Diagnostic Value of Physical Tests for Isolated Chronic Acromioclavicular Lesions

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Purpose: Chronic acromioclavicular joint lesions are a common source of pain and disability in the shoulder. The goal of this study was to evaluate diagnostic values of physical tests for isolated, chronic acromioclavicular joint lesions.

Study Design: A retrospective case-control study.

Methods: Between 1994 and 2002, 35 patients underwent a distal clavicle excision for isolated acromioclavicular joint lesions. The results of 3 commonly used examinations for acromioclavicular joint lesions were calculated for sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy.

Results: The cross body adduction stress test showed the greatest sensitivity (77%), followed by the acromioclavicular resisted extension test (72%) and active compression test (41%). The active compression test had the greatest specificity (95%). All tests had a negative predictive value of greater than 94%, but the positive predictive value was less than 30% for all tests. The active compression test had the highest overall accuracy (92%), followed by the acromioclavicular resisted extension test (84%) and the cross arm adduction stress test (79%). Combinations of the tests increased the diagnostic values for chronic acromioclavicular joint lesions.

Conclusions: These tests have utility in evaluating patients with acromioclavicular joint pathologic lesions, and a combination of these physical tests is more helpful than isolated tests.

Keywords: acromioclavicular joint; examination; arthritis; osteolysis; resection

Acromioclavicular (AC) joint conditions are a common source of pain and disability, and they occur in athletes and inactive patients. The diagnosis of AC joint problems can be based on historical data, physical examination, the result of injections, and imaging studies.[23,29,30] Patients may give a history of an injury directly to the AC joint, or they may be involved in activities known to aggravate the AC joint, such as weight lifting, push-ups, or dips.[2,4,5,33]

The patient with AC lesions typically complains of pain on the top of the shoulder near the AC joint. The distribution of pain with AC pathologic lesions can be into the trapezius or anterior shoulder.[10,22,23] Gerber et al[10] injected saline into the AC joint of volunteers and found that the pain radiated into the trapezius in 80% (12/15) of the subjects. They then injected the subacromial space, and 100% (10/10) of the subjects had pain radiating into the deltoid. They concluded that the pain pattern was a reliable observation, which helped to support the diagnosis of AC joint lesions.

On physical examination, the patient with AC joint pathologic lesions may have swelling or deformity and may have tenderness locally at the AC joint. Several other physical examination signs have been described as provocative for AC joint abnormalities. The cross body adduction stress sign was first described by McLaughlin[21] in 1951. In 1997, Jacob and Sallay[13] described the AC resisted extension test. Another physical examination test was described by O'Brien et al[25] in 1998 and was called the active compression test. This test was found to be also useful for superior labral lesions. They reported that this test was 100% sensitive and 96.6% specific for AC joint lesions.

Despite the frequent use during physical examination of these signs of AC joint abnormalities, we could find no previous study evaluating their diagnostic value. We could

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TABLE 1
Demographic Data and Intra-articular Findings of the No AC Lesion Group and the AC Lesion Group[a]

Variable	Comparisons[b]				
	No AC Group N = 580		AC Group N = 35		Significance[c] (*P* Value)
Demographic data					
Male patients	319	(55)	21	(60)	.563
Mean age, y	47.5	(SD = 18.99)	45.2	(SD = 10.8)	.484
Involvement of dominant arm	368	(63)	20	(57)	.453
Traumatic onset of symptoms	331	(57)	21	(60)	.606
High-demand occupation (eg, sports player, outdoor manual laborer)	94	(16)	8	(23)	.304
High-level (above high school level) sport activity	130	(22)	4	(11)	.126
Intra-articular pathologies					
Supraspinatus tendon tear, partial thickness	163	(28)	11	(31)	.671
Supraspinatus tendon tear, full thickness	124	(21)	0		Not applicable[d]
Infraspinatus tendon tear	48	(8)	0		Not applicable[d]
Subscapularis tendon tear, partial thickness	70	(12)	4	(9)	.588
SLAP lesions, type I	91	(16)	8	(23)	.263
SLAP lesions, type II, III, IV	37	(6)	0		Not applicable[d]
Bankart lesion	101	(17)	0		Not applicable[d]
Hill-Sachs lesion	118	(20)	0		Not applicable[d]
Superior glenohumeral ligament tear	39	(7)	2	(5)	.597
Middle glenohumeral ligament tear	20	(3)	0		Not applicable[d]
Humeral head osteoarthritis	112	(19)	8	(19)	.910
Glenoid osteoarthritic change	97	(17)	8	(19)	.751

[a] AC, acromioclavicular; SLAP, superior labral anterior posterior.
[b] The data are given as the number of subjects, with the percentage in parentheses.
[c] Statistical significance was determined by chi-square test for categorical variables and Student's *t* test for age.
[d] In the chi-square test, it is not appropriate to take *P* values when 1 of the 2 groups for the comparison has no subject in the cell.

find no study that compared the frequency of these physical symptoms in patients with AC joint problems to those with no AC joint problems. In our clinical practice, the observation was made that these signs could produce pain, but the pain could have other causes. The goal of this study was to evaluate the clinical usefulness of these signs. Specifically, we were interested in the overall accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of these signs when examining a patient for chronic AC joint lesions.

MATERIALS AND METHODS

Between 1994 and 2002, 880 patients underwent shoulder surgery in the senior author's practice. Of these patients, 35 were given a diagnosis of isolated chronic AC lesions based on localization of pain to the AC joint or the top of the shoulder, tenderness at the AC joint, and positive response to a local injection test (AC lesion group). A total of 87 patients with a diagnosis of nonisolated chronic AC lesions were excluded: 68 patients associated with subacromial impingement syndrome, 17 patients with AC joint instability, and 2 patients with glenohumeral instability. Another 178 patients were excluded because they did not undergo diagnostic arthroscopy to confirm a final diagnosis for the following reasons: fracture (n = 28), arthroplasty (n = 81), surgical revision (n = 35), manipulation for stiffness (n = 9), or isolated open procedures (n = 25). Patients who underwent shoulder procedures for other shoulder conditions (impingement syndrome or rotator cuff tears, n = 287; glenohumeral instability, n = 159; frozen shoulder, n = 27; and other shoulder conditions, n = 107) were used as a comparison group (no AC lesion group, n = 580) for statistical purposes. There were 319 men and 261 women, with a mean age of 47.5 (±19.0) years, in this group.

All 35 patients in the AC lesion group had located pain to the AC joint area or the top of the shoulder and had local AC tenderness on palpation.[22,35] All patients in the lesion group had at least 1 diagnostic injection performed by us or at another facility prior to surgery. In all cases, pain relief was complete or nearly complete, at least temporarily. All patients had radiographs of their shoulders taken, but radiographic criteria were not the defining reason for the surgical procedure. Final diagnoses for these 35 patients were primary osteoarthritis (n = 29), posttraumatic osteoarthritis without AC instability (n = 3), posttraumatic osteoarthritis with mild instability not requiring additional stabilization (n = 1), and osteolysis (n = 2). There were 21 men and 14 women with a mean age of 45.2 (±10.8) years.

The dominant arm was involved in 20 patients. Trauma was the original cause of symptoms in 21 patients (60%).

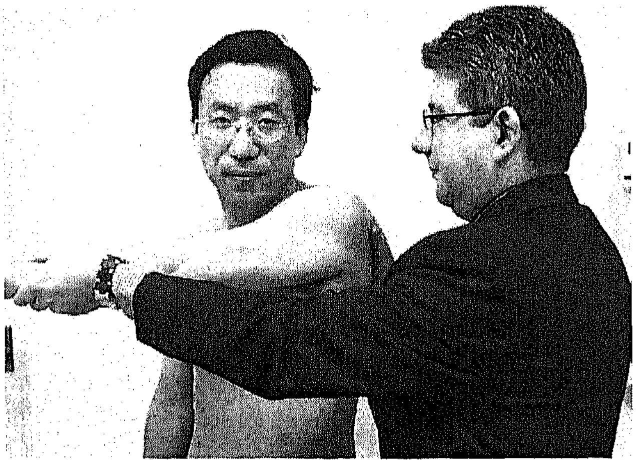


Figure 1. A photograph showing the cross arm adduction stress test.

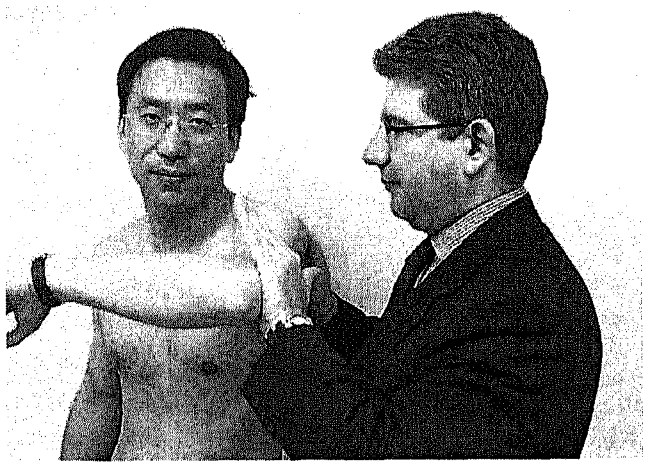
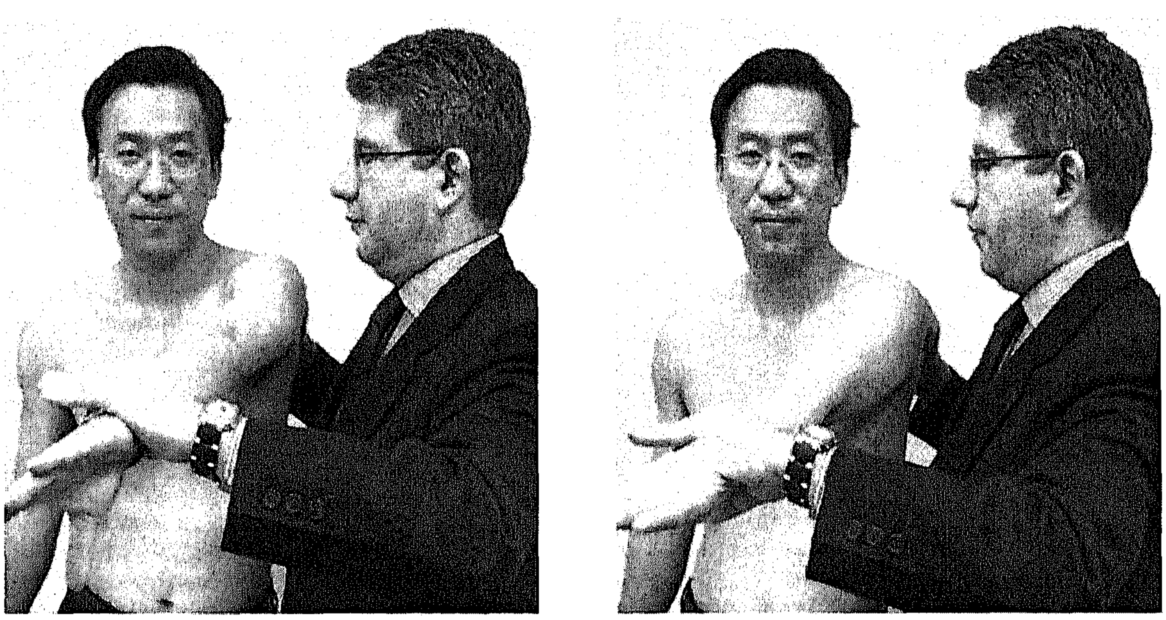


Figure 2. A photograph showing the AC resisted extension test.



(A) (B)

Figure 3. A photograph showing the active compression test. A, performing with the palm down; B, performing with the palm up.

Eight patients (23%) who developed AC joint arthritis were heavy manual workers, and four (11%) were high-level sports participants (above high school level). There were no significant differences between the no AC lesion group and the AC lesion group in demographic factors (Table 1). None of the AC lesion group had intra-articular lesions requiring an independent surgical procedure (ie, there were no full-thickness supraspinatus tendon tears, infraspinatus tendon tears, superior labral anterior posterior [SLAP] lesions [type II, III, IV], Bankart lesions, Hill-Sachs lesions, or middle glenohumeral ligament tears). There was no significant difference in other observable intra-articular lesions between the 2 groups ($P > .05$) (Table 1).

All patients signed informed consent forms prior to their procedure. Approval of the institutional review board of our institution was obtained for this study. All patients completed a detailed questionnaire to provide demographic information, subjective symptoms, and functional status prior to their procedure.[18-20] The questionnaire we have used for our database was an amalgamation of several previously published questionnaires, including the American Shoulder Elbow Society score, the UCLA score, the Simple Shoulder Test, and the Western Ontario rotator cuff and arthritis scores.[17] A history of trauma and etiology of the condition were obtained. Participation in sports and level of sports participation (defined as recreational, high

TABLE 2
Basic Setup for 2 × 2 Table to Calculate Diagnostic Values[a]

		Disease	
		Positive	Negative
Test	Positive	TP (true positive)	FP (false positive)
	Negative	FN (false negative)	TN (true negative)

[a] Diagnostic values were calculated using the following equations: sensitivity = TP/(TP + FN); specificity = TN/(FP + TN); positive predictive value = TP/(TP + FP); negative predictive value = TN/(FN + TN); and overall accuracy = (TP + TN)/(TP + FP + FN + TN).

school, collegiate, or professional) was recorded. All patients underwent a thorough preoperative physical examination. This examination included range of motion, the Neer impingement sign, the Hawkins impingement sign, the painful arc sign, the drop arm sign, and the Speed's test.

Three examinations were performed specifically for the AC joint by the senior author (EGM) or under his direct supervision. The first was the cross body adduction stress test (Figure 1).[21] It was performed with the arm forward flexed 90° and then adducted across the body. It was considered positive if it caused pain on the top of the shoulder near the AC joint. The second test was the AC resisted extension test, described by Jacob and Sallay.[13] In this test, the patient's arm is flexed 90° with the elbow bent 90°, and then the patient is asked to extend the arm against resistance (Figure 2). This test is considered positive if pain is created at the AC joint. The third maneuver was the active compression test, as described by O'Brien et al.[25] This maneuver was performed with the arm flexed forward 90° and adducted 10°. The patient was then asked to resist a dominant force on the arm with the thumb facing down and then with the thumb facing up. The test was positive if pain localized to the AC joint was elicited during the first maneuver and was reduced or eliminated with the second. If the patient felt pain at another location, it was considered a negative test (Figure 3). All 3 of the tests were not performed in all patients because the articles describing the procedures were not published until later; however, 315 patients did undergo all 3 tests.

All patients underwent diagnostic arthroscopy performed by the senior author, followed by the definitive operative procedure. The final diagnosis was based on the history, examination, and arthroscopic findings. Arthroscopy was performed with the patient in a lateral decubitus position with the arm in an arm holder. After the diagnostic arthroscopy, the patient underwent an open distal clavicle excision. An intraoperative data sheet consisting of 60 variables was completed in each case.

The SPSS (version 10.0, SPSS Science, Chicago, Ill) software package was used for statistical analysis and for calculating the diagnostic values. Statistical significance was determined for the differences of proportions of positive results of the 3 tests between the no AC lesion group and the AC lesion group. Significance was set at $P < .05$. Diagnostic values were calculated using a 2 × 2 table for sensitivity, specificity, PPV, NPV, and overall accuracy (Table 2).

RESULTS

The results of all the physical examination findings are summarized in Table 3. Despite the findings of isolated AC abnormalities, many patients from the AC lesion group had positive results on other tests: the Neer impingement sign (20 of 35 patients, 57%), the Hawkins impingement sign (8 of 17 patients, 47%), the painful arc sign (8 of 16 patients, 50%), the drop arm sign (9 of 26 patients, 35%) and the Speed's test (7 of 29 patients, 24%). The cross body adduction stress test showed the greatest sensitivity (77%), followed by the AC resisted extension test (72%) and active compression test (41%). The active compression test showed the greatest specificity (95%). All tests had a negative predictive value of more than 94%, but the positive predictive value was lower than 30% for all tests. The active compression test was the most accurate (92%), followed by the AC resisted extension test (84%) and the cross arm adduction stress test (79%). Combinations of the tests increased the diagnostic values for chronic AC joint lesions (Table 4).

DISCUSSION

Chronic AC joint lesions are a relatively common source of shoulder pain, restricted range of motion, and overall disability. Patient history, physical examination, AC joint imaging, and administration of local anesthetic injections help when assessing for AC joint abnormalities. Although the physical examination tests are used for clinical evaluation and diagnosis, there is no scientific information of their diagnostic value. This study documents the clinical usefulness of 3 commonly used signs during physical examination for AC joint instability and confirms the relatively high sensitivity, specificity, and NPV of the cross body adduction stress test and the AC resisted extension test. The active compression test had high specificity but low sensitivity. Combinations of the 3 tests may be used to increase their clinical usefulness. Requiring all 3 tests to be positive increases the specificity but decreases the sensitivity. Therefore, if a clinician wants to increase sensitivity, he or she should require only 1 test to be positive, whereas if high specificity is necessary, the clinician should require all 3 tests to be positive.

Previous study of the role of physical examination in assessing the AC joint has been limited. Only 1 study by Maritz and Oosthuizen[16] provided the sensitivities of several tests used in a cohort of patients with "probable" AC inflammation. The sensitivities, which they reported for joint line tenderness (96%) and the cross arm adduction stress test (100%), are similar to those in our study. They

TABLE 3
Diagnostic Values of Various Physical Tests in Diagnosing a Chronic Acromioclavicular Joint Lesion

Test	Sensitivity		Specificity		PPV		NPV		Overall Accuracy[a]	
	%	n of N	%	n of N	%	n of N	%	n of N	%	n of N
Cross body adduction stress test	77	(27 of 35)	79	(410 of 518)	20	(27 of 135)	98	(410 of 418)	79	(437 of 553)
AC resisted extension test	72	(13 of 18)	85	(279 of 330)	20	(13 of 64)	98	(279 of 284)	84	(292 of 348)
Active compression test	41	(7 of 17)	95	(291 of 308)	29	(7 of 24)	97	(291 of 301)	92	(298 of 325)
Neer impingement sign	57	(20 of 35)	41	(227 of 550)	06	(20 of 343)	94	(227 of 242)	59	(247 of 585)
Hawkins impingement sign	47	(8 of 17)	45	(142 of 314)	04	(8 of 180)	94	(142 of 151)	45	(150 of 331)
Painful arc sign	50	(8 of 16)	47	(159 of 342)	04	(8 of 191)	95	(159 of 167)	47	(167 of 358)
Drop arm sign	35	(9 of 26)	72	(357 of 498)	06	(9 of 150)	96	(357 of 374)	70	(366 of 524)
Speed's test	24	(7 of 29)	71	(356 of 504)	05	(7 of 155)	94	(356 of 378)	68	(363 of 533)

[a] PPV, positive predictive value; NPV, negative predictive value.

TABLE 4
Diagnostic Value of Combined Physical Tests[a]

Test	Sensitivity		Specificity		PPV		NPV		Overall Accuracy[a]	
	%	n of N	%	n of N	%	n of N	%	n of N	%	n of N
Positive in all 3 tests	25	(4 of 16)	97	(290 of 299)	31	(4 of 13)	96	(290 of 302)	93	(294 of 315)
Positive in 2 or more than 2 of the tests	81	(13 of 16)	89	(266 of 299)	28	(13 of 46)	99	(266 of 269)	89	(279 of 315)
Positive in 1 or more than 1 of the tests	00	(16 of 16)	74	(221 of 299)	17	(16 of 94)	100	(221 of 221)	75	(237 of 315)

[a] A total of 315 patients (16 in the AC lesion group and 299 in the no AC lesion group) who underwent all 3 tests (the cross body adduction stress test, the AC resisted extension test, and the active compression test) were included in this analysis. PPV, positive predictive value; NPV, negative predictive.

found that the active compression test had a sensitivity of 68%, which is slightly higher than in our study. Other studies in the literature on AC joint abnormalities and distal clavicle excision typically are consecutive case series that provide neither a statistical analysis nor any control groups when discussing the physical examination.[7-9,11,14-16,24,25,37]

O'Brien et al[25] described the active compression test for diagnosing labral tears and AC joint abnormality. They claimed that the AC joint loading method by the shoulder position (90° of flexion, 15° adduction, maximum internal rotation) and active muscle contraction was more efficient than that of the cross arm adduction stress test. In contrast with their results, in our study, the active compression test had lower sensitivity (41% versus 77%) and higher specificity (95% versus 79%) than the cross arm adduction stress test. The sensitivity of the active compression test in our study was much lower than the sensitivity (100%, n = 55) originally reported in their study. We did not perform any biomechanical studies to investigate this difference, but this partly reflects the different patient population of their study, which included asymptomatic shoulders in 50 patients who did not have injections, MRI studies, or arthroscopy of the unaffected shoulders.

Our study demonstrates that provocative maneuvers believed to be typical of other shoulder abnormalities, such as the Neer impingement sign, the painful arc sign, and the drop arm sign, can produce pain in patients with isolated AC joint lesions. Maritz and Oosthuzen[16] found that of their patients with AC joint symptoms, 59% had a painful arc sign, 86% had a positive Speed's test, 57% had neck tenderness, and 91% a positive Jobe's test. Our study suggests that symptoms and signs of the shoulder can be nonspecific, and results of shoulder physical examinations need to be interpreted with caution.

One of the limitations of any study of AC joint abnormalities is the difficulty in establishing definitive criteria for making the diagnosis. Previous studies in the literature indicate that the presence of radiologic arthritic changes of the AC joint does not correlate well with the presence of symptoms.[3,26-28,34] Several studies using plain radiographs and MRI have demonstrated the increasing incidence of degenerative changes of the AC joint with age.[30-32,36] The conclusion of these studies is that the presence of AC arthritis on MRI or plain radiographs is not an adequate criterion for the diagnosis of AC joint lesions.

The diagnosis in our patients was made based on historical and clinical findings, particularly the localization of pain to the AC joint by the patient, local tenderness at the AC joint, and positive local injections of the AC joint. This reliance on pain localization, local tenderness, and injections to make the diagnosis of AC joint lesions introduces an inherent bias into this study, which should be taken into account when interpreting the results. This study did not verify the diagnostic accuracy of the injection of anesthetic into the AC joint, but their use has widespread support in the literature.[12,23,26,29]

There are several other limitations of this study. First, this was not a prospective study, and not all tests were done on all patients. Another difficulty with a case-control study is the selection of an appropriate control group.[1] The ideal control group would be patients identical with those in the study group but not suffering from the condition being investigated. When studying patients with a particular condition undergoing surgery in a case-control series, it is common practice to use patients with different conditions undergoing surgery as controls. Nevertheless, such patients may have several confounding factors that can influence the study results.[1,6] However, it would not be possible to obtain a control group of patients with no shoulder symptoms and have them undergo injections or shoulder arthroscopy. Despite the difficulties in selecting an ideal control group, the large control group used in this study is probably closer to the typical patient population referred to orthopaedic surgeons for shoulder problems, and the large size can provide some advantages in obtaining actual predictive values of the physical tests. Lastly, the predictive value of the physical findings on the surgical result was not established in this study, but this would require a control group with no symptoms to undergo distal clavicle excision.

This study is the first to critically evaluate the clinical accuracy of these tests. Local tenderness remains one of the best diagnostic signs for AC joint lesions and should be performed when evaluating the AC joint. Injections of the AC joint provide important information. None of the tests with high sensitivity had equally high specificity, which suggests the necessity to consider multiple factors in the choice of the surgical procedure. Combined positive tests increase the overall accuracy of the examination, but reliance on these tests alone is not recommended. Further study is needed to determine the prognostic value of these tests for the surgical result.

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