Knotless Suture Bridge Technique in High-Grade Bursal-Sided Rotator Cuff Tears. Is This The Way Forward?

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Abstract: We present our technique in managing high-grade bursal-sided rotator cuff tears. In this technique, the remaining intact cuff tissue is not sacrificed. The suture bridge technique is used to uniformly tension the torn tissue to the rotator cuff footprint. No knots are tied on the rotator cuff to minimize the tension on the cuff. The sutures are then anchored on the lateral cortex of the humerus. This technique allows repair with minimum tension while preserving the original length of the rotator cuff.

The high rate of tear progression after subacromial decompression in patients with bursal-sided partial rotator cuff tears has been noted by Ellman.[1] This has led to a change in the management of these partial bursal-sided tears.

The incidence of partial tears of the rotator cuff has been described by many authors. Löhr and Uhthoff[2] studied 309 cadavers and found full thickness tears in 19% of the cadavers, and 32% of the cadavers had partial tears of the rotator cuff. Fukuda[3] in 2000 studied 249 cadavers, and he found 13% partial tears of the rotator cuff, with bursal-sided tears comprising 18% of the tears. Clinical studies have also shown that the incidence of these partial tears increases with age.[4]

The repair of bursal-sided rotator cuff tears has been described in many research works. Some authors prefer to complete the tear, whereas others repair the tears without taking down the remaining tendon of the rotator cuff. We reviewed 2 articles in which the remaining footprint of the rotator cuff was left intact. Wolff et al.[5] in 2006 described their repair technique in which anchors were placed at the medial footprint, and the sutures were then passed through the tendon and later tied on the bursal surface of the rotator cuff. Yoo et al.[6] in 2007 described their technique in which a small window was made at the remaining cuff. The sutures were passed through the cuff and tied on the bursal side of the rotator cuff.

Our technique offers a variation in the techniques described by the above-named authors. We believe that repair of high-grade bursal-sided rotator cuff tears must be done with as little tension as possible, without damaging the remaining intact rotator cuff tissue. In this way, the original tension of the cuff is maintained.

Surgical Technique

Preoperative Setup

After the induction of anesthesia, the patient is positioned on a beach chair. The shoulder is cleaned and draped in the usual manner. The limb is free and not placed on an arm positioner or traction device. Instead, the arm is placed on a Mayo table. The assistant can help the surgeon with the positioning of the arm to the desired position. Important surgical landmarks are then drawn: the clavicle, acromioclavicular joint, coracoid process, lateral and posterior border of the acromion.

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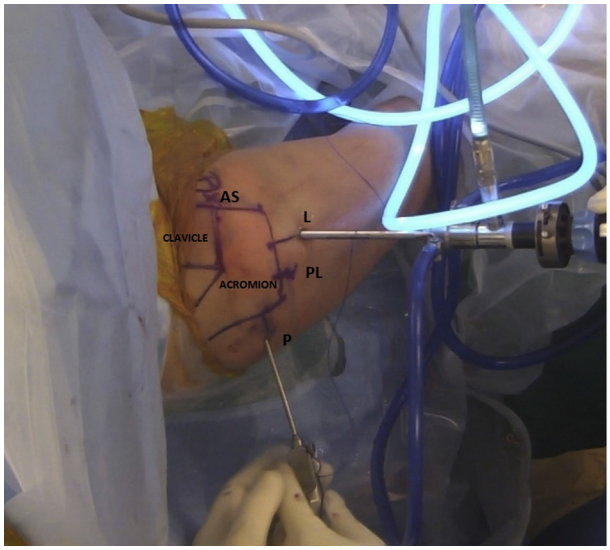

Fig 1. Bird's eye view of the right shoulder with a 30° arthroscope from the lateral (L) portal. The anterosuperior (AS) portal is located just adjacent to the acromioclavicular joint. The spectrum device was introduced from the posterior portal (P). (PL, posterolateral.)

Portal Placement

We use 4 portals to repair the bursal-sided rotator cuff tear. The first portal is the standard posterior viewing portal. The second portal is the lateral portal, which is approximately 2.5 cm from the lateral border of the acromion. The third portal is the posterolateral portal, which is 1 cm from the posterolateral border of the acromion. The fourth portal is the anterosuperior portal, which is 1 cm anterior to the acromioclavicular joint. The location of these portals is illustrated in Figure 1.

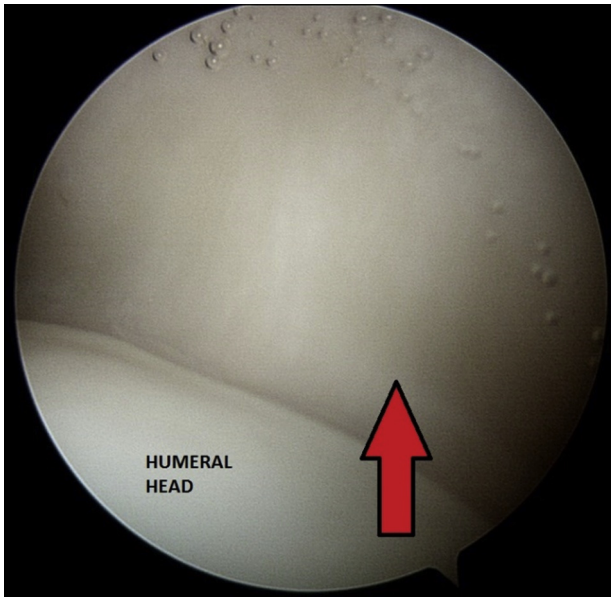

Fig 2. Arthroscopic view of the right shoulder viewed from the posterior portal with a 30° arthroscope. The intact articular side rotator cuff footprint depicted by the red arrow.

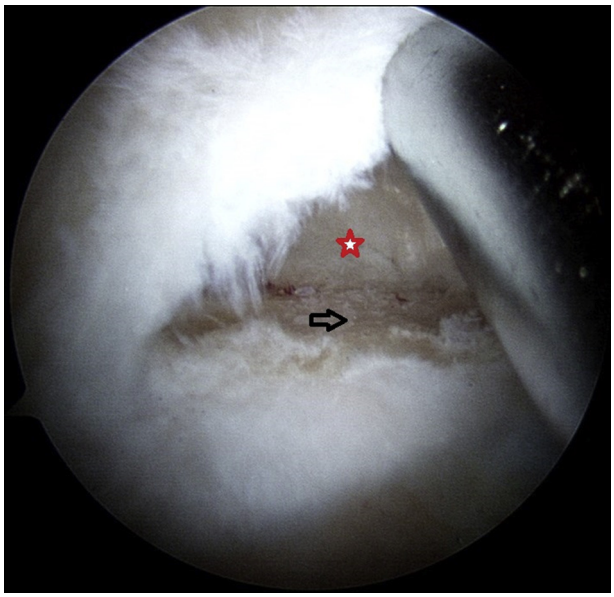

Fig 3. Arthroscopic view of the right shoulder viewed from the posterolateral portal using a 30° arthroscope showing a high-grade bursal-sided tear. The exposed footprint (black arrow) after decortication. Note that the tear (red star) did not extend to the articular side.

Technique

The glenohumeral joint is first inspected with a 30° arthroscope through the posterior viewing portal, and

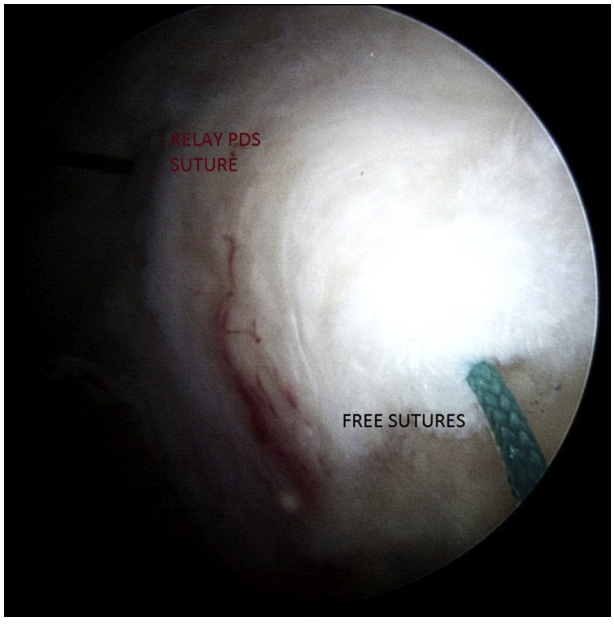

Fig 4. Arthroscopic view of the right shoulder viewed from the posterolateral portal using a 30° arthroscope. The 2 free sutures (ULTRABRAID and ETHIBOND EXCEL) being relayed through the rotator cuff.

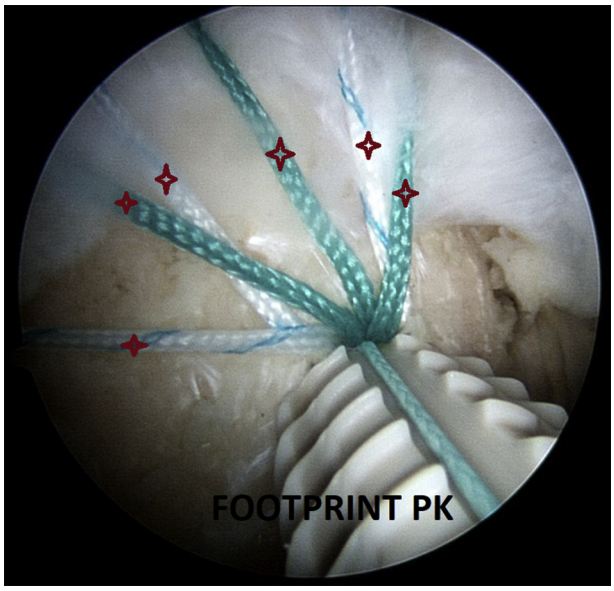

Fig 5. Arthroscopic view of the right shoulder viewed from the posterolateral portal using a 30° arthroscope. The 6 limbs of the free sutures (red stars) being tensioned individually before the anchor (FOOTPRINT PK) being advanced into the lateral cortex.

the subscapularis tendon, long head of the biceps tendon, and the glenoid labrum are inspected (Video 1). The articular side of the rotator cuff is carefully inspected to look for any evidence of tear (Fig 2).

The arthroscope is then inserted in the subacromial space. The acromion process morphology is inspected and acromioplasty is then performed after the establishment of the lateral portal. Once the acromioplasty is completed, the arthroscope is turned 180° toward the bursal surface. Complete bursectomy is performed using a 4.5-mm arthroscopic shaver (Smith & Nephew). This is necessary as the bursal tissue could interfere with suture management and subsequent anchor placement at the lateral footprint. The arthroscope is then changed to the lateral portal and the adequacy of the acromioplasty is assessed. Occasional bleeding may be encountered and this is managed by using an ArthroCare Super TurboVac 90 RF ablation wand (Smith & Nephew), and by increasing the pump pressure temporarily. The bursal-sided tear of the rotator cuff is carefully inspected for any extension into the articular side (Fig 3).

We start by gentle debridement of the edge of the bursal tear. The exposed footprint of the rotator cuff is decorticated using a motorized shaver blade. We create another viewing portal at the posterolateral aspect of the acromion. A 7.0-mm arthroscopic cannula (CLEAR TRAC, Smith & Nephew) is placed at the lateral portal. Once the footprint preparation is completed, the bursal-sided tear would be ready for repair.

Three size 2 ETHIBOND EXCEL sutures (Ethicon, Somerville, NJ) and 3 size 2 ULTRABRAID sutures (Smith & Nephew Endoscopy, Andover, MA) are then used as free sutures in the following manner. A Spectrum suture hook (ConMed-Linvatec, Largo, FL) is preloaded with a No. 1 PDS (Ethicon) suture. From the posterior portal, the suture hook is first pierced 1.5 cm medial from the torn bursal edge. Once the full thickness of the cuff has been pierced, the tip of the suture hook is then directed to the torn edge and the PDS suture is relayed. The edge of the PDS suture is then brought out to the lateral working portal. One ETHIBOND EXCEL and one ULTRABRAID suture are tied together to the PDS and then shuttle relayed to the posterior portal (Fig 4). The second bite is taken approximately 0.8 cm from the first. Once the full thickness of the cuff has been pierced and the PDS suture is brought to the torn edge, the other end of the ETHIBOND EXCEL and the ULTRABRAID suture is then relayed to the cuff. This process is repeated to relay another set of ETHIBOND EXCEL and ULTRABRAID sutures in the anterior half of the rotator cuff. Another portal is then created, approximately 1 cm anterior to the acromioclavicular joint, for easier passage and manipulation of the Spectrum suture hook. In total, there are 6 points on the cuff pierced by the spectrum device, each with 1 ETHIBOND EXCEL and 1 ULTRABRAID suture.

Once all 12 limbs of the free sutures have been relayed, the lateral footprint is identified for anchor placement. The sutures are then retrieved from the bursal surface of the rotator cuff; 1 suture limb each from the point the cuff is pierced. We use 2 anchors, that is, one 4.5-mm FOOTPRINT ULTRA PK (Smith & Nephew) and one 4.5-mm POPLOCK (ConMed-Linvatec) to anchor the sutures at the lateral row. No knots are tied on the cuff. Each limb of the suture is then individually tensioned before each anchor is advanced into the cortex (Fig 5).

Discussion

The dilemma of completing partial bursal-sided tears into a complete tear has always been debated. When a partial tear is completed, the cuff is sometimes inadvertently lateralized. This can cause undue tension to the rotator cuff. High tension in the cuff is inversely

Table 1. Advantages and Disadvantages

Advantages:
Less implants used in this technique. No medial row suture anchors were used.
No knot tying resulting in no tissue strangulation and knot impingement under the acromion.
Less surgical time.
Intact articular side tendon not sacrificed.
Disadvantage:
Not suitable for full thickness rotator cuff tears.

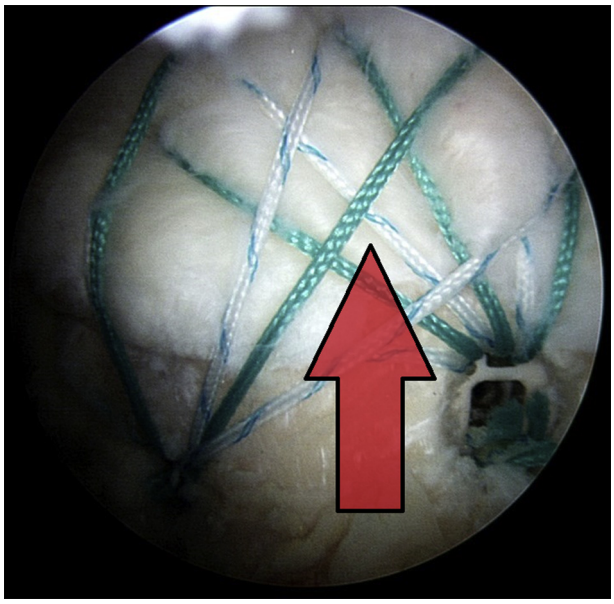

Fig 6. Arthroscopic view of the right shoulder with the patient in beach chair position, viewed from the posterolateral portal using a 30° arthroscope showing the bursal-sided tear after the repair. The sutures uniformly press down the whole tissue of the rotator cuff to the footprint (red arrow), distributing even tension.

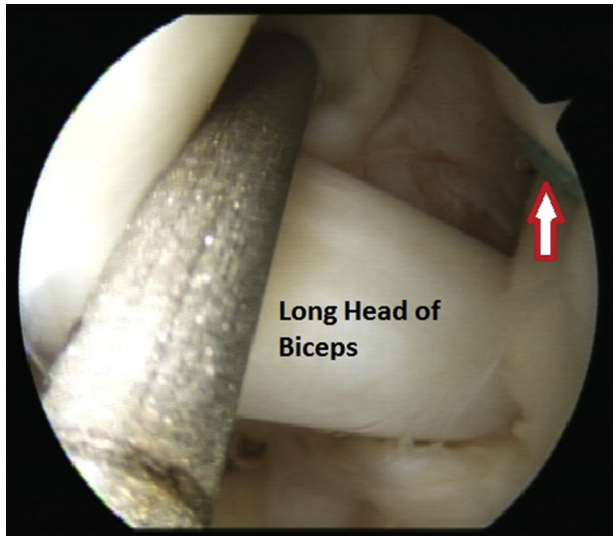

Fig 7. Arthroscopic view of the right shoulder viewed from the posterior portal using a 30° arthroscope showing the long head of biceps tendon being mobilized with a probe to ensure no incarceration of the sutures to the biceps tendon. The red arrow shows the suture that was relayed from the subacromion space.

correlated with the healing of the cuff.[7] Repair of the rotator cuff must be performed with as minimum tension as possible. By keeping the remaining tissue at the footprint intact, the original length of the rotator cuff can be preserved. The added advantage of this technique is that only the bursal-sided tissue will undergo the healing process. The articular tissue acts as a splint in maintaining the tension of the rotator cuff.[5] By not completing the tear, the vascular supply to the remaining intact rotator cuff is left undisturbed.

Kim et al.[8] in 2015 compared outcomes between in situ repairs and tear completion repairs of partial thickness rotator cuff tears. Although the visual analog score for pain, Constant Score, American Shoulder and Elbow Society Score, and the Korean Shoulder Score did not show any statistically significant difference in both methods, the retear rate in the tear completion group of the bursal tear was higher. There was no difference in the retear rate of the articular side partial tears. This study strengthens our preference in preserving rotator cuff tissue at the footprint in managing these bursal-sided tears of the rotator cuff.

There are several key points to remember when attempting to repair a high-grade bursal-sided rotator cuff tear. Adequate visualization and control of bleeding are paramount. Emphasis must be given to ensure an adequately decompressed subacromial space via complete bursectomy and adequate acromioplasty, before attempting to repair the rotator cuff because the bursa tissue will block the field of vision and can interfere in suture management. The other key point is that the suture hook tip must exit at the bursal-sided tear for easy passage of the PDS suture. This technique varies with the technique described by Yoo et al.[6] in which the relay suture was not stuffed into the joint or retrieved through a window made at the intact rotator cuff.

There are several advantages of this technique (Table 1). First, no knots were tied on the bursal surface of the cuff. We believe that this will also help to reduce the tension on the rotator cuff. With no knot tying, there will be no tissue strangulation that may otherwise further compromise the vascular supply to the rotator cuff tissue. In addition, there are no knot impingement on the undersurface of the acromion.

Another advantage of this technique is that the free sutures are placed across the whole length of the footprint. By doing so, the tension generated during the anchor placement is uniformly distributed across the rotator cuff footprint (Fig 6).

Table 2. Pearls and Pitfalls

Pearls:
Adequate subacromial decompression before attempting repair. Incomplete bursectomy will complicate suture management.
After passing the free sutures through the cuff, always check intra-articularly for biceps tendon incarceration.
Suture hook tip must be visualized at the tear site before relaying the PDS suture.
Pitfall:
Excessive suture hook manipulation may lead to tip breakage. Necessary to make another portal to prevent this complication.

Table 3. Step by Step Summary

1.	Position the patient on a beach chair after induction of anesthesia.
2.	Clean and drape the affected shoulder.
3.	Mark and draw important landmarks, that is, lateral border of acromion process, acromioclavicular joint, coracoid process, clavicle and also the portal placement, that is, posterior portal, lateral portal, posterolateral portal, and anterosuperior portal.
4.	Begin diagnostic arthroscopy of the shoulder joint through the posterior viewing portal. Ensure that articular side rotator cuff tissue is intact.
5.	Move the arthroscope into the subacromial space. Inspect the acromion morphology and perform acromioplasty as needed via the lateral portal.
6.	Create another viewing portal at the posterolateral aspect of the acromion. Turn the arthroscope 180° toward the bursal side of the rotator cuff. Perform bursectomy and identify the bursal tear of the rotator cuff.
7.	Insert a 7.0-mm arthroscopic cannula at the lateral portal
8.	Debride the torn edge of the torn bursal edge and gently decorticate the footprint using a 4.5-mm motorized shaver.
9.	Using a Spectrum suture hook from the posterior portal, pierce the bursal tissue 1.5 cm from the torn edge, and bring the tip of the suture hook to the tear site.
10.	Relay the PDS suture from the spectrum device and retrieve the suture from the lateral portal.
11.	Tie 1 limb of the ETHIBOND and ULTRABRAID suture together with the PDS and relay the suture to the posterior portal.
12.	Take another bite of the torn tissue (approximately 0.8 cm from the first bite) and relay the PDS suture.
13.	Retrieve the PDS from the lateral portal and tie the other end of the ETHIBOND and ULTRABRAID suture, and relay them to the posterior portal.
14.	Repeat this process using another set of ETHIBOND and ULTRABRAID suture.
15.	Create another portal, 1 cm anterior to the acromioclavicular joint.
16.	Approach the anterior half of the cuff using this anterosuperior portal. Pierce the torn bursal tissue using the Spectrum suture hook. Relay the ETHIBOND and ULTRABRAID sutures as mentioned above.
17.	Once all sutures have been relayed through the rotator cuff, inspect the glenohumeral joint for any incarceration of the long head of biceps tendon by the sutures.
18.	Identify the lateral cortex of the humeral head for anchor placement. Perform adequate bursectomy to clear the lateral footprint.
19.	Retrieve 1 suture limb from each point the cuff was pierced. Insert the 6 limbs of the suture into the first anchor. Individually tension each suture before final hammering of the anchor into the bone.
20.	Retrieve the remaining 6 limbs of the sutures and insert into another anchor. Identify the placement of the anchor and individually tension each suture before the final placement of the anchor.

In cases where the long head of biceps tendon is left intact, caution must be exercised during passing of the suture hook through the rotator cuff. The long head of the biceps tendon might be accidentally caught while passing the sutures. We advocate that the arthroscope must be reintroduced into the glenohumeral joint to confirm that the biceps tendon is not caught together with the cuff tissue (Fig 7).

One of the pitfalls (Table 2) of this technique is that excessive manipulation of the suture hook must be avoided. Excessive manipulation of any suture hook device may lead to tip breakage. To avoid this complication, it is recommended to approach the anterior half of the cuff by creating another working portal, 1 cm in front of the acromioclavicular joint as shown in Figure 1.

High-grade bursal-sided tears of the rotator cuff can be repaired without taking down the remaining intact tendon. We feel that this method is simple and reproducible, as summarized in Table 3. This method preserves the original length and width of rotator cuff footprint, thus minimizing cuff length-tension mismatch. Without knot tying, this technique minimizes the tension generated at the footprint and prevents tissue strangulation, thus giving the rotator cuff tissue a better chance to heal.

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