LoSCALPELLO Journal (2022) 36:100-104
doi number: 10.36149/0390-5276-260

Clinical and surgical diagnostic evidence in subscapularis tendon injuries

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Summary

Objective. The purpose of the present study was to estimate the diagnostic accuracy of a spectrum of physical examination tests, explaining how to perform them and compare them with arthroscopic findings to identify which have the best ability to accurately detect a subscapularis tear in a population of primary care patients with shoulder pain.
Methods. Three established clinical tests were evaluated in 56 consecutive patients prior to shoulder arthroscopy. The tests included the Lift Off test, Napoleon test, and Bear Hug test. The integrity or not of the subscapularis tendon at surgery was considered as the gold standard. Lesions to the subscapularis were graded according to Lafosse.
Results. Among the 56 patients there were 17 with arthroscopic diagnosis of subscapularis lesions accounting for an incidence of 30%. The sensitivity for subscapularis tears for the Lift-off test, Napoleon test, and Bear Hug test was 80.15, 58.82, and 82.35%, respectively. Specificity was 54.55, 56.82, and 55.56%, respectively. A significant correlation was found between arthroscopic findings and physical examination only for the Bear Hug.
Conclusions. In the present study, the Bear Hug test was found to have the highest sensitivity of all tests studied. Nevertheless, it appears advisable to perform more than one clinical test to further improve the clinical ability to detect subscapularis tears.

Key words: diagnosis, physical examination, rotator cuff, shoulder examination, subscapularis tendon tear

Received: May 25, 2022
Accepted: September 12, 2022

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How to cite this article: Lagorio M, Fidanza A, Fardetti F, et al. Clinical and surgical diagnostic evidence in subscapularis tendon injuries. Lo Scalpello Journal 2022;36:100-104. https://doi.org/10.36149/0390-5276-260

Introduction

Rotator cuff tears are a common cause of shoulder pain with a reported prevalence of 26% among patients with symptomatic shoulder conditions [1]. Although the supraspinatus is the most commonly torn rotator cuff muscle [2] and is widely researched, subscapularis pathology is often overlooked, hard to recognize, may be underdiagnosed, and can lead to poor long-term patient outcomes[3]. A subscapularis tendon tear not repaired during surgery may leave part of the humeral head uncovered and contribute to poorer outcomes and residual pain[4].
In primary care practice, the clinical diagnosis of rotator cuff tears begins with clinical examination.
Nevertheless, over the past several decades, it is well documented that physicians have lost clinical examination capabilities [5]. Factors such as time constraints, lack of confidence in one's clinical testing capabilities, and improvements in technology, have perpetuated a focus on laboratory, and imaging.

With the increasing costs of diagnostic imaging, the usefulness of the clinical examination strategy cannot be understated [6]. Imaging interpretation without the appropriate clinical context or examination may lead to over- or under interpretation of the imaging itself. Clinical findings are paramount for a thorough physical examination to pair with imaging to optimize diagnosis and plan the appropriate treatment strategy.
Therefore, the aim of this study was to estimate the diagnostic accuracy of a spectrum of physical examination tests, explaining how to perform them and compare them with arthroscopic findings to identify which have the best ability to accurately detect a subscapularis tear in a population of primary care patients with shoulder pain.

Materials and methods

We included in our study adult patients with symptomatic shoulder conditions (at least 3 months) who were scheduled for arthroscopic anatomic repair of rotator cuff tendon tears. We planned to exclude from our prospective analysis: 1) patients < 18 years; 2) those who were operated on the same shoulder in the past; 3) individuals with shoulder instability; or 4) had an adhesive capsulitis; 5) those who did not have a preoperative MRI; and 6) patients with advanced osteoarthritis (Hamada grade II or III) [7].

Clinical test

Preo-peratively, lift-off, Napoleon and bear-hug tests were performed on all patients in a standardized manner to detect subscapularis pathology on both shoulders. The lift-off test was performed by placing the hand of the involved arm on the back at the mid-lumbar region and then asking the patient to rotate the arm internally and to lift the hand off the back [8]. The test was considered positive if the patient was unable to lift the hand off or performed the lifting maneuver by extending the elbow or shoulder (Fig. 1A).
The bear-hug test was performed with the palm of the involved side placed on the opposite shoulder and fingers extended and the elbow positioned anterior to the body. The patient was then asked to hold that position (resisted internal rotation) as the physician tried to pull the patient's hand from the shoulder with an external rotation force applied perpendicular to the forearm [9]. The test was considered positive if the patient could not hold the hand against the shoulder or if he or she showed weakness of resisted internal rotation compared with the opposite side (Fig. 1C).
The Napoleon test, a variation of the belly-press test, was performed by placing the hand on the belly in the same position in which Napoleon Bonaparte held his hand for portraits. We graded the Napoleon test as negative (or normal) if the patient was able to push the hand against the stomach with the wrist straight, as positive if the wrist was flexed to 90° to push

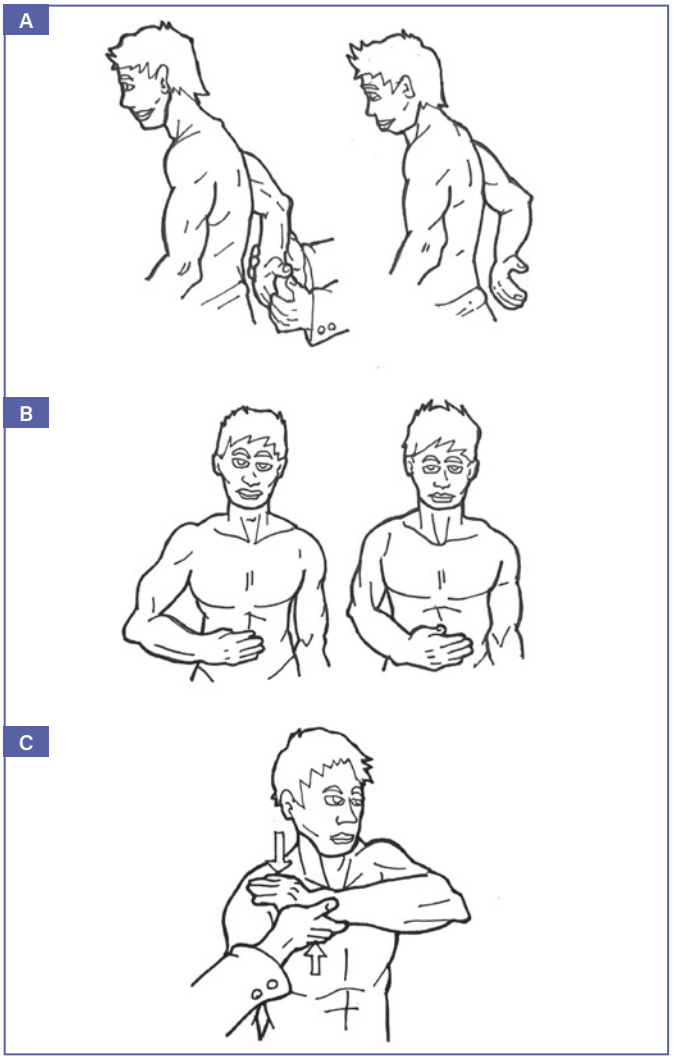

Figure 1. A) lift-off test: the patient, doing the internal rotation of the shoulder so that the dorsum of his hand is resting on the lumbar spine, lift the hand off the lower back. Inability to do so is an indicator of subscapularis muscle weakness. Some patients may compensate for the lack of internal rotation with elbow extension to lift the hand; B) Napoleon sign: the patient rests the hand on the belly, keep the elbow forward the coronal plane and press on the abdomen without letting the elbow move backward. If subscapularis muscle is weak, it makes difficult to press into the belly without moving the elbow back because the patient compensates for the lack of internal rotation with shoulder extension; C) bear hug test: the patient places the hand of the affected arm on the top of the contralateral shoulder and points the elbow anteriorly. The examiner tries to lift the hand off the shoulder, forcing external rotation, while the patient resists trying to maintain internal rotation. If the examiner can externally rotate the arm this is a sign of subscapularis muscle weakness.

against the stomach, and as intermediate if the wrist was flexed from 30° to 60° to accomplish a belly press (Fig. 1B). To simplify our results, in this study an intermediate Napoleon test was considered positive, because an intermediate test has been correlated with partial tears of the subscapularis [10].
For all tests, we further divided the positive results in two categories: 1) if the strength was comparable to that of the opposite side with pain and 2) if the patient showed weakness or any of the other characteristics signs above mentioned.

Surgical technique

All the patients were positioned in the beach chair position with the use of an arm holder in regional anesthesia. A 30° arthroscope is inserted through a posterior portal, for better visualization of the subscapularis tendon and its insertion into the lesser tuberosity we place the shoulder in flexion and internal rotation, translating the proximal humerus posteriorly ("posterior lever push"), or alternatively using a 70° arthroscope [11].
Intra-operatively, we differentiated subscapularis tendon tears using Lafosse classification. A Type I lesion is defined as a partial lesion of the superior third of the subscapularis tendon without complete detachment (undersurface tear of the upper third). Type II is a complete detachment of the superior third of the tendon. Type III is a complete tear of the superior two-thirds of the tendon without muscle detachment of the inferior third, thus limiting retraction of the tendon. Type IV is a complete tear of the lesser tuberosity with the tendon retracted closer to the glenoid, but with the head centered and stage ≤ 3 fatty atrophy in the subscapularis muscle. Type V is a complete tear of the subscapularis tendon with eccentric positioning of the head or fatty degeneration stage > 3 atrophy[12].
Once the tear has been identified, an anterosuperolateral portal, angled 5-10° to the lesser tuberosity, parallel to the subscapularis tendon, is produced. In cases of Type III or IV lesions a traction suture is used to put lateral traction on the tendon when it is retracted medially, preserving where the "comma sign" occurs. Adhesions between the surface of the subscapularis and adjoining structures are released to mobilize a retracted tendon, being careful especially in the subcoracoid region anteriorly because of its proximity to the brachial plexus and axillary vasculature.
For optimal tendon-bone healing, the lesser tuberosity footprint is debrided but not fully decorticated.
In Type I tears, debridement was performed. Type II, III, and IV tears were repaired with suture anchors. In none of the cases treated in this study was a coracoplasty performed, usually indicated when a coracohumeral interval < 6 mm, as can be estimated comparing it to the shaver [13]. Acromioclavicular (AC) joint arthritis, supraspinatus and infraspinatus lesions, biceps tendon pathologies, and superior labrum anterior–posterior (SLAP) lesions were also recorded.

Statistical analysis

The number of true-positive tests, true-negative tests, false-positive tests, and false-negative tests were calculated to determine the sensitivity, specificity, and Kendall rank correlation coefficient of each test. In this setting, diagnostic arthroscopy was critical for evaluation of the subscapularis and for quantification of the percentage that was torn.
Statistical analysis was performed using SAS Statistical Software 9.1.3.
A P-value < 0.05 was considered statistically significant.

Results

Seventy patients were referred to the study between January 2021 and May 2021, and 56 were included. All completed clinical examination and underwent magnetic resonance imaging (MRI), although the latter was not evaluated in the present study.
The mean age of patients was 64 ± 12.5 years. There were 32 males and 24 females, and the dominant side was involved in 43 cases.
Among the 56 patients studied, 17 had a tendon lesion (30%), of which 13 (76%) presented a partial lesion in the upper third (Lafosse I, II) and 4 (16%) had complete lesion with the tendon retracted (Lafosse IV). Two patients who presented longitudinal lesions of the upper third, without disinsertion, were included in Lafosse Type I. Of the 17 patients with arthroscopic diagnosis of subscapularis tear, 16 (94%) had associated lesions (sopra/infraspinatus and/or long head of the bicep).
The results obtained from physical examination were compared with arthroscopic findings, and the sensitivity, specificity, and Kendall rank correlation coefficient were calculated.
Taking into consideration presence or absence of a lesion, the sensitivity calculated for the bear hug test was 82.35% and 58.82% for the Napoleon test, while it was 80.15% for the lift-off test.
Using the same criteria, we calculated the specificity for diagnosing the lesion. The results obtained were 55.56% for the bear hug test, 54.55% for the lift-off test, and 56.82% for Napoleon test.
The Kendall rank correlation coefficient, a non-parametric test for statistical dependence, was used to evaluate the relationship between arthroscopic findings and physical examination. In this setting, only the Bear-hug test was statistically significant (p < 0.5) (Tab. I).

Discussion

The subscapularis is the largest and most powerful of the rotator cuff muscles and is more important for arm elevation than either the supraspinatus or infraspinatus [11]. Although subscapularis' pathology is both infrequently identified and not com-

Table I. Sensitivity and specificity were carried out with clinical tests and compared with arthroscopic evidence. Kendall's test allows to evaluate non-parametric correlation coefficients.

Test	Sensitivity (%)	Specificity (%)	Kendall's test (%)
Lift-off test	80.15%	54.55%	W = 0.683 P = 0.100
Napoleon test	58.82%	56.45%	W = 0.645 P = 0.146
Bear-hug test	82.35%	55.56%	W=0.784 **P = 0.033**

monly considered as a major source of shoulder pain [14], tears of the subscapularis tendon have gained increasing attention among physicians [15].

To diagnose subscapularis tears, we found a higher sensitivity (82.35%) and a significant value using the Kendall rank correlation coefficient (W = 0.784, p = 0.033) with the bear-hug test, but not the lift-off test or Napoleon test. The results of the present study are comparable with results from the literature, especially for the bear-hug test [16,17]. The main contradicting value that we found in our study was related to the lift-off test. Hertel et al. [18] reported a specificity and sensibility for the lift-off test, respectively, of 100 and 62% in contrast with 54.55% and 80.15% found herein. The discrepancy between these results could be attributed to the difference in lesion prevalence, since our study population involved mainly patients with a partial lesion of the upper third instead of a complete lesion (76 *vs* 16%). These our data more closely reflect the statistics that we found in the general population. Barth et al. [16] showed a positive lift-off test with lesions greater than or equal to 75%, which may be explained by the different criteria used for considering the test to be positive. Moreover, one must consider that the lift-off test is sometimes impossible to perform because of pain and loss of internal rotation.

The limitations of the present study comprise the limited number of high-grade subscapularis lesions. In fact, some authors that have reported that only up to 30% of total tears can be classified as irreparable due to the massive tear size and severe muscle atrophy. Furthermore, clinical examination will, however, always be subject to examiner, patient, and time-dependent variations. The patient's history and physical examination findings are important to heighten the suspicion of a subscapularis tendon tear.

Conclusions

Tears of the subscapularis tendon are no longer forgotten or hidden lesions. Increased diagnostic awareness when collecting clinical history and physical examination are the first steps to diagnosis of subscapularis tendon tears.

We believe that the more sensitive a test is, the more useful it is in alerting the surgeon in the specific pathology for which he or she is testing. The quality of increased sensitivity makes the bear-hug test uniquely valuable in the surgeon's diagnostic armamentarium.

Acknowledgements
None.

Conflict of interest statement
The Authors declare no conflict of interest.

Funding
This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions
All the Authors contributed equally to this work. ML, AF: conceptualization; ML, AF, FF, AB: data curation; ML, AF, FF: writing-original draft preparation; ML, AB: writing-review and editing; VC: supervision. All Authors have read and agreed to the published version of the manuscript.

Ethical consideration
No experimental procedures have been conducted. All procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional and/ or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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