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Diagnostic Accuracy of History and Physical Examination of Superior Labrum Anterior-Posterior Lesions

Lori A. Michener, PhD, PT, ATC, SCS*; William C. Doukas, MD†; Kevin P. Murphy, MD‡; Matthew K. Walsworth, MD, PT§

*Department of Physical Therapy, Virginia Commonwealth University, Richmond; †Department of Orthopaedics and Rehabilitation, Walter Reed Army Medical Center, Washington, DC; ‡Uniformed Services University of the Health Sciences, Bethesda, MD, and Heekin Orthopaedic Specialists, Jacksonville, FL; §Department of Radiology, Virginia Commonwealth University Health Systems, Medical College of Virginia, Richmond

Context: Type I superior labrum anterior-posterior (SLAP) lesions involve degenerative fraying and probably are not the cause of shoulder pain. Type II to IV SLAP lesions are tears of the labrum.

Objective: To determine the diagnostic accuracy of patient history and the active compression, anterior slide, and crank tests for type I and type II to IV SLAP lesions.

Design: Cohort study.

Setting: Clinic.

Patients or Other Participants: Fifty-five patients (47 men, 8 women; age = 40.6 ± 15.1 years) presenting with shoulder pain.

Intervention(s): For each patient, an orthopaedic surgeon conducted a clinical examination of history of trauma; sudden onset of symptoms; history of popping, clicking, or catching; age; and active compression, crank, and anterior slide tests. The reference standard was the intraoperative diagnosis. The operating surgeon was blinded to the results of the clinical examination.

Main Outcome Measure(s): Diagnostic utility was calculated using the receiver operating characteristic curve and area under the curve (AUC), sensitivity, specificity, positive likelihood ratio (+LR), and negative likelihood ratio (–LR). Forward stepwise binary regression was used to determine a combination of tests for diagnosis.

Results: No history item or physical examination test had diagnostic accuracy for type I SLAP lesions (n = 13). The anterior slide test had utility (AUC = 0.70, +LR = 2.25, –LR = 0.44) to confirm and exclude type II to IV SLAP lesions (n = 10). The combination of a history of popping, clicking, or catching and the anterior slide test demonstrated diagnostic utility for confirming type II to IV SLAP lesions (+LR = 6.00).

Conclusions: The anterior slide test had limited diagnostic utility for confirming and excluding type II to IV SLAP lesions; diagnostic values indicated only small shifts in probability. However, the combination of the anterior slide test with a history of popping, clicking, or catching had moderate diagnostic utility for confirming type II to IV SLAP lesions. No single item or combination of history items and physical examination tests had diagnostic utility for type I SLAP lesions.

Key Words: labral tears, diagnostic tests, sensitivity, specificity, likelihood ratio

Key Points

- History of trauma; sudden onset of symptoms; history of popping, clicking, or catching; the active compression test; and the crank test had no diagnostic utility for type II to IV superior labrum anterior-posterior (SLAP) lesions.
- The anterior slide test had limited diagnostic utility for confirming and excluding type II to IV SLAP lesions.
- To confirm type II to IV SLAP lesions, the anterior slide test combined with a history of popping, clicking, or catching had moderate diagnostic accuracy, but the test combination should not be used to exclude the diagnosis for these lesions.
- For type I SLAP lesions, no single item or combination of history and physical examination test had adequate diagnostic utility.

Snyder et al[1] described and classified superior labrum anterior-posterior (SLAP) lesions into 4 types. Type I SLAP lesions involve degenerative fraying, whereas type II to IV lesions are tears of the labrum, with or without involvement of the long head of the biceps. Type II to IV SLAP lesions might be best treated through surgery and rehabilitation, whereas type I lesions are not considered a source of symptoms and therefore do not warrant treatment.

Numerous history findings have been described to identify SLAP lesions. Specifically, a history of posterior shoulder pain, popping or clicking, and both traumatic and insidious onset have been described for SLAP lesions.[1,2] However, the diagnostic utility of history findings has not been investigated.

Physical examination tests for SLAP lesions have been the source of many studies of diagnostic accuracy. Three of these are the anterior slide,[3] active compression,[4] and crank[5] tests.

Researchers[3–12] investigating the diagnostic accuracy of these 3 tests for SLAP lesions have reported widely variable findings. Contributing to this variability are study design, particularly retrospective studies that can have low internal validity; verification bias when the criterion standard was applied only to patients who were positive on the investigated test; performance and positive criteria of the physical examination test; and severity of disease. In addition, the variability in diagnostic accuracy can be attributed to the use of different reference standard criteria across studies. The reference standard for SLAP lesions has included all SLAP lesions without differentiation among types,[3–5,8,11] only type I or II SLAP lesions,[6] only type II SLAP lesions,[10,12] and type II to IV SLAP lesions.[7,9] In 4 studies, researchers specifically excluded type I SLAP lesions because they did not consider these lesions a likely source of mechanical symptoms.[7,9,10,12] In systematic reviews of studies in which tests for SLAP lesions were investigated, authors have indicated that no single test or combination of tests consistently has demonstrated adequate diagnostic utility for identifying SLAP lesions.[13,14] However, in their meta-analysis of SLAP lesion tests using summary receiver operating characteristic (ROC) curves, Meserve et al[15] reported that the active compression and crank tests had better diagnostic utility than the anterior slide test for determining SLAP lesions; the anterior slide test was not recommended for use.

Further research is needed to investigate the diagnostic utility of physical examination tests used to diagnose SLAP lesions, both as individual tests and in combination with other tests. Moreover, the diagnostic utility of history items associated with SLAP lesions should be investigated to determine whether they have diagnostic utility individually or in combination with physical examination tests. Finally, SLAP lesions must be categorized by type, and these categories should facilitate treatment decision making. Therefore, the purpose of our study was to determine the diagnostic accuracy of 3 patient history items, age, the active compression test, the anterior slide test, and the crank test for 2 groups of SLAP lesions: type I and type II to IV SLAP lesions. Because the degenerative fraying of type I SLAP lesions is considered a normal variant and often is believed to be asymptomatic, type I lesions were separated from type II to IV lesions, which are considered tears of the labrum and probably require treatment. We hypothesized that the history and physical examination tests would have diagnostic utility for confirming (ruling in) and excluding (ruling out) type II to IV SLAP lesions and that a combination of tests would have greater diagnostic utility than any single finding. We also hypothesized that no history and physical examination tests would have diagnostic utility for type I lesions. Results will assist in diagnosing and thus guide treatment decision making for SLAP lesions.

METHODS

Research Design

Our study was a secondary analysis of data from a prospective cross-sectional cohort study in which we examined the diagnostic accuracy of all types of glenoid labrum lesions.[16] The reference standard was the intraoperative diagnosis.

Participants

Sixty-five consecutive patients who had shoulder pain and an index of suspicion of a labrum lesion as the cause of their shoulder pain were invited to participate. Sixty-two patients agreed, but 7 did not have surgery. Fifty-five participants (47 men, 8 women; age = 40.6 ± 15.1 years) completed the study. The mean time between the clinical examination and surgery was 2.6 ± 2.7 months (range, 1 day to 8 months). All patients provided written informed consent, and the study was approved by the Institutional Review Board of Walter Reed Army Medical Center.

Procedures

Clinicians participated in a training session to standardize each examination procedure before beginning data collection. The clinician, who was not the operating surgeon, took the history and physical examination. The operating surgeon (W.C.D. or K.P.M.) was blinded to the physical examination findings of the other clinician (W.C.D. or K.P.M.) and to the results of any imaging studies.

The history and physical examination data considered for utility in diagnosing SLAP lesions included age; history of trauma; sudden onset of symptoms; history of popping, clicking, or catching; active compression test; crank test; and anterior slide test. We defined a *history of trauma* as a glenohumeral dislocation or high-velocity impact injury, such as a fall, contact sports injury, or motor vehicle accident. *Sudden onset* was defined as shoulder pain that started at a clearly defined point but was not necessarily the result of a traumatic event (eg, symptoms that started within hours after a sporting event or after engaging in heavy labor). We determined a *history of popping, clicking, or catching* based on the patient answering affirmatively to the presence of these symptoms.

Three physical examination tests for SLAP lesions were performed on each participant. The active compression test[4] was performed with the patient's shoulder in 90° of flexion with 10° of horizontal adduction. The patient was instructed to internally rotate his or her shoulder (thumb-down position), and the examiner applied force downward while the patient resisted. The patient then assumed a position of shoulder external rotation (palm-up position). The examiner again placed downward pressure as the patient resisted. Pain with the first maneuver (humeral internal rotation) that decreased with the second maneuver (humeral external rotation) was considered a positive test. If the patient described pain at the glenohumeral joint rather than the acromioclavicular joint, the test was considered positive for a labrum lesion. The anterior slide test[3] was performed with the patient sitting in a hands-on-hips position with the thumb pointing posteriorly. The examiner applied an anterior-superior force at the elbow while stabilizing the scapula and clavicle with the other hand. Reproduction of shoulder pain or a pop or click was considered a positive test. To perform the crank test,[5] the examiner passively elevated the patient's shoulder to 160° in the scapular plane and then applied an axial load on the humerus while internally and externally rotating the shoulder. The test was positive if symptoms of pain or popping were reproduced.

All 55 patients underwent intraoperative examination. Intraoperative findings that confirmed a type I SLAP lesion included fraying of the superior labrum; findings that confirmed a type II to IV lesion included visualization of tearing, with or without detachment of the SLAP aspect of the glenoid labrum, when tension was applied to the long tendon of the biceps. Particular care was taken during the arthroscopic examination to differentiate normal anatomic variants from true labrum injury. As noted, findings were recorded as the reference or criterion standard.

Statistical Analysis

History and physical examination tests were analyzed individually and in combination to determine the diagnostic utility for each of the 2 categories of SLAP lesions: type I and type II to IV. Patients were classified as positive or negative for the type of SLAP lesion using the operative findings. An ROC curve analysis for each history and test was performed to calculate the area under the curve (AUC), which represents the probability that the test can discriminate between having and not having the disease (SLAP lesion). The range for the AUC is 0 to 1, with 1 indicating 100% probability that a given test can discriminate between healthy shoulders and those with SLAP lesions.[17] A test with an AUC greater than 0.70 is considered clinically useful.[18] Diagnostic accuracy values of sensitivity, specificity, positive likelihood ratio (+LR), and negative likelihood ratio (–LR) were calculated for each history and test. A +LR of 2.0 or more results in a small but important increase in the posttest probability of the disease, and a –LR of 0.50 or less results in a small but important decrease in the posttest probability of the diagnosis.[19] Prevalence was calculated by dividing the number of patients positively confirmed via the reference standard in both SLAP categories by the total number of patients. Age was entered into an ROC curve analysis to determine a threshold of age that was predictive for either category of SLAP lesion.

Forward stepwise binary logistic regression analyses were performed to determine the optimal test combination for diagnosing each category of SLAP lesions. This approach controlled for shared variance between history and physical examination test items. All history and examination data were entered into the binary regression analyses to determine diagnostic utility.[19] For the regression analyses, the liberal entrance criterion was 0.15 and liberal exit criterion was 0.20. For test clusters that yielded significant findings of the regression analyses, diagnostic accuracy values of sensitivity, specificity, and likelihood ratios were calculated. The α level was set a priori at .05. We used SPSS (version 16; SPSS Inc, Chicago, IL) for statistical analysis.

RESULTS

The Snyder et al[1] classification of SLAP lesions and additional diagnoses for the participants are summarized in Table 1. The AUC and diagnostic accuracy values of individual history and physical examination items for diagnosing type I SLAP lesions (n = 13) and type II to IV SLAP lesions (n = 10) are reported in Tables 2 and 3, respectively. For type I SLAP lesions, no test had an AUC of 0.70 or greater, a +LR of 2.0 or greater, or a –LR of 0.50 or less. For Type II to IV SLAP lesions, the only single history or physical examination test with diagnostic utility was the anterior slide test (AUC = 0.70, +LR = 2.25, –LR = 0.44).

For type I SLAP lesions, the forward stepwise binary logistic regression analysis yielded no diagnostic utility for any test combination (Hosmer-Lemeshow goodness of fit $\chi^2 = 6.22$, $P = .01$). For type II to IV SLAP lesions, this analysis yielded diagnostic utility for the combination of a history of popping, clicking, or catching and the anterior slide test (Hosmer-Lemeshow goodness of fit $\chi^2 = 0.59$, $P = .75$), with an explained variance of 20%. These 2 items retained in the model to predict the diagnosis of type II to IV SLAP lesions had a +LR of 6.00 when both findings were positive and a –LR of 0.64 when they were both negative (Table 4). The ROC curve analysis did not reveal a threshold of age that was predictive for either SLAP lesion category (AUC = 0.38, $P = .24$).

Table 1. Description of Superior Labrum Anterior-Posterior Lesions and Additional Diagnoses

	Lesion Type	
Other Diagnosis	I (n = 13)	II–IV (n = 10)
No additional diagnosis	2	3
Rotator cuff disease[a]	8	3
Instability	0	3
Acromioclavicular joint osteoarthritis	0	1
Instability and rotator cuff disease	2	0
Frozen shoulder	1	0

[a] Includes impingement and partial- and full-thickness lesions.

DISCUSSION

We are the first to examine the diagnostic accuracy of history and physical examination tests individually and in combination for SLAP lesions, specifically for type I and for type II to IV SLAP lesions. Because decisions regarding treatment might differ, we examined the diagnostic utility for determining type I and type II to IV SLAP lesions separately. We found no diagnostic utility of the investigated history or physical examination tests for determining type I SLAP lesions, which confirmed our hypothesis. For type II to IV SLAP lesions, only 1 of the investigated history and physical examination tests had diagnostic utility. Specifically, the anterior slide test indicated diagnostic utility for both confirming and excluding type II to IV SLAP lesions; however, the diagnostic values indicated limited utility. The likelihood ratios produced only small shifts from pretest to posttest probability of a type II to IV SLAP lesion when the anterior slide test was used. The test combination of history of popping, clicking, or catching and the anterior slide test had diagnostic utility for confirming the presence of a type II to IV SLAP lesion. The positive test combination had better diagnostic accuracy values than the anterior slide test alone, indicating improved ability to confirm a type II to IV SLAP lesion and a large shift in pretest to posttest probability. The negative test combination did not have diagnostic values that would be useful for excluding a type II to IV SLAP lesion.

The ROC curve analysis indicates the ability of a test or history item to discriminate between the presence and absence of a SLAP lesion. Specifically, an AUC greater or equal to 0.70[18] indicates the ability to discriminate between the presence and absence of the disease. Likelihood ratios allow for the interpretation and clinical application of findings because they combine sensitivity and specificity values to provide a ratio useful for quantifying the posttest probability of having the disease. Although sensitivity and specificity are used frequently, they are less useful than likelihood ratios because they provide a less quantifiable estimate of the probability of the diagnosis. Thus, likelihood ratios provide the focus of this discussion, and they are interpreted as suggested by Jaeschke et al,[19] whereby a +LR of 2.0 or more might result in an important increase in the likelihood and a –LR of 0.50 or less might result in an important decrease in the likelihood of having a particular diagnosis.

For type I SLAP lesions, no single history or physical examination finding had diagnostic utility. No AUC was equal to or greater than 0.70, no +LR was equal to or greater than 2.0, and

Table 2. Diagnostic Accuracy Value (95% Confidence Interval) of Individual History and Physical Examination Findings (Pretest Probability = 24%) for Type I Superior Labrum Anterior-Posterior Lesions

Item	Area Under Curve	*P*	Sensitivity	Specificity	Positive Likelihood Ratio	Negative Likelihood Ratio	Posttest Probability	
							Positive Likelihood Ratio, %	Negative Likelihood Ratio, %
History								
Trauma	0.30 (0.15, 0.4)	.04	0.23 (0.00, 0.46)	0.38 (0.23, 0.53)	0.37 (0.13, 1.03)	2.02 (1.24, 3.29)	11	39
Sudden onset	0.31 (0.14, 0.49)	.04	0.46 (0.19, 0.73)	0.17 (0.05, 0.28)	0.55 (0.30, 1.00)	3.23 (1.39, 7.51)	15	51
Popping, clicking, or catching	0.53 (0.35, 0.71)	.74	0.54 (0.27, 0.81)	0.52 (0.37, 0.67)	1.13 (0.62, 2.05)	0.88 (0.46, 1.69)	26	22
Physical examination								
Active compression test	0.56 (0.38, 0.74)	.51	0.69 (0.44, 0.94)	0.43 (0.28, 0.58)	1.21 (0.77, 1.89)	0.72 (0.30, 1.74)	28	19
Anterior slide test	0.60 (0.42, 0.78)	.27	0.69 (0.44, 0.94)	0.52 (0.37, 0.67)	1.45 (0.90, 2.35)	0.59 (0.25, 1.39)	31	16
Crank test	0.52 (0.34, 0.70)	.81	0.54 (0.27, 0.81)	0.52 (0.37, 0.67)	1.13 (0.62, 2.05)	0.88 (0.46, 1.69)	26	22

Table 3. Diagnostic Accuracy Value (95% Confidence Interval) of Individual History and Physical Examination Findings (Pretest Probability = 18%) for Type II to IV Superior Labrum Anterior-Posterior Lesions

Item	Area Under Curve	*P*	Sensitivity	Specificity	Positive Likelihood Ratio	Negative Likelihood Ratio	Posttest Probability	
							Positive Likelihood Ratio, %	Negative Likelihood Ratio, %
History								
Trauma	0.54 (0.35, 0.74)	.66	0.60 (0.30, 0.90)	0.49 (0.34, 0.63)	1.17 (0.66, 2.10)	0.82 (0.36, 1.85)	20	15
Sudden onset	0.53 (0.34, 0.73)	.74	0.80 (0.55, 1.05)	0.27 (0.14, 0.40)	1.09 (0.76, 1.56)	0.75 (0.20, 2.84)	19	14
Popping, clicking, or catching	0.57 (0.37, 0.76)	.51	0.60 (0.30, 0.90)	0.53 (0.39, 0.68)	1.29 (0.71, 2.33)	0.75 (0.33, 1.68)	22	14
Physical examination								
Active compression test	0.44 (0.24, 0.64)	.55	0.50 (0.19, 0.81)	0.38 (0.24, 0.52)	0.80 (0.42, 1.56)	1.32 (0.64, 2.73)	15	22
Anterior slide test	0.70 (0.51, 0.88	.05	0.70 (0.42, 0.98)	0.69 (0.55, 0.82)	2.25 (1.24, 4.08)	0.44 (0.17, 1.15)	33	9
Crank test	0.51 (0.31, 0.71)	.91	0.60 (0.30, 0.90)	0.42 (0.28, 0.57)	1.04 (0.59, 1.83)	0.95 (0.41, 2.18)	19	17

Table 4. Regression Analysis Results (95% Confidence Interval) for Type II to IV Superior Labrum Anterior-Posterior Lesion for Combination of Tests

Test Combination	Sensitivity	Specificity	Pretest Probability	Positive Likelihood Ratio	Negative Likelihood Ratio	Posttest Probability	
						Positive Likelihood Ratio, %	Negative Likelihood Ratio, %
History of popping, clicking, or catching and the anterior slide test	0.40 (0.10, 0.70)	0.93 (0.86, 1.00)	18%	6.00 (1.59, 22.71)	0.64 (0.39, 1.07)	57	13

no –LR was equal to or less than 0.50 (Table 2). Furthermore, the regression analysis did not identify a test combination with diagnostic utility. This provides support for the premise that type I SLAP lesions probably are not the cause of mechanical shoulder symptoms.

For type II to IV SLAP lesions, the anterior slide test was the only single test indicating diagnostic values with the potential to rule in or rule out type II to IV SLAP lesions (AUC = 0.70, 95% confidence interval [CI] = 0.51, 0.88) with a +LR of 2.25 and –LR of 0.44. However, the anterior slide test provided only small, potentially meaningful increases and decreases in the probability of a patient having a type II to IV SLAP lesion. When the anterior slide test was positive, the probability of a type II to IV SLAP lesion shifted from 18% pretest to 33%

posttest; when the test was negative, it shifted from 18% pretest to 9% posttest. These shifts in probability were small, with only minimal clinical importance. Our findings for the anterior slide test were similar to those of Kibler,[3] who found likelihood ratios useful to both confirm and exclude SLAP lesions. However, authors of 3 previous studies and a meta-analysis indicated poor diagnostic utility of the anterior slide for either confirming or excluding a SLAP lesion.[6,7,15,20] Our study indicated that the anterior slide test probably has limited diagnostic utility as a single test. In light of our findings and those of previous investigators,[6,7,15,20] the anterior slide test should be used with caution as a single test to diagnose type II to IV SLAP lesions.

Results for the crank and active compression tests indicated that they had no diagnostic utility. Our results agreed with those in multiple previous studies,[6–9,20] indicating limited or no diagnostic utility. However, our results disagreed with those reported in other studies[4,5,10,11] and in a meta-analysis,[15] which yielded likelihood ratios with better diagnostic utility for the crank and active compression tests. The conflicting results might be the result of differences in methods, the reference standard, and sample populations.

The test combination of the anterior slide test and the history of popping, clicking, or catching demonstrated diagnostic utility for confirming the presence of a type II to IV SLAP lesion, with a +LR of 6.00. This combination had a better +LR than either individual component of the combination. When this combination was positive (both components were positive), a large increase occurred in the probability of type II to IV SLAP lesion, with a shift from 18% pretest to 57% posttest. However, when this test combination was negative, the diagnostic accuracy values were minimal. The –LR was greater than 0.50 (–LR = 0.64), and the decrease in probability of a type II to IV SLAP lesion was very small, with a shift from 18% pretest to 13% posttest. The negative test combination was not helpful in excluding the diagnosis of a type II to IV SLAP lesion. No one has investigated combinations of history and physical examination tests for diagnosing SLAP lesions.

Our study had several limitations. Patients enrolled in the study were referred to a tertiary care orthopaedic clinic; therefore, these results should be generalized to only those types of patients. Patients had surgery to treat their shoulder pain and had long-standing shoulder pain, which probably indicated increased disease severity. The history and tests examined might not have the same diagnostic utility in patients with less severe disease. Although history and examination findings were useful in helping to rule in or rule out type II to IV SLAP lesions, the CIs associated with the likelihood ratios generally were wide. In addition, our study had a small number of patients with confirmed type I and type II to IV SLAP lesions. Kim et al[20] reported that most (88.5%) patients with SLAP lesions have concomitant intra-articular lesions. We found that most patients (70%) with type II to IV SLAP lesions in our study had concomitant shoulder lesions. This probably affected the diagnostic accuracy of the history and physical examination tests. The effects of other shoulder lesions on the diagnostic accuracy of the history and physical examination items are unclear. Future large-scale studies that reveal narrower CIs for the diagnostic accuracy values are needed to determine the diagnostic utility of the history and physical examination, to examine the spectrum of the disease from acute to chronic, to compare activity levels of participants in overhead and nonoverhead sports and work, and to examine SLAP lesions in the presence of other shoulder disorders.

CONCLUSIONS

We are the first to examine the diagnostic utility of the history and the combination of the history and physical examination tests for diagnosing SLAP lesions. The anterior slide test had limited diagnostic utility for confirming and excluding the presence of type II to IV SLAP lesions. Based on the results of our study and previous studies of this test used alone to diagnose type II to IV SLAP lesions, we do not recommend the anterior slide test for use as a single test. The combination of a history of popping, clicking, or catching and the anterior slide test had moderate diagnostic accuracy for confirming type II to IV SLAP lesions; however, the CIs were wide. This combination should not be used to exclude the diagnosis of a type II to IV SLAP lesion. No single item or combination of history and examination findings had adequate diagnostic utility for determining type I SLAP lesions, supporting the premise that a type I SLAP lesion probably is not a source of symptoms. These results can assist with clinical decision making in patients with shoulder pain and suspected SLAP lesions.

DISCLAIMER

The views, opinions, and/or findings contained in this article are those of the authors and should not be construed as those of the Department of the Army or Department of Defense unless so designated by other official documentation.

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Address correspondence to Lori A. Michener, PhD, PT, ATC, SCS, Department of Physical Therapy, Virginia Commonwealth University, Room 100, West Hospital Basement, 1200 E. Broad Street, Richmond, VA 23298. Address e-mail to lamichen@vcu.edu.