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Feasibility of latissimus and teres major transfer to reconstruct irreparable subscapularis tendon tear: an anatomic study

Bassem Elhassan, MD*, Thomas J. Christensen, MD, Eric R. Wagner, MD

Department of Orthopedic Surgery, Mayo Clinic, Rochester, MN, USA

Background: Several tendon transfers have been described to reconstruct irreparable subscapularis (SS) tears, but their outcomes are variable and unsatisfactory in the presence of anterior glenohumeral subluxation. We evaluated the anatomic feasibility of the latissimus dorsi (LD) or teres major (TM) muscle tendon transfer to reconstruct an irreparable SS tendon tear.

Materials and methods: The dimensions of the LD and TM tendons and the distance between their insertion and the SS tendon insertion were determined In 20 cadaveric shoulders. Feasibility of the isolated LD and TM tendon transfer to 3 locations on the SS tendon insertion, transfer of the LD to the proximal half, TM to the lower half of the SS tendon, and combined transfer of the LD/TM tendon to the central aspect of the SS tendon was assessed.

Results: The LD and TM were an average length of 5.9 cm and 2.3 cm and an average width of 2.2 cm and 2.4 cm, respectively. The mean distances from the center of the LD and TM tendons insertion to the central aspect of the SS tendon insertion was 4.0 cm and 4.7 cm, respectively. All of the tendon transfers were feasible, and the risk of nerve compression was low, except for the combined tendon LD/TM transfer to the proximal third of the SS tendon.

Conclusions: This study shows that transfer of the LD/TM to the lesser tuberosity to reconstruct an irreparable SS tear is feasible, with a low risk of nerve compression, with the exception of the combined LD/TM and more proximal TM tendon transfers.

Level of evidence: Basic Science Study, Anatomy, Cadaver Dissection.

Keywords: Latissimus; teres major; irreparable; subscapularis; tear; transfer

Irreparable subscapularis (SS) tendon tear is an uncommon rotator cuff injury that can be very challenging to manage.[1,3,5,6,13,18,19,21] Treatment depends on the patient's age, symptoms, and whether the glenohumeral joint is affected by arthritis. The most commonly reported procedure to manage an irreparable SS tear is pectoralis major tendon transfer.[1,3,5,6,13,18,21] This transfer has been described in different forms, with passage of the sternal head or clavicular head, or both, deep or superficial to the conjoint tendon, with variable reported outcomes.[1,3,5,6,13,18,21] Less commonly, but also reported for treatment of this pathology, is the transfer of pectoralis minor.[15,17] Elhassan et al[3] reported poor outcomes of transfer of the sternal head to the pectoralis to reconstruct an irreparable SS tear when there is an established anterior glenohumeral joint subluxation. For

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*Reprint requests: Bassem Elhassan, MD, Orthopedic Department, Mayo Clinic, 200 First St SW, Rochester MN 55905, USA.

E-mail address: elhassan.bassem@mayo.edu (B. Elhassan).

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patients who have additional glenohumeral joint arthritis, reverse shoulder arthroplasty has been reported to be the only reliable option to manage the shoulder instability and arthritis.[4,9] Although this treatment could be a feasible option in older patients, it is not desirable or recommended in more active younger patients due to the high potential risk of implant failure in the younger patient population.

Aside from the use of pectoralis major and minor, the only other transfer that has been described to reconstruct irreparable SS tendon tears is the upper trapezius transfer with its bony insertion.[11] In that report, however, patients' symptoms improved after surgery, but without improvement in anterior shoulder subluxation.[11]

Latissimus dorsi (LD) or teres major (TM) tendon transfer, or transfer of both, has been frequently cited in published reports as a common transfer performed for patients with massive irreparable posterior-superior rotator cuff tears (supraspinatus and infraspinatus), with good reported outcomes in patients who did not present with pseudoparalysis.[7,8,10,12,20] To our knowledge this transfer has never been described previously for the reconstruction of anterior-superior irreparable rotator cuff tear of the SS, with or without the supraspinatus. The purpose of this study was analyze the anatomic feasibility of LD or TM transfer, or both, to reconstruct an irreparable tear of the SS tendon.

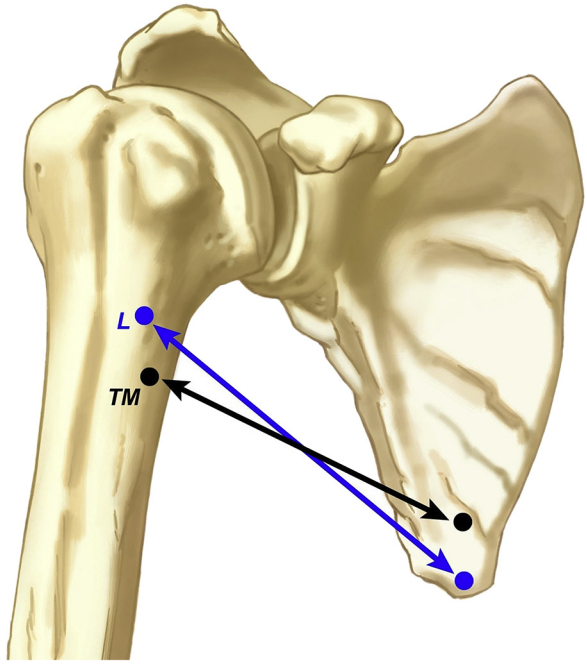

Figure 1 Drawing shows how we performed the measurements between the inferior pole of the scapula and the insertion of the teres major (*TM*) and latissimus dorsi (*L*) tendons.

Materials and methods

Cadaveric measurements

As determined by fluoroscopy, 20 shoulders in 10 fresh frozen cadavers had intact glenohumeral joints. The deceased donors (11 women, 9 men) were aged from 54 to 81 years. The cadavers were initially placed position, enabling access to all periscapular and posterior shoulder muscles, as well as the scapulothoracic and posterior glenohumeral articulations. Dissection was performed to expose all shoulder muscles. The deltoid was excised to reveal the insertions of the rotator cuff, LD, and TM. The LD and TM muscle bodies and tendons, as well as nearby neurovascular structures, were carefully isolated.

Using a tape ruler, we measured the distances from relevant bony landmarks, dimensions of the TM and LD tendons, and relationship to important neurovascular structures. First, the distance between the inferior angle of the scapular spine and the LD and TM tendinous insertions and musculotendinous junction were measured (Fig. 1). To perform the remainder of the measurements, the cadavers were flipped supine to access the anterior tendon insertions.

Second, the insertions of the LD, TM, and SS were exposed (Fig. 2). At the bone–tendon interface, the tendinous insertions of the LD and TM were detached and retracted, and the dimensions of the LD and TM tendons and insertions, along with the SS insertion, were measured (Fig. 3). Of the 20 dissected shoulders, the LD/TM tendon insertions had the following patterns: completely separate insertion in 11, partially conjoined tendon in 7, and a common tendon in 2. When looking at the insertion of these tendons anteriorly, although the TM tendon insertion appears to extend distal to the LD tendon, there is an average 3.2 ± 0.6 cm overlap between these 2 tendons that is more noticeable once the LD tendon is detached (Fig. 4). In the 2 shoulders in which the tendons were completely conjoined, we were able to separate the tendons with sharp dissection.

Third, the distance necessary to perform the transfer was determined by measuring the distance (center-to-center) from the LD and TM insertions to the SS insertion (Fig. 5). Along the lesser tuberosity, we identified three distinct parts of the SS insertion, including the lower, middle, and upper third (Fig. 6). We then measured the distance necessary for the transfer to each region of the insertion (Fig. 7). These measurements were all performed by the different investigators using a tape measure, and the means were recorded. The interobserver reliability was very high for all measurements ($\kappa > 0.85$).

TM and LD transfer

Once the above measurements were recorded, the detached tendons were prepared for transfer to the SS insertion site. The LD and TM tendons were first transferred as isolated transfers to the 3 locations on the SS insertion sites. Next, the 2 tendons were transferred together at separate locations, with the TM tendon transferred to the lower half of the SS tendon insertion and LD tendon to the upper site of the SS insertion. Lastly, the 2 tendons were sutured together as they were in their original anatomic position before detachment and were then transferred together to the 3 insertion sites of the SS tendon. The proximity of the axillary and radial nerves to the transferred tendons before and after the transfer was noted with the shoulder in neutral adduction, 90° abduction, adduction with external rotation, 90° abduction with full external rotation, and forward flexion.