Technical Note

Arthroscopic-Assisted Middle Trapezius Transfer Using an Achilles Tendon Allograft in Treatment of Isolated Supraspinatus Irreparable Rotator Cuff Tears in Lateral Decubitus Position

Chang Hee Baek, M.D., Bo Taek Kim, M.D., and Jung Gon Kim, M.D.

Abstract: The optimal treatment for patients diagnosed with isolated supraspinatus irreparable rotator cuff tears continues to be a subject of debate. Joint-preserving methods, including partial repair, superior capsule reconstruction, balloon spacers, and tendon transfer, have been introduced. Among these options, the middle trapezius tendon (MTT) transfer has garnered attention for its potential to replace the irreparable portion of the supraspinatus tendon and provide dynamic stability to the joint. Although some reports have highlighted promising clinical outcomes of MTT, there remains a dearth of literature regarding the techniques and methods involved in the surgical procedure. This Technical Note introduces an arthroscopic-assisted technique for MTT transfer using an Achilles tendon allograft for patients diagnosed with isolated supraspinatus irreparable rotator cuff tears in lateral decubitus.

Treating isolated supraspinatus irreparable rotator cuff tears (ISIRCTs) can present a complex challenge, particularly in young and physically active patients with intact glenohumeral cartilage. Joint-preserving methods for ISIRCTs include several techniques such as partial repair, superior capsular reconstruction, subacromial balloon spacer, and tendon transfer.[1-3]

Middle trapezius tendon (MTT) transfer is one of viable treatment options for addressing ISIRCTs. The procedure involves relocating the MTT from the medial half of the scapular spine to the supraspinatus (SSP) footprint using an interpositional graft. This procedure serves to recreate the biomechanics of the SSP tendon and potentially contributes to a biological subacromial spacer effect.[4,5] Consequently, MTT transfer offers the dual benefits of dynamic joint-centering stability and static spacers within the glenohumeral joint.[4] Recent short-term clinical reports have demonstrated promising results, indicating substantial advancements in pain relief, clinical score, and range of motion in forward flexion and abduction.[5,6] However, as MTT transfer is still a recently evolving technique, there remains a scarcity of comprehensive reports regarding the surgical methodology.[7,8] This Technical Note serves to introduce an arthroscopic-assisted MTT transfer using an Achilles tendon allograft in lateral decubitus position for patient diagnosed ISIRCTs.

From the Department of Orthopaedic Surgery, Jeollanam-do, Republic of Korea.

Received November 21, 2023; accepted February 3, 2024.

Address correspondence to Chang Hee Baek, M.D., Department of Orthopaedic Surgery, Yeosu Baek Hospital, 50, Yeoseo 1-ro, Yeosu-si, Jeollanam-do, Republic of Korea. E-mail: Yeosubaek@gmail.com

2212-6287/231685

https://doi.org/10.1016/j.eats.2024.102976

Surgical Technique

The whole procedure of surgical techniques is shown in Video 1.

Indication

Transfer of the MTT is considered appropriate under the following conditions: (1) failed conservative treatment; (2) little to no arthritic change, characterized by Hamada[9] grade 2 or less (Fig 1 A and B); (3) severe retraction of SSP tendon, characterized by Patte[10] classification grade 3 (Fig 1C); (4) high-grade fatty infiltration in SSP, characterized by Goutallier[11] classification grade 3 or 4 (Fig 1D); and (5) intraoperative arthroscopic finding of irreparable SSP tendon.

Patient Preparation and Arthroscopic Portals

Before the surgery, the patient is given a combination of general anesthesia and interscalene brachial plexus

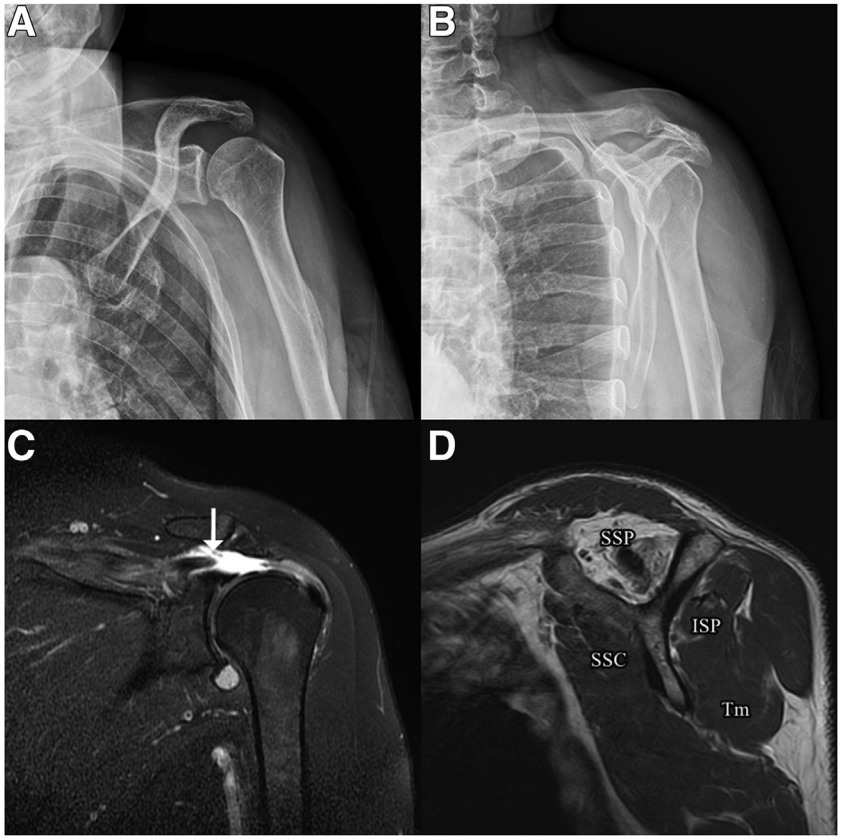

Fig 1. Indication (radiography and magnetic resonance imaging [MRI]). (A-B) Preoperative radiograph with minimal arthritic glenohumeral joint of left shoulder. (C) Preoperative T2-weighted fat suppression coronal-view of MRI demonstrates the supraspinatus tendon (white arrow) retracted to the level of the glenoid. (D) Preoperative T2-weighted oblique sagittal-view of MRI shows severe fatty infiltration and atrophy of the supraspinatus. (ISP, infraspinatus; SSC, subscapularis; SSP, supraspinatus; Tm, teres minor.)

block. The shoulder is draped and prepared in standard fashion. The patient is placed in lateral decubitus position with the arm suspended in a traction arm holder (Fig 2A). First, a standard posterior portal and anterior portal are created to evaluate articular surface of humerus and glenoid. Standard lateral and posterolateral portals are created for both viewing and working portal within the subacromial space. The borders of the acromion, clavicle, and scapula spine are marked on the skin (Fig 2B).

Arthroscopic Examination

The patient goes under diagnostic arthroscopy to assess the reparability of the remaining SSP tendons. The long head of the biceps is evaluated and treated accordance with preoperative clinical manifestation and arthroscopic findings of biceps pathology. In cases of any subscapularis or infraspinatus tendon tear, repair is done with using double-row suture bridge technique. After confirming that the SSP tendon is surgically irreparable (Fig 3A and B), we begin MTT transfer.

Harvesting Middle Trapezius Tendon

During the MTT harvest, a 6-cm horizontal incision is made along the upper edge of the scapular spine. After the skin and subcutaneous dissection, the upper border of the scapular spine can be identified, where the lower portion of the MTT is inserted (Fig 4A). The lower portion of MTT is meticulously detached from the insertion site of the medial half of the scapular spine. Nevertheless, the extension of the release should not go beyond the lateral scapular border and the acromion attachment, preventing any potential injury to the posterior acromioclavicular joint capsule and ligament. Also, care should be taken to avoid damage to the vertically running spinal accessory nerve, which runs parallel to the scapula's inner border. Using nonabsorbable No. 2 suture in a Krackow configuration, traction sutures are placed to secure both superficial and deep facia of the harvested MTT (Fig 4B). Lastly, we release any surrounding soft tissue adhesions around the harvested MTT to allow for further excursion and smooth gliding.

Achilles Tendon Allograft Preparation

For interpositional graft material, an Achilles tendon allograft is prepared. After the calcaneal bone section of the allograft is removed, the graft is augmented with an acellular dermal matrix (ADM) graft, SureDerm (Hans Biomed Co., Daejeon, Republic of Korea) (Fig 5A). We use two No. 2 nonabsorbable sutures on each lateral edge in the Krackow configuration to augment the

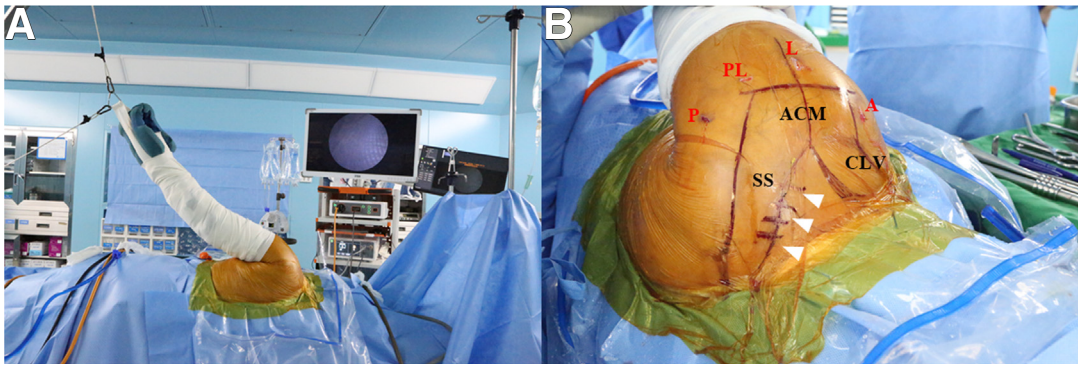

Fig 2. Patient's positions and skin marking. (A) Patient is positioned in the lateral decubitus with the left arm in traction. (B) Bony landmarks, arthroscopic portals, and surgical site (white arrowhead) are marked on skin. (A, anterior portal; ACM, acromion; CLV, clavicle; L, lateral portal; P, posterior portal; PL, posterolateral portal; SS, scapular spine.)

ADM graft to the Achilles tendon allograft (Fig 5B). Lastly, one additional No. 2 nonabsorbable suture is applied on the side of the ADM-augmented graft.

Arthroscopic Preparation and Graft Delivery

The arthroscope is reinserted. First, rotator interval and capsular release are performed to prevent postoperative stiffness, and acromioplasty is performed to prevent postoperative attrition of the graft. The tendon remnants of torn SSP are debrided and the footprint of the SSP is prepared. One triple-loaded medial-row suture anchor (5.5-mm HEALICOIL Anchor; Smith & Nephew, Andover, MA) is inserted on posteromedial corner of SSP footprint (Fig 6A). Using the 45° Curved SutureLasso SD (Arthrex, Naples, FL), 2 strands are passed through the anterior portion of infraspinatus to be used as side-to-side suture with the graft in the later procedure (Fig 6B).

For the graft delivery, a 5.75-mm Crystal Cannula (Arthrex) is placed in lateral portal. A long-curved clamp (Solco-Rochester Pean Forceps 18.0 cm; Solco Biomedical Co., Seoul, Republic of Korea) is introduced into the subacromial space through the opening of scapular incision area (Fig 7A). With the help of arthroscopic viewing from posterolateral portal, the distal end of a long-curved clamp (Solco Biomedical Co.) pushes out the Crystal Cannula (Arthrex) of the lateral portal (Fig 6C and Fig 7B), and grasps the graft (Fig 7C). The graft is carefully pulled into the subacromial space (Fig 6D and Fig 7D) and positioned within the SSP footprint to ensure that the lateral edge of the graft covers the lateral edge of the greater tuberosity. Using arthroscopy during the delivery of the graft assists in preventing graft flipping and entanglement of suture materials.

Arthroscopic Graft Fixation to Humerus

The graft is initially secured with a 4.75-mm SwiveLock anchor (Arthrex), preloaded with all nonabsorbable sutures of the graft, in the anterolateral aspect of the greater tuberosity, positioned just behind the bicipital groove (Fig 8A). Using 18-gauge spinal needle with wire loop, 2 suture strands of medial-row suture anchor are passed through the graft (Fig 8B), and side-to-side sutures are tied together (Fig 9A). An additional 4.75-mm SwiveLock anchor (Arthrex), preloaded with the remaining 2 suture strands of the medial-row suture anchor, is inserted into the anterolateral corner of

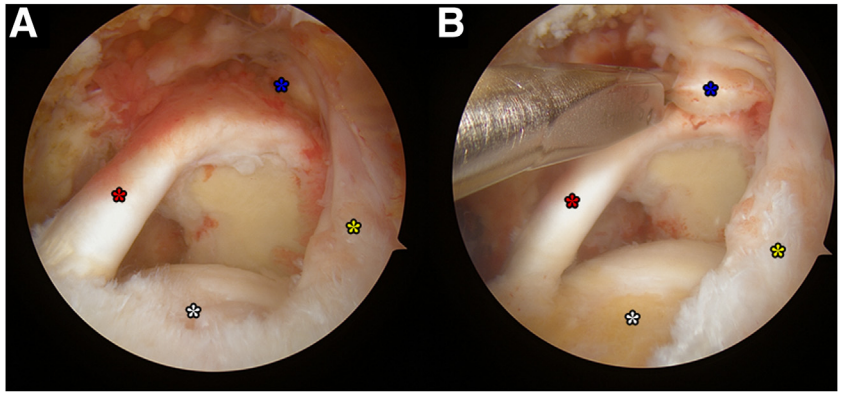

Fig 3. Arthroscopic image of irreparable supraspinatus tendon tear. (A) Arthroscopic image of the left shoulder from the lateral viewing portal shows isolated supraspinatus irreparable rotator cuff tear. (B) Viewing from the lateral portal, retracted supraspinatus tendon (blue asterisk) cannot be reduced to its original footprint (white asterisk). Red asterisk, long head of the biceps tendon; white asterisk, footprint of supraspinatus; Blue asterisk, supraspinatus tendon; Yellow asterisk, infraspinatus.

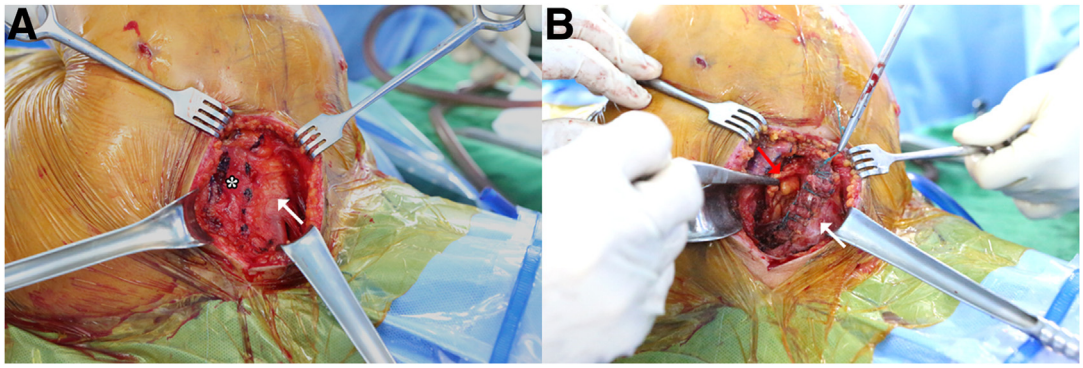

Fig 4. Harvesting the middle trapezius tendon (MTT). Shown are intraoperative images of harvesting MTT in left shoulder. (A) After the initial dissection of skin and subcutaneous tissue, the scapular spine (white asterisk) can be identified, where the MTT (white arrow) is inserted. (B) The lower portion of the MTT (white arrow) is detached from the insertion site of the medial portion of the scapular spine. The harvested MTT is secured using No. 2 suture material in a Krackow configuration. An irreparable supraspinatus muscle (red arrow) with high fatty infiltration can be observed underneath the harvested MTT.

the SSP footprint to provide further compression of the graft into the SSP footprint (Fig 9B). These 2 suture strands, along with 1suture strand from the side-to-side sutures, are reloaded into a 4.75-mm SwiveLock anchor (Arthrex) and inserted into the middle-lateral aspect of the greater tuberosity (Fig 9C). Another 4.75-mm SwiveLock anchor (Arthrex), preloaded with additional suture strands from the previously inserted SwiveLock anchor (Arthrex) in the anterolateral corner the SSP footprint, is inserted into the posterolateral aspect of the greater tuberosity to complete the graft compression into the footprint of the SSP (Fig 9D). Remaining suture strands are cut with the suture cutter, and the final appearance of the graft is confirmed (Fig 10A and B).

Graft Attachment to Middle Trapezius Tendon

After fixing the graft on the SSP footprint, we attach the graft to the lower border of harvested MTT using a running locking suture configuration (Fig 11A and B). The anastomosis is performed with the shoulder in a position of 60° abduction, 30° forward elevation, and neutral rotation. (Fig 12). Finally, the integrity of the transferred MTT is confirmed by rotating the arm.

Wound Closure

The MTT opening is closed with a No. 2 POLYSORB (Covidien, Mansfield, MA), followed by subcutaneous closure with No. 0 POLYSORB (Covidien) and skin closure. The arthroscopy portals are closed in a standard fashion, and standard dressings are applied.

Postoperative Rehabilitation

The patient wears an abduction brace with the shoulder held in 0° external rotation for a duration of 4 weeks. Throughout this period, the patient is encouraged to engage in gentle movements involving the elbows, wrists, and fingers, as well as perform daily activities such as eating and writing, as long as they remain tolerable. Upon the completion of the 4-week brace period, the patient begins active-assisted range of motion exercises, alongside physical therapy and

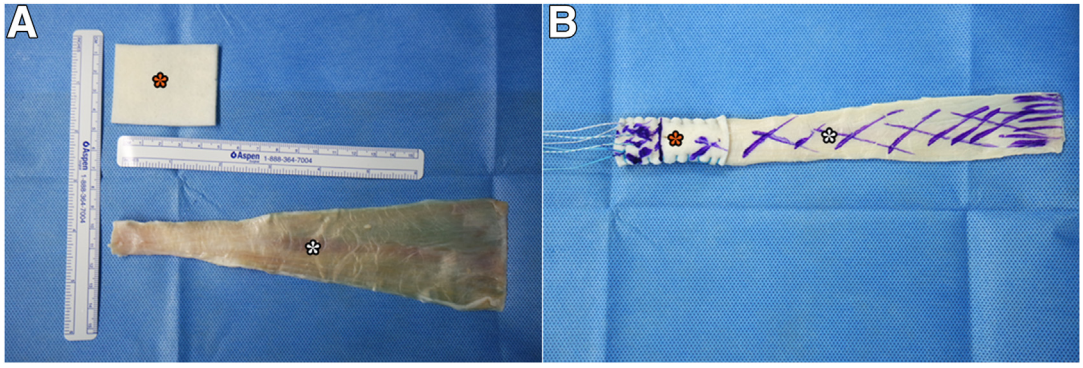

Fig 5. Achilles tendon allograft and acellular dermal matrix (ADM) graft augmentation. (A) Achilles tendon allograft spine (white asterisk) and ADM graft (orange asterisk) are prepared. (B) Achilles tendon allograft (white asterisk) is augmented with ADM graft (orange asterisk), and two no. 2 nonabsorbable sutures are used to augment ADM graft in a Krackow configuration. An additional no. 2 nonabsorbable suture is applied.

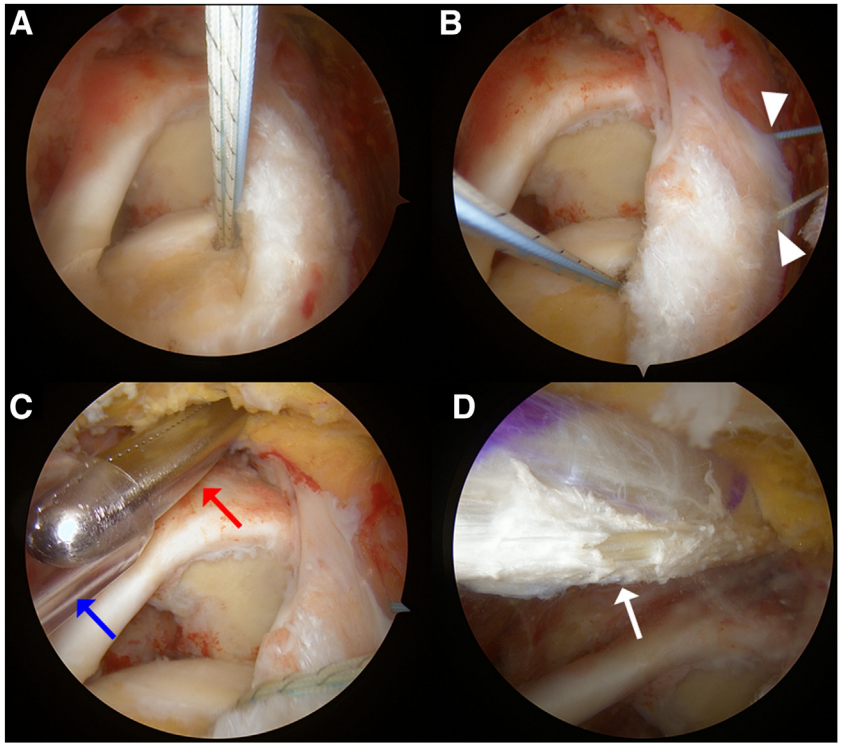

Fig 6. Arthroscopic image of medial-row anchor placement and graft delivery. (A) Arthroscopic image of the left shoulder from the lateral viewing portal shows the insertion of a triple-loaded suture anchor on posteromedial corner of supraspinatus footprint. (B) Viewing from the posterolateral portal, the placement of 2 suture strands (white arrowheads) in the anterior portion of infraspinatus muscle is seen. (C) Viewing from the posterolateral portal, distal end of a long-curved clamp (red arrow) is inserted into the opening of the cannula (blue arrow) (5.75-mm Crystal Cannula; Arthrex). (D) Viewing from the posterolateral portal, the graft (white arrow) is carefully delivered into the subacromial space.

strengthening exercises with elastic bands. The patient is advised to refrain from undertaking any strenuous work or participating in sports activities until postoperative 6 months.

Discussion

MTT transfer has demonstrated promising clinical outcomes for ISIRCTs by replacing the irreparable portion of the SSP tendon.[5,6] This procedure allows for the achievement of dynamic joint-centering stability.[4] However, because of its relatively new and evolving nature, there is a scarcity of literature on the surgical techniques associated with MTT transfer.

Unlike the MTT procedure technique used by Moroder et al.[7] and Kandeel[8] in the beach-chair position, our MTT procedure is conducted with the patient in the lateral decubitus position. It is crucial to consider that surgical positioning may affect both perioperative and postoperative complications, including nerve injuries, risks of cerebral hypoperfusion, traction injuries, thromboembolic events, and airway problems.[12] Although the beach-chair position offers the advantage of easier setup from a supine to upright position, it may pose risks such as cerebral hypoperfusion and complications ranging from cranial nerve injuries to infarction.[12,13] Conversely, the lateral decubitus position provides improved visualization, better instrument access for specific procedures, and a reduced risk of cerebral hypoperfusion.[12,14,15] As demonstrated in this Technical Note, the MTT procedure can be effectively performed in the lateral decubitus position, allowing us to leverage the benefits of this positioning.

Throughout our procedure, we present a similar but also distinct approach that differs from previously reported surgical techniques. Specifically, similar to Kandeel,[8] we release the insertion of the middle trapezius at the scapular—spine insertion. This approach contrasts with the method used by Moroder et al.,[7] who released the acromial insertion site through subperiosteal dissection. Our method mitigates the risk of acromioclavicular joint ligament injury. Furthermore, differing from the technique described by Kandeel,[8] who employed the Pulvertaft technique in a side-to-side fashion to attach the graft to MTT, we used the running locking suture configuration when attaching the graft to the lower border of the MTT. This fixation method increases the contact area between the harvested MTT and the graft, providing strong stability. Furthermore, our fixation method to the SSP footprint is different. Although previous techniques employed transosseous sutures or transosseous tunnels, we used a modified double-row suture bridge technique. This double-row suture bridge technique may offer distinct advantages, including greater initial stability for fixation, increased surface area of contact between the graft and the footprint, and a more even distribution of load across the repair site, ultimately reducing stress on individual suture anchors.[16,17] Lastly, the double-row

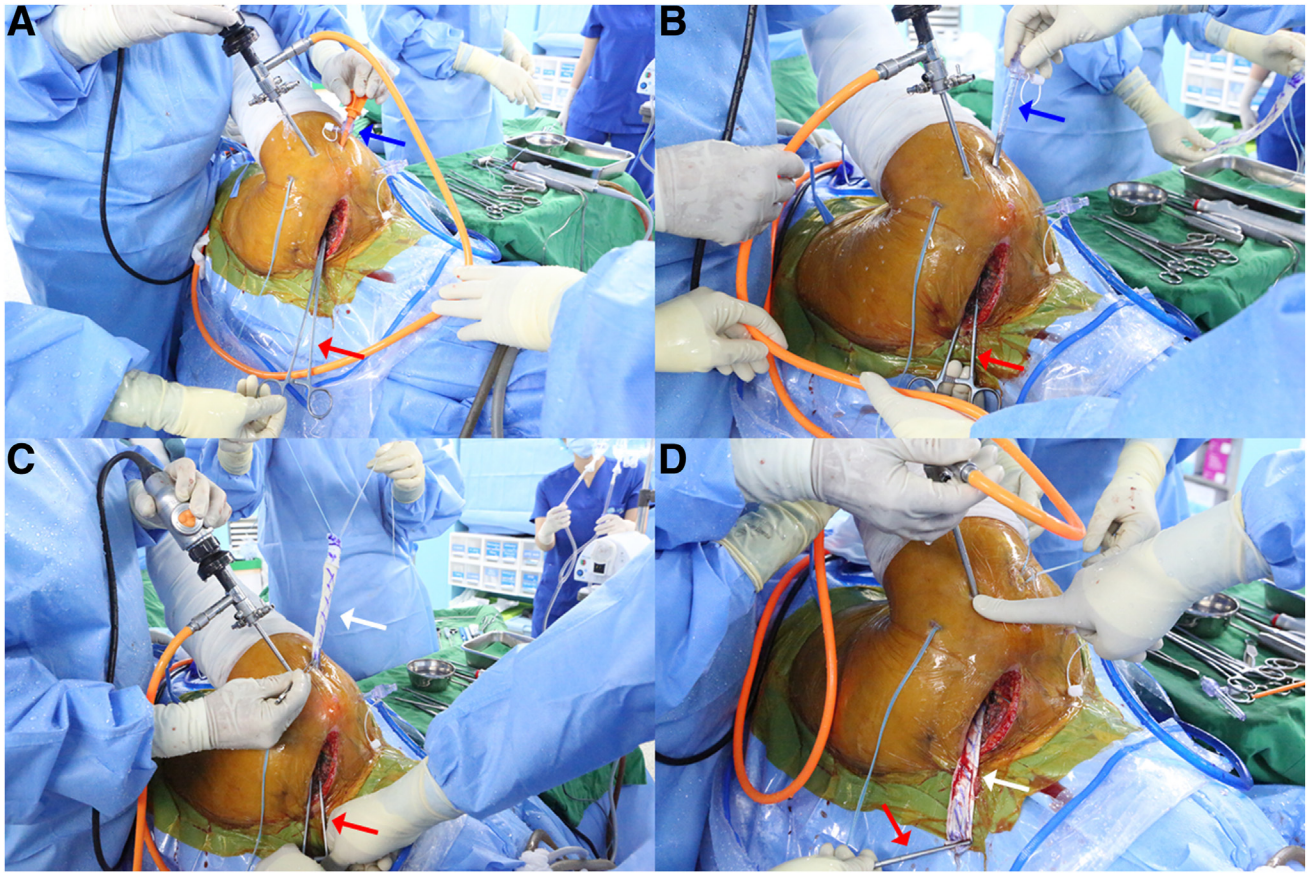

Fig 7. Graft delivery. Intraoperative images are shown of graft delivery in the left shoulder. (A) A 5.75-mm Crystal Cannula (blue arrow) (Arthrex) is placed in lateral portal and a long-curved clamp (red arrow) (Solco-Rochester Pean Forceps 18.0 cm, Solco Biomedical Co.) is inserted into the subacromial space through the opening of scapular incision area. (B) The distal end of a long-curved clamp (red arrow) (Solco Biomedical Co.) pushed out the Crystal Cannula (blue arrow) (Arthrex) in the lateral portal. (C) The graft (white arrow) is grasped with a long-curved clamp (red arrow) (Solco Biomedical Co.). (D) As the long-curved clamp (red arrow) (Solco Biomedical Co.) is pulled, the graft is gently delivered into subacromial space through lateral portal.

suture bridge technique provides greater pull-out strength and structural healing, minimizing the risk of retear.[18-20] Although different surgical procedures exist in surgical steps of MTT, their biomechanics and implications for clinical outcomes should be studied further in the future.

A different interpositional graft, or even no graft at all, can be used during MTT transfer. Kandeel[8] used an

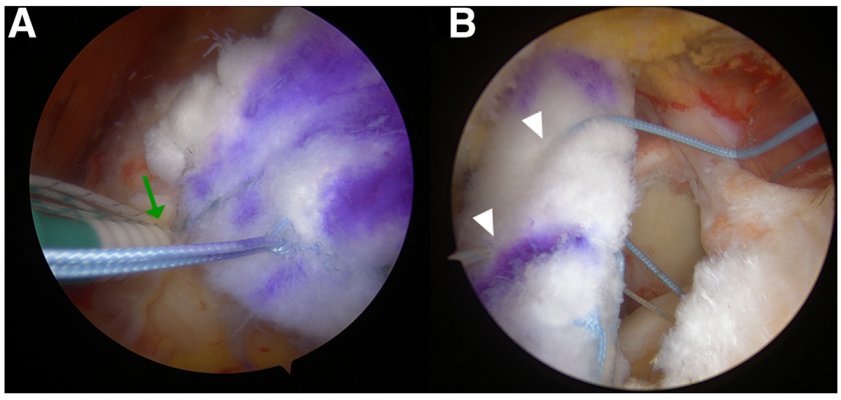

Fig 8. Arthroscopic image is shown of lateral-row anchor placement and side-to-side suture. (A) An arthroscopic image of the left shoulder from the posterolateral viewing portal shows the preliminary fixation of the graft using a knotless anchor (green arrow) (4.75-mm SwiveLock anchor; Arthrex). The knotless anchor (green arrow), preloaded with all nonabsorbable suture strands of the graft, is placed in the anterolateral aspect of the greater tuberosity. (B) Viewing from the posterolateral portal, 2 suture strands (white arrowheads) are passed through the graft to be used as side-to-side sutures.

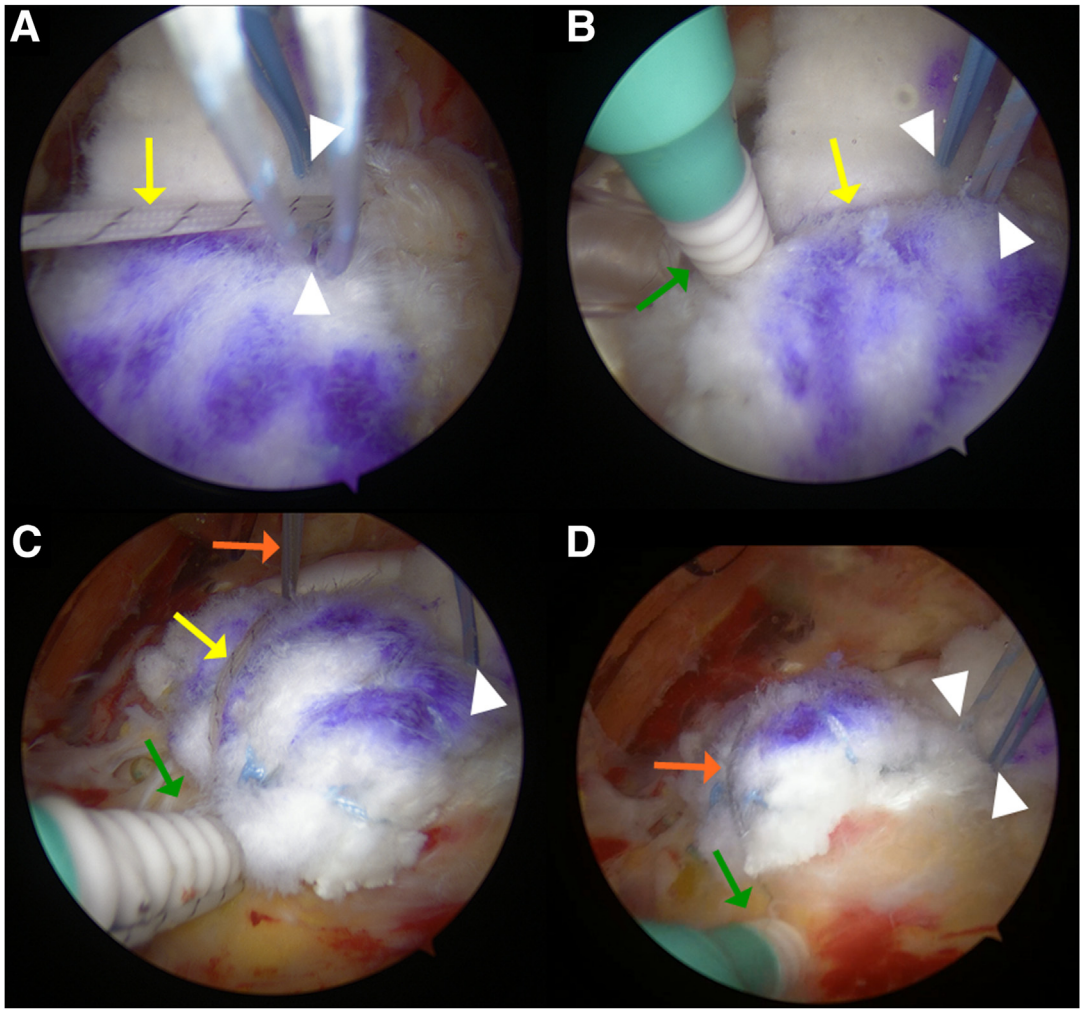

Fig 9. Arthroscopic graft fixation into greater tuberosity. (A) Arthroscopic image of the left shoulder from posterolateral viewing portal shows side-to-side sutures (white arrowhead) are tied together. (B) Viewing from the posterolateral portal, a knotless anchor (green arrow) (4.75-mm SwiveLock anchor; Arthrex), preloaded with remaining suture strands (yellow arrow) of the medial-row suture anchor, is inserted in the anterolateral aspect of supraspinatus footprint. (C) Viewing from the posterolateral portal, these 2 suture strands (yellow arrow), along with one suture strand from the side-to-side sutures, are reloaded into an another knotless anchor (green arrow) (Arthrex) and are inserted in middle-lateral aspect of greater tuberosity. (D) Viewing from the posterolateral portal, an additional knotless anchor (green arrow) (Arthrex), preloaded with extra-loaded suture strands (orange arrow) from the previously inserted knotless anchor (Arthrex) in anterolateral aspect of supraspinatus footprint, is inserted in the posterolateral aspect of the greater tuberosity.

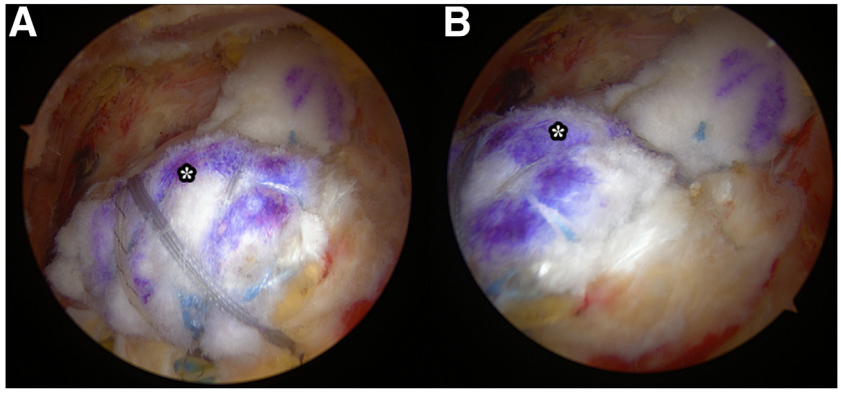

Fig 10. Final appearance of graft fixation to footprint of supraspinatus. Arthroscopic images of the left shoulder from (A) the lateral viewing portal and (B) the posterolateral viewing portal demonstrate the final appearance of the graft (white asterisk) fixed to supraspinatus footprint using the modified double-row suture-bridge technique.

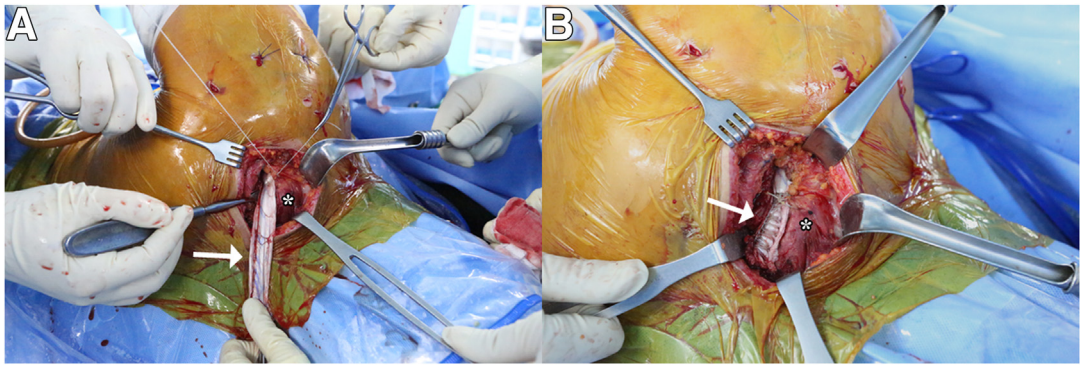

Fig 11. Graft attachment to the middle trapezius tendon (MTT). Intraoperative images are shown of graft attachment to MTT in the left shoulder. (A) The graft (white arrow) is placed parallel to the lower border of harvested MTT (white asterisk). (B) The graft (white arrow) is attached to the harvested MTT (white asterisk) in running locking suture configuration.

Fig 12. The patient's position during the anastomosis is shown. The anastomosis is performed with the shoulder in a position of 60° abduction, 30° forward elevation, and neutral rotation position.

Table 1. Advantages and Limitations

Advantages	Reproduction of dynamics stability
	Restoration of glenohumeral kinematics
	Preservation of scapular kinematics
	Providing spacer effect and biotuberosity effect
	Reduced risk of cerebral hypoperfusion from lateral decubitus position.
	No violation of the AC joint
	Strong against retear of graft caused by augmentation of acellular dermal matrix graft
	Offers stability of the graft by side-to-side suture
Limitation	Extensive arthroscopic technique
	Risk of allograft-related complications
	Relatively greater risk of postoperative infection
	No long-term clinical studies

AC, acromioclavicular.

autohamstring graft. However, Moroder et al.[7] performed the procedure without using an interpositional graft, but instead, directly reattached the transferred tendon to the footprint. In our technique, we opted for an Achilles tendon allograft, a widely chosen and readily available graft. To enhance its thickness, the graft was augmented with an ADM graft. The thick graft, precisely positioned in the footprint of the SSP, is believed to simulate the effects of biologic tuberoplasty by reducing bone-to-bone contact between the greater tuberosity and the acromion. Promising clinical outcomes of biologic tuberoplasty with ADM graft have already been reported in patients with massive rotator cuff tears.[21,22] Lastly, supported by a biomechanical study, ADM graft augmentation offers additional advantages, including providing a biocompatible scaffold, exhibiting excellent suture retention properties, and offering high strength against high tensile loads.[23-25]

During the surgical procedure, we performed a side-to-side suture between the interpositional graft and the infraspinatus. The significance of the side-to-side suture was emphasized in a biomechanical study conducted by Mihata et al.[26] The study shows that employing side-to-side suturing in superior capsule reconstruction leads to a reduction in glenohumeral superior translation and a notable decrease in subacromial peak contact pressure. Ultimately, this enhances the overall stability of the shoulder joint. We believe that the inclusion of a side-to-side suture between the graft and the infraspinatus can further enhance the stability of the graft, potentially minimizing the risk of retear.

Despite the limitations outlined in the Table 1, this surgical technique presents a method for arthroscopic-assisted MTT transfer using Achilles tendon allograft in the lateral decubitus position.

Disclosures

All authors (C.H.B., B.T.K., J.G.K.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The authors express gratitude to Yeong Ran Seo, Hyun Mi Kim, Seung Hwan Oh, and Seul Gi Yun for their helps in the surgery room.

References

1. Oh JH, Park MS, Rhee SM. Treatment strategy for irreparable rotator cuff tears. *Clin Orthop Surg* 2018;10:119-134.
2. Kovacevic D, Suriani RJ Jr, Grawe BM, et al. Management of irreparable massive rotator cuff tears: A systematic review and meta-analysis of patient-reported outcomes, reoperation rates, and treatment response. *J Shoulder Elbow Surg* 2020;29:2459-2475.
3. Kucirek NK, Hung NJ, Wong SE. Treatment options for massive irreparable rotator cuff tears. *Curr Rev Musculoskelet Med* 2021;14:304-315.
4. Moroder P, Akgün D, Lacheta L, et al. Middle trapezius transfer for treatment of irreparable supraspinatus tendon tears—anatomical feasibility study. *J Exp Orthop* 2021;8:5.
5. Baek CH, Kim JG. Outcomes of arthroscopic-assisted middle trapezius tendon transfer for isolated irreparable supraspinatus tendon tears: Minimum 2-year follow-up. *Arch Orthop Trauma Surg* 2023;143:2547-2556.
6. Kandeel AA. Middle trapezius tendon transfer for augmentation of in situ superior capsular reconstruction-reinforced partial rotator cuff repair: Short-term outcomes of a prospective cohort study. *Orthop J Sports Med* 2023;11:23259671221147537.
7. Moroder P, Lacheta L, Danzinger V, Thiele K, Ellermann S, Akgün D. Arthroscopic middle trapezius transfer for treatment of irreparable superior rotator cuff tendon tears. *Arthrosc Tech* 2021;10:e581-e586.
8. Kandeel AA. Rotator cuff irreparability or failure of repair (re-tear): Technical note on middle trapezius tendon transfer for reproduction of supraspinatus function. *J Exp Orthop* 2021;8:105.
9. Hamada K, Fukuda H, Mikasa M, Kobayashi Y. Roentgenographic findings in massive rotator cuff tears. A long-term observation. *Clin Orthop Relat Res* 1990:92-96.
10. Patte D. Classification of rotator cuff lesions. *Clin Orthop Relat Res* 1990:81-86.
11. Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. *Clin Orthop Relat Res* 1994:78-83.
12. Yow BG, Anderson AB, Aburish Z, et al. Beach-chair versus lateral decubitus positioning for primary arthroscopic anterior shoulder stabilization: A consecutive series of 641 shoulders. *Am J Sports Med* 2023;51:3367-3373.
13. Baradaran A, Sabzevari S, Godshaw B, Kachooei AR, Mousavian A, Lin A. The impact of lateral decubitus vs. beach chair positioning on the clinical outcome of the patients with isolated SLAP type II repair: A systematic review and meta-analysis. *Arch Bone Joint Surg* 2022;10:847-857.
14. Li X, Eichinger JK, Hartshorn T, Zhou H, Matzkin EG, Warner JP. A comparison of the lateral decubitus and beach-chair positions for shoulder surgery: Advantages and complications. *J Am Acad Orthop Surg* 2015;23:18-28.
15. Meex I, Vundelinckx J, Buyse K, et al. Cerebral tissue oxygen saturation values in volunteers and patients in the lateral decubitus and beach chair positions: A prospective observational study. *Can J Anaesth* 2016;63:537-543.
16. Senju T, Okada T, Takeuchi N, et al. Biomechanical analysis of four different medial row configurations of suture bridge rotator cuff repair. *Clin Biomech (Bristol, Avon)* 2019;69:191-196.
17. Mancini MR, Horinek JL, Phillips CJ, Denard PJ. Arthroscopic rotator cuff repair: A review of surgical techniques and outcomes. *Clin Sports Med* 2023;42:81-94.
18. Li C, Zhang H, Bo X, et al. Arthroscopic release combined with single-row fixation or double-row suture bridge fixation in patients with traumatic supraspinatus tear and adhesive capsulitis non-responsive to conservative management: A prospective randomized trial. *Orthop Traumatol Surg Res* 2021;107:102828.
19. Pandey V, C JJ, Mathai NJ, Madi S, Karegowda LH, Willems J. Five year follow up of retrospective cohort comparing structural and functional outcome of arthroscopic single-row versus double-row suture bridge repair of large posterosuperior rotator cuff tear in patients less than or equal to 70 years. *Arch Bone Jt Surg* 2021;9:391-398.
20. Plachel F, Siegert P, Rüttershoff K, et al. Long-term results of arthroscopic rotator cuff repair: A follow-up study comparing single-row versus double-row fixation techniques. *Am J Sports Med* 2020;48:1568-1574.
21. Gbejuade H, Patel MS, Singh H, Modi A. Reconstruction of irreparable rotator cuff tears with an acellular dermal matrix in elderly patients without joint arthritis. *Shoulder Elbow* 2022;14:83-89.
22. Haque A, Pal Singh H, Pandey R. Treatment of massive irreparable rotator cuff tears using dermal allograft bridging reconstruction. *J Clin Orthop Trauma* 2021;22,101593.
23. Omae H, Steinmann SP, Zhao C, et al. Biomechanical effect of rotator cuff augmentation with an acellular dermal matrix graft: A cadaver study. *Clin Biomech (Bristol, Avon)* 2012;27:789-792.
24. Kim JS, Kim SC, Park JH, et al. Arthroscopic incomplete rotator cuff repair with patch augmentation using acellular dermal matrix allograft. *Arthrosc Tech* 2023;12:e2203-e2209.
25. de Andrade ALL, Garcia TA, Brandão HS, Sardeli AV, Mouraria GG, Belangero WD. Benefits of patch augmentation on rotator cuff repair: A systematic review and meta-analysis. *Orthop J Sports Med* 2022;10:23259671211071146.
26. Mihata T, McGarry MH, Kahn T, Goldberg I, Neo M, Lee TQ. Biomechanical role of capsular continuity in superior capsule reconstruction for irreparable tears of the supraspinatus tendon. *Am J Sports Med* 2016;44:1423-1430.