An Evaluation of the Provocative Tests for Superior Labral Anterior Posterior Lesions

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Background: Although our understanding of superior labral anterior posterior lesions has grown, the physical diagnosis remains imperfect.

Study Design: Cohort study (diagnostic); Level of evidence, 2.

Purpose: To determine the most effective provocative maneuver with which to diagnose superior labral anterior posterior lesions.

Methods: A series of 132 consecutive patients scheduled to undergo diagnostic shoulder arthroscopy were examined preoperatively over a 6-month period, and the final diagnosis in each case was made arthroscopically. The following assessments were included: active compression (O'Brien), anterior slide, pain provocation, crank, Jobe relocation, Hawkins, Neer, Speed, and Yergason tests.

Results: The most sensitive diagnostic tools for type II superior labral lesions were the active compression, Hawkins, Speed, Neer, and Jobe relocation tests. When type I and type II lesions were combined, the results were similar. However, none of the sensitive tests were specific for either type I or type II lesions.

Conclusions: The authors' results contradict the current literature regarding provocative testing for both stable and unstable superior labral lesions. There is no single maneuver that can accurately diagnose superior labral anterior posterior lesions; arthroscopy remains the standard by which to diagnose such lesions.

Keywords: shoulder; superior labral anterior posterior (SLAP) lesions; tear; arthroscopy; diagnostic

Our understanding and treatment of superior labral anterior to posterior (SLAP) lesions has improved since their initial description and classification by Snyder in 1990.[24] However, making an accurate diagnosis of SLAP lesions remains elusive.[7,14] Diagnostic arthroscopy is currently the most accurate tool with which to diagnose such lesions.[14] Most clinicians use a combination of patient history, physical examination, and MRI arthrography to assist them in their preoperative diagnosis.[3,23]

A number of authors have reported results on specific provocative maneuvers that they have developed to aid in the diagnosis of SLAP lesions. This list includes the active compression test,[18] the slaprehension test,[1] the pain provocation test,[15] the crank test,[12] and the anterior slide test.[10] In addition, other authors have reported their results in diagnosing SLAP lesions using assessments developed for alternative shoulder lesions, such as the Jobe relocation,[6] Neer,[17] Hawkins,[8] and Speed[5] tests.[7,13,14,19,23,24] To date, no author has compared either SLAP-specific or general shoulder tests in a prospective fashion using arthroscopy on all patients as the final diagnostic tool.

The goal of this study was to determine which provocative test was most accurate in the diagnosis of SLAP lesions. We compared 9 different tests in a prospective protocol and determined their sensitivity, specificity, positive predictive value, and negative predictive value with regard to SLAP lesion types I and II.

MATERIALS AND METHODS

A total of 132 consecutive patients scheduled to undergo diagnostic shoulder arthroscopy as the initial step in their surgical procedure were enrolled in the study between October 1999 and April 2000. The only patients who were excluded from the study were those with adhesive capsulitis,

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as such patients could not participate in the physical examination portion of the study.

In addition to the standard preoperative examination, each patient was evaluated with the following diagnostic tools: the active compression test, Jobe relocation test, pain provocation test, crank test, anterior slide test, Yergason test, Speed test, Hawkins test, and Neer test.

Three orthopaedic surgeons performed the clinical examination on the subjects participating in the study. All examiners had completed 3 months of their 1-year Sports Medicine Fellowship at the initiation of data collection. To ensure uniformity within the study, each of the examiners was separately instructed on how to perform the provocative maneuvers. The Hawkins test was performed by forward flexion and adduction of the shoulder with internal rotation of the humerus and 90° of elbow flexion; re-creation of the pain on this maneuver indicated a positive test result. The Neer test was performed by passive forward flexion of the shoulder, which if the patient's discomfort was re-created was considered a positive result. The Speed test was performed by fully supinating the forearm and extending the elbow with resisted forward flexion of the shoulder; re-creation of the pain indicated a positive test result. The Yergason test was performed by resisting supination with the elbow flexed to 90°; a positive test result was given if the patient's pain was re-created. The active compression test was performed with the patient standing. The shoulder was flexed forward to 90° and adducted 10° while the elbow was fully extended. The shoulder was then fully internally rotated. A downward force was applied, and the patient was asked to resist. This motion was then repeated with the shoulder externally rotated. Patients received a positive test result if pain was present with internal rotation and then improved or went away with external rotation of the shoulder. We did not ask subjects to differentiate between pain "on top" of the shoulder versus pain "inside" the shoulder, as described by O'Brien et al,[18] because of the additional level of subjectivity it would add to this test. The Jobe relocation test was performed with the patient supine on the examining table. The test was performed at 90°, 110°, and 120° of shoulder abduction with the arm in maximal external rotation. An anterior force and then a posterior force were applied to the proximal humerus. The test result was positive when there was pain with the anterior force that was relieved with the posterior force. The crank test was performed by elevating the arm to 160° of forward flexion while axially loading the shoulder through the elbow. The shoulder was then fully externally and internally rotated. Patients received a positive test result when they felt pain during the test, usually with external rotation, or if they felt a reproduction of symptoms. The pain provocation test was performed with the patient in the seated position while abducting the shoulder to 90° and flexing the elbow to 90°; the forearm was then maximally pronated and supinated. If pain only occurred or worsened in the pronated position, the patient received a positive test result. The anterior slide test was performed with the patient seated and positioned with both hands on hips. The examiner's hand was placed anteriorly over the shoulder with the fingers at the acromion. The other hand was then placed on the elbow with a forward and slightly superiorly directed force. The patient then pushed posteriorly against the examiner's anteriorly directed force. The test result was positive if there was pain, or a pop or click, localized to the anterior shoulder or if symptoms were reproduced.

All data were recorded on a standardized form that was included with the patient's preoperative paperwork. Patients then underwent their operative procedure, which necessarily began with diagnostic arthroscopy, and their diagnosis and treatment were included on the same data form.

The data were then evaluated by grouping each patient into a diagnostic category based on their arthroscopic examination. The diagnoses included SLAP lesion types I and II, instability, impingement, partial rotator cuff tears, and complete rotator cuff tears. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated for each test with regard to either type II lesions alone or lesion types I and II combined.

RESULTS

A total of 98 men and 34 women were included in the study. The mean age of all patients was 42 years (range, 15-71 years). Eighty-seven of the shoulders were on the right, and 45 shoulders were on the left.

Forty patients in the study had a SLAP lesion. The mean age of the patients with SLAP lesions was 41 years (range, 29-68 years). Twenty-three patients had a type II lesion, and 17 had a type I lesion, as described by Snyder et al.[24] The prevalence of type II SLAP lesions in our patients was 17.4%, whereas type I lesions were found in 12.9% of patients. The overall prevalence of subjects with SLAP lesions in our study was 30.3%. The mean age of the patients with type I lesions was 45 years.

In addition to SLAP lesions, we found 20 shoulders with a complete rotator cuff tear, 23 shoulders with impingement, 21 shoulders with a partial rotator cuff tear, 21 shoulders with instability, and 7 shoulders with various other diagnoses, including loose bodies, clavicular osteolysis, and degenerative disease.

Only 8 of the 23 type II SLAP lesions were isolated. Of the remaining 15 type II lesions, 2 were associated with a complete rotator cuff tear, 11 with impingement or a partial rotator cuff tear, and 2 with instability. Similarly, only 2 of the type I SLAP lesions were isolated. Of the remaining 15 type I lesions, 1 was associated with a rotator cuff tear, 13 with impingement or a partial rotator cuff tear, and 1 with instability.

The sensitivity, specificity, and positive and negative predictive values for each of the tests with regard to the diagnosis of type II SLAP lesions is presented in Table 1. The most sensitive tools were the active compression and Hawkins tests, followed by the Speed, Neer, and Jobe relocation tests. These 5 tests were statistically different from the other 4 assessment tools ($P < .05$) but were not statistically different from one another. Of note, the active compression and Hawkins tests were also the least specific. The most specific assessments for type II lesions were the Yergason and pain provocation tests ($P < .05$). Positive predictive values

TABLE 1
Results of Diagnostic Tests by Type II SLAP Lesions[a]

Test	Sensitivity %	Specificity %	PPV %	NPV %
Active compression	65.2[b]	48.6	21.1	86.9
Anterior slide	13.0	83.5	14.3	81.1
Crank	8.7	82.6	9.5	81.1
Hawkins	65.2[b]	30.3	16.5	80.5
Neer	47.8[b]	51.4	17.2	82.4
Pain provocation	17.4	89.9[b]	26.7	83.8
Relocation	43.5[b]	51.4	15.9	81.2
Speed	47.8[b]	67.9	23.9	86.0
Yergason	13.0	92.7[b]	27.3	88.5
Standard error, %	17.4	4.8		

[a]SLAP, superior labral anterior posterior; PPV, positive predictive value; NPV, negative predictive value.
[b]$P < .05$.

TABLE 2
Results of Diagnostic Tests by SLAP Lesion Types I and II[a]

Test	Sensitivity %	Specificity %	PPV %	NPV %
Active compression	62.5[b]	50.0	35.5	75.4
Anterior slide	10.0	81.5	19.0	67.6
Crank	12.5	82.6	23.8	68.4
Hawkins	67.5[b]	30.4	29.7	68.3
Neer	50.0[b]	52.2	31.3	70.6
Pain provocation	15.0	90.2[b]	40.0	70.9
Relocation	50.0[b]	53.3	31.7	71.0
Speed	47.8[b]	67.4	34.8	72.1
Yergason	12.5	93.5[b]	45.5	71.1
Standard error, %	7.9	5.2		

[a]SLAP, superior labral anterior posterior; PPV, positive predictive value; NPV, negative predictive value.
[b]$P < .05$.

were poor for all of the tests; the negative predictive value was in the 80% range for each of the tests.

We believe that sensitivity and specificity are the most appropriate statistical measures for the evaluation of our data. Predictive values are dependent on the true prevalence of SLAP lesions in the population; therefore the positive and negative predictive values will vary from study to study if the prevalence of SLAP lesions varies in the study population. We believe that only the sensitivity and specificity are characteristic of the tests themselves.

The data were then analyzed to determine the sensitivity, specificity, positive predictive value, and negative predictive value for both lesion types I and II (Table 2). The Hawkins, active compression, Speed, Neer, and relocation tests were the most sensitive ($P < .05$), with the same poor specificity as seen for type II lesions alone. The Yergason and pain provocation tests were once again the most specific ($P < .05$) for the combined lesions. The positive predictive values were once again quite poor overall, and the negative predictive values were all approximately 70%.

TABLE 3
Sensitivity (in percentages) of Provocative Tests for Other Shoulder Diagnoses

Test	Complete Rotator Cuff Tear	Partial Rotator Cuff Tear	Impingement	Instability
Active compression	55	48	61	45
Hawkins	75	76	83	48
Neer	50	52	57	19
Relocation	50	38	26	86
Speed	50	19	39	42

The 5 most sensitive tests were then analyzed to determine their sensitivities with regard to the other diagnostic categories used in the study. This step was taken to better understand what other diagnoses a clinician should have in mind when using these tools. The results are shown in Table 3. The relocation test was quite sensitive for instability, whereas the Hawkins test was clearly the best for both partial rotator cuff tears and impingement. The Hawkins test was also the most sensitive with regard to full rotator cuff tears. The active compression test had a sensitivity of approximately 50% for all of the other diagnoses.

DISCUSSION

The treatment of unstable SLAP lesions has evolved significantly since their initial description a decade ago. Most authors now agree that symptomatic SLAP lesions should be arthroscopically repaired.[2,4,16,20,21,25,27] However, there is no consensus among authors regarding the physical diagnosis of SLAP lesions,[7,14,24] a point that became the stimulus for this study. We were interested in determining which provocative maneuver was best for diagnosing SLAP lesions.

The literature regarding SLAP lesions generally acknowledges the difficulty in their diagnosis.[14] Although MRI is helpful, a number of anatomical variants such as the sublabral recess and the Buford complex can lead to false-positive results.[9,13,22,26] Authors describe the use of the Hawkins, Neer, Speed, Jobe relocation, and Yergason tests to diagnose SLAP lesions and generally note that they are nonspecific.[7,13,14,19,23,24] As a result, a number of authors have developed specific tests that they believe are both sensitive and specific in the diagnosis of SLAP lesions.[1,10-13,15,18]

Mimori et al[15] developed the pain provocation test and reported a 100% sensitivity and 90% specificity with regard to type II SLAP lesions. However, half of the 22 patients in the study who were thought to have a type II SLAP lesion had their definitive diagnosis made by MRI only. Liu et al[12] described the use of the crank test in a group of 62 patients, 30 of whom had SLAP lesions of unclear type. The crank test was reported to have a sensitivity of 91%, a specificity of 93%, a positive predictive value of 94%, and a negative predictive value of 90%.

Kibler[10] developed the anterior slide test and described its use in a study with 88 arthroscopically confirmed SLAP lesions, although the lesions were not classified. He found that the anterior slide test had a sensitivity of 78.4% and a specificity of 91.5%. Kim et al[11] described the biceps load test in patients with instability and SLAP lesions. Although only 10 patients had type II lesions, the authors determined that the test had a sensitivity of 90.9% and a specificity of 96.9%, with a positive predictive value of 83% and a negative predictive value of 98%. Finally, O'Brien et al[18] described the active compression test, which they believed could be used to diagnose both SLAP lesions and acromioclavicular joint injury. In their study, which included 53 SLAP lesions that they repaired but did not classify, the test had a sensitivity of 100%, a specificity of 98.5%, a positive predictive value of 94.6%, and a negative predictive value of 100%.

The common feature of all of the above-mentioned tests is that they were reported to be both highly sensitive and specific. Our results do not show nearly the same accuracy for any of the tests. The active compression and Hawkins tests were the most sensitive for both type II SLAP lesions and lesion types I and II combined in our study, but they were still only in the 60% sensitivity range. Similarly, the Neer, Hawkins, and relocation tests were all found to have sensitivities of approximately 50%. The remainder of the tests, which included the pain provocation, Yergason, crank, and anterior slide tests, were dismal, with the best having a sensitivity of only 17.4%. In general, the sensitive tests uniformly had very poor specificity. Of note, the active compression and Hawkins tests had specificities at or below 50%. The most specific tests were the Yergason and pain provocation tests. There were no significant differences among the tests with regard to positive or negative predictive values.

Our study was the first to compare a large number of provocative tests in a prospective fashion. We believe that our results differed significantly from those previously reported in the literature because we were the first investigators to evaluate a number of tests in an unbiased random population while using arthroscopy as the final diagnostic tool in all patients. It must be noted that our study population had a relatively high prevalence of SLAP lesions compared with other studies in the literature.[7,23,24] Our clinic is a referral center for a large number of overhead-throwing athletes, which most likely accounts for the increased rate of SLAP lesions in our study.

Our results indicate that there is no single test described in the literature that is both sensitive and specific with regard to the diagnosis of SLAP lesions. We believe that a combination of tests should be used to improve the clinical diagnosis of SLAP lesions in patients, in addition to clinical history and radiographic analysis.

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