JSES Reviews, Reports, and Techniques 2 (2022) 539–545

Contents lists available at ScienceDirect

JSES Reviews, Reports, and Techniques

journal homepage: www.jsesreviewsreportstech.org

Arthroscopic-assisted lower trapezius transfer with peroneus longus graft for massive irreparable rotator cuff tear and glenohumeral joint instability: a case report

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ARTICLE INFO

Keywords:
Lower trapezius transfer
Tendon transfer
Massive irreparable rotator cuff tear
Glenohumeral instability
Recurrent shoulder dislocation

Level of evidence: Level IV; Case Report

Posterosuperior rotator cuff tears after shoulder dislocation can result in pain, dysfunction, and aggravation of glenohumeral instability. Without these dynamic stabilizers, the balance between anteroposterior force couple and centering compression force that pulls the humeral head toward the center of the glenoid will disappear and result in instability.[3,6,7,10,13,17] Restoring the force of rotator cuffs will help reestablish glenohumeral stability. However, this is challenging in chronic cases, wherein massive irreparable rotator cuff tears are complicated by shoulder instability. To restore the dynamic force, anteroposterior force couple, and centering compression force performed by the rotator cuff, tendon transfer is a surgical option before considering reverse shoulder arthroplasty.[4,7,9]

Various tendons can be transferred for the treatment of posterosuperior cuff tears. Recently, the lower trapezius tendon has been considered as an option because of its more similar straight line of pull to the supraspinatus and infraspinatus tendons.[3–5,8,11] In addition, biomechanical investigations have demonstrated superior external rotation moment arm of lower trapezius tendon over latissimus dorsi or teres major transfers.[3,7,11,19] Nonetheless, a major drawback of this alternative is the requirement for a bridging graft.[4,5,8]

The original option for bridging grafts is the Achilles tendon allograft[4,8,9]; however, allografts are not widely performed and are relatively expensive. A graft length of approximately 15 cm is required. Although a double-stranded hamstring autograft might be a possible choice, it results in a small graft diameter, and its strength is a concern. The double-stranded peroneus longus graft, estimated to be 15 cm in length and 8-9 mm in diameter,[12,14,21,22] may be a better alternative, providing even greater tensile strength than the quadrupled hamstring graft.[23]

Herein, we report the successful outcome of an arthroscopic-assisted lower trapezius transfer with a peroneus longus tendon graft for restoring posterosuperior rotator cuff function in a patient with massive irreparable rotator cuff tear and glenohumeral joint instability. Informed consent for publication was obtained from the patient.

Case report

A 59-year-old man presented with a recurrent anterior left shoulder dislocation, pain, and impaired active shoulder elevation. He had a traffic accident with first-time anterior left shoulder dislocation 3 years before arrival. The patient's shoulder was reduced, and he was followed up at a local hospital. However, he still experienced several recurrent left shoulder dislocations, which usually occur while lifting heavy objects. Over the past 2 years, the pain and impaired active shoulder elevation gradually worsened and could not be relieved with nonoperative treatment. Subsequently, the patient was referred from the local hospital to our hospital.

Physical examination revealed loss of active shoulder elevation with only 60° active forward flexion. Passive forward flexion, external rotation with the arm to the side, and internal rotation

Institutional review board approval was not required for this case report.

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https://doi.org/10.1016/j.xrrt.2022.05.007

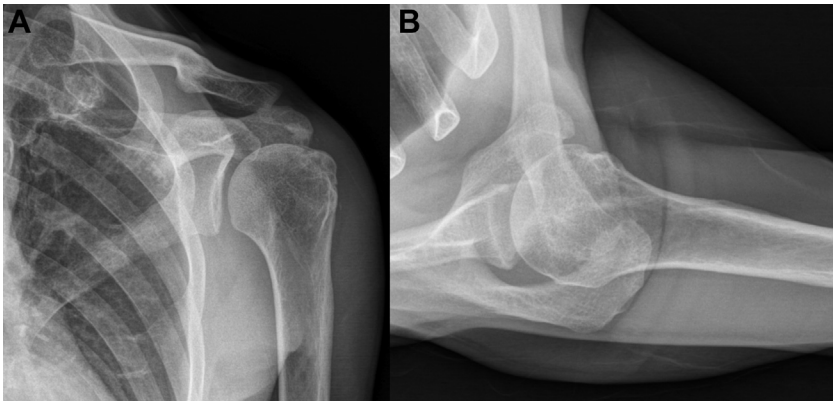

Figure 1 (**A** and **B**) Plain left shoulder true anteroposterior and transaxillary radiographs. The images show some degree of superior migration of the humeral head without glenohumeral joint osteoarthritis.

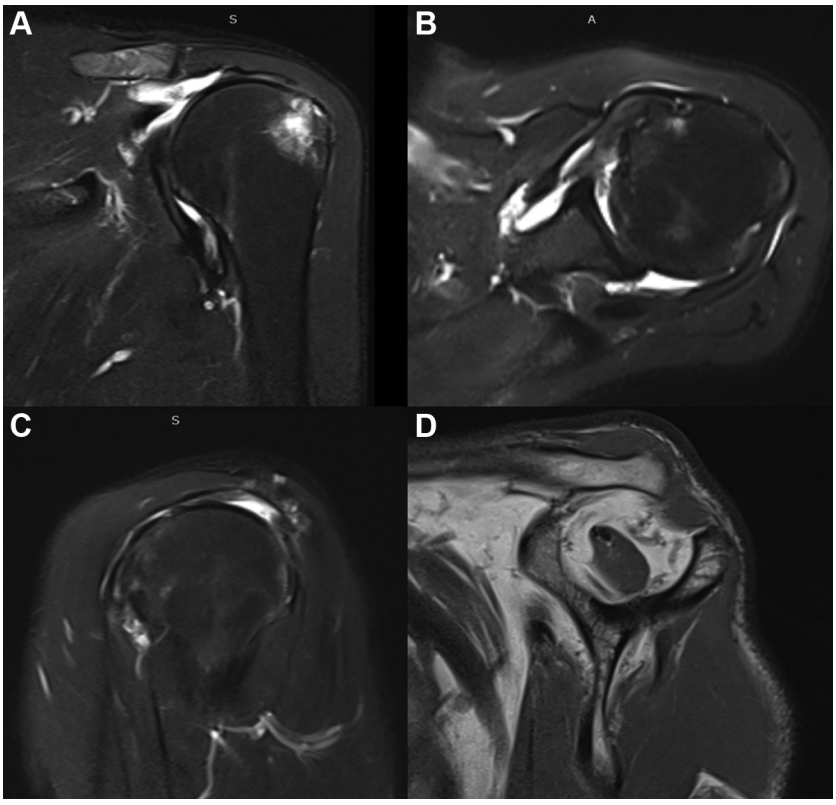

Figure 2 Magnetic resonance images of the left shoulder. (**A**) Full-thickness tear of the supraspinatus tendon and a bone cyst at the greater tuberosity. (**B**) Torn subscapularis tendon at the tendinous part. (**C**) No tendon attachment is visible at the supraspinatus and infraspinatus footprints. (**D**) Fatty degeneration is noted at the supraspinatus, infraspinatus, and subscapularis muscles.

were 170°, 60°, and lower lumbar level, respectively. The Jobe test, drop-arm test, external rotation lag sign, bear hug test, and belly press test results were positive. After intraarticular lidocaine injection, no change was noted in the range of motion in the shoulder and rotator cuff tests. Moreover, grade 2 anterior translation was detected along with a positive apprehension test.

A 6-mm acromiohumeral interval was observed on plain shoulder radiographs without glenohumeral osteoarthritis (Fig. 1). Magnetic resonance imaging revealed full-thickness insertional site tears of the supraspinatus and infraspinatus tendons with grade 3 fatty infiltration according to Goutallier's classification. The width of the tears and tendons retraction from their footprints were estimated to be 3.5 and 4 cm, respectively. The subscapularis was partially torn at its tendinous part (Fig. 2).

The patient was diagnosed with massive irreparable rotator cuff tear with glenohumeral joint instability in the left shoulder. Surgical intervention was indicated in this case because of the persistent pain, dysfunction, and instability. Accordingly, an arthroscopic-assisted lower trapezius transfer with a peroneus longus graft was performed.

Under general anesthesia, the patient was placed in the beach chair position. His medial scapular border was free from the beach chair backrest and draping to provide adequate exposure to the lower trapezius tendon (Fig. 3).

Figure 3 Example of the surgical position of another patient. The medial scapular border is free from the beach chair backrest and draping. The illustration demonstrates the anatomy of lower trapezius and surface landmarks.

Subsequently, a posterior portal was created, and the injured structures were evaluated arthroscopically. This case had an intact anteroinferior capsulolabral structure. A full-thickness tear in the upper two-thirds of the subscapularis tendon and full-thickness tears with retraction of the supraspinatus and infraspinatus tendons were discovered. Fortunately, the long head of biceps tendon was available for anterior cable reconstruction (Fig. 4).

After débridement and release, the retracted subscapularis tendon was repaired using a double-row technique. The acromial debris and bursa were resected. The supraspinatus and infraspinatus footprints were identified and débrided before advancing to anterior cable reconstruction using the long head of biceps tendon. A soft suture anchor (Y-knot RC; ConMed Linvatec) was anchored to the anterior edge of the supraspinatus footprint (Fig. 5). The sutures were then passed around and through the biceps tendon, tensioned, and tied during 30° of shoulder abduction.

The peroneus longus tendon was then harvested. The skin was incised longitudinally posterior to the lateral malleolus, followed by the division of the peroneal tendon sheath. The peroneus longus and brevis tendons were identified. Side-to-side sutures of both tendons were performed using nonabsorbable sutures. The peroneus longus was divided above the side-to-side suture and was harvested using a tendon stripper. The harvested tendon was then folded into a double-stranded graft approximately 15 cm in length for adequate bridging between the lower trapezius tendon and cuff footprint. The apex of the fold was sutured using high-strength suture (No. 2 HIFI; ConMed Linvatec).

Before transferring the lower trapezius tendon, we partially repaired the remaining posterosuperior cuff. The tendons were released and repaired in a single-row fashion, with the least possible tension. Anchored sutures were applied to the posterior portion of the footprint, near the edge of the cartilage. Subsequently, the cuffs were sutured and tied, leaving the tails of all the knots for the next procedure (Fig. 6).

For lower trapezius transfer, an incision was made over the medial aspect of the scapular spine. The trapezius was divided along its tendon fiber and released from its insertion into the scapular spine. A Kelly clamp was then passed through the incision immediately above the infraspinatus muscle into the shoulder joint (Fig. 7) and spread to dilate the tunnel. The graft was placed into the intraarticular region through the tunnel. A knotless suture anchor (4.5 mm PopLok anchor; ConMed Linvatec) was used to secure the end of the graft. Sutures from the previous cuff repair procedure were passed over the graft. The graft was then fixed and compressed into the footprint using PopLok (Fig. 8). Finally, under full shoulder external rotation, the end of the graft was tensioned and sutured to the lower trapezius tendon using a No. 2 HIFI suture.

Postoperatively, the patient's left shoulder was immobilized with an abduction brace at 30° of abduction and external rotation for 6 weeks. Isometric parascapular muscle strengthening exercises were immediately allowed. At 6 weeks, the brace was removed, and passive forward flexion exercises were started. Shoulder retraction exercises are essential for retraining the lower trapezius muscle to function like posterosuperior cuffs. Active forward flexion and rotation exercises were performed after 12 weeks.

Three months postoperatively, the patient reported near-complete recovery of pain and improved arm elevation. His active and passive shoulder forward flexion angles were 130° and 170°, respectively. At 18 weeks, there was no residual pain, and the patient showed 170° of active forward flexion. At the most recent visit, 24 weeks postoperatively, he could perform overhead activities such as putting on and taking off shirts with a full active range of motion, including 180° of active forward flexion (Fig. 9). Quick Disabilities of the Arm, Shoulder, and Hand decreased from preoperative score of 75 to postoperative score of 41. Likewise, an improvement in the visual analog scale score from 8 to 2 was noted. No symptoms were observed in the ankle or foot stance.

Discussion

Rotator cuff restoration not only recovers its primary functions but also helps in re-establishing glenohumeral stability and other shoulder functions in patients with massive cuff tears.[10,13] Although attempted repair remains the standard of care for massive rotator cuff tears, outcomes are variable. When the status of the rotator cuff is irreparable, tendon transfer, most commonly using the latissimus dorsi, pectoralis major, or trapezius, can be performed as a substitute for the rotator cuff, aiding in the restoration of dynamic rotator cuff forces.[4,5,7-10]

Historically, the latissimus dorsi has been the most commonly described tendon transfer for irreparable posterosuperior rotator cuff tears.[3,5,7] However, compared with other tendon transfers available for posterosuperior cuff tears, lower trapezius transfer provides better characteristics. First, the straight line of the pull resembles that of the infraspinatus tendon. Second, it provides an external rotational force that better mimics the function of the posterosuperior cuff than the latissimus dorsi. Finally, it has a synergistic function, including scapular retraction and shoulder external rotation over the latissimus dorsi, which has an anterior function of proximal humeral internal rotation. However, the disadvantage of the lower trapezius is that it has a short excursion, introducing the need for a bridging graft between the lower trapezius tendon and greater tuberosity of the humerus.[4,7-9,11,19]

Originally, lower trapezius transfer required the use of an Achilles tendon allograft.[8,9] However, allografts are expensive, costing over 5000 U.S. dollars, and universal health care coverage or

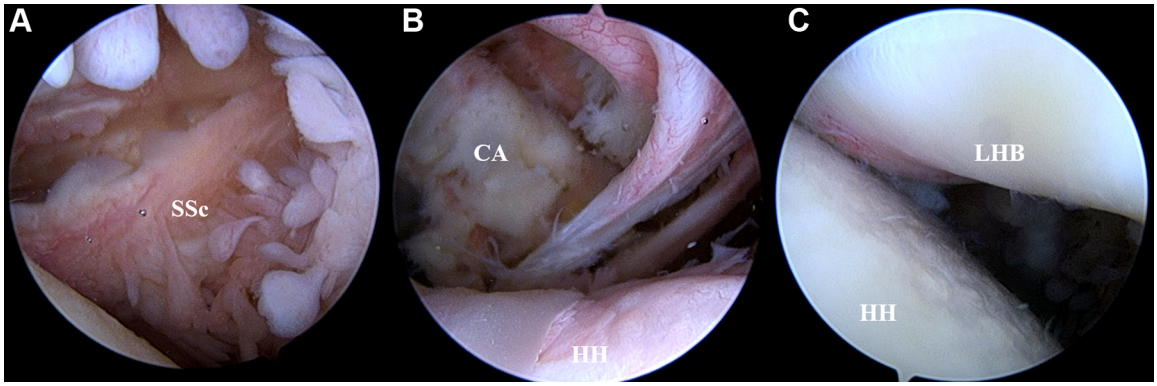

Figure 4 (**A**) Full-thickness tear at the upper two-thirds of subscapularis tendon. (**B**) Full-thickness tear of the supraspinatus tendon. (**C**) The intact long head of biceps tendon. *SSc*, subscapularis tendon; *CA*, coracoacromial ligament; *HH*, humeral head; *LHB*, long head of the biceps tendon.

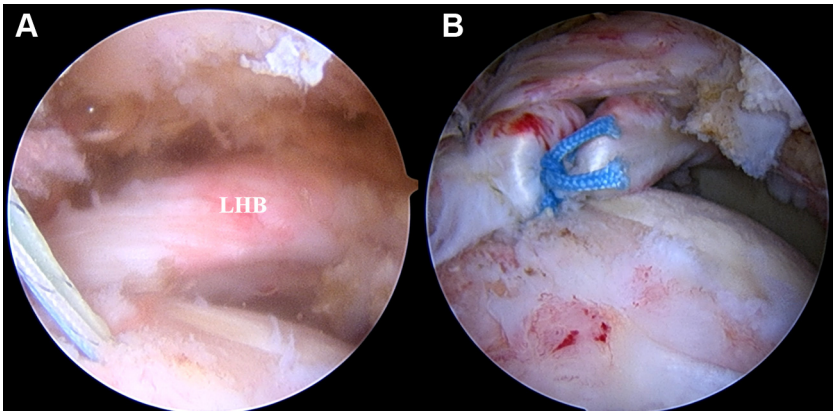

Figure 5 (**A**) Suture anchor applied at the anterior edge of supraspinatus footprint. (**B**) Anterior cable reconstruction was performed using the long head of biceps tendon. *LHB*, long head of the biceps tendon.

health insurance does not provide for such expenses. An autologous tendon graft may be a better option, considering its properties, such as the low risk of transmitted diseases, lower failure rate, and cost-effectiveness.[1,18] In a cadaveric study, the mean gap between the lower trapezius tendon and lesser tuberosity was 10.9 (8.5-13.8) cm,[2] indicating that 10-15 cm of tendon graft length is required for adequate gap bridging and graft fixation. A previous study proposed semitendinosus autograft as an alternative graft choice, requiring two 10-cm hamstring tendon grafts.[24] However, a two-stranded hamstring tendon graft may be extremely small to occupy the entire posterosuperior cuff footprint, highlighting the need for a novel graft with appropriate size, geometric shape, tensile strength, and length.

Peroneus longus tendon autografts have been used in orthopedic procedures, including posterior cruciate ligament and revision anterior cruciate ligament reconstructions, with good clinical outcomes. The graft length is approximately 29 cm[14]; therefore, a double-stranded peroneus longus graft can adequately bridge between the lower trapezius tendon and humeral head with an estimated 8 mm diameter.[12,21,22] This tendon is larger and has superior tensile strength compared with hamstrings.[23] Although complications such as decreased ankle eversion strength after peroneus longus tendon resection might be a concern, they can be avoided by side-to-side repair of the distal peroneus longus stump to the peroneus brevis tendon. With this technique, insignificant differences in ankle eversion between the donor and healthy ankles were reported.[23] Furthermore, excellent patient-reported outcomes, mainly the mean American Orthopedic Foot and Ankle Score of >98, were established.[14,21,22] Based on our experience in using the peroneus longus tendon autograft for the reconstruction of the posterior cruciate ligament and several other knee ligament injuries, we have never experienced such donor site morbidity. As the outcomes from published reports and our experience were satisfactory, we desired to use this tendon graft option. From a biomechanical perspective, Omid et al[19] found a tension of only 24 N to be effective for restoring the initial vectors on the humeral head and scapula; therefore, the double-stranded peroneus longus graft with an ultimate tensile strength of >4000 N can certainly withstand such tension.[23]

Our patient showed favorable outcomes, specifically in terms of complete pain relief at 4 months and full active range of motion with the ability to perform overhead activities at 6 months. In the first report of lower trapezius transfer in massive irreparable rotator cuff tears, Elhassan et al[9] reported the outcomes of 33 patients who underwent lower trapezius transfer. At an average follow-up period of 47 months, the patients showed improvement in pain and range of motion, with an average forward flexion of 120° (80°-150°). A systematic review by Clouette et al[4] of 7 studies on lower trapezius transfer with either an Achilles tendon allograft or semitendinosus autograft reported that clinical studies have consistently demonstrated significant improvements in range of motion and functional outcomes among patients with massive rotator cuff tears. Our patient showed an increase of >100° of active forward elevation, comparable with the results of Elhassan et al,[9] and a

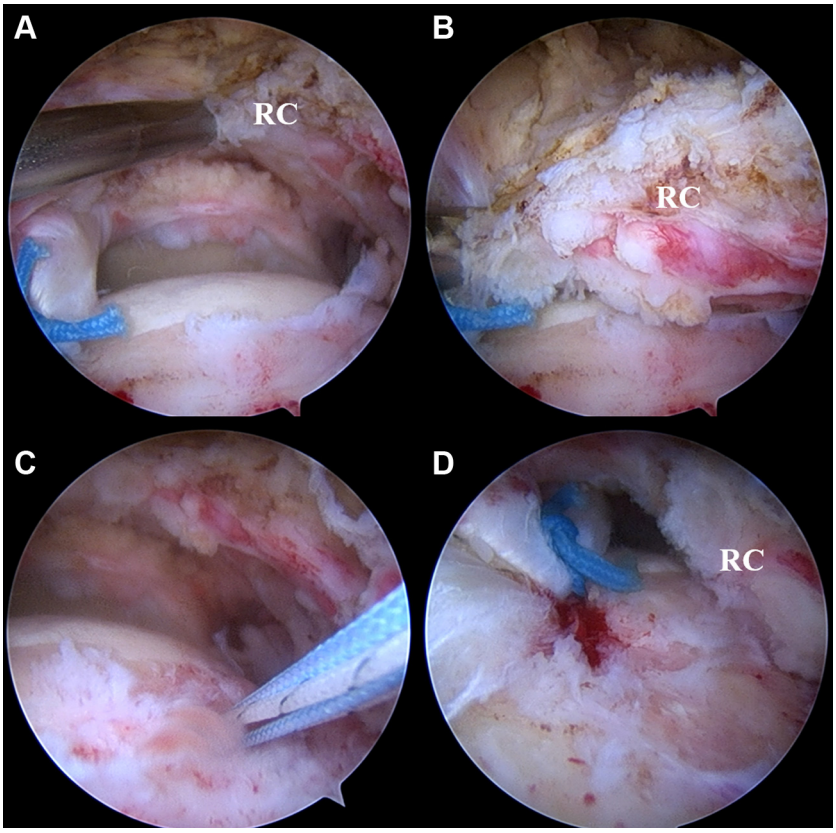

Figure 6 (**A** and **B**) Reduction of the remaining posterosuperior cuff. (**C**) Suture anchor applied at the posterior part of footprint, adjacent to the articular edge. (**D**) Suture of the cuff, leaving the anterior footprint for fixation with the lower trapezius transfer tendon graft. *RC*, rotator cuff.

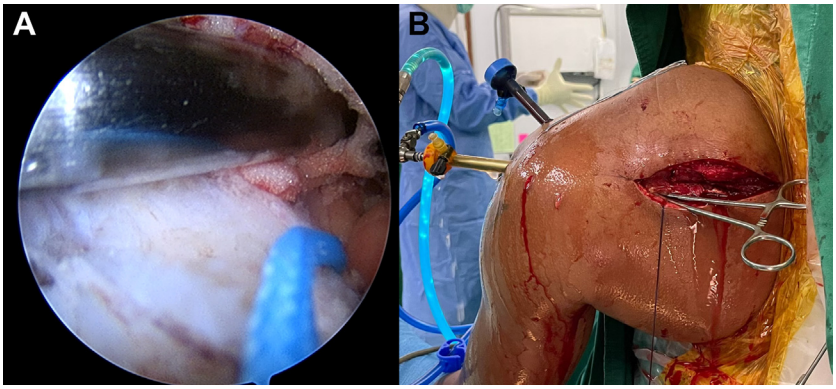

Figure 7 (**A** and **B**) Kelly clamp was passed through the incision, just above the infraspinatus muscle, into the shoulder joint.

mean increase of 37.5° forward elevation reported in a systematic review.[4]

A limitation of this study is that the outcomes of tendon transfer may be confounded by the results of anterior cable reconstruction and partial rotator cuff repair. However, according to recent literature,[15,20] the superior static stability provided by anterior cable reconstruction cannot adequately improve the biomechanics of the shoulder with massive irreparable rotator cuff tear, especially if it is complicated by anterior shoulder instability. This procedure was used only as an initial static stabilizer to promote a good environment for the healing of a large-to-massive rotator cuff tear and not for the massive irreparable rotator cuff.[15] Moreover, the repair of massive irreparable rotator cuff has a high failure rate.[16] In this patient, the rotator cuff's quality was poor, with severe retraction and fatty infiltration, so we cannot rely on it to heal and function properly as a dynamic stabilizer. Consequently, we considered tendon transfer, in this case, lower trapezius transfer with the peroneus longus graft, to provide better biologics and biomechanics for rebalancing the rotator cuff forces to restore shoulder function and stability.

To our knowledge, this study is the first to report a case of massive irreparable rotator cuff tear with glenohumeral joint instability treated with arthroscopic-assisted lower trapezius transfer and a peroneus longus graft. The resulting shoulder range

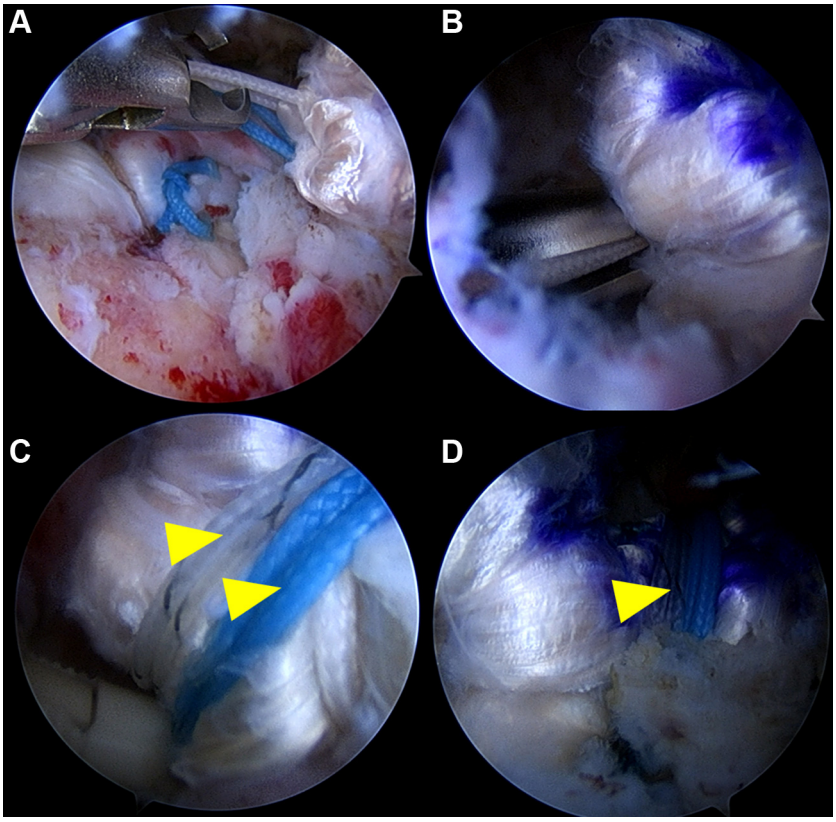

Figure 8 (**A**) Graft shuttled into the intraarticular space. (**B**) A PopLok anchor is used to secure the end of this graft. The sutures from the previous cuff repair are passed over the graft. (**C**) The graft is then fixed and compressed into the footprint by another PopLok anchor. (**D**) Under full shoulder external rotation, the end of graft is tensioned and sutured to the lower trapezius tendon. The *arrowheads* show the sutures from the previous rotator cuff repair.

Figure 9 At 24 weeks postoperatively, the patient shows full range of motion, including 180° active forward flexion.

of motion and function were satisfactory, and no complications were observed.

Conclusion

Massive irreparable rotator cuff tears combined with shoulder instability are challenging. Without labral tears, restoring the force of rotator cuffs will help restore glenohumeral stability. If lower trapezius tendon transfer is used as a substitute for the rotator cuff, the peroneus longus graft may be a good alternative, as shown by our early satisfactory outcomes.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.
Patient consent: Obtained.

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