Sensitivity of Physical Examination Versus Arthroscopy in Diagnosing Subscapularis Tendon Injury

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abstract

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The purpose of this study was to examine the accuracy of physical examination in the detection of subscapularis tendon tears and compare it with the gold standard of arthroscopy to determine whether clinical examination can reliably predict the presence of subscapularis tendon tears. This was a retrospective analysis of 52 patients (52 shoulders) who underwent arthroscopic subscapularis tendon repairs between September 2008 and April 2012. Positive findings on any combination of the belly press, lift-off, and bear hug tests constituted a positive physical examination result. There was a positive finding on physical examination in 42 of 52 patients. The sensitivity of the physical examination as a whole was 81%. The literature has shown that the belly press, bear hug, and lift-off tests are specific to the subscapularis tendon. To the authors' knowledge, this is the first study to evaluate the sensitivity of these 3 separate clinical tests as a composite. Knowledge regarding the sensitivity of the subscapularis-specific physical examination as a composite can lead practitioners to implement all 3 components, even when 1 test has a negative finding, thus promoting a more thorough physical examination. Because unrepaired subscapularis tendon tears can result in poor outcomes in the repair of other rotator cuff tendons, a complete physical examination would be beneficial to patients with shoulder pathology. The authors conclude that physical examination, when performed consistently by an experienced practitioner, can reliably predict the presence of subscapularis tendon tears.

Figure: Photograph of the lift-off test. The patient is placing the dorsum of his right hand just below the midlumbar spine, keeping the elbows anterior to the midline. He is attempting to maximally lift his hand off of the back by internally rotating his shoulder..

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The subscapularis is the only anteriorly positioned rotator cuff muscle, making it an important source of resistance to anterior, posterior, and inferior displacement.[1-4] It is involved in both active and static stabilization of the glenohumeral joint during abduction, extension, and external rotation. The multipennate structure and dense organization of collagen fibers of the subscapularis muscle and tendon, respectively, contribute to static stability, which is particularly important in the hanging arm position as well as during the initiation of abduction.[5] An injury to the subscapularis can result in a loss of glenohumeral stability and considerable shoulder dysfunction.[6,7]

Traditionally, magnetic resonance imaging (MRI) and magnetic resonance arthrography (MRA) have been used to diagnose rotator cuff tears, including those of the subscapularis tendon. However, several studies have reported a low level of reliability in the detection of subscapularis pathology using MRA.[8-11] The sensitivity of MRA has been reported to be between 25% and 38% in these studies, indicating that subscapularis tears are underdiagnosed using traditional MRI techniques. Undiagnosed subscapularis tendon tears can lead to residual shoulder dysfunction and poor postoperative outcomes.[12] It has been reported that most subscapularis tears occur on the articular and cephalad aspect of the footprint.[10,13,14] Because of this, arthroscopic evaluation of the subscapularis tendon is considered the gold standard in the definitive detection of subscapularis tears.[10]

The low sensitivity of MRA and the reported resultant suboptimal postoperative outcomes necessitate evaluation of the accuracy of clinical screening tests for subscapularis tears.[12] The belly press, bear hug, and lift-off tests have all been described as clinical tests to identify subscapularis tears. The use of electromyographic data has confirmed that these clinical tests are specific to the subscapularis muscle.[15,16] The purpose of this study was to compare subscapularis-specific physical examination findings with the universally applied gold standard of arthroscopy. The authors' hypothesis was that the physical examination would be able to reliably predict the presence of subscapularis tendon tears.

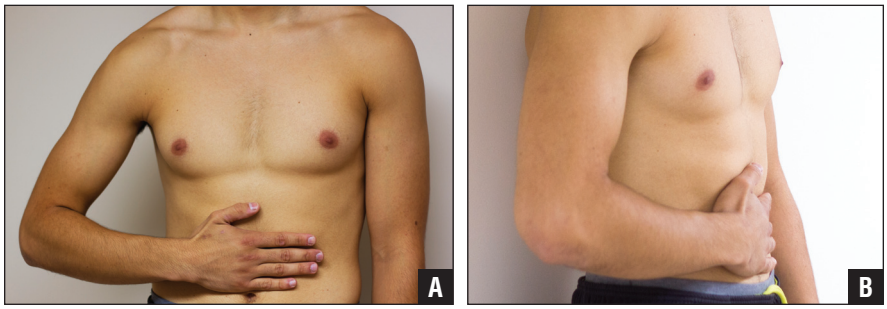

Figure 1: Anterior (A) and lateral (B) photographs of the belly press test. With the elbow aligned with the trunk sagittally, the patient is pressing maximally against his abdomen by internally rotating his right shoulder without changing the position of his elbow.

Materials and Methods

Patients

After institutional review board approval, a retrospective review was conducted to identify all patients who underwent subscapularis tendon repair between September 2008 and April 2012 by a single fellowship-trained sports medicine surgeon (A.F.). All surgeries were performed consecutively at the same outpatient ambulatory surgery center over a period of 4 years. The inclusion criteria for the study were that all patients must have had at least 1 of the 3 screening tests performed prior to arthroscopy, arthroscopic evidence of a subscapularis tear, and subsequent repair of this tear. Exclusion criteria included a lack of documentation of screening tests. A differentiation between isolated subscapularis repairs or those performed in combination with other procedures or rotator cuff repairs was not made. Using these criteria, a total of 52 patients were identified. After obtaining age, sex, hand dominance, dates of physical examination findings, and dates of surgery, the sensitivity of the physical examination was assessed. The definition of true positive in this study was any patient who tested positive in any combination of the screening tests.

Physical Examination

The belly press, bear hug, and lift-off tests were performed to detect subscapularis pathology.

The belly press test was performed by asking the patient to place the palm of the hand against the abdomen slightly below the xiphoid process. With the elbow aligned with the trunk sagittally, the patient was then asked to push maximally against the abdomen by internally rotating the shoulder being tested without changing the position of the elbow. A positive test was indicated by unilateral weakness or an inability to perform the motion without elbow or other shoulder compensation[15,16] (**Figure 1**).

The lift-off test required the patient to place the dorsum of the hand just below the midlumbar spine, keeping the elbow anterior to the midline. Then, the patient was asked to maximally lift the hand off of the back by internally rotating the shoulder. A positive lift-off test was demonstrated by an inability to lift the hand off of the back or the use of the elbow or other components of the glenohumeral joint to perform the movement[15,16] (**Figure 2**).

The bear hug test was performed by asking the patient to place the hand on the contralateral acromioclavicular joint. Then, with the elbow in line with the shoulder and parallel to the floor,

the patient was instructed to press down maximally on the acromioclavicular joint without dropping the elbow by internally rotating the shoulder while an external rotational force was applied to the hand. A positive bear hug test resulted if the patient was unable to perform the task without moving the elbow or when there was unilateral weakness of internal rotation of the shoulder[15,16] (**Figure 3**).

A positive finding in any of these 3 screening tests was considered a positive physical examination. An individual specific test for subscapularis injury is not universally accepted, and the reliability may not be truly known. Therefore, a positive finding on all or any combination of these 3 clinical tests raised suspicion for a subscapularis tear.

Figure 2: Photograph of the lift-off test. The patient is placing the dorsum of his right hand just below the midlumbar spine, keeping the elbows anterior to the midline. He is attempting to maximally lift his hand off of the back by internally rotating his shoulder.

Figure 3: Photograph of the bear hug test. The patient has placed his right hand on the contralateral acromioclavicular joint. With the elbow in line with the shoulder and parallel to the floor, he is pressing down maximally on the acromioclavicular joint without dropping the elbow by internally rotating his shoulder while the practitioner applies an external rotational force to his hand.

Surgical Technique

All subscapularis repairs were performed arthroscopically with the patient in the beach-chair position under general anesthesia as described by Foad and Wijdicks.[11] A posterior lever push, as described by Burkhart and Brady,[17] was performed, where the assistant simultaneously pushed posteriorly on the proximal humerus and pulled the distal humerus distally. Thirty degree and 70° arthroscopes were used interchangeably to confirm a tear, with the 70° arthroscope usually used for the subscapularis repair. A clean bleeding bone bed at the lesser tuberosity footprint was prepared. A coracoplasty and a 3-sided soft tissue release were performed if deemed necessary. Bioabsorbable suture anchors with double-loaded nonabsorbable sutures were placed through the anterior portal, creating a horizontal mattress repair.

Results

All 52 patients in this study had an arthroscopic subscapularis repair performed by the senior author (A.F.). The study data are summarized in **Table 1**.

The sensitivity was measured to identify all true positives. A sensitivity of 100% implies that a negative test result confirms the absence of a subscapularis tendon tear. In this study, the sensitivity of the physical examination was found to be 81%. Ten of the 52 patients with subscapularis tendon tears had negative physical examination results (false negatives). The median number of days between physical examination and arthroscopic confirmation of a subscapularis tendon tear was 16 days.

Complications included 2 patients who reported postoperative shoulder stiffness that was managed with physical therapy. There were no cases of rerupture, infection, neurovascular compromise, hardware failure, or complex regional pain syndrome.

Discussion

Arthroscopy is the current universally applied gold standard in the diagnosis of subscapularis tendon tears. Several studies have reported that MRI and MRA cannot be reliably used to detect subscapularis tendon tears.[8-11] In a study by Foad and Wijdicks,[11] the sensitivities of MRI and MRA were 40% and 36%, respectively. The belly press, bear hug, and lift-off tests allow the practitioner to examine for subscapularis injury. If there are positive clinical signs from any or all of the clinical tests, the increased suspicion for a tear can lead the practitioner to prepare more appropriately for surgery. For example, the anterior portal can be placed more strategically, and a 70° arthroscope can be used to view the footprint of the subscapularis more effectively. The increased suspicion of subscapularis tear can lead the practitioner to implement the posterior lever push, as described by Burkhart and Brady,[17] to enlarge the subcoracoid space and help visualize the subscapularis insertion site.[17] Despite arthroscopic repair of other rotator cuff tendons, unrepaired subscapularis tears can result in imbalanced force couples and therefore poor post-surgical outcomes.[12] Because of this, it is imperative to assess patients for subscapularis tears with a sensitive clinical examination. This study sought to determine the sensitivity of physical examination in the detection of subscapularis tendon tears. Previous studies have examined the reliability of the physical examination with regard to subscapularis tears (**Table 2**).[6,18-21] For each of the clinical tests used in the detection of subscapularis tears, the reported sensitivities in these studies were highly variable. This disparity may be attributable to dissimilar examiner technique, inconsistent definitions of positive findings, and subjectivity of the physical examination findings. In addition, limited sample sizes and a long duration between

Table 1

Study Data

Variable	Data
Mean age (range), y	52 (23-69)
No. of M/F	42/10
No. of R/L shoulders	41/11
No. of dominant/ nondominant hands	46/6
Median follow-up, d	16
Average follow-up (range), d	27±31 (3-149)
Physical examination sensitivity, %	81

Abbreviations: F, female; L, left; M, male; R, right.

Table 2

Results of Previous Studies on the Reliability of Physical Examination With Regard to Subscapularis Tears

		Sensitivity, %		
Study	Sample Size	Bear Hug	Lift-off	Belly Press
Gerber and Krushell[6]	13	N/A	92	N/A
Barth et al[18]	68	60	17.60	40
Scheibel et al[19]	12	N/A	59	N/A
Hertel et al[20]	53	N/A	62	N/A
Leroux et al[21]	55	N/A	17	N/A

Abbreviation: N/A, not applicable.

physical examination findings and arthroscopy could potentially be sources of discrepancy. Although there were outliers in these previous studies, almost all of the studies found the sensitivity of clinical examination to be higher than the sensitivity found in studies of MRA.

In these previous studies, the subscapularis-specific tests were all examined separately. Many of these studies were performed to discern which test was the most reliable, and they did not assess all 3 tests together. Pennock et al[16] reported no statistically significant electromyographic difference between the belly press, bear hug, and lift-off tests. The authors stated that all 3 tests are equally effective in testing for subscapularis integrity, and it was concluded that practitioners may use any of the 3 tests, depending on the patient, to isolate the subscapularis muscle. In the current study, the sensitivity of the cumulative subscapularis-specific tests was 81%. As opposed to evaluating the clinical tests that have previously been shown to be specific to the subscapularis, the subscapularis-specific physical examination as a whole was studied because a positive result in any of the tests raised suspicion for subscapularis pathology.

One strength of this study was that a high level of procedural consistency was possible because all physical examinations and surgeries were performed by the same board-certified, fellowship-trained sports medicine orthopedic surgeon, thus eliminating interexaminer variability. In addition, because this was a consecutive series, intraexaminer variability was further minimized. Furthermore, the median time between positive physical examination findings and arthroscopy was 16 days, reducing the likelihood that further injuries were acquired in the time period between the physical examination and surgery.

One weakness of this study is that it is a retrospective analysis, which can lead to selection or information bias. However, because subscapularis tears are less common than other rotator cuff tears, it was possible to attain a larger sample size using this type of analysis as opposed to a prospective cohort study, which may have required an extensive study population to achieve the same number of patients with subscapularis tendon tears. In addition, the sensitivity of the subscapularis-specific tests as a whole was evaluated as opposed to assessing the individual screening tests. This results in a higher sensitivity but, if evaluated, would likely lead to a lower specificity. The 3 tests were considered together as a positive finding if any of the screening tests raised suspicion for a subscapularis tear, prompting the surgeon to search for the tear during arthroscopy. The sensitivity of each of the subscapularis-specific tests has been previously described in the literature. However, this is the first study that reports the sensitivity of the composite of the 3 tests specific to the subscapularis. This provides valuable information as to the importance of implementation of all 3 tests, even when 1 is negative. The incidence of false positives, and therefore specificity and predictive values, was not studied because this was not the purpose of this study. The presence of false positives is problematic when either the screening test is costly or the result of a false positive leads to an invasive or costly intervention. In the context of the physical examination, a false positive finding is not particularly detrimental because the performance of the examination requires little time. In addition, although a false positive finding leads the practitioner to evaluate the integrity of the subscapularis during arthroscopy, confirmation of the absence of a tear adds little to the overall operative time. Therefore, although it is possible that the composite of the subscapularis-specific physical examination has a low specificity, this would not be problematic in terms of time or cost. The only scenario in which a low specificity would be highly detrimental would be in the case of an isolated subscapularis

tendon tear. In this context, a false positive could lead the practitioner to unnecessarily evaluate the subscapularis tendon arthroscopically. The ability of this inexpensive screening test to reliably predict the presence of 4 out of 5 subscapularis tendon injuries is valuable. However, if an experienced orthopedic surgeon relied solely on the physical examination to diagnose subscapularis tendon injury, 1 out of 5 tears would be missed; thus, arthroscopy still remains the gold standard in the detection of subscapularis tendon injury.

Conclusion

The belly press, lift-off, and bear hug tests can reliably predict subscapularis tendon tears. Consistent implementation of these 3 components of the physical examination can potentially lead to fewer undetected subscapularis tears, resulting in fewer failed rotator cuff repairs and improved overall postoperative outcomes.

References

1. Keating JF, Waterworth P, Shaw-Dunn J, Crossan J. The relative strengths of the rotator cuff muscles: a cadaver study. *J Bone Joint Surg Br*. 1993; 75:137-140.
2. Saha AK. Dynamic stability of the glenohumeral joint. *Acta Orthop Scand*. 1971; 42:491-505.
3. Gerber C, Hersche O, Farron A. Isolated rupture of the subscapularis tendon: results of operative repair. *J Bone Joint Surg Am*. 1996; 78:1015-1023.
4. Turkel SJ, Panio MW, Marshall JL, Girgis FG. Stabilizing mechanisms preventing anterior dislocation of the glenohumeral joint. *J Bone Joint Surg Am*. 1981; 63(8):1208-1217.
5. Kronberg M, Nemeth G, Brostrom LA. Muscle activity and coordination in the normal shoulder: an electromyographic study. *Clin Orthop Relat Res.* 1990; 257:76-85.
6. Gerber C, Krushell R. Isolated rupture of the tendon of the subscapularis muscle: clinical features in 16 cases. *J Bone Joint Surg Br*. 1991; 73:389-394.
7. Warner JJ, Higgins L, Parsons IM, Dowdy P. Diagnosis and treatment of anterosuperior rotator cuff tears. *J Shoulder Elbow Surg*. 2001; 10(1):37-46.
8. Denard PJ, Lädermann A, Burkhart SS. Arthroscopic management of subscapularis tears. *Sports Med Arthrosc*. 2011; 19(4):333-341.
9. Garavaglia G, Ufenast H, Taverna E. The frequency of subscapularis tears in arthroscopic rotator cuff repairs: a retrospective study comparing magnetic resonance imaging and arthroscopic findings. *Int J Shoulder Surg*. 2011; 5(4):90-94.
10. Adams CR, Schoolfield JD, Burkhart SS. Accuracy of preoperative magnetic resonance imaging in predicting a subscapularis tendon tear based on arthroscopy. *Arthroscopy.* 2010; 26(11):1427-1433.
11. Foad A, Wijdicks CA. The accuracy of magnetic resonance imaging and magnetic resonance arthrogram versus arthroscopy in the diagnosis of subscapularis tendon injury. *Arthroscopy*. 2012; 28(5):636-641.
12. Pfirrmann CW, Zanetti M, Weishaupt D, Gerber C, Hodler J. Subscapularis tendon tears: detection and grading at MR arthrography. *Radiology.* 1999; 213:709-714.
13. Burkhart SS, Tehrany AM. Arthroscopic subscapularis tendon repair: technique and preliminary results. *Arthroscopy.* 2002; 18:454-463.
14. Sakurai G, Ozaki J, Tomita Y, Kondo T, Tamai S. Incomplete tears of the subscapularis tendon associated with tears of the supraspinatus tendon: cadaveric and clinical studies. *J Shoulder Elbow Surg.* 1998; 7:510-515.
15. Tokish JM, Decker MJ, Ellis HB, Torry MR, Hawkins RJ. The bellypress test for the physical examination of the subscapularis muscle: electromyographic validation and comparison to the lift-off test. *J Shoulder Elbow Surg*. 2003; 12(5):427-430.
16. Pennock AT, Pennington WW, Torry MR, et al. Influence of arm and shoulder position on the bear-hug, belly-press, and lift-off tests: an electromyographic study. *Am J Sports Med*. 2011; 39(11):2338-2346.
17. Burkhart SS, Brady PC. Arthroscopic subscapularis repair: surgical tips and pearls A to Z. *Arthroscopy.* 2006; 22:1014-1027.
18. Barth J, Burkhart S, De Beer J. The bear-hug test: a new and sensitive test for diagnosing a subscapularis tear. *Arthroscopy.* 2006; 22(10):1076-1084.
19. Scheibel M, Magosch P, Pritsch M, Lichtenberg S, Habermeyer P. The belly-off sign: a new clinical diagnostic sign for subscapularis lesions. *Arthroscopy.* 2005; 21(10):1229-1235.
20. Hertel R, Ballmer FT, Lombert SM, et al. Lag signs in the diagnosis of rotator cuff rupture. *J Shoulder Elbow Surg.* 1996; 5:307-313.
21. Leroux JL, Thomas E, Bonnel F, et al. Diagnostic value of clinical tests for shoulder impingement syndrome. *Rev Rhum Engl Ed.* 1995; 62:423-428.