

A Technique for a Suture-Based Cable Reconstruction of an Irreparable Posterosuperior Rotator Cuff Tear



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Abstract: The management of irreparable rotator cuff tears remains challenging. In patients in whom a complete repair cannot be obtained, a partial repair remains an option. The goal of a partial rotator cuff repair is to obtain a stable glenohumeral joint fulcrum by restoring the rotator cable complex. Traditionally, partial repair has been performed with independent reattachment(s) of the rotator cable complex with or without margin convergence medially. This Technical Note describes an alternative approach to a partial rotator cuff repair with a suture-based cable reconstruction.

The rotator cable (RC) complex is one of the most important contributors to glenohumeral stability.^{1,2} This structure is a continuation of the deep layer of the coracohumeral ligament that runs perpendicularly to the supraspinatus from just posterior to the bicipital groove to the posterior border of the infraspinatus.³ The RC was initially described by Burkhart et al.⁴ as “the suspension bridge” of the shoulder. Indeed, during force transmission from the supraspinatus to the humerus, it has been shown to be the primary load-bearing structure.⁴ Cadaveric studies have demonstrated that rotator cuff tears with involvement of the RC attachment result in increased tendon strain

and tear displacement, as well as reduced tendon stiffness compared with tears within the rotator cuff crescent alone.⁵ In addition, tears with RC disruption have demonstrated a greater risk of retear after repair when cable reattachment has not been addressed.^{6,7} These findings have led some authors to suggest that cable disruption is a relative indication for earlier intervention and surgical management of rotator cuff tears.^{8,9}

In the setting of a massive rotator cuff tear, one or both of the RC attachments are typically disrupted. While complete repair is the goal, in some cases this cannot be obtained and a partial repair with restoration of the anterior and posterior RC attachments is an option. Traditionally, this technique has emphasized the repair of the RC attachments alone.¹⁰ In this Technical Note, we present an alternative approach with a suture-based cable reconstruction (SBCR).

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Surgical Technique (With Video Illustration)

We consider this technique in patients with massive irreparable rotator cuff tears (MIRCT) of the supraspinatus and infraspinatus tendons who are not candidates for superior capsule reconstruction based on advanced age (i.e., >70 years of age), diminished health status (i.e., desire to avoid a prolonged operative procedure), Hamada classification (i.e., grade 3 or greater), or patient desire to avoid extensive rehabilitation.

Patient positioning is based on surgeon preference, although we prefer the lateral decubitus position with the arm suspended and in traction. Diagnostic arthroscopy is carried out through a standard posterior portal into the glenohumeral joint. The rotator cuff is

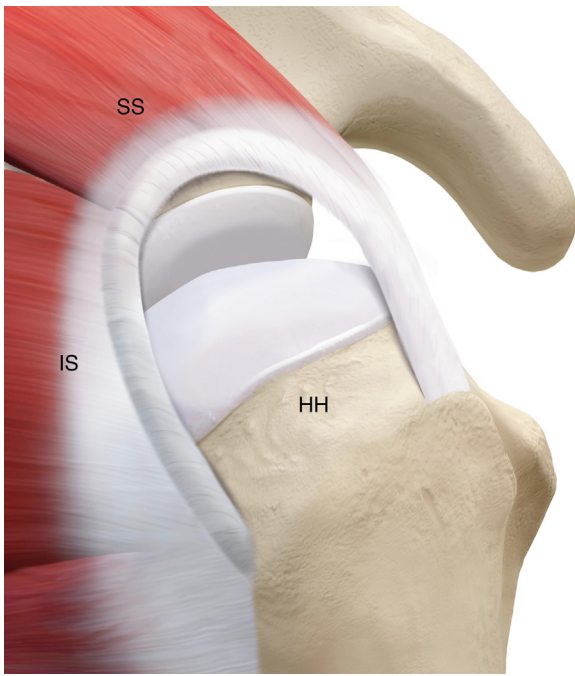


Fig 1. Schematic view of a massive irreparable poster-superior rotator cuff tear in a right shoulder. (HH, humeral head; IS, infraspinatus; SS, supraspinatus.)

evaluated intra-articularly to identify the extent of the tear anterior to posterior. The subscapularis and long head of the biceps tendons are first assessed and then addressed as indicated. The arthroscope is moved to the subacromial space through the same posterior portal. A lateral working portal is created. A complete bursectomy with the removal of bursal leaders is required for visualization of the rotator cuff. Once the tear has been identified and rotator cuff mobilization is performed, the tissue is assessed to determine whether it can be reduced back to the anatomic footprint without excessive force. If mobility of the tissue precludes complete

repair over the greater tuberosity from anterior to posterior, a SBCR is considered.

The anterior and posterior limits of the rotator cable are identified with the arthroscope in the posterior portal (Fig 1). We prefer to work from posterior to anterior and create rip-stop configurations at the anterior and posterior cable attachment sites. Through a lateral portal, the limbs of a high strength 2-mm suture tape (FiberTape; Arthrex, Inc., Naples, FL) are passed through the most posterior edge of the posterior cable in an inverted mattress fashion approximated 5 mm apart with an antegrade suture. Next, a second suture tape of a different color is passed between the first 2 limbs in a rip-stop configuration. The superficial is pulled through the tissue approximately three-quarters of the suture tape length, leaving one short and one long limb. The long limb of suture tape is again passed antegrade just anterior to the first set of suture limbs to complete the rip-stop configuration and prevent sliding.

A percutaneous portal is established for posterior anchor insertion at the site of the posterior cable attachment. Just lateral and anterior to the posterolateral corner of the acromion, a spinal needle is used as a guide to determine the adequate angle of approach and a small stab incision is made. Three suture limbs are retrieved through the percutaneous portal, leaving only the long limb from the second suture behind. A bone socket is created at the desired anchor placement site. The 3 suture tails are then secured with a knotless anchor (4.75-mm or 5.5-mm BioComposite SwiveLock; Arthrex) under tension to advance the posterior rotator cuff and reestablish the posterior rotator cable attachment. These suture tails are then cut flush with the anchor (Fig 2).

Returning to the lateral portal, the remaining long limb of the suture is passed through the rotator cuff edge in a running baseball stitch configuration to reinforce the rotator cable (Fig 3). Each pass is

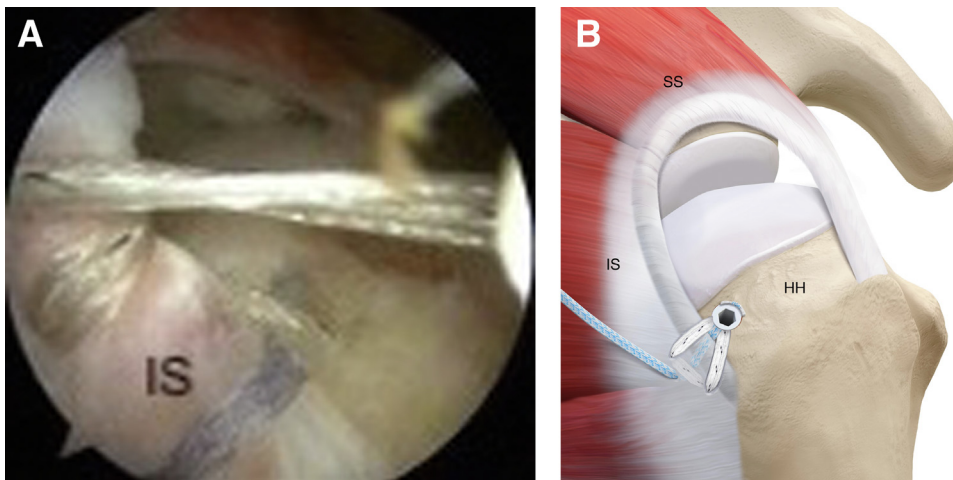


Fig 2. Arthroscopic view of a right shoulder from the posterior subacromial viewing portal (A) and corresponding schematic (B). The posterior rotator cable attachment is secured with 2 suture tapes in a rip-stop configuration, leaving one suture limb long. (HH, humeral head; IS, infraspinatus; SS, supraspinatus.)

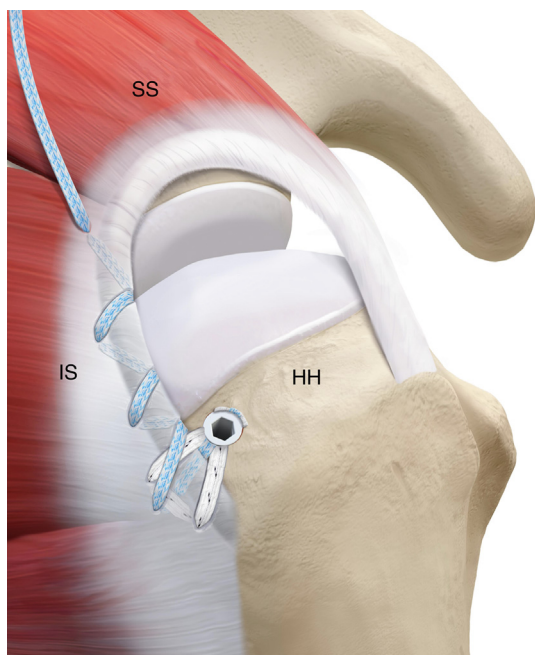


Fig 3. Schematic of a right shoulder. The long limb of the suture tape is progressive passed from posterior to anterior through the margins of the rotator cuff. (HH, humeral head; IS, infraspinatus; SS, supraspinatus.)

performed 2 to 3 mm lateral to the musculotendinous junction, spaced 5 mm apart from posterior to anterior until the anterior edge of the rotator cuff tear is reached. Typically, 5 to 6 additional passes are required. Following each pass, it is important to pull the suture tight to remove any slack. Frequently, as slack is removed the rotator cuff will progressively be pulled laterally and partially close the defect overlying the humeral head.

A third suture tape is used to create the next rip-stop configuration at the anterior rotator cuff edge as was done posteriorly. These 2 limbs as well as the cable

reconstruction limbs are then secured with a second knotless anchor at the anterior aspect of the greater tuberosity, just posterior to the bicipital groove to complete the SBCR (Fig 4). Placement of this anchor is either conducted via an anterosuperolateral portal if one was previously established for subscapularis or biceps work, or via percutaneous portal (Video 1).

Postoperatively, the patient is placed in a sling for 6 weeks. Range of motion is initiated at 6 weeks postoperatively, followed by strengthening at 12 weeks postoperatively and then gradual advancement to normal activities. The surgical steps and pearls and pitfalls are highlighted in Tables 1 and 2, respectively.

Discussion

MIRCTs are a common cause of pain and disability of the shoulder.¹¹ These tears directly affect normal biomechanics by disrupting active and passive restraints.¹² While several treatment options have been described for these tears, the failure rate remains unacceptably high.^{11,13,14} Therefore, it is imperative for surgeons to improve treatment strategies for the treatment of MIRCTs to obtain better postoperative outcomes.¹⁵

In this setting of a MIRCT, it is important to restore a stable glenohumeral joint fulcrum. Burkhart et al.⁴ first coined the term “rotator cable complex” and described it as a suspension bridge, suggesting that it transmits contractile forces of the supra- and infraspinatus muscles to the greater tuberosity. Indeed, the anterior and posterior attachments of the RC have been shown to be critical for shoulder biomechanics.^{5,6,13,16-21} Denard et al.¹⁶ and Collin et al.¹⁹ have highlighted the importance of the RC attachment integrity for maintenance of forward elevation above shoulder level. RC detachment is also associated with more advanced fatty infiltration and increased risk of tear propagation.^{6,7,20}

Fig 4. Arthroscopic view of a right shoulder from the posterior subacromial viewing portal (A) and corresponding schematic (B) demonstrate the completed suture-based rotator cable reconstruction. Reconstruction has been achieved with a running baseball stitch from posterior to anterior. (HH, humeral head; IS, infraspinatus; SS, supraspinatus.)

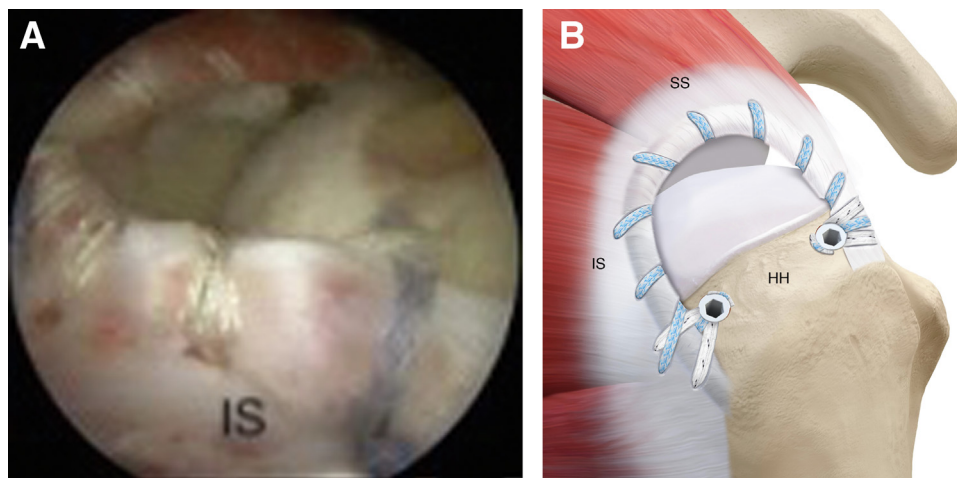


Table 1. Steps in Suture-Based Rotator Cable Reconstruction for Irreparable Posterosuperior Rotator Cuff Tear

Surgical Step	Description
1	Diagnostic arthroscopy is performed to a standard posterior portal to identify disruption of the rotator cable attachments and address the subscapularis as indicated.
2	The arthroscope is moved to the subacromial space to confirm an irreparable tear of the supraspinatus and infraspinatus tendons.
3	The posterior rotator cable attachment is re-established with a rip-stop configuration and a knotless anchor, leaving 1 suture tape limb long for subsequent advancement anteriorly.
4	The long suture tape is passed in a continuous running or locking baseball stitch configuration from posterior to anterior through rotator cuff tear edge until the anterior edge is reached.
5	At the anterior cable attachment, the running suture and an additional rip-stop suture are secured just posterior to bicipital groove.

Table 2. Pearls and Pitfalls

The technique is considered in patients who are candidates for partial repair based on age, activity level, radiographic classification, or patient preference

A complete bursectomy with removal of bursal leaders is required for visualization of the rotator cuff

Rip-stop configurations are used anteriorly and posteriorly to provide enhanced stability at the cable attachment sites.

Two different-colored suture tape limbs are used for distinguishing the rip-stop suture from the cable reinforcement limb

Secure the posterior anchor first to provide a point of fixation

Remove the slack from the suture with each progressive pass in order to reinforce the rotator cable and reduce the rotator cuff tear as much as possible

Although rotator cuff tears should be preferably anatomically repaired, complete repair of massive chronic tears is not always possible.¹¹ In this setting and based on the aforementioned “suspension bridge” theory, Burkhart et al.¹⁰ described a thesis for partial rotator cuff repairs which emphasized restoration of the transverse force couples via repair of the anterior and posterior RC attachments. At short-term follow-up, they demonstrated improvement in functional outcomes with this approach.¹⁰ However, subsequent studies have shown that clinical outcomes after partial repair deteriorate over time.²¹ Cuff et al.²² and Ishigaki et al.²³ also observed significant osteoarthritis progression at 5 and >10 years of follow-up, respectively. One explanation for this deterioration may be re-reatar and even tear propagation. It is well-established that the weak link in rotator cuff repair is the suture-tendon interface. Our technique may provide an option for improving fixation by providing 2 important additions to a traditional partial repair. First, our technique uses rip-stop configurations at the site of the RC attachments which may help prevent tissue failure. Second, the suture-based reconstruction of the entire RC complex may enhance load sharing across the RC suspension bridge.

Other joint-preserving procedures, including superior capsule reconstruction and cable reconstruction, have been proposed to treat MIRCTs.^{12,24-32} However, our technique presents some advantages, including less surgical time, it is technically easier, and potential cost savings. A disadvantage is that as the rotator cuff is not repaired completely, our technique may not be preferable for young and active patients where the risk of progression is of greater concern. Although overall efficient, the technique may require slight increase in operative time compared to a standard partial repair. Finally, this approach needs further biomechanical and clinical investigation, to verify if it is a beneficial alternative approach. Table 3 further highlights the advantages and disadvantages of this procedure.

Conclusions

A suture-based reconstruction of the rotator cable can be considered as an alternative treatment option for irreparable posterosuperior rotator cuff tear patients indicated for a partial repair.

Table 3. Advantages and Disadvantages

Advantages	Disadvantages
Use of suture tape reinforcement may help prevent tissue pull-through	This technique does not reconstruct the entire rotator cuff
Reconstruction of the entire rotator cable may add biomechanical strength to the overall construct.	Increased in operative time compared with a partial rotator cuff repair
The technique is efficient and low-risk	Lack of clinical data to support superiority over a standard partial repair

References

- Pinkowsky GJ, ElAttrache NS, Peterson AB, Akeda M, McGarry MH, Lee TQ. Partial-thickness tears involving the rotator cable lead to abnormal glenohumeral kinematics. *J Shoulder Elbow Surg* 2017;26:1152-1158.
- Goetti P, Denard PJ, Collin P, Ibrahim M, Hoffmeyer P, Lädermann A. Shoulder biomechanics in normal and selected pathological conditions. *EFORT Open Rev* 2020;5:508-518.
- Huri G, Kaymakoglu M, Garbis N. Rotator cable and rotator interval: Anatomy, biomechanics and clinical importance. *EFORT Open Rev* 2019;4:56-62.
- Burkhart SS, Esch JC, Scott Jolson R. The rotator crescent and rotator cable: An anatomic description of the shoulder's "suspension bridge." *Arthroscopy* 1993;9:611-616.
- Mesiha MM, Derwin KA, Sibole SC, Erdemir A, McCarron JA. The biomechanical relevance of anterior rotator cuff cable tears in a cadaveric shoulder model. *J Bone Joint Surg* 2013;95:1817-1824.
- Namdari S, Donegan RP, Dahiya N, Galatz LM, Yamaguchi K, Keener JD. Characteristics of small to medium-sized rotator cuff tears with and without disruption of the anterior supraspinatus tendon. *J Bone Joint Surg* 2014;23:20-27.
- Cho NS, Moon SC, Hong SJ, Bae SH, Rhee YG. Comparison of clinical and radiological results in the arthroscopic repair of full-thickness rotator cuff tears with and without the anterior attachment of the rotator cable. *Am J Sports Med* 2017;45:2532-2539.
- Petersen SA, Murphy TP. The timing of rotator cuff repair for the restoration of function. *J Shoulder Elbow Surg* 2011;20:62-68.
- Park MC, Itami Y, Lin CC, et al. Anterior cable reconstruction using the proximal biceps tendon for large rotator cuff defects limits superior migration and subacromial contact without inhibiting range of motion: A biomechanical analysis. *Arthroscopy* 2018;34:2590-2600.
- Burkhart SS, Nottage WM, Ogilvie-Harris DJ, Kohn HS, Pachelli A. Partial repair of irreparable rotator cuff tears. *Arthroscopy* 1994;10:363-370.
- Lädermann A, Denard PJ, Collin P. Massive rotator cuff tears: Definition and treatment. *Int Orthop* 2015;39:2403-2414.
- Callegari JJ, Phillips CJ, Lee TQ, Kruse K, Denard PJ. Semitendinosus allograft cable reconstruction technique for massive irreparable rotator cuff tears. *Arthrosc Tech* 2022;11:e153-e161.
- St Pierre P, Millett PJ, Abboud JA, et al. Consensus statement on the treatment of massive irreparable rotator cuff tears: A Delphi approach by the Neer Circle of the American Shoulder and Elbow Surgeons. *J Shoulder Elbow Surg* 2021;30:1977-1989.
- Henry P, Wasserstein D, Park S, et al. Arthroscopic repair for chronic massive rotator cuff tears: A systematic review. *Arthroscopy* 2015;31:2472-2480.
- Seo JB, Kwak KY, Park B, Yoo JS. Anterior cable reconstruction using the proximal biceps tendon for reinforcement of arthroscopic rotator cuff repair prevent retear and increase acromiohumeral distance. *J Orthop* 2021;23:246-249.
- Denard PJ, Koo SS, Murena L, Burkhart SS. Pseudoparalysis: The importance of rotator cable integrity. *Orthopedics* 2012;35:e1353-e1357.
- Nguyen ML, Quigley RJ, Galle SE, et al. Margin convergence anchorage to bone for reconstruction of the anterior attachment of the rotator cable. *Arthroscopy* 2012;28:1237-1245.
- Wang L, Kang Y, Xie G, et al. Incomplete rotator cable did not cause rotator cuff dysfunction in case of rotator cuff tear: A biomechanical study of the relationship between rotator cable integrity and rotator cuff function. *Arthroscopy* 2021;37:2444-2451.
- Collin P, Matsumura N, Lädermann A, Denard PJ, Walch G. Relationship between massive chronic rotator cuff tear pattern and loss of active shoulder range of motion. *J Shoulder Elbow Surg* 2014;23:1195-1202.
- Miller RM, Matthew Miller R, Fujimaki Y, Araki D, Musahl V, Debski RE. Strain distribution due to propagation of tears in the anterior supraspinatus tendon. *J Orthop Res* 2014;32:1283-1289.
- Shon MS, Koh KH, Lim TK, Kim WJ, Kim KC, Yoo JC. Arthroscopic partial repair of irreparable rotator cuff tears: Preoperative factors associated with outcome deterioration over 2 years. *Am J Sports Med* 2015;43:1965-1975.
- Cuff DJ, Pupello DR, Santoni BG. Partial rotator cuff repair and biceps tenotomy for the treatment of patients with massive cuff tears and retained overhead elevation: Midterm outcomes with a minimum 5 years of follow-up. *J Shoulder Elbow Surg* 2016;25:1803-1809.
- Ishigaki N, Hata Y, Matsuba T, Hino M, Murakami N, Kobayashi H. Long-term results of partial repair for irreparable rotator cuff tear. *JSES Int* 2021;5:642-648.
- Chen RE, Bakhsh WR, Lipof JS, McVicker ZG, Voloshin I. Rotator cuff anterior cable reconstruction with long head of biceps tendon autograft. *Arthrosc Tech* 2020;9:e711-e715.
- De Giacomo AF, Park MC, Lee TQ. Anterior cable reconstruction using the proximal biceps tendon for large rotator cuff defects. *Arthrosc Tech* 2021;10:e807-e813.
- Veen EJD, Koorevaar CT, Diercks RL. Using the long head of biceps tendon autograft as an anatomical reconstruction of the rotator cable: An arthroscopic technique for patients with massive rotator cuff tears. *Arthrosc Tech* 2018;7:e699-e703.
- Shin SJ, Kim IW, Park I, Lee S, Kim MS. Anterior cable reconstruction using the biceps tendon in retracted anterior L-shaped rotator cuff tears. *Arthrosc Tech* 2021;10:e55-e60.
- Park MC, Hung VT, DeGiacomo AF, McGarry MH, Adamson GJ, Lee TQ. Anterior cable reconstruction of the superior capsule using semitendinosus allograft for large rotator cuff defects limits superior migration and subacromial contact without inhibiting range of motion: a biomechanical analysis. *Arthroscopy* 2021;37:1400-1410.
- Denard PJ, Park MC, McGarry MH, Adamson G, Lee TQ. Biomechanical assessment of a v-shaped semitendinosus allograft anterior cable reconstruction for irreparable rotator cuff tears. *Arthroscopy* 2022;38:719-728.
- Werthel JD, Vigan M, Schoch B, et al. Superior capsular reconstruction—A systematic review and meta-analysis. *Orthop Traumatol Surg Res* 2021;107:103072.

31. Sommer MC, Wagner E, Zhu S, et al. Complications of superior capsule reconstruction for the treatment of functionally irreparable rotator cuff tears: A systematic review. *Arthroscopy* 2021;37:2960-2972.
32. Park MC, Detoc E, Lee TQ. Anterior cable reconstruction: Prioritize rotator cable and tendon cord when considering superior capsular reconstruction. *Arthroscopy* 2022;38:1705-1713.