Technical Note

Arthroscopy-Assisted Latissimus Dorsi Transfer for Irreparable Subscapularis Tears

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Abstract: Irreparable tears of the subscapularis (SS) tendon are difficult to manage and represent a challenge for the surgeon, especially in young and active patients. They are associated with a horizontal imbalance of the shoulder, causing pain and limitation of active internal rotation. Historically, the alternative for these patients has been transfer of the pectoralis major, with all its variations, total or partial, up or under the conjoint tendon. However, this transfer has mechanical disadvantages, especially related to the vector of traction, because it originates in the anterior region of the chest. In 2013, Elhassan and colleagues demonstrated in cadavers the technical feasibility and neurological safety of performing transfers of the latissimus dorsi (LD) to the lesser tuberosity to reconstruct irreparable lesions of the subscapularis. This option, compared with alternatives, has superior biomechanical advantages such as a similar vector of traction, originating from lower and posterior to the thorax, in addition to involving a synergistic muscle in action. In early 2016, Kany and colleagues first published a study of 5 patients undergoing arthroscopic assisted LD to SS transfer, with promising results. Our purpose is to present an arthroscopically assisted latissimus dorsi transfer technique in patients with irreparable subscapularis rupture.

Irreparable subscapularis (SS) tears are difficult injuries to treat and represent a challenge to the surgeon, particularly in young and active patients. The main function of the SS is balance of the muscular forces around the shoulder, and an irreparable tear leads to a horizontal imbalance that may or may not be accompanied by an anterosuperior escape, depending on the associated injuries.[1,2] These injuries lead to functional limitation and pain.[2] An injury is defined as an SS irreparable tear if it has retraction of the tendon to the glenoid and a fatty infiltration above that of Goutallier stage 3,[3] classifying it as Lafosse stage 4 or 5.[4]

Salvage procedures have been described for the treatment of irreparable tears or reruptures of the SS. Both open and arthroscopic repairs of this type of injury have shown a high failure rate, with poor functional results, and therefore have been abandoned.[5]

In young and active patients, transfer of a different tendon has been tried to replace the absence of the subscapularis. Transfer of the pectoralis major (PM) has been described; however, the results have not been entirely satisfactory in terms of stability, internal rotation strength, recovery of lift-off and belly-press tests, and progression to osteoarthritis.[1,4,6] Arthroscopic-assisted transfer of the pectoralis minor (Pm) has also been described, with promising results in young patients with irreparable tears of SS Lafosse stage 3.[7]

In 2013, Elhassan et al.[8] demonstrated, in cadavers, the technical feasibility and neurological safety of performing a latissimus dorsi (LD) transfer to the lesser tuberosity to reconstruct irreparable tears of the subscapularis. The objective of this study is to present an arthroscopy-assisted latissimus dorsi transfer technique for irreparable subscapularis tears.

Surgical Technique

This procedure is performed in patients with irreparable SS on magnetic resonance imaging (MRI), defined as stage 3 tendon retraction according to Patte,[9] fatty

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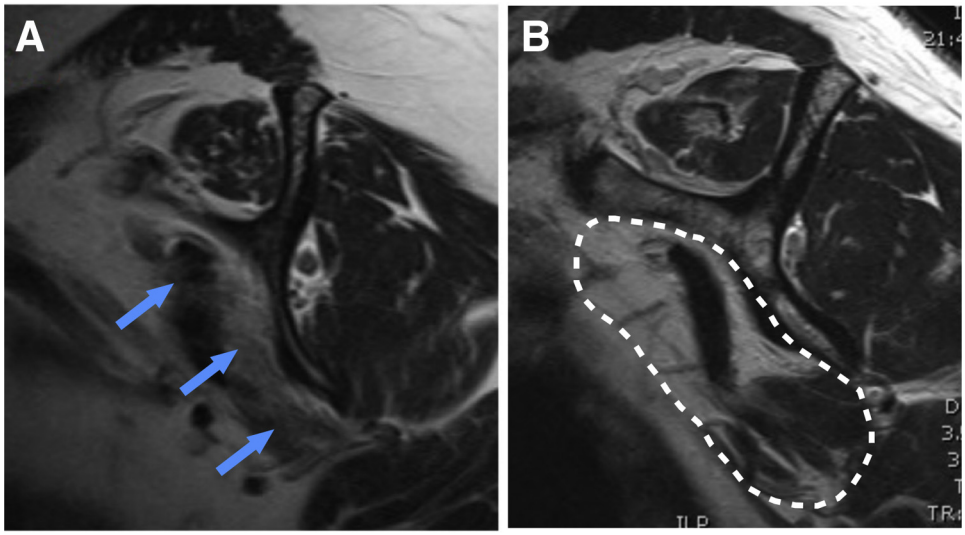

Fig 1. Oblique sagittal magnetic resonance image (T2) of the right scapula showing 2 irreparable SS tears. (A) Blue arrow shows severe fatty infiltration, Goutallier 4. (B) Severe muscle atrophy with respect to the subscapular fossa (dotted white line).

infiltration of Goutallier stage ≥3,[3] and SS tear of Lafosse stage 4 or 5[4] (Fig 1). Patients with glenohumeral osteoarthritis, Hamada arthropathy ≥2,[10] associated posterosuperior irreparable tears, history of glenohumeral infections, and history or sequelae of proximal humerus fractures were excluded.

Position

All patients are operated in beach chair position, with a head angle of inclination <40°. A single interscalene block is performed under ultrasound assistance, and local infiltration is applied around the axillary incision with bupivacaine 0.25%, 15 ml. The arm to be operated

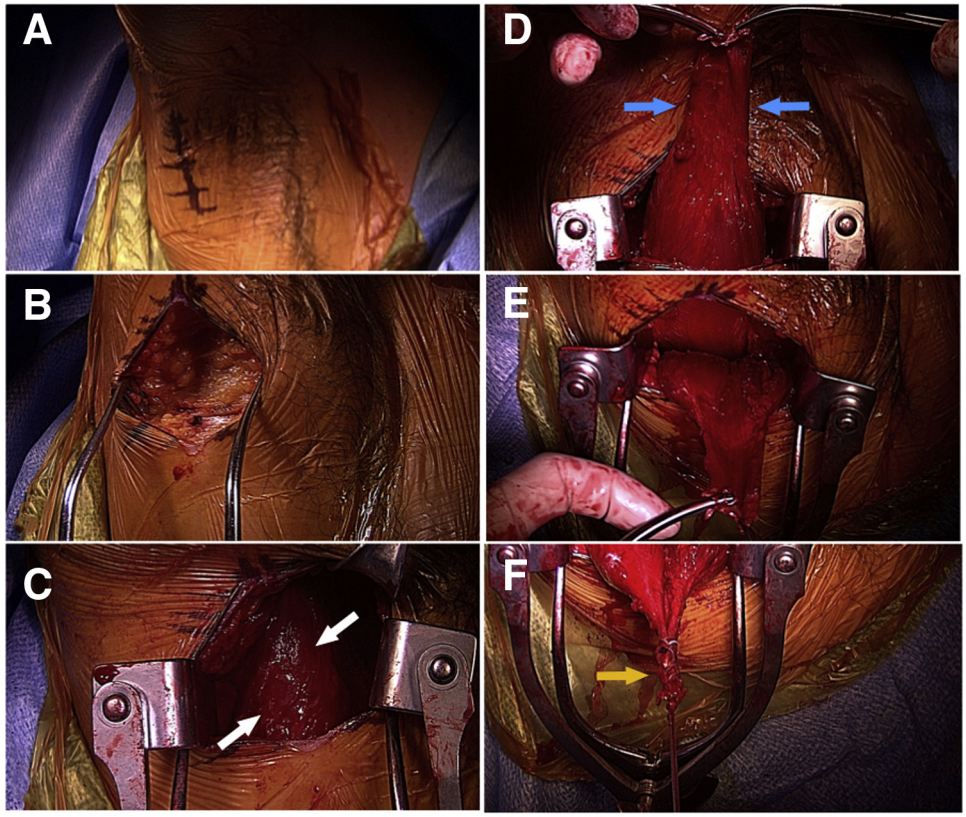

Fig 2. Latissimus dorsi (LD) harvest, right shoulder. Patient is in beach chair position in full abduction and internal rotation. (A) A 5-cm approach in the posterior axillary line is performed. (B) Subcutaneous and fat dissection is made to the LD fascia. (C) After opening the fascia, LD (white arrow) and teres major are identified. (D) The white aponeurosis band (blue arrow) insertion of the LD is released from the humerus with the shoulder in full internal rotation. (E) Complete release of the subcutaneous adhesions is done, gaining full excursion while protecting the neurovascular package. (F) Tubulization of the tendon is performed with nonabsorbable suture (FiberWire; Arthrex) using a Krakow configuration (yellow arrow).

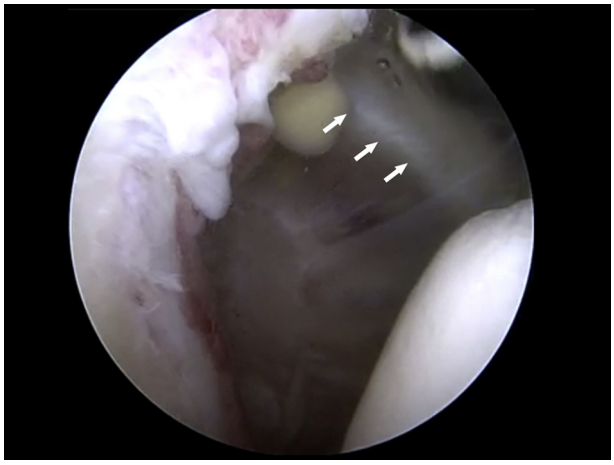

Fig 3. Diagnostic arthroscopy view from the posterior portal with a 30° optic (right shoulder, patient in beach chair position). Absence of the subscapular tendon is shown, allowing the complete conjoint tendon visualization (white arrow) in the anterior part of the shoulder.

on is left completely free, and the surgical field spans the axillary region to the medial edge of the full scapula.

Latissimus Dorsi Harvest

A 5-cm approach incision is made in the posterior axillary line (2 cm above the root of the limb and 3 cm in the thorax) (Fig 2A, B). LD and teres major (TM) muscles are identified (Fig 2C), and the white aponeurosis band insertion of the LD—s identified and released from the tendon-bone junction with the help of a blunt retractor on the anterolateral wall of the humerus, obtaining the greatest possible length (Fig 2D). Afterward, the dissection and release of the LD is carried out distally, posteriorly, and anteriorly

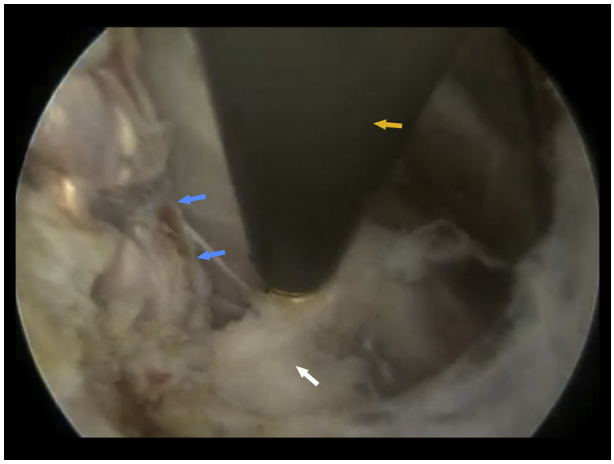

Fig 4. Anterolateral portal view in right shoulder. The latissimus dorsi tendon (blue arrow) passes to the anterior bursal space posteriorly and medially to the pectoralis major tendon (white arrow). Radiofrequency device (yellow arrow) moves the pectoralis major tendon anteriorly from the anterior working portal.

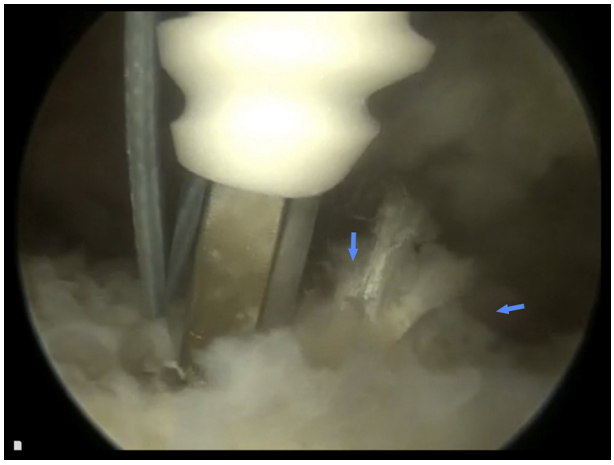

Fig 5. Anterolateral portal view in right shoulder showing the tendon transfer (blue arrow) and fixation using a 23 × 7-mm interferential biocomposite screw (Arthrex) in the highest part of the lesser tuberosity.

while accurately identifying the neurovascular package (located in the anterior region 10 to 14 cm from its humeral insertion), protecting it and preventing its traction at all times. The arm is maintained in medial rotation to push out the nerves, particularly the axillary nerve superiorly and the radial nerve inferiorly.

An important step is to identify, manage to advance, and release the muscle to obtain the greatest possible excursion, by releasing adhesions between the posterior region and the tip of the scapula (Fig 2E). The tubulization of the tendon is performed with nonabsorbable suture (FiberWire; Arthrex, Naples, FL) and a Krakow configuration (Fig 2F).

Arthroscopy

We perform diagnostic arthroscopy using the usual portals (posterior, anterior, anterolateral, and lateral). We identify the rupture from the articular side, and if

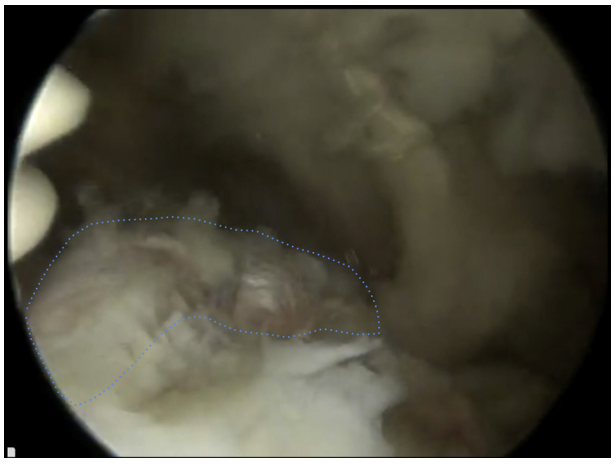

Fig 6. Anterolateral portal view in right shoulder showing the final position of the latissimus dorsi transfer (surrounded by blue dotted line) after fixation in the lesser tuberosity.

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Identify the latissimus dorsi muscle, from the insertion in the aponeurotic band, not from the muscular belly.	Avoid harvesting teres major muscle
Release insertion of latissimus dorsi to the inferior angle of the scapula to achieve maximum excursion.	Insufficient tendon excursion, not able to fix in the upper region of the lesser tuberosity
Rescue with suture retriever and FiberLink from the anterolateral portal, following the conjoint tendon inferiorly, posterior to the tendon of pectoralis major.	Passage through inadequate segment of the latissimus dorsi tendon
Always try to repair the subscapularis remnant, independent of fatty infiltration and muscular atrophy	Loose tenodesis effect of the tendon remnant

there are any remnants of the muscular portion of the SS (Fig 3) we released them and, when possible, reinsert them in a medialized position, taking the tenodesic effect into consideration with metallic anchors and mattress-type knots.

The management of the biceps tendon is as usual, with a tenotomy or tenodesis, according to age, clinical/physical status, and patient preference. Subsequently, from the bursal space, using the lateral or anterolateral portal, we identify the conjoint tendon and continue inferiorly until we identify the PM. After that, we advance posteroinferiorly with a suture grasper loaded at the tip with a FiberLink suture (Arthrex), up to our axillary approach, at the place where we performed the LD tenotomy. Using this suture, we rescue the tubulized LD tendon and advanced into the anterior bursal space (Fig 4).

LD Insertion in the Lesser Tuberosity

We identify the site of the bone tunnel for the insertion of our transfer, usually on the uppermost portion of the lesser tuberosity, mark it with a drill guide wire, and drill a 25-mm tunnel with a diameter of 7 mm. We fix the transfer using a 23 × 7-mm interferential biocomposite screw (Arthrex) (Figs 5 and 6). A repair of the associated posterosuperior cuff tear is performed on all patients, using a double-row SpeedBridge technique (Arthrex). A list of pearls and pitfalls is available in Table 1.

The closure of the axillary approach is performed with skin staples, with deep drainage for 24 hours and compressive dressing. The limb is placed in an internally rotating immobilizer, which is strictly maintained for 6 weeks. This technique is demonstrated in the Video 1.

Rehabilitation

The rehabilitation protocol begins formally after the postoperative week 6 with assisted passive joint range of motion exercises, accompanied by scapular stabilization exercises. At week 12, the patient starts progressive active mobility exercises (from reclining to standing position), always accompanied by scapular stabilization exercises. From week 16, muscle recovery therapy is supplemented with biofeedback techniques to allow the patient to fully return to activities at month 8.

Discussion

Various transfer techniques have been described for the treatment of massive SS tears, seeking to recover internal rotation and dynamic stability of the shoulder. Among them, the most frequently reported is the PM transfer.[6] Numerous authors have made variations to this technique seeking to better mimic the function of the SS. Using either the clavicle or sternocostal portion of the PM, passing through superficially[6] or deeply[1] to the conjoint tendon, no differences have been found between the techniques. Functional results in these studies vary in terms of pain, recovery of internal rotational strength, and in some cases, without achieving adequate glenohumeral stability.[1,6]

Kany et al.[11] and Elhassan et al.[8] postulated that these results would not become optimal, since the transfer of the PM does not meet the basic requirements of tendon transfer and understanding that the force vector of the SS is perpendicular to that of the PM. The LD muscle presents the best match in terms of the action vector, being very similar to the SS given its origin in the

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
Mininvasive technique assisted by arthroscopy, which allows treatment of associated injuries	In the posterior axillary approach to free graft in the axillary-radial interneural plane, there is possibility of injury if improper technique is used
Biomechanical characteristics superior to other subscapularis reconstruction alternatives	Technically demanding, advanced arthroscopy
Latissimus dorsi presents the greatest excursion, which avoids the use of grafts and allows tension-free fixation	Initial results are promising, but there are only a few clinical series with short follow-up

posterior side of the ribcage. Different options of LD transfer, both isolated and combined with the teres major, were evaluated by Elhassan et al.,[8] the isolated transfer being the safest in terms of associated nerve injuries (axillary and radial nerves).

Despite the theoretical advantage of this type of transfer, few clinical studies have evaluated the results. Mun et al.[12] recently published a study of 24 patients in whom an LD to SS transfer was performed with an open technique using a deltopectoral approach, with a mean follow-up of 27 months. They described that the American Shoulder and Elbow Surgeons and Constant scores increased from 40 to 70 and 46 to 69, respectively. They also found a significant improvement in internal rotation from L5 to L1. This series did not present major complications.

To the best of our knowledge, the study by Kany et al.[11] is the only one to report the technique of transferring LD to SS with arthroscopic assistance, in a series of 5 patients with irreparable SS tears and a minimum follow-up of 12 months. That study presented a case of infection with poor clinical and functional results. Nevertheless, when analyzing the rest of the patients, they found an increase in subjective shoulder value of 18% to 63% and an increase of 32 to 68 points on the Constant scale.

In summary, the LD has biomechanical advantages over other transfers used in the treatment of irreparable subscapularis tears. This transfer improves the traction vector to posterior and inferior; it presents a muscular power similar to the SS; and having an insertion as an aponeurotic band avoids compromising neighboring structures. In addition, it has enough tendon excursion to perform the transfer without requiring an allograft. A summary of the advantages and disadvantages is presented in Table 2.

Nonetheless, this surgery is technically demanding and there are few published studies. Long-term studies with a larger number of patients are necessary to evaluate this technique, which seems to be a good alternative for irreparable subscapularis tears.

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