JSES Open Access 2 (2018) 74–83

Contents lists available at ScienceDirect

JSES Open Access

journal homepage: www.elsevier.com/locate/jses

Subscapularis tears: hidden and forgotten no more

Julia Lee, MD, Dave R. Shukla, MB, BCh, BAO, Joaquín Sánchez-Sotelo, MD, PhD *

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

ARTICLE INFO

Keywords:
Subscapularis tear
Irreparable subscapularis
Rotator cuff tear
Arthroscopic rotator cuff repair
Rotator cuff imaging
Subscapularis physical examination
Shoulder tendon transfer

Level of evidence: Narrative Review

The subscapularis tendon, at one point, was thought of as the forgotten tendon, with "hidden lesions" that referred to partial tears of this tendon. Better understanding of anatomy and biomechanics combined with improved imaging technology and the widespread use of arthroscopy has led to a higher rate of subscapularis tear diagnoses and repairs.

The bulk mass of the subscapularis muscle is more than that of all 3 other rotator cuff muscles combined. It functions as the internal rotator of the shoulder as the stout, rolled border of its tendon inserts onto the superior portion of the lesser tuberosity. A thorough history combined with specific physical examination maneuvers (including the bear hug, lift-off, and belly-press tests) is critical for accurate diagnosis. A systematic approach to advanced shoulder imaging also improves diagnostic capacity.

Once identified, most subscapularis tendon tears can be successfully repaired arthroscopically. The Lafosse classification is useful as part of a treatment algorithm. Type I and II tears may be addressed while viewing from the standard posterior glenohumeral portal; larger Lafosse type III and IV tears are best repaired with anterior visualization at the subacromial or subdeltoid space. Tendon mobilization for larger tears is critical for adequate repair.

In Lafosse type V tears, in which there is glenohumeral imbalance, tendon transfers and reverse replacement are commonly considered salvage options.

Despite being the largest and strongest muscle in the rotator cuff, the subscapularis was once the "forgotten tendon," with tears of this tendon described as "hidden lesions."[39,63] Not uncommonly, detachment of the subscapularis fibers off the lesser tuberosity starts on the articular side and may have been missed in some patients when open cuff repair surgery was routinely performed. Increased awareness coupled with improved quality of imaging studies and the widespread adoption of arthroscopic techniques for the management of rotator cuff tears has led to a higher rate of subscapularis tear diagnoses and repairs.[13,55] In addition, new surgical procedures have been developed for patients with irreparable tears of the subscapularis.

This article provides a review of history, physical examination findings, and advanced imaging pearls for the diagnosis of subscapularis tendon tears. The classification, technique, and outcomes of arthroscopic repair techniques are discussed along with salvage options for irreparable tears.

Brief historical review

Subscapularis tendon tears were first described in cadavers by Smith in 1834, whereas the first description of subscapularis repair was published in 1954 by Hauser.[31,58] Interestingly, back then, Hauser already described the tear to be an undersurface tear, seen only with opening of the anterior fascial covering. Gerber refocused attention on the subscapularis in 1996 when he published the outcomes of open repair of isolated subscapularis tendon tears.[26] Burkhart published the first series of arthroscopic subscapularis repairs in 2002.[10] Once the forgotten tendon, advances in imaging and diagnostic awareness have brought recognition to the subscapularis tendon as we continue to understand its role in the shoulder biomechanics and rotator cuff repair outcomes. Although the description of isolated subscapularis tears is what brought attention to their importance, most subscapularis tears do occur in combination with tears of at least the anterior portion of the supraspinatus.[9,10,43] The term *anterosuperior tears* was coined by Warner to recognize this pattern of cuff tearing.[64]

Anatomy

The subscapularis muscle originates in the subscapularis fossa along the anterior aspect of the scapula. Based on its muscle cross

* Corresponding author: Joaquín Sánchez-Sotelo, MD, PhD, Department of Orthopaedic Surgery, Mayo Clinic, 200 First Street SW, Rochester, MN 55905, USA.
E-mail address: SanchezSotelo.Joaquin@mayo.edu (J. Sánchez-Sotelo).

https://doi.org/10.1016/j.jses.2017.11.006

section, the subscapularis represents 53% of rotator cuff muscle mass, more than all 3 other muscles combined.[35] Four to 6 tendon slips coalesce superiorly to form the rolled upper border of the subscapularis tendon as it inserts onto the lesser tuberosity.[12] Several investigators have reported on the area of the subscapularis footprint. D'Addesi et al reported a 25 × 18-mm insertional footprint; Arai et al reported a 40.7 × 12.5-mm footprint; and Yoo et al described 4 facets of the subscapularis insertion totaling 51.5 × 10.7 mm, with the first facet representing 34% of the entire footprint.[5,14,66] Differences in these measurements are based on incomplete representation of all 4 subscapularis tendon facets.[66] The upper subscapularis attachment is through a robust tendon, whereas the lower third is largely muscular with very short tendon fibers.[14]

The biceps tendon and its sheath are intimately related to the subscapularis tendon. The superior border of the subscapularis tendon becomes the floor of the biceps groove and interdigitates with the supraspinatus fibers. Any evidence of instability or tearing of the long head of the biceps should prompt careful assessment of the subscapularis tendon because these conditions are commonly associated with each other.[57] Concomitant biceps disease has been reported in at least 20% and as frequently as 90% of the time in patients with confirmed subscapularis tears, with increasing tear size correlating with more frequent biceps involvement.[5,18,26,30]

The superior glenohumeral ligament and the coracohumeral ligament contribute to form the reflection pulley, or the superior-medial border of the biceps sheath.[5,63] Disruption of this pulley can also correspond to biceps tendon instability and tears of the superior portion of the subscapularis tendon. As the torn upper edge of the subscapularis tendon retracts medially, a bundle of fibers from the coracohumeral and superior glenohumeral ligaments that attach to the superior-lateral edge of the subscapularis become visible, adopting a bent configuration that corresponds to the "comma sign" in arthroscopic surgery.[40,62]

Biomechanics

The subscapularis muscle functions as an internal rotator of the glenohumeral joint, working synergistically with the pectoralis major, latissimus dorsi, and teres major. In addition, it has a buttressing and stabilizing effect on the glenohumeral joint, especially in abduction and external rotation. This tenodesing effect is seen in throwers, in whom the muscle is electrically silent but the tendon itself stabilizes the joint during certain throwing motions.[34] To evaluate its impact on glenohumeral stability, Marquardt et al evaluated the effects of arthroscopic release of the subscapularis tendon in cadavers and found that the subscapularis tendon inhibited anterior-inferior translation at the midrange of motion.[44] Severe subscapularis tears may allow static anterior subluxation of the humeral head, a situation considered by most to require salvage procedures as opposed to primary repair.

The subscapularis is theorized to contribute anteriorly as a force couple with the infraspinatus and teres minor to transversely stabilize the glenohumeral joint. This is important for rotator cuff tensioning, as fixation of the subscapularis tendon restores the anterior portion of the cuff cable and balances the shoulder, decreasing the strain on posterosuperior rotator cuff repairs.[60] The subscapularis muscle also opposes the upward pull of the deltoid with humerus abduction and elevation, thus maintaining proper glenohumeral joint mechanics with shoulder motion.

Diagnosis

History

A high index of suspicion for subscapularis disease should be held in evaluating patients older than 40 years with weakness after an anterior shoulder dislocation. Likewise, the subscapularis should be carefully assessed in patients with long head of the biceps disease or when pain is felt mostly anteriorly.[12,27,37] Difficulty with activities that involve pushing inward, such as holding a box in front of the body with 2 hands, may also hint at subscapularis involvement.

Examination

As with any other shoulder condition, examination of the patient with possible subscapularis tearing should start with a general assessment of pain location, motion, and strength. Subscapularis tendon tears can translate into increased passive external rotation of the shoulder. This is best detected by assessing passive external rotation of both shoulders simultaneously to determine whether there is a substantial increase on the affected side. A number of physical examination maneuvers have been described to specifically assess the subscapularis. The 3 most commonly performed in our practice are the lift-off test, the belly-press test, and the bear hug test.

Lift-off test and internal rotation lag sign

First described by Gerber, this examination maneuver requires the shoulder to be placed in internal rotation so that the dorsum of the patient's hand is resting on the lower lumbar spine.[26,27] The patient is asked to lift the hand off the lower back (Fig. 1, *A*). Inability to do so is considered an indicator of subscapularis weakness. Some patients may "cheat" and extend the elbow to lift the hand, as opposed to further internally rotating the shoulder. The internal rotation lag sign is a similar test, but the examiner places the hand of the patient behind the trunk and off the body and asks the patient to maintain the hand in that position, not letting the hand drop to the lower back.

Belly-press test

In the belly-press test, the patient is asked to rest the hand on the abdomen, to keep the elbow forward past the mid–coronal plane, and to press on the belly without letting the elbow move backward (Fig. 1, *B*). Subscapularis weakness makes it difficult or impossible to press into the abdomen without moving the elbow back because the patient compensates for lack of shoulder internal rotation with shoulder extension.[26] The "Napoleon sign" was introduced to grade the severity of the belly-press test in reference to Napoleon Bonaparte's posture in paintings.[10]

Bear hug test

The bear hug test is performed with the hand of the affected extremity placed on top of the contralateral shoulder and the elbow pointing anteriorly (Fig. 1, *C*). The examiner tries to lift the hand off the patient's shoulder while the patient resists external rotation.[6] This test is considered positive when the examiner can externally rotate the arm while the patient is trying to actively maintain internal rotation.

Comparative value of physical examination tests

Studies indicate that the combined sensitivity of these 3 diagnostic maneuvers to detect subscapularis tears is approximately 80%.[21] The bear hug test is the most sensitive as it can detect isolated tears of the upper third of the subscapularis tendon. In an electromyography study, Tokish et al demonstrated that the lift-off test activated the lower subscapularis muscle more, whereas the belly-press test activated the upper subscapularis muscle more.[61]