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Full arthroscopic vs. arthroscopically assisted posterosuperior latissimus dorsi tendon transfer for shoulders with failed and irreparable rotator cuff repair: matched case-control study

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Purpose: To compare clinical outcomes and complication rates of full arthroscopic latissimus dorsi tendon transfer (LDTT) vs. arthroscopically assisted LDTT, for the treatment of irreparable posterosuperior massive rotator cuff tears (mRCTs) in shoulders that had failed rotator cuff repair (RCR).

Methods: We evaluated a continuous series of 191 patients who underwent LDTT over 4 consecutive years. A total of 107 patients did not have previous shoulder surgery, leaving 84 patients who had prior surgical procedures. All procedures performed over the first 2 years were arthroscopically assisted (n = 48), whereas all procedures performed over the last 2 years were full arthroscopic (n = 36). We noted all complications, as well as clinical scores and range of motion at ≥24 months. To enable direct comparison between the 2 techniques, propensity score matching was used to obtain 2 groups with equivalent age, sex, and follow-up.

Results: Compared with the 48 patients who underwent arthroscopically assisted LDTT, the 36 patients who underwent full arthroscopic LDTT had comparable complications (13% vs. 11%) and conversions to RSA (8.3% vs. 5.6%). Propensity score matching resulted in 2 groups, each comprising 31 patients, which had similar outcomes in terms of clinical scores (except mobility component of Constant score, which was better following fully arthroscopic LDTT; $P = .037$) and range of motion at a minimum follow-up of 2 years.

Conclusion: At a minimum follow-up of 24 months, for the treatment of irreparable posterosuperior mRCTs in shoulders that had surgical antecedents, full arthroscopic LDTT had significantly better mobility component of the Constant score than arthroscopically assisted LDTT, although there were no significant differences in the other clinical or functional outcomes. Arthroscopically assisted LDTT and full arthroscopic LDTT had comparable rates of complications (8.3% vs. 13%) and conversion to RSA (5.6% vs. 8.3%).

This study has been approved by the Conseil d'Orientation Scientifique Ramsay Santé ethics committee (IRB COS-RGDS-2021-09-006-KANY-J).
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Keywords: Latissimus dorsi tendon transfer; massive rotator cuff tear; arthroscopically assisted; all arthroscopic; complications; scores; operation time

Management of failed rotator cuff repair (RCR) is somewhat controversial, as conservative treatments are sometimes unsuccessful, whereas surgical treatments are technically demanding, and associated with risks of complications and inadequate recovery. Posterior latissimus dorsi tendon transfer (LDTT) has demonstrated satisfactory outcomes, for the treatment of both irreparable posterosuperior massive rotator cuff tears (mRCTs) and failed RCR, regardless of patient age.[15,18,20]

A recent systematic review by Memon et al[18] suggested that LDTT grants similar postoperative clinical scores and range of motion in shoulders with posterosuperior mRCTs or failed RCR, although 2 studies[4,11] found significantly lower net improvements in shoulders with failed RCR. The systematic review solely evaluated arthroscopically assisted LDTT, and there are yet no published studies that report outcomes of full arthroscopic LDTT for irreparable posterosuperior mRCTs in shoulders with failed RCR. In patients with no surgical antecedents, however, equivalent outcomes were achieved between fully arthroscopic LDTT and arthroscopically assisted LDTT.[14]

The purpose of the present study was to compare clinical outcomes and complication rates of full arthroscopic LDTT vs. arthroscopically assisted LDTT, for the treatment of irreparable posterosuperior mRCTs in shoulders that had failed RCR. The hypothesis was that, at a minimum follow-up of 24 months, full arthroscopic LDTT would grant equivalent or better patient-reported outcome measures (PROMs) with fewer complications than arthroscopically assisted LDTT.

Materials and methods

The authors retrieved the records of a consecutive series of 191 patients who underwent LDTT for irreparable mRCTs by the same senior surgeon (J.K.) between 2015 and 2019. A total of 107 patients did not have previous shoulder surgery, leaving 84 patients who had prior RCR. All procedures performed over the first 2 years were arthroscopically assisted (n = 48), whereas all procedures performed over the last 2 years were full arthroscopic (n = 36). All patients provided informed consent at index surgery for the use of their data and images for research and publishing purposes, and the study was approved by the ethics committee in advance (GCS Ramsay Santé pour l'Enseignement et la Recherche: IRB COS-RGDS-2021-09-006-KANY-J).

Indications and contraindications

The indications for LDTT were (1) a massive irreparable tear of the posterosuperior rotator cuff with fatty infiltration grade III or higher in 2 or more muscles (according to the Fuchs method[8] based on the Goutallier[10] classification), (2) 2 or more tendons retracted to the glenoid, (3) pseudoparesis (active forward elevation <90°), and (4) persistent pain after failed conservative treatment. The contraindications were (1) concomitant irreparable tear of the subscapularis, (2) cuff tear arthropathy with glenohumeral arthritis (Hamada stage ≥4), (3) complete and permanent axillary nerve palsy, (4) shoulder pseudoparalysis (active forward elevation <45° despite 3 months of physiotherapy),[3] or (5) shoulder stiffness (limitation of passive movements in forward elevation, external rotation, and internal rotation despite 3 months of physiotherapy).[16]

Preoperative assessment

Prior to surgery, the authors collected demographic data, and all patients underwent radiographic evaluation to assess subacromial space and grade of glenohumeral arthritis according to the Hamada classification[12] on standard anteroposterior radiographs (aka Grashey view) (Table I). All patients also underwent preoperative magnetic resonance imaging (MRI) to assess tear pattern according to Collin et al,[5] tendon retraction, and fatty infiltration, according to Goutallier et al,[10] in each of the rotator cuff muscles. Finally, an independent observer (M.S.) collected range of motion, including active forward elevation, abduction, external rotation 1 (elbow at the side), external rotation 2 (elbow at 90° of abduction), as well as the Constant score.[6]

Surgical treatment

Arthroscopically assisted LDTT was performed in the lateral decubitus position under general anesthesia and an interscalene nerve block. A 5-cm incision was made along the anterior (axillary) border of the scapula (Fig. 1). The latissimus dorsi was separated from the teres major and its neurovascular bundle was identified. Once the muscle belly was released from its surrounding structures, the aponeurotic band leading to the latissimus dorsi tendon was identified and followed until its humeral insertion. The latissimus dorsi tendon was then cut and detached from the humerus. The tendon was left flat and harvested using 2 no. 2 nonresorbable sutures (Vims, Toulouse, France). The long head of the triceps is identified, and the dissection is pursued under the posterior deltoid toward the subacromial space, to prepare the most direct route for the transfer. Arthroscopic débridement of the subacromial space was performed (without acromioplasty to prevent superior escape of the humeral head) with tenotomy of the biceps, if present.[2] Adjuvant subscapularis repair is performed in shoulders with Collin type C tears. The free sutures of the flat latissimus dorsi tendon were retrieved arthroscopically and fixed onto the junction between the footprints of the supraspinatus and infraspinatus using 2 knotless anchors (Versalok; DePuy Mitek,

Table I Radiologic data

	Arthroscopically assisted, n (%) (n = 31)	Full arthroscopic, n (%) (n = 31)	*P* value
Preoperative fatty infiltration SSP			.796
Stage 3	13 (42)	12 (39)	
Stage 4	18 (58)	19 (61)	
Preoperative fatty infiltration ISP			>.999
Stage 2			
Stage 3	7 (23)	7 (23)	
Stage 4	24 (77)	24 (77)	
Preoperative fatty infiltration SSC			
Stage 0	25 (81)	22 (71)	
Stage 1	6 (19)	4 (13)	
Stage 2	0 (0)	5 (16)	
SSP retraction			.368
Grade 1	0 (0)	1 (3)	
Grade 2	1 (3)	0 (0)	
Grade 3	30 (97)	30 (97)	
ISP retraction			.313
Grade 2	0 (0)	1 (3)	
Grade 3	31 (100)	30 (97)	
SSC retraction			.061
Grade 0	25 (81)	22 (71)	
Grade 1	6 (19)	4 (13)	
Grade 2	0 (0)	5 (16)	
Teres minor atrophy	3 (10)	3 (10)	>.999
Hamada classification			**.008**
0			
1	11 (35)	9 (29)	
2	19 (61)	15 (48)	
3	1 (3)	7 (23)	
Collin classification			**.019**
C	0 (0)	5 (16)	
D	31 (100)	24 (77)	
E	0 (0)	2 (6)	

SSP, supraspinatus; *ISP*, infraspinatus; *SSC*, subscapularis.
Boldface indicates statistical significance.

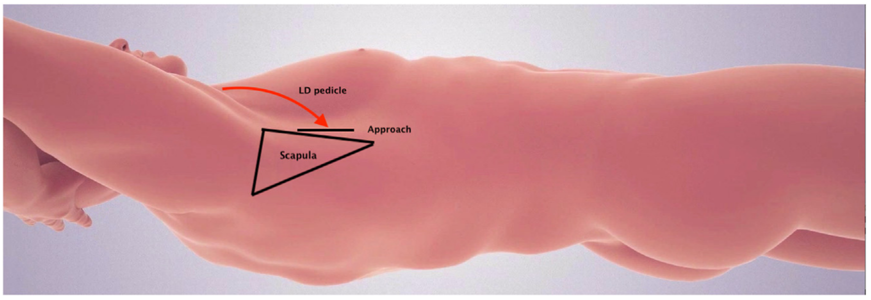

Figure 1 Arthroscopically assisted latissimus dorsi tendon transfer was performed in the lateral decubitus position and a 5-cm incision was made along the anterior (axillary) border of the scapula.

Raynham, MA, USA), which can also tighten the posterior cuff remnants.

Full arthroscopic LDTT was performed under general anesthesia in the beach chair position with the arm in a pneumatic holder (Spider; Smith & Nephew, London, UK) without axillary portals (Fig. 2). Arthroscopic débridement of the subacromial space was performed (without acromioplasty to prevent superior escape of the humeral head) with tenotomy of the biceps, if present.[2] Adjuvant subscapularis repair is performed in shoulders with Collin type C tears. Dissection of the posterior space was

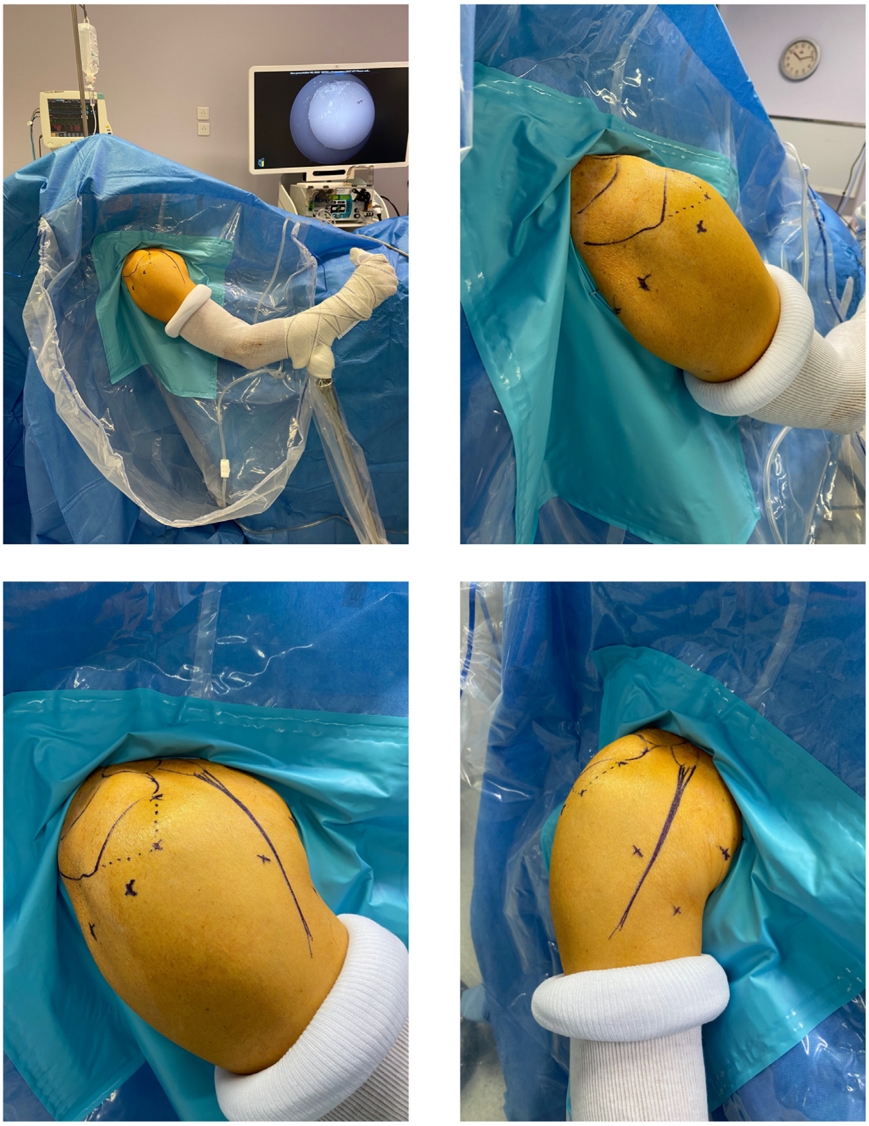

Figure 2 For full-arthroscopic latissimus dorsi tendon transfer, 8 portals were created.

performed using an extra-large radiofrequency probe (Turbo XL 90°; Smith & Nephew) after identification of the scapular spine. Further dissection was performed in an inferomedial direction between the distal deltoid aponeurosis and the remnants of infraspinatus and teres minor. The vertical fibers of the long head of the triceps were visualized to prevent any injury to the axillary nerve crossing through the quadrilateral space (lateral to the long head of the triceps). Furthermore, soft tissues were released medial to the long head of the triceps, to access the triangular space (delimited by the long head of the triceps laterally, the teres minor superiorly, and the latissimus dorsi/teres major distally) (Fig. 3). The scope was switched to an anterolateral portal (Fig. 4), following the long head of the biceps tendon to reach the lateral edge of the conjoint tendon and the upper border of the pectoralis major that was partially released to facilitate exposure. The "3 sisters" (terminal branches of the circumflex vessels) were identified, marking the inferior border of the subscapularis tendon and the upper border of the latissimus dorsi tendon. The dissection followed the upper edge and anterior surface of the latissimus dorsi. The teres major is located posterior to the latissimus dorsi, with several anatomic connections. Great care is taken to prevent any injury to the axillary nerve, the circumflex vessels, and the radial nerve that crosses the superficial surface of the latissimus dorsi, 3 to 4 cm medial to its humeral insertion. Two "triple Krakow" sutures were made 3 cm along the common insertion of the latissimus dorsi and teres major tendons, which were then detached to perform a double transfer through the triangular space toward the back of the humeral head. The latissimus dorsi and teres major double transfer was then reattached onto the junction between the footprints of the supraspinatus and infraspinatus using 2 knotless anchors (Versalok; DePuy Mitek), which can also tighten the posterior cuff remnants. It is worth noting that the full arthroscopic technique uses the same anchors at the same locations as the arthroscopically assisted technique, but the latter requires double transfer of the latissimus dorsi and teres major muscles that are closely connected and challenging to separate

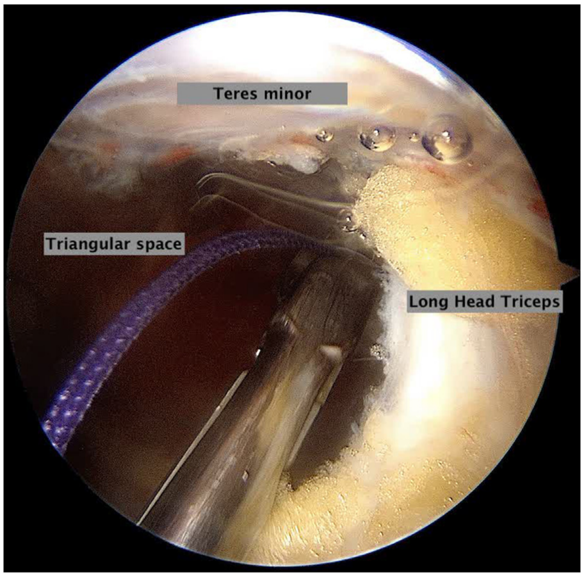

Figure 3 Posterior view of the shoulder. Soft tissues were released medial to the long head of the triceps, to access the triangular space (delimited by the long head of the triceps laterally, the teres minor superiorly, and the latissimus dorsi/teres major distally).

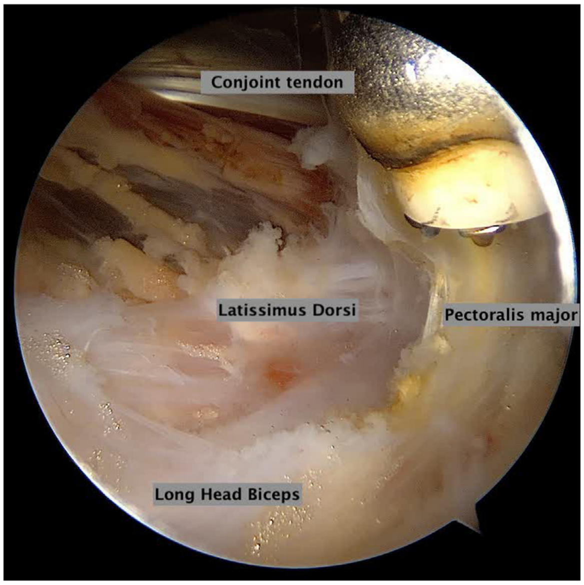

Figure 4 Anterior view of the shoulder. The scope was placed in an anterolateral portal, following the long head of the biceps tendon to reach the lateral edge of the conjoint tendon and the upper border of the pectoralis major that was partially released to facilitate exposure to the latissimus dorsi tendon.

arthroscopically, whereas the former allows isolated transfer of the latissimus dorsi that can be separated through an open incision (Fig. 5).

Postoperative rehabilitation

For both techniques, all patients were immobilized using a 30° abduction pillow in neutral rotation for 4 weeks at home, and self-assisted passive exercises in the supine position were started immediately. At 4 weeks, a supervised physiotherapy program was initiated with the goal to restore passive flexion, and gentle aquatic therapy was recommended. After 3 months, strengthening exercises were started.

Postoperative assessment

Operative time was recorded, and following surgery, all complications were noted, specifying ruptures and whether patients required conversion to reverse shoulder arthroplasty (RSA). Furthermore, at a minimum follow-up of 24 months, 1 independent observer (M.S.) collected the range of motion and clinical scores through telephone (n = 15) or in person (n = 69), including the Constant score,[6] the Subjective Shoulder Value,[9] Simple Shoulder Test,[21] the Activities of Daily Living requiring Active External Rotation score,[1] American Shoulder and Elbow Surgeons Standardized Shoulder Assessment scores,[19] and pain on visual analog scale.

Statistical analysis

A sample size calculation indicated that 28 patients per group were needed to determine a significance in minimal clinically important difference of 10.4 points of the Constant score between the groups,[17] assuming equal standard deviation of 13.3 points, with a statistical power of 0.80. Descriptive statistics were used to summarize the demographic data, clinical scores, and radiographic measurements. For categorical variables, comparisons between groups were performed using the Fisher test or χ^2 test for binary and nonbinary variables, respectively. Normality of continuous variables was assessed through Shapiro-Wilk tests. For continuous variables, comparisons between groups were performed using Wilcoxon signed-rank tests with Bonferroni correction, as none of the variables were normally distributed. To enable comparison of outcomes of arthroscopically assisted vs. full arthroscopic LDTT, propensity scores were estimated for each patient using a logistic regression model, to obtain 2 similar groups in terms of age, sex, and follow-up. A 1:1 nearest-neighbor algorithm with a caliper of 0.7 was applied to match patients using their corresponding propensity scores. Statistical analyses were conducted using R, version 4.1 (R Foundation for Statistical Computing, Vienna, Austria). P values <.05 were considered statistically significant.

Results

Arthroscopically assisted LDTT

From the initial cohort of 48 patients who had arthroscopically assisted LDTT, 8 were lost to follow-up, 1 died because of reasons unrelated to shoulder surgery, and 4 required conversion to RSA because of progression of glenohumeral osteoarthritis (8.3%; Hamada grade 4) (Fig. 6). Of the remaining 35 patients, 6 had complications

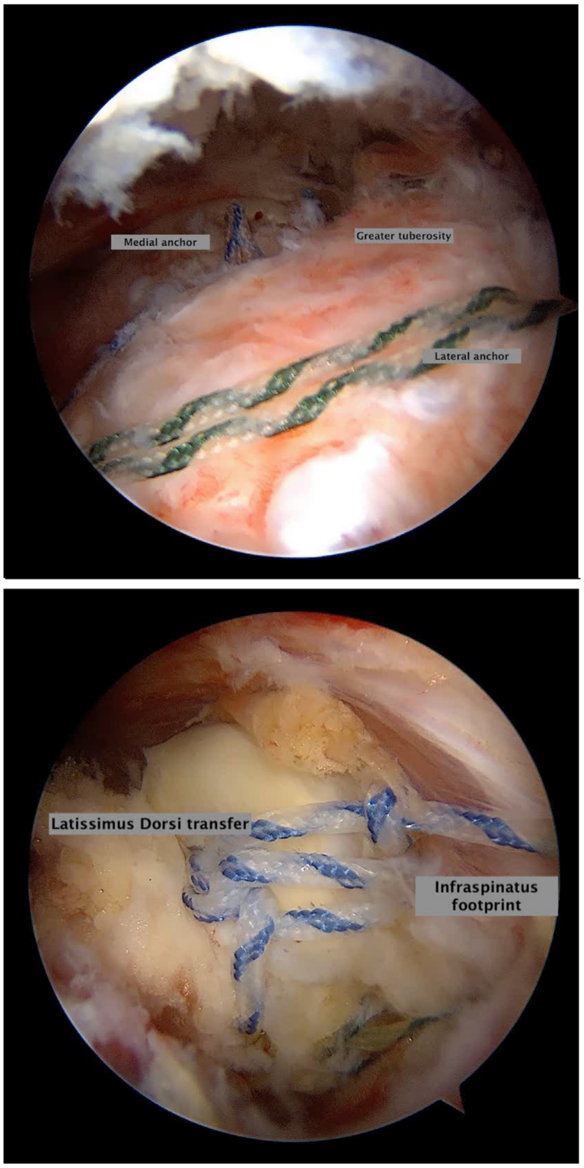

Figure 5 Posterior view of the shoulder. The double transfer of the latissimus dorsi and teres major was fixed onto the junction between the footprints of the supraspinatus and infraspinatus using 2 knotless anchors.

(13%; 2 infections, 2 hematomas, 1 delayed axillary incision healing, and 1 traumatic latissimus dorsi rupture).

Full arthroscopic LDTT

From the initial cohort of 36 patients who had full arthroscopic LDTT, 2 were lost to follow-up, and 2 required conversion to RSA (5.6%) because of progression of glenohumeral osteoarthritis (Hamada grade 4); it is worth noting that 1 of those patients had 3 prior surgeries (primary open RCR, revision arthroscopic RCR, and nail fixation of traumatic humeral fracture) (Fig. 6). Moreover, 4 patients had complications (11%; 1 lymphedema, 1 hematoma, 1 distal radial nerve palsy that partially recovered, and 1 osteoarthritis). Arthroscopically assisted LDTT and full arthroscopic LDTT had comparable rates of complications (13% vs. 11%) and conversions to RSA (8.3% vs. 5.6%).

Clinical scores

Propensity score matching resulted in 2 groups, each comprising 31 patients, with comparable patient demographics and follow-up (Table II). Despite propensity score matching, patients who underwent full arthroscopic LDTT had significantly worse preoperative adjusted Constant score (5.5 ± 1.5 vs. 7.1 ± 1.8, $P = .047$) and activity component of the Constant score (38.5 ± 8.6 vs. 44.1 ± 11.1, $P < .001$), compared with patients who underwent arthroscopically assisted LDTT (Table III). These small differences could be explained considering the expansion of indications for LDTT over the inclusion period for this study, as the senior surgeon included shoulders with worse preoperative function and more comorbidities as he gained familiarity and confidence with the procedure; that is, in 2018 the preoperative Constant score was 31.1 ± 7.8, whereas in 2019 it decreased to 29.0 ± 6.7. Subgroup analysis revealed that there was no significant difference ($P = .687$) in postoperative Constant scores between patients who had prior open cuff repair vs. arthroscopic cuff repair following arthroscopically assisted LDTT (55.1 ± 21.8 vs. 69.0 ± 14.7) or fully arthroscopic LDTT (62.4 ± 18.6 vs. 64.0 ± 16.0), most likely because of small groups.

At 33.3 ± 8.8 months (range, 24-62) following arthroscopically assisted LDTT and 30.6 ± 8.2 months (range, 24-51) following full arthroscopic LDTT, the latter had significantly better mobility component of the Constant score ($P = .037$), whereas there were no significant differences in any other clinical or functional outcomes (Tables III and IV).

Discussion

The most important findings of this study were that at a minimum follow-up of 24 months, for the treatment of irreparable posterosuperior mRCTs in shoulders that had failed RCR, full arthroscopic LDTT granted significantly better mobility component of the Constant score compared with arthroscopically assisted LDTT, whereas there were no significant differences in any other clinical or functional outcomes. Furthermore, arthroscopically assisted LDTT and full arthroscopic LDTT had comparable rates of complications (11% vs. 13%) and conversions to RSA (8.3% vs. 5.6%). The hypothesis that full arthroscopic LDTT would grant equivalent or better PROMs with fewer complications than arthroscopically assisted posterior LDTT is therefore

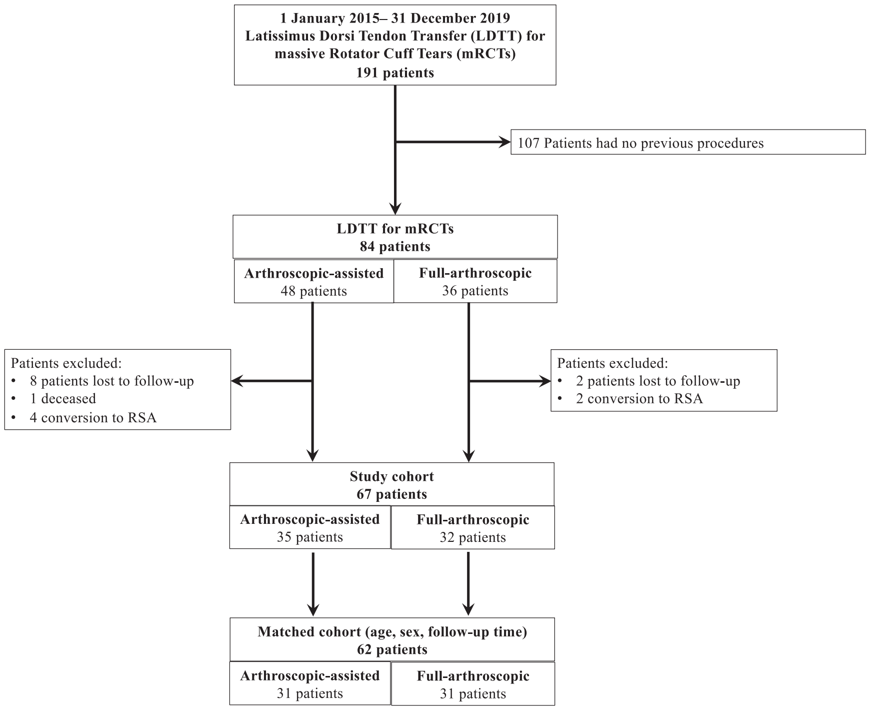

Figure 6 Flowchart.

Table II Demographics (age, sex, and follow-up time matched cohort)

	Arthroscopically assisted, mean ± SD (range) or n (%) (n = 31)	Full arthroscopic, mean ± SD (range) or n (%) (n = 31)	*P* value
Age at index surgery, yr	63.1 ± 10.66 (43.1-81.4)	61.0 ± 9.53 (42.7-80.5)	.495
Sex			.445
Male	18 (58)	16 (52)	
Female	13 (42)	15 (48)	
Smoking	5 (16)	7 (23)	.520
Dominant arm	20 (65)	24 (77)	.263
Profession			
Manual	18 (58)	23 (74)	.180
Sedentary	13 (42)	8 (26)	
Prior shoulder procedures			
1	29 (94)	28 (90)	
2	2 (6)	2 (6)	
3	0 (0)	1 (3)	

SD, standard deviation.

only partially confirmed. The differences in PROMs may be due to the double transfer of the latissimus dorsi and teres major muscles by the full arthroscopic technique, which is stronger than the isolated transfer of the latissimus dorsi by the arthroscopically assisted technique, although further studies are required to investigate this. The clinical relevance of these findings is that full arthroscopic LDTT seems safe and effective for the treatment of irreparable posterosuperior mRCTs.

Full arthroscopic LDTT requires a lot of experience in LDTT procedures, as it is a demanding shoulder procedure with a steep learning curve. Compared to arthroscopically assisted LDTT, full arthroscopic LDTT is less invasive and therefore reduces latissimus dorsi tendon donor site morbidity,[7] which could enhance recovery. There are, however, drawbacks of full arthroscopic LDTT, which include the difficulty of releasing the muscle belly from its connective tissue, as reported in a recent publication,[22] therefore making it challenging to transfer the tendon to the desired point on the greater tuberosity, and exacerbating tension within the tendon-to-bone fixation. In the authors' experience, full arthroscopic LDTT requires extensive

Table III Pre- and postoperative clinical scores

	Arthroscopically assisted, mean ± SD (range) (n = 31)	Full arthroscopic, mean ± SD (range) (n = 31)	*P* value
Follow-up, mo	33.3 ± 8.8 (24 to 62)	30.6 ± 8.2 (24 to 51)	.077
Operation time, min	91.7 ± 19.8 (70 to 135)	91.5 ± 14.5 (64 to 115)	.634
Constant score (0-100)			
Preoperative	34.0 ± 7.9 (20 to 47)	30.5 ± 6.4 (18 to 42)	.072
Postoperative	61.1 ± 19.1 (21 to 93)	64.7 ± 16.5 (26 to 87)	.436
Net change	27.0 ± 18.6 (−13 to 58)	32.1 ± 19.3 (−23 to 58)	.179
Constant Score—pain			
Preoperative	0.3 ± 1.2 (0 to 5)	0.2 ± 0.9 (0 to 5)	.570
Postoperative	11.4 ± 3.8 (3 to 15)	12.2 ± 3.9 (0 to 15)	.360
Constant score—activity			
Preoperative	7.1 ± 1.8 (4 to 12)	5.5 ± 1.5 (4 to 8)	**<.001**
Postoperative	14.7 ± 4.3 (6 to 20)	13.8 ± 4.2 (4 to 20)	.323
Constant score—mobility			
Preoperative	25.5 ± 6.3 (14 to 36)	23.9 ± 5.0 (14 to 34)	.314
Postoperative	29.9 ± 9.9 (8 to 40)	34.2 ± 7.7 (16 to 40)	**.037**
Constant score—strength			
Preoperative	1.1 ± 0.9 (0 to 4)	0.9 ± 0.8 (0 to 2)	.476
Postoperative	5.1 ± 3.8 (0 to 18)	4.7 ± 3.5 (0 to 12)	.743
Adjusted Constant score (0-100)			
Preoperative	44.1 ± 11.1 (27 to 64)	38.5 ± 8.6 (22 to 54)	**.047**
Postoperative	79.3 ± 26.1 (28 to 119)	81.7 ± 21.5 (32 to 126)	.834
Net change	35.2 ± 24.2 (−14 to 79)	40.6 ± 24.8 (−26 to 84)	.257
ADLER			
Postoperative	22.3 ± 6.6 (7 to 30)	25.9 ± 3.8 (17 to 30)	.068
SSV (0-100)			
Postoperative	60.2 ± 24.6 (15 to 95)	61.7 ± 22.0 (10 to 90)	.812
ASES			
Postoperative	60.6 ± 26.4 (10 to 97)	64.2 ± 23.3 (7 to 97)	.740
SST			
Postoperative	5.3 ± 3.5 (0 to 11)	6.9 ± 2.4 (2 to 10)	.106
Pain on VAS			
Postoperative	3.3 ± 2.9 (0 to 10)	2.8 ± 2.7 (0 to 10)	.592
Subacromial space			
Preoperative	7.6 ± 2.3 (3 to 12)	7.8 ± 1.8 (5 to 12)	.904
Postoperative	8.3 ± 1.9 (4 to 12)	7.3 ± 1.8 (4 to 12)	.061

ADLER, Activities of Daily Living requiring Active External Rotation; *SSV*, Subjective Shoulder Value; *ASES*, American Shoulder and Elbow Surgeons Standardized Shoulder Assessment; *SST*, Simple Shoulder Test; *VAS*, visual analog scale; *SD*, standard deviation.
Boldface indicates statistical significance.

cadaveric training to familiarize surgeons with the approach and new portals, which could improve tendon fixation and minimize risks of radial and/or axillary nerve injuries. An alternative technique is a lower trapezius transfer; however, this procedure is better suited for patients with isolated loss of external rotation 1 (elbow at side), whereas the patients in the present study required more active forward elevation and external rotation 2 (elbow at 90° of abduction).[13]

In the present study, the complication rate was comparable for the LDTT techniques, but the type of complications differed. The complication rates of full arthroscopic LDTT were comparable to the findings of a recent systematic review by Memon et al,[18] who reported that 2.3% of patients had deep infections requiring lavage and antibiotic therapy, 1.6% had hematoma, 0.4% had transient postoperative brachial plexus palsy, and 0.4% had a hematoma infection at the donor site.

In the present study, there were no significant differences in postoperative clinical scores and range of motion between arthroscopically assisted vs. full arthroscopic LDTT. In our series, patients achieved greater clinical scores and range of motion than reported in the systematic review by Memon et al[18] on arthroscopically assisted LDTT, who found a postoperative Constant score of 66, Subjective Shoulder Value of 56, active forward elevation of 155°, external rotation of 40°, and abduction of 132°. It is worth noting, however, that Memon et al[18] included studies on patients who underwent arthroscopically assisted LDTT with and without surgical history, and revealed similar

Table IV Pre- and postoperative range of motion

	Arthroscopically assisted, mean ± SD (range) (n = 31)	Full arthroscopic, mean ± SD (range) (n = 31)	*P* value
Follow-up, mo	33.3 ± 8.8 (24 to 62)	30.6 ± 8.2 (23 to 51)	
Active forward elevation (degrees)			
Preoperative	136.5 ± 27.3 (60 to 170)	132.6 ± 28.0 (60 to 160)	.220
Postoperative	145.5 ± 43.6 (30 to 180)	150.7 ± 35.2 (70 to 180)	.965
Net change	9.0 ± 35.9 (−80 to 70)	13.2 ± 43.8 (−80 to 110)	.634
Abduction (degrees)			
Preoperative	96.8 ± 36.2 (30 to 160)	91.3 ± 23.8 (40 to 130)	.723
Postoperative	123.1 ± 46.5 (30 to 180)	133.0 ± 40.0 (40 to 180)	.381
Net change	26.3 ± 39.2 (−60 to 100)	37.4 ± 47.0 (−70 to 100)	.188
External rotation 1 (degrees)			
Preoperative	23.9 ± 12.4 (0 to 45)	18.5 ± 14.4 (−20 to 45)	.158
Postoperative	33.7 ± 17.1 (−20 to 50)	37.3 ± 11.0 (10 to 45)	.700
Net change	9.8 ± 22.2 (−50 to 45)	17.6 ± 16.2 (−20 to 50)	.166
External rotation 2 (degrees)			
Postoperative	46.3 ± 21.6 (0 to 90)	51.5 ± 22.8 (0 to 90)	.321

SD, standard deviation.

results of LDTT for both posterosuperior mRCTs and failed RCR, albeit with smaller improvements in clinical scores and range of motion following failed RCR in some studies.[4,11] In one of those studies, Castricini et al[4] reported that arthroscopically assisted LDTT after failure of previous rotator cuff repair is associated with less strength in forward flexion and lower postoperative Constant score compared with primary procedures. Finally, compared to the study by Kany et al[14] on arthroscopically assisted vs. full arthroscopic LDTT in shoulders with no surgical history, patients in the present series had lower clinical scores, most likely as they had already undergone 1 to 3 previous surgeries.

The results of the present study should be interpreted with the following limitations in mind. This is the learning experience of a senior surgeon who is familiar with arthroscopically assisted LDTT, but who had not previously performed full arthroscopic LDTT. Despite this, the outcomes might still lack generalizability because of the steep learning curve. This is a retrospective study with a small sample size, in which patients underwent arthroscopically assisted LDTT from 2015 to 2017, and full arthroscopic LDTT from 2018 to 2019. Therefore, the complications of the full arthroscopic LDTT procedures might have been associated with a learning curve, as these occurred in the first year using this technique, whereas in the second year no complications were noted. Furthermore, differences in PROMs could be due to slight variations in surgical techniques among the 2 groups, as the arthroscopically assisted technique transfers the latissimus dorsi tendon only, whereas the full arthroscopic technique transfers both the latissimus dorsi and the teres major together, without intermediate dissection. Finally, the cohort size was small, which did not allow for regression analyses, and longer follow-up is required to confirm the long-term safety.

Conclusion

At a minimum follow-up of 24 months, for the treatment of irreparable posterosuperior mRCTs in shoulders that had failed RCR, full arthroscopic LDTT had significantly better mobility component of the Constant score than arthroscopically assisted LDTT, whereas there were no significant differences in the other clinical or functional outcomes. Furthermore, arthroscopically assisted LDTT and full arthroscopic LDTT had comparable rates of complications (11% vs. 13%) and conversions to RSA (8.3% vs. 5.6%). The clinical relevance of these findings is that full arthroscopic LDTT seems safe and effective for the treatment of irreparable posterosuperior mRCTs with failed prior RCR.

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References

1. Boileau P, Chuinard C, Roussanne Y, Bicknell RT, Rochet N, Trojani C. Reverse shoulder arthroplasty combined with a modified

latissimus dorsi and teres major tendon transfer for shoulder pseudoparalysis associated with dropping arm. Clin Orthop Relat Res 2008;466:584-93. https://doi.org/10.1007/s11999-008-0114-x

2. Bradbury T, Dunn WR, Kuhn JE. Preventing the Popeye deformity after release of the long head of the biceps tendon: an alternative technique and biomechanical evaluation. Arthroscopy 2008;24:1099-102. https://doi.org/10.1016/j.arthro.2008.06.002
3. Burks RT, Tashjian RZ. Should we have a better definition of pseudoparalysis in patients with rotator cuff tears? Arthroscopy 2017;33:2281-3. https://doi.org/10.1016/j.arthro.2017.07.024
4. Castricini R, De Benedetto M, Familiari F, De Gori M, De Nardo P, Orlando N, et al. Functional status and failed rotator cuff repair predict outcomes after arthroscopic-assisted latissimus dorsi transfer for irreparable massive rotator cuff tears. J Shoulder Elbow Surg 2016;25:658-65. https://doi.org/10.1016/j.jse.2015.08.043
5. Collin P, Matsumura N, Ladermann 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;23:1195-202. https://doi.org/10.1016/j.jse.2013.11.019
6. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. Clin Orthop Relat Res 1987:160-4.
7. Cutbush K, Peter NA, Hirpara K. All-arthroscopic latissimus dorsi transfer. Arthrosc Tech 2016;5:e607-613. https://doi.org/10.1016/j.eats.2016.02.007
8. Fuchs B, Weishaupt D, Zanetti M, Hodler J, Gerber C. Fatty degeneration of the muscles of the rotator cuff: assessment by computed tomography versus magnetic resonance imaging. J Shoulder Elbow Surg 1999;8:599-605.
9. Gilbart MK, Gerber C. Comparison of the subjective shoulder value and the Constant score. J Shoulder Elbow Surg 2007;16:717-21. https://doi.org/10.1016/j.jse.2007.02.123
10. 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.
11. Grimberg J, Kany J, Valenti P, Amaravathi R, Ramalingam AT. Arthroscopic-assisted latissimus dorsi tendon transfer for irreparable posterosuperior cuff tears. Arthroscopy 2015;31:599-607.e591. https://doi.org/10.1016/j.arthro.2014.10.005
12. Hamada K, Fukuda H, Mikasa M, Kobayashi Y. Roentgenographic findings in massive rotator cuff tears. A long-term observation. Clin Orthop Relat Res 1990:92-6.
13. Hartzler RU, Barlow JD, An KN, Elhassan BT. Biomechanical effectiveness of different types of tendon transfers to the shoulder for external rotation. J Shoulder Elbow Surg 2012;21:1370-6. https://doi.org/10.1016/j.jse.2012.01.026
14. Kany J, Meirlaen S, Werthel JD, van Rooij F, Saffarini M, Grimberg J. Matched cohort study comparing arthroscopic-assisted versus full-arthroscopic latissimus dorsi tendon transfer for irreparable massive rotator cuff tears. Orthop J Sports Med 2023;11:23259671231160248. https://doi.org/10.1177/23259671231160248
15. Kany J, Sekakaran P, Amavarathi RS, Patil P, Grimberg J, Valenti P, et al. Posterior latissimus dorsi transfer for massive irreparable posterosuperior rotator cuff tears: does it work in the elderly population? A comparative study between 2 age groups (</=55 vs. >/=75 years old). J Shoulder Elbow Surg 2021;30:641-51. https://doi.org/10.1016/j.jse.2020.06.018
16. Kany J, Selim HA. Combined fully arthroscopic transfer of latissimus dorsi and teres major for treatment of irreparable posterosuperior rotator cuff tears. Arthrosc Tech 2020;9:e147-57. https://doi.org/10.1016/j.eats.2019.09.008
17. Kukkonen J, Kauko T, Vahlberg T, Joukainen A, Aarimaa V. Investigating minimal clinically important difference for Constant score in patients undergoing rotator cuff surgery. J Shoulder Elbow Surg 2013;22:1650-5. https://doi.org/10.1016/j.jse.2013.05.002
18. Memon M, Kay J, Quick E, Simunovic N, Duong A, Henry P, et al. Arthroscopic-assisted latissimus dorsi tendon transfer for massive rotator cuff tears: a systematic review. Orthop J Sports Med 2018;6:2325967118777735. https://doi.org/10.1177/2325967118777735
19. Michener LA, McClure PW, Sennett BJ. American Shoulder and Elbow Surgeons standardized shoulder assessment form, patient self-report section: reliability, validity, and responsiveness. J Shoulder Elbow Surg 2002;11:587-94. https://doi.org/10.1067/mse.2002.127096
20. Namdari S, Voleti P, Baldwin K, Glaser D, Huffman GR. Latissimus dorsi tendon transfer for irreparable rotator cuff tears: a systematic review. J Bone Joint Surg Am 2012;94:891-8. https://doi.org/10.2106/JBJS.K.00841
21. Roy JS, Macdermid JC, Faber KJ, Drosdowech DS, Athwal GS. The simple shoulder test is responsive in assessing change following shoulder arthroplasty. J Orthop Sports Phys Ther 2010;40:413-21. https://doi.org/10.2519/jospt.2010.3209
22. Wieser K, Ernstbrunner L, Zumstein MA. Surgical management of massive irreparable cuff tears: latissimus dorsi transfer for posterosuperior tears. Curr Rev Musculoskelet Med 2020;13:605-11. https://doi.org/10.1007/s12178-020-09659-3