannula placed through a low-lateral portal (A) and held in place against the greater tuberosity. The posteromedial anchor is being inserted through a percutaneous portal (B) just off of the lateral edge of the acromion. The anteromedial anchor has already been inserted percutaneously through a more anterior percutaneous portal (C); the anchor inserter has been removed and the repair sutures are seen exiting the portal (D).

are then passed through the suture channels at the distal end of a retractable graft spreader (Arthrex) (Fig 1). The suture ends are subsequently cleated onto the opposite side of the spreader arm through which it was passed. This creates a crisscross pattern that eases passage through the 10-mm flexible cannula and retains tension on the graft (Fig 2). The articulating arm of the graft spreader can be collapsed to introduce the graft spreader through the cannula and into the subacromial space, where the graft is then spread over the exposed supraspinatus footprint. With the graft in place, a spinal needle is used to help determine the ideal location and trajectory for a small, percutaneous port of Wilmington through which the medial anchors will be inserted. It is important to stay on the lateral edge of the acromion so that the angle of approach is as perpendicular to the bone surface as possible and medial access is not
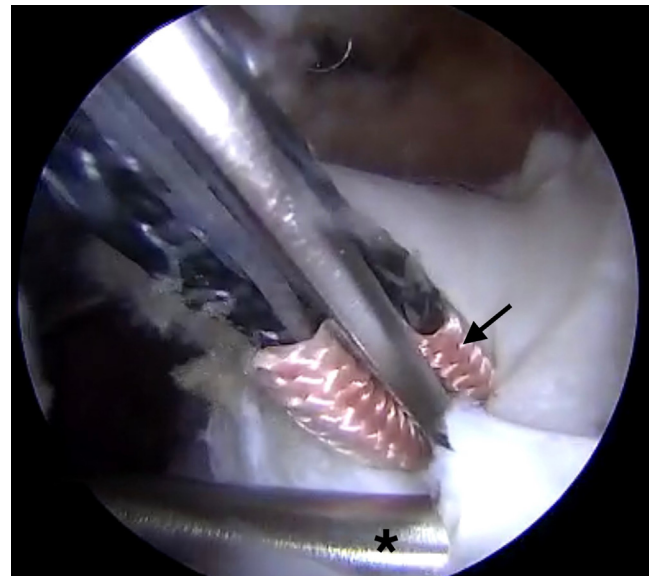

Fig 4. Arthroscopic view of left shoulder through standard posterior portal. The dermal allograft is being held over the greater tuberosity with the graft inserter (asterisk). The posteromedial anchor (arrow) is inserted through the posteromedial pre-punched hole in the graft.
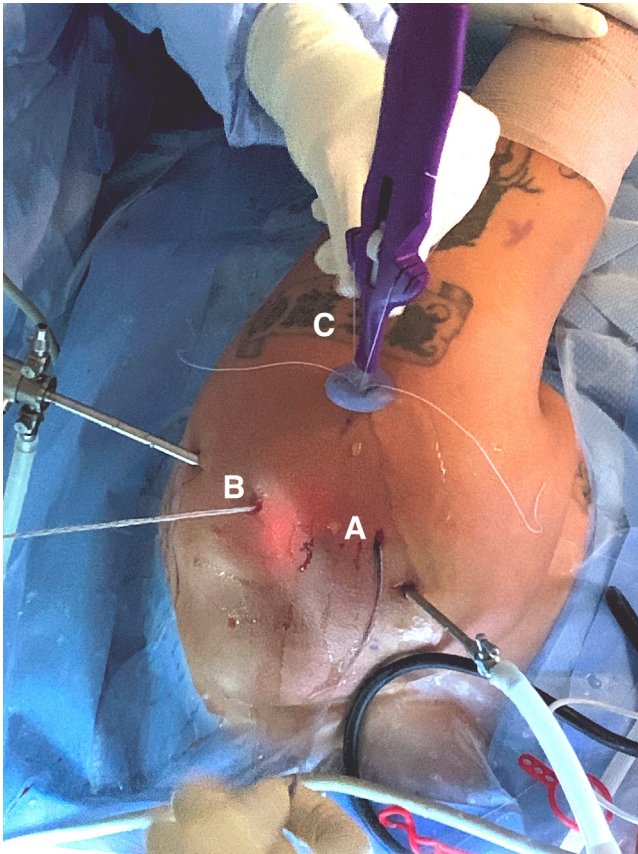
Fig 5. Left shoulder in lateral decubitus position. With the anteromedial (A) and posteromedial (B) anchors in place, the graft is fixated medially over the greater tuberosity. The graft can then be disengaged from the graft inserter by uncleating the No. 0 FiberWire tag sutures (C) from the handle and pulling 1 end of each of the sutures.

medial anchor is retrieved through the lateral portal and loaded through the eyelet of the lateral anchor (SwiveLock, 4.75 mm; Arthrex). At this point, the position of the lateral graft should be assessed to ensure that it remains flat against the bone and unfolded. We have found that lateral control of the graft is simple once the medial edge is secured. If the lateral graft edge needs adjustment, a probe or grasper can be used to lay it flat against the bone.

Creation of the lateral row can now be performed. By use of a punch through the lateral cannula, a bone socket is prepared just lateral to the free graft edge along the lateral and proximal humeral cortex. Slight arm abduction can help access this portion of the bone. With the socket now punched, the eyelet of the pre-loaded lateral implant is engaged in the edge of the bone socket. Final adjustment and tensioning of the FiberTape are completed to remove any slack and ensure compression of the underlying graft against the bone. Once this step is completed, the lateral anchor driver is advanced completely into the bone socket until

the anchor body contacts bone. The thumb pad is used to provide axial compression, and the driver handle is rotated clockwise to insert the anchor body until is it flush with the bone. The FiberTape tails are cut, and the steps are repeated for the second lateral anchor (Fig 6).

With the graft secured, the knotless core mechanism of the medial anchors can provide some adjuvant repair variability. We have used the medial repair sutures in several ways depending on the associated shoulder pathology and pattern of the remaining rotator cuff tissue. If some supraspinatus tendon exists, we have often used the knotless repair suture to lateralize the torn supraspinatus tendon edge and accomplish a partial repair. If the superior edge of the subscapularis or infraspinatus is detached, the repair suture may be used to restore the force-couple effect of the tendon by advancing the torn edge over the patch anteriorly or posteriorly. If a biceps tenodesis is indicated, we have used the anteromedial repair suture to perform tenodesis of the long head of the biceps tendon at the top of the bicipital groove. Finally, interconnecting the medial sutures can create a medial bridge to further compress the graft against the humerus.

Discussion

Clinical data surrounding the outcomes of arthroscopic SCR have shown that this procedure is a viable non-arthroplasty option for the patient with an irreparable rotator cuff tear and little glenohumeral arthritis.[1-4] However, the technical challenges associated with graft delivery, graft fixation, and suture management make this procedure challenging to perform well. Mirzayan et al.[7] reviewed the results of patients who had glenoid-sided radiographic failure of their SCR grafts and found that they showed equal
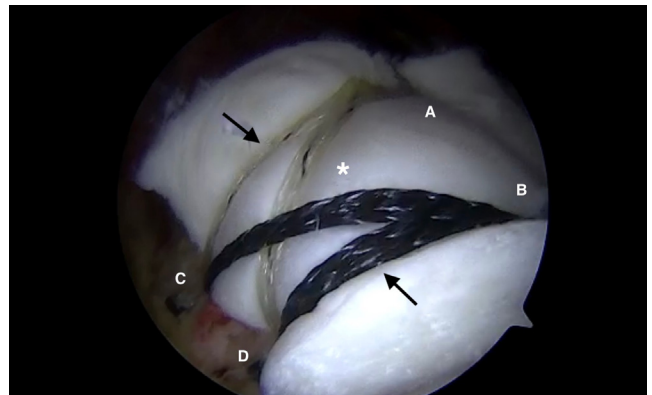

Fig 6. Arthroscopic view of left shoulder through posterior portal. The dermal graft (asterisk) is compressed by the crossing FiberTapes (arrows), which originate from the anteromedial (A) and posteromedial (B) anchors and are fixated by the anterolateral (C) and posterolateral (D) SwiveLock anchors.

Table 1. Advantages and Disadvantages of Dermal Tuberoplasty Using Self-Punching, Knotless Fixation

Advantages
Simple graft delivery
No glenoid fixation
Simple suture management
Lower cost than SCR (fewer implants)
Disadvantages
Unknown joint kinematics compared with SCR
No clinical outcomes
Ideal patient selection unknown

SCR, superior capsular reconstruction.

results in terms of visual analog scale scores and American Shoulder and Elbow Surgeons shoulder scores to patients in whom the graft was intact. These authors concluded that an interpositional cushion between the acromion and the humeral head decreased contact pressure and pain derived from friction of the proximally migrated humerus against the undersurface of the acromion. The findings of this study spurred several authors to explore whether glenoid fixation could be obviated completely. Griffin et al.[6] described the use of a 5-mm dermal allograft for interpositional arthroplasty. Their technique required independent insertion of medial anchors followed by external passage of 2 or 3 repair sutures through the graft prior to its insertion. The steps required to create this construct make suture management challenging, and the authors recommended the use of a divider for the lateral cannula to prevent cross-passage of each medial suture. Mirzayan and Bouz[5] described their technique using a folded 3-mm dermal allograft, which also necessitated external passage of medial sutures through the graft. The folded graft and suture construct required the use of a 10-mL syringe with its end cut off to accommodate insertion into the subacromial space.

Our technique has several advantages over previously described dermal allograft tuberoplasty procedures as well as SCR (Table 1). First, graft delivery is simplified by virtue of a graft inserter. This allows for the graft to be inserted into the subacromial space and held in place without the need for passing fixation through its medial edge external to the shoulder. Second, the self-punching medial implants eliminate the need for external suture passage and provide the added benefit of a knotless core, which can serve various purposes including reinforcement of the graft as a medial bridge, tenodesis of the long head of the biceps tendon, or securing of any remaining rotator cuff cable tissue to restore the shoulder's force couple. Third, this technique obviates glenoid fixation, which is necessary when performing SCR. This results in the use of fewer implants and a potential cost savings. Although we want to emphasize the fact that there is no clinical evidence at this time to suggest that the results after dermal tuberoplasty are comparable to those after SCR, we believe that further studies should be performed to show whether this technique has a role to play in the management of patients with irreparable supraspinatus deficiency.

References

1. Smith TJ, Gowd AK, Kunkel J, Kaplin L, Waterman BR. Superior capsular reconstruction provides sufficient biomechanical outcomes for massive, irreparable rotator cuff tears: A systematic review. *Arthroscopy* 2021;37: 402-410.
2. Lacheta L, Horan MP, Schairer WW, et al. Clinical and imaging outcomes after arthroscopic superior capsule reconstruction with human dermal allograft for irreparable posterosuperior rotator cuff tears: A minimum 2-year follow-up. *Arthroscopy* 2020;36:1011-1019.
3. Mihata T, Lee TQ, Hasegawa A, et al. Arthroscopic superior capsule reconstruction for irreparable rotator cuff tears: Comparison of clinical outcomes with and without subscapularis tear. *Am J Sports Med* 2020;48:3429-3438.
4. Hammad AM, Phillips C, Wijdicks CA, Adams CR, Denard PJ. Two-year retrospective patient-reported outcomes following superior capsular reconstruction. *Arthroscopy* 2022;38:262-266.
5. Mirzayan R, Bouz G. Biologic tuberoplasty with an acellular dermal allograft for massive rotator cuff tears. *Arthrosc Tech* 2021;10:e1743-e1749.
6. Griffin JW, Runzo D, Bonner KF. Arthroscopic biologic interpositional tuberosity graft for the treatment of irreparable rotator cuff tears. *Arthrosc Tech* 2021;10:e1729-e1735.
7. Mirzayan R, Stone MA, Batech M, Acevedo DC, Singh A. Failed dermal allograft procedures for irreparable rotator cuff tears can still improve pain and function: The "biologic tuberoplasty effect." *Orthop J Sports Med* 2019;7: 2325967119863432.