Technical Note

Subscapularis Repair Prior to Subscapularis Takedown in Anatomic Shoulder Arthroplasty: Improving Anatomic Restoration and Mechanics of the Subscapularis

Brendan M. Lilley, B.A., Joseph J. Ruzbarsky, M.D., Stephanie K. Eble, B.A., Annalise M. Peebles, B.A., Tyler J. Zajac, M.S., A.T.C., O.T.C., and CAPT Matthew T. Provencher, M.D., M.B.A., M.C., U.S.N.R. (Ret.)

Abstract: Traditionally, total shoulder arthroplasty is performed using a deltopectoral approach through which the glenohumeral joint is accessed by mobilization of the subscapularis. Despite several variations on the subscapularis management techniques, postoperative complications, including subscapularis deficiency and lower functional outcomes, remain an area for improvement. The purpose of this Technical Note is to describe in detail our technique for management of the subscapularis in the setting of a stemless humeral implant through which the repair is planned and almost entirely performed at the beginning of the case, prior to the subscapularis peel. This technique aims to improve outcomes after total shoulder arthroplasty by 1) avoiding the anatomic implant with anchor drilling, 2) improving procedure efficiency, and 3) anatomically "repairing" the subscapularis prior to takedown by placing anchors exactly at the repair-tension site.

Introduction

Total shoulder arthroplasty (TSA), which has improved dramatically over the past decade, has become the treatment of choice for young active individuals with shoulder arthritis (Fig 1).[1] Stemless or humeral head resurfacing components have also gained popularity in this population due to good fixation in dense bone, as well as their bone preservation upside.[2,3] During a TSA procedure, access to the glenohumeral joint is often gained through the mobilization of the subscapularis muscle,[4] and failure of the subscapularis after TSA is a common issue directly linked to worse patient outcomes. Subscapularis management remains an area of active debate with several different techniques currently employed, including a subscapularis tenotomy (ST), subscapularis peel (SP), or a lesser tuberosity osteotomy (LTO).[4-7]

ST has been the traditional approach to the TSA, as it provides easy access to the glenohumeral joint while leaving a tendon stump for direct tendon to tendon repair. However, many complications have been reported regarding the lack of subscapularis function after TSA, and in some cases, it is difficult to complete an adequate repair.[8,9] Although some studies have shown improved functional outcomes with an LTO, many others have noted equivalence between LTO and SP.[5,7,10] An improved methodology for completing the repair of the SP or ST (this technique can be used for both), which yields successful patient outcomes when performed correctly,[11] is the subject of this technique article. The purpose of this Technical Note is to describe in detail a technique for fixation of SP or ST with the

Frank H. Netter M.D. School of Medicine, North Haven, Connecticut, U.S.A. (B.M.L.); The Steadman Clinic, Vail, Colorado, U.S.A. (J.J.R., T.J.Z., M.T.P.); Geisel School of Medicine at Dartmouth College, Hanover, Massachusetts, U.S.A. (S.K.E.); and The Steadman Philippon Research Institute, Vail, Colorado, U.S.A. (A.M.P., M.T.P.)

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Address correspondence to CAPT Matthew T. Provencher, M.D., M.B.A., M.C., U.S.N.R., (Ret.), Steadman Philippon Research Institute, The Steadman Clinic, 181 W. Meadow Dr., Ste. 400, Vail, CO 81657, U.S.A. E-mail: mprovencher@thesteadmanclinic.com

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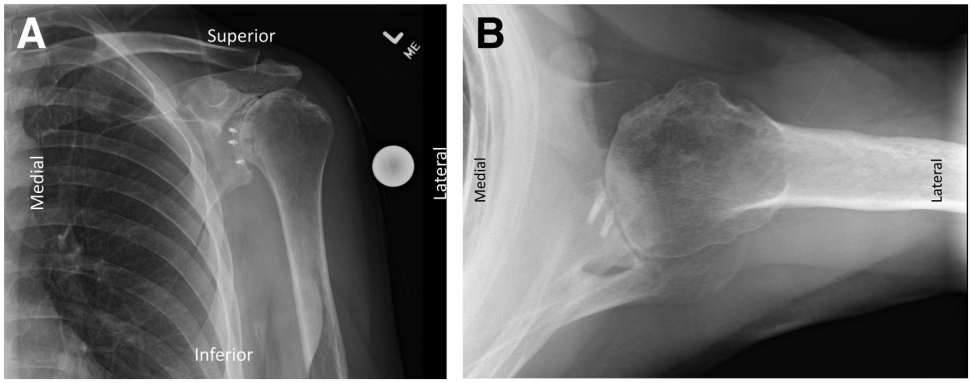

Fig 1. (A) Anteroposterior radiograph of a left shoulder demonstrating glenohumeral arthritis with three prior anterior glenoid metal anchors and joint space obliteration, indicating the need for TSA. (B) Axillary radiograph of a left shoulder demonstrating glenohumeral arthritis with three prior anterior glenoid metal anchors and joint space obliteration, indicating the need for TSA.

goal of improving outcomes after total shoulder arthroplasty. More specifically, the goal of this technique is to show how the subscapularis repair is essentially performed at the beginning of the case, even prior to subscapularis takedown in order to 1) avoid the implant with anchor drilling, 2) improve the efficiency of the procedure, and 3) anatomically "repair" the subscapularis prior to takedown by placing anchors exactly at the repair-tension site.

Surgical Technique

A narrated video with demonstration of the surgical technique described below may be reviewed (Video 1).

Patient Positioning and Anesthesia

Prior to transfer to the operating room, an interscalene nerve block is placed by the regional anesthesia team using ultrasound guidance, and a catheter is left in place. Following administration of anesthesia, the patient is brought into the operating room and positioned in the beach chair position. All bony prominences are well padded, and a padded towel is additionally placed on the posteromedial edge of the scapula to ensure proper shoulder positioning.

Surgical Opening

A deltopectoral incisional approach is performed just lateral to the coracoid and through the deltopectoral interval. The cephalic vein is identified and retracted laterally for protection throughout the case. The conjoint tendon is then identified and freed from scarring from a previous surgery, and a Kolbel retractor is placed underneath the conjoint tendon.

Subscapularis "Repair" Prior to Takedown

Prior to a subscapularis peel, the distinguishing factor of this technique is that the subscapular repair is prepared prior to tendon detachment, which allows for a more precise and anatomic repair, along with efficiency of the surgery. First, the high strength #5 FiberWire looped sutures (Arthrex, Naples, FL) are passed through the subscapularis tendon beginning 2 cm medial from the most lateral tendon attachment on the lesser tuberosity (Fig 2, A and B). A standard full-thickness throw through the tendon is performed in a vertical fashion, and the needle end is passed through the loop to lock the construct, and then three additional vertical throws working further laterally are completed (Fig 3). This is repeated with 2 additional high-strength nonabsorbable looped sutures from superior to inferior, spaced approximately 1 cm apart from each other (Table 1).

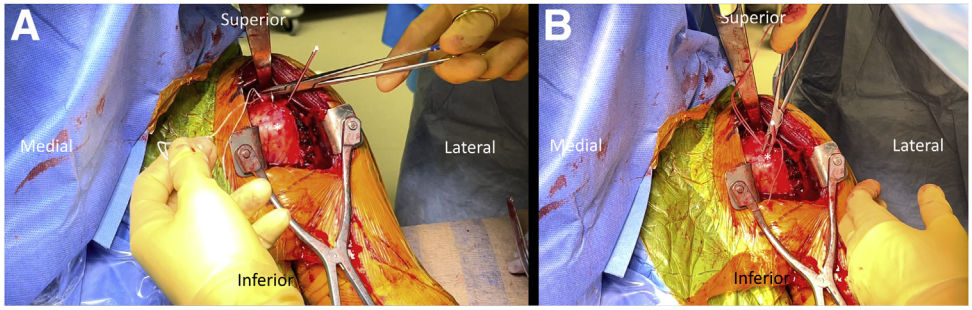

Fig 2. (A, B) High-strength looped sutures are passed through the subscapularis tendon beginning 2 cm medial from the most lateral tendon attachment on the lesser tuberosity in order to prep the tendon for later subscapularis repair. *Denotes the subscapularis.

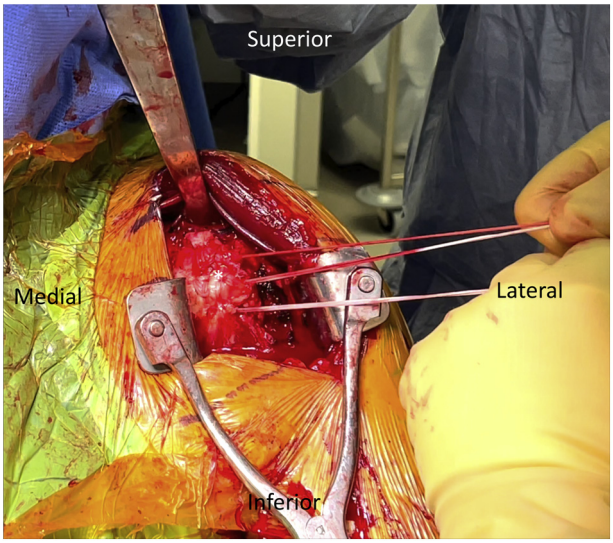

Fig 3. In continuation of subscapularis repair preparation beyond the high-strength looped sutures previously added, a standard full-thickness throw through the tendon is performed in a vertical fashion and the needle end is passed through the loop to lock the construct followed by three additional vertical throws working further laterally are completed. *Denotes the subscapularis.

Next, in a sequential fashion from superior to inferior, a spade-tipped drill is used to pilot three holes for the unicortical buttons starting at the medial border of the bicipital groove and spaced approximately 1 cm apart to prevent convergence (Fig 4). The key to this is that the buttons sit against the anterior cortex, which avoids the implant (Table 1). Just the suture tails are passed through each of the three unicortical buttons, which are then implanted and flipped unicortically. The suture ends are then tagged with a hemostat, as are the suture strands just medial to the button, making sure to leave enough suture, so it does not restrict access to properly view and prepare the glenoid. This portion of the sutures is used for traction on the tendon during the subscapularis peel (Fig 5).

Subscapularis Peel

Next, an additional no. 2 absorbable suture is placed at the superolateral border of the subscapularis tendon, and this along with the previously passed 3 suture loops are used to facilitate a subscapularis peel, performed from the bicipital groove working medially (Fig 6).

Humeral Head and Glenoid Management

The humeral head osteophytes are removed using a Rongeur, using a Darrach retractor inferiorly to protect the axillary nerve. The angle of the head was then confirmed to be 135°, based on preoperative templating. The coring template is placed, and coring is completed to ensure the proper size of the cage screw, and then the humeral head component is malleted into place. To address the glenoid component, the arm is placed onto a padded mayo stand, and preparation begins with complete excision of labral tissue, osteophytes, and loose bodies, followed by a 360° capsulotomy with the use of a rongeur and needle-tipped electrocautery device (Table 1). The axillary nerve is identified through digital palpation near the anteroinferior glenoid and gently protected throughout the case. The glenoid is prepared, and a polyethylene inlay component is fixed into position with methyl methacrylate cement.

Subscapularis Repair

The sutures previously passed through the subscapularis and through the unicortical buttons are sequentially tightened to reduce the subscapularis back to its footprint. Next, a free needle is used to double back the link suture through the subscapularis tendon where each suture was tied to the inferior suture. Finally, the repair is reinforced with interrupted throws of suture tape. This completes the subscapularis repair (Fig 7).

Final Inspection and Closure

Appropriate implant choice is confirmed using the 40-50-60 principle. After the wound is closed in layers, the surgeon uses a 0-vicryl suture to close the deltopectoral

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
A subscapularis peel should begin laterally in the bicipital groove to optimize the amount of tendon available for repair.	Avoid the supraspinatus muscle and tendon when releasing the rotator interval from the upper border of the subscapularis. If the long head of the biceps is present, its tendon can be used as a guide for avoiding the supraspinatus.
A needle tip electrocautery device is used for the peel for precise dissection and to optimize tendon volume and dissection from bone.	The reinsertion unicortical buttons are spaced approximately 1 cm apart in the medial aspect of the bicipital groove, which provides strong cortical bone. Avoid spacing closer than 1 cm to avoid risk of fracture or tunnel convergence.
After carefully tensioning each of the free suture ends to reduce the subscapularis back to its bony footprint, tie these ends together for both further compression and backup fixation.	Attempt this repair technique in stemmed implants with great caution, as there is likely not enough space from the cortical bone to the implant stem to allow for the buttons to flip and function appropriately.

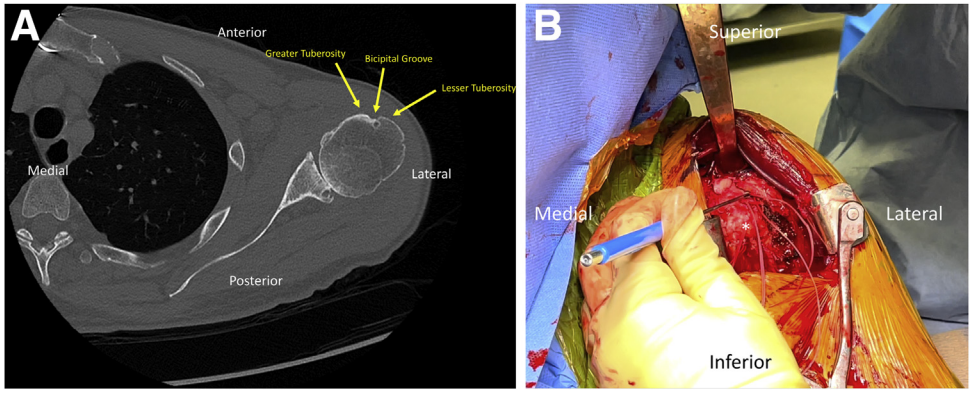

Fig 4. (A) The trajectory of cortical buttons on a labeled axial CT image, which are created in fashion to allow the suture tails to pass through while avoiding the implant. (B) In sequential fashion from superior to inferior, a spade-tipped drill is used to pilot three holes for the unicortical buttons starting at the medial border of the bicipital groove and spaced approximately 1 cm apart to prevent convergence. *Denotes the subscapularis.

interval, a 2-0 absorbable deep dermal layer, and finally noninvasive closure device.

Postoperative Rehabilitation

The joint should be supported in a sling for ~4-5 weeks to allow healing of the soft tissue structures. During that time there should also be a focus on both passive and active-assisted range of motion (ROM) with the patient not exceeding 45° of internal rotation during that time. Active ROM should wait until week 5 to prevent injuring the subscapularis repair; isometric exercises should be coupled with ROM for muscle stimulation, and neuromuscular electrical stimulation may be used at this time. Strengthening occurs during weeks 8 to 12; progressive advancement through this phase over a period of 2 months is optimal. The focus during this time is to help reduce pain and improve movement (therapy should focus on both shoulder, back musculature, and posture), so that the patient rehabs most advantageously. Finally, between 4 and 5 months, the patient can work on return to play, while strengthening continues around the operative joint. Full strength can take up to 12 months in some cases for patients (Fig 8, A and B).

Discussion

Optimal subscapularis tendon management in the setting of TSA remains controversial. The primary options for management include subscapularis tenotomy (ST), lesser tuberosity osteotomy (LTO), and subscapularis peel (SP). The limitations of ST, including the potential for inadequate tissue to make the repair if the incision is performed too lateral or too medial or tendon attenuation occurs postoperatively,[12] have caused SP and LTO to become more favorable options for subscapularis management. The authors advocate for the

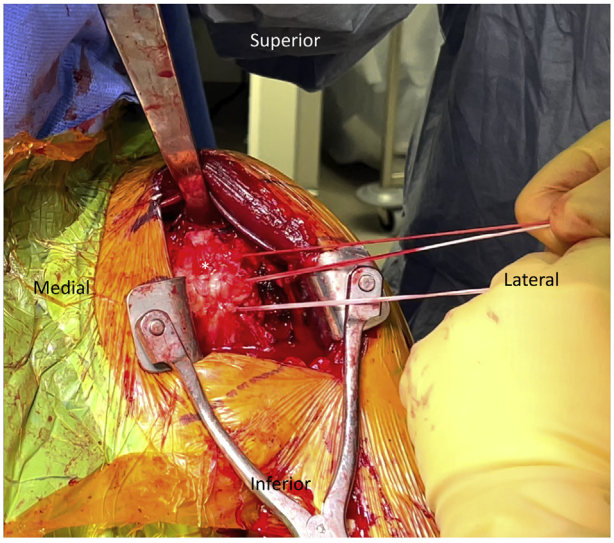

Fig 5. Suture ends and suture strands medial to the button, which are tagged with hemostat, are used for traction on the tendon during the subscapularis peel. *Denotes the subscapularis.

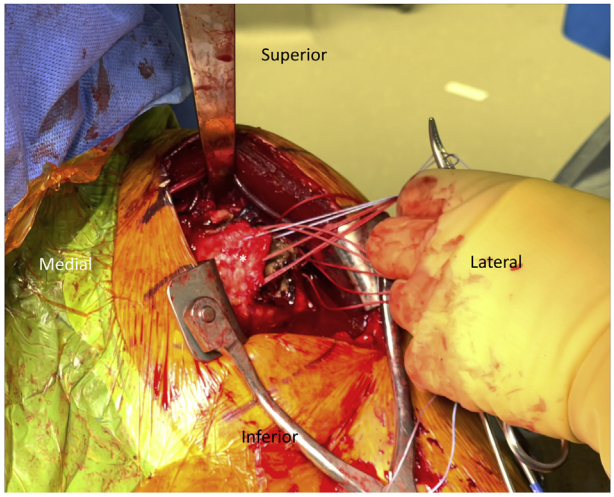

Fig 6. Three suture loops are used to facilitate a subscapularis peel, performed from the bicipital groove working medially. *Denotes the subscapularis.

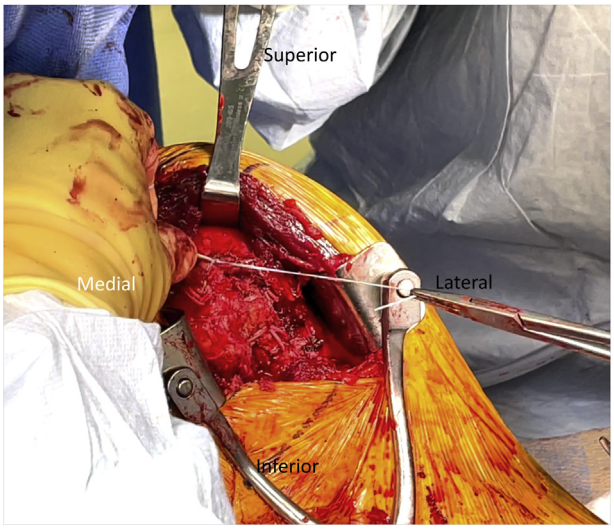

Fig 7. In the final step of the post-total shoulder arthroplasty TSA subscapularis repair, the subscapularis is reinforced with interrupted throws of suture tape. This completes the subscapularis repair.

SP technique described, as it allows for the integrity of the muscle to be maintained, which limits the possibility of scar tissue formation associated with ST and nonunion associated with LTO. Further, this technique allows for subscapularis preparation prior to the peel, which allows for a more precise anatomic repair. The sutures passed through the subscapularis and unicortical buttons in preparation for repair also allow for traction during the peel.

While the limitations of ST have caused a shift toward LTO and SP for subscapularis management, many studies have reported no difference between LTO and SP repairs.[5,7,10] In a biomechanical study comparing LTO and SP, Buraimoh et al. found no differences in repair gapping, fatigue failure, or load to fatigue.[13] In their randomized controlled trial evaluating a cohort of 43 patients with LTO or SP, Lapner et al. found no differences between the two techniques with regard to postoperative strength or patient-reported outcome scores.[14] In a follow-up study evaluating healing on CT and subscapularis fatty infiltration for the same cohort, the authors again found no differences between LTO and SP.[15] In contrast, Shafritz et al. performed lift-off tests at an average of 4 years and minimum 1 year postoperatively for their cohort of patients undergoing SP ($n = 46$) or LTO ($n = 44$).[16] These authors found that 69.6% of SP patients compared to 90.9% of LTO patients had a normal lift-off test.

Although LTO has been routinely used for its high healing rates and biomechanical strength, the possibility of LTO nonunion remains a concern. Small et al. reviewed computed tomography (CT) scans at a minimum of 6 months postoperatively and reported nondisplaced nonunion in 8.74% of patients and displaced nonunion in 4.3% of patients whose LTO site was able to be visualized.[17] Subsequent studies have shown that patients with nonunion LTO have lower postoperative function and higher postoperative pain scores, although satisfaction levels remained high.[18] The SP technique described avoids the potential for nonunion associated with LTO and uses an anatomic repair of the subscapularis to bone via self-locking unicortical buttons.

Limitations of this SP technique include potential for fracture if buttons are placed too close together (minimum 1 cm apart), and limited utility with stemmed TSA implants to ensure adequate cortical bone for button placement. Additionally, care must be taken to avoid the supraspinatus muscle and tendon when performing the peel (Table 1).

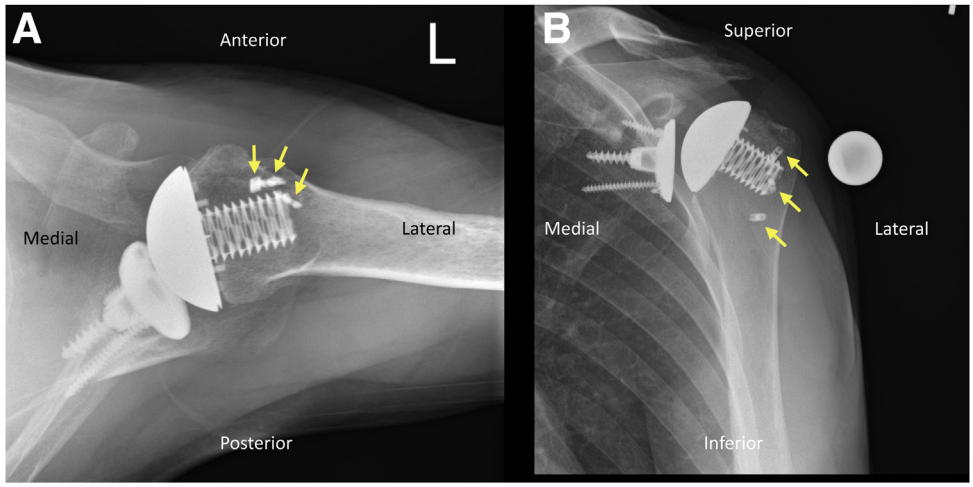

Fig 8. Imaging of the patient at 12 months postoperative: postoperative axial (A) and anteroposterior (B) radiographs of three unicortical buttons, starting at the medial border of the bicipital groove and spaced approximately 1 cm apart.

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