Clinical Assessment of Three Common Tests for Traumatic Anterior Shoulder Instability

By Adam J. Farber, MD, Renan Castillo, MS, Mark Clough, MD, Michael Bahk, MD, and Edward G. McFarland, MD

Investigation performed at the Division of Sports Medicine and Shoulder Surgery, Department of Orthopaedic Surgery, and the Center for Injury Research and Policy, Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, Johns Hopkins University, Baltimore, Maryland

Background: Although traumatic anterior shoulder instability is common, the usefulness of various physical examination tests as tools for the diagnosis of this condition has been studied infrequently. We hypothesized that (1) such tests would be specific but not sensitive for this condition, (2) the usefulness of the anterior drawer test would be limited because of pain during the test, and (3) an anterior drawer test would be a useful adjunct for making the diagnosis if it reproduced the instability symptoms.

Methods: Between 2000 and 2004, 363 patients underwent a physical examination followed by shoulder arthroscopy. Forty-six patients with traumatic anterior shoulder instability that had been noted arthroscopically or documented radiographically after the trauma were included in our study group, and the remaining patients served as controls. The clinical usefulness of three tests (anterior apprehension, relocation, and anterior drawer tests) performed during the physical examination to make a diagnosis of traumatic anterior instability then was evaluated with statistical methods to assess their sensitivity, specificity, and likelihood ratios.

Results: If demonstration (or relief) of apprehension was used as the diagnostic criterion for a positive test, the sensitivity, specificity, and likelihood ratio were 72%, 96%, and 20.2, respectively, for the apprehension test and 81%, 92%, and 10.4, respectively, for the relocation test. If pain (or relief of pain) was used as the diagnostic criterion for a positive test, the values for the sensitivity, specificity, and likelihood ratio of both tests were lower. The anterior drawer test could be performed successfully in the physician's office for 87% of the patients. If reproduction of instability symptoms was used as the criterion for a positive anterior drawer test, the sensitivity, specificity, and likelihood ratio values of that test were 53%, 85%, and 3.6, respectively.

Conclusions: The three physical examination tests for traumatic anterior shoulder instability are specific but not sensitive. Apprehension is a better criterion than pain for a positive apprehension or relocation test. The anterior drawer test (when pain does not prevent it from being performed) is helpful for diagnosing traumatic anterior instability.

Level of Evidence: Diagnostic Level I. See Instructions to Authors for a complete description of levels of evidence.

The shoulder is the most commonly dislocated joint in the body, accounting for approximately 45% of all dislocations (1044 of 2324)[1]. Most glenohumeral dislocations occur in the anterior direction, and traumatic anterior shoulder instability is the most common type of shoulder instability evaluated by clinicians[2-4]. The diagnosis of anterior shoulder instability frequently is based on the patient's history and the findings of the physical examination[4-8]. Many patients report a history of a painful dislocation or subluxation with or without a reduction. However, some patients do not have the classic history of this condition or they are unsure of what exactly happened to the shoulder. It is important that the clinician be able to verify the diagnosis through a physical examination before devising a treatment plan.

A multitude of physical examination tests for diagnosing anterior shoulder instability have been described[4,8-10], with the apprehension test and the relocation test being the most common[6,7]. In addition, the anterior drawer test, recognized as a measure of shoulder laxity, can be used as a provocative maneuver for anterior shoulder instability[10-12]. Despite the frequent use of these tests during physical examinations for anterior shoulder instability, the accuracy of any of them, or a combination of

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TABLE I Comparison of Demographic Data and Intra-Articular Findings between Groups*

Variable	Study Group* (Traumatic Anterior Instability) (N = 46)	Comparison Group* (No Anterior Instability) (N = 317)	P Value†
Male	30 (65)	167 (52.7)	0.12
Mean age (and stand. dev.) *(yr)*	28.6 ± 14.6	50.5 ± 16.3	<0.001
Involvement of dominant arm	31 (67)	199 (62.8)	0.63
Traumatic onset of symptoms	46 (100)	156 (49.2)	<0.001
High-demand occupation (e.g., sports, strenuous labor)	7 (15)	35 (11.0)	0.46
Sports activity above high-school level	11 (24)	11 (3.5)	<0.001
Engaged in overhead sports	16 (35)	84 (26.5)	0.29
Bankart lesion	39 (85)	0 (0)	<0.001
Hill-Sachs lesion	40 (87)	0 (0)	<0.001

*The data are given as the number of subjects, with the percentage in parentheses, unless otherwise indicated. †Significance was determined with the chi-square test for categorical variables and with the Student t test for age.

them, for diagnosing this condition has been studied infrequently. Speer et al.[13] evaluated the diagnostic accuracy of the relocation test in 100 patients who underwent shoulder surgery for a variety of shoulder disorders. In 2004, Lo et al.[14] studied the diagnostic value of the apprehension and relocation tests in forty-six patients with a variety of diagnoses who had not undergone surgery. In both of those studies, the authors noted that apprehension was more accurate than pain as a criterion for diagnosing instability. Although several studies have documented the reproducibility and reliability of the anterior drawer test[15-17], we are not aware of any previous studies of its clinical usefulness in the diagnosis of traumatic anterior shoulder instability.

The goal of this study, therefore, was to determine the clinical value (overall accuracy, sensitivity, specificity, positive predictive value, negative predictive value, likelihood ratios, and the post-test probabilities) of the apprehension, relocation, and anterior drawer tests for the diagnosis of traumatic anterior shoulder instability. Because the criterion for a positive apprehension test or relocation test has been the reproduction (or relief) of pain or apprehension, we were interested specifically in which criterion would result in the most accurate prediction of traumatic anterior instability of the shoulder[6,7,13,18-23]. On the basis of our subjective impressions of these tests as used preoperatively, we hypothesized that (1) such tests would be specific but not sensitive for this condition, (2) the usefulness of the anterior drawer test in the physician's office would be limited because of the pain experienced by the patient during the test, and (3) an anterior drawer test would be a useful adjunct for making the diagnosis of traumatic anterior instability if it reproduced the symptoms of instability.

Materials and Methods

Patient Population

Between July 2000 and April 2004, 363 patients underwent shoulder arthroscopy in the practice of the senior author (E.G.McF.). All patients gave informed consent, and the study was approved by our institutional review board. Forty-six of the 363 patients had a diagnosis of traumatic unidirectional anterior instability of the shoulder after arthroscopy, and they formed our study group. The criterion for diagnosing traumatic unidirectional anterior instability of the shoulder was either radiographic documentation of an anterior shoulder dislocation after trauma or demonstration of a Hill-Sachs lesion, a Bankart lesion, or a humeral avulsion of the glenohumeral ligament at the time of arthroscopy. The 317 patients who underwent procedures for shoulder conditions other than traumatic anterior instability formed a comparison group. The conditions in these patients included impingement syndrome or a rotator cuff tear in 192, osteoarthritis in twenty-nine, occult instability (shoulder pain with activity but no history of a shoulder subluxation or dislocation in an overhead-throwing athlete) in sixteen, an acromioclavicular lesion in fifteen, a superior labrum anterior and posterior (SLAP) lesion in fifteen, posterior shoulder instability in twelve, multidirectional instability (instability in more than two directions seen during arthroscopy and requiring stabilization in more than one direction or a previous procedure for instability in one or more directions followed by surgical repair by us for instability in a direction not addressed with the previous repair) in seven, osteonecrosis in six, frozen shoulder in four, and other shoulder conditions in twenty-one.

The study group was significantly different from the comparison group ($p < 0.001$) in that it was younger, included more individuals involved in sports beyond the high-school level, more frequently had trauma as an etiology, and had more Bankart and Hill-Sachs lesions at the time of arthroscopy (Table I).

Preoperatively, all patients completed a detailed questionnaire that elicited demographic information and asked about symptoms and functional status[24,25]. The patients also underwent a thorough preoperative physical examination in which the three tests under study were performed by the senior author or under his direct supervision. In this examina-

Fig. 1
The apprehension test.

tion, a maximum of 125 variables were assigned on the basis of measurement of the range of motion, strength testing, testing of shoulder laxity, and the results of provocative maneuvers for shoulder instability.

The first test that was performed was a modification of the anterior apprehension test described by Rowe and Zarins[7]. Those authors described testing one shoulder with the patient standing or supine and the arm in 90° of abduction and maximum external rotation and the examiner's hand posterior to the shoulder to stabilize the scapula. We performed this test with the patient standing, but both of the patient's shoulders were concurrently placed in approximately 90° of abduction and 90° of external rotation and the examiner did not place a hand posterior to the shoulder to stabilize the scapula. A test was deemed to be positive when the patient became apprehensive about having an episode of instability (Fig. 1). Because

Fig. 2
The relocation test.

other authors have suggested that pain with this test indicates instability, we also noted if the patient reported pain with the affected arm in this position[7,13,20-23].

The second test was the relocation test as described by Jobe et al.[6]. In this test, the patient lay supine on an examining table and was brought to the side of the table (Fig. 2). The patient's arm was then placed in abduction and external rotation, a position similar to that used for the anterior apprehension test. The patient was asked if this position produced a sense of instability or pain. If it did, the humeral head was stabilized with a posteriorly directed force to relocate the humeral head and prevent it from subluxating anteriorly. The test was considered positive if the patient confirmed that the posteriorly directed force relieved the sense of apprehension. We also noted whether application of the posteriorly directed force relieved pain.

The third test that was performed was the anterior drawer test as described by Gerber and Ganz[11]. With the patient supine and the shoulder just over the edge of the table, the examiner placed one hand on the wrist and the other hand on the proximal part of the humerus (Fig. 3). The patient's arm then was abducted 60° to 80° and placed in 0° of rotation. A slight axial load was applied to the arm, and then the humeral head was translated anteriorly over the glenoid rim[8,11]. The amount of translation of the humeral head over the glenoid was measured with a modified version[15] of the classification by Hawkins and Bokor[5]. Grade I indicated translation to the glenoid rim but not over it, Grade II indicated translation over the glenoid rim that spontaneously reduced, and Grade III indicated that the humeral head remained dislocated when the hand on the humerus was removed. If the humeral head could be subluxated over the glenoid rim (that is, if there was Grade-II or Grade-III laxity), the patient was asked if this test reproduced the symptoms of instability. The examiner also noted on the data sheet if the patient would not relax for the test because of muscle contraction or pain. The determination of whether or not a patient was relaxed was based on the examiner's subjective assessment of whether there was muscle contraction producing resistance to translation of the humeral head.

The load-and-shift test, which can be performed with the patient sitting or supine, was not carried out as part of this study[5,8].

Examination Under Anesthesia

Every patient received general anesthesia with or without a scalene block. The senior author performed an anterior drawer test on all patients in the study and control groups, and the result was graded with the same modified version[15] of the Hawkins and Bokor[5] classification that had been used preoperatively. The senior author also evaluated the range of shoulder motion.

Diagnostic Arthroscopy

All patients underwent diagnostic arthroscopy while in the lateral decubitus position. A systematic examination of the glenohumeral joint was performed, with the examiner specifically looking for Bankart lesions, Hill-Sachs lesions, tears of the capsule, and anteroinferior glenoid erosions. A Bankart lesion was defined as a complete detachment of the anteroinferior aspect of the labrum from the glenoid rim. A Hill-Sachs lesion was defined as an osseous or cartilage defect on the posterior aspect of the humeral head that was distinct and different from the bare area of the posterior aspect of the humeral

Fig. 3

The modified anterior drawer test.

TABLE II Diagnostic Value of Physical Examination Tests for Anterior Shoulder Instability*

Test/Criterion for Positive Test	Sensitivity (%)	Specificity (%)	Predictive Value (%)		Overall Accuracy (%)	Likelihood Ratio		Post-Test Probability	
			Pos.	Neg.		Pos.	Neg.	Pos.	Neg.
Apprehension test									
Pain	50	56	14	88	55	1.13	0.90	0.14	0.12
Apprehension	72	96	75	96	93	20.22	0.29	0.75	0.04
Relocation test									
Relief of pain	30	90	19	94	86	3.02	0.77	0.19	0.06
Relief of apprehension	81	92	53	98	91	10.35	0.20	0.53	0.02
Anterior drawer test									
Pain	28	71	13	86	65	0.97	1.01	0.13	0.14
Reproduction of instability symptoms	53	85	35	92	81	3.57	0.56	0.35	0.08
Grade II or III laxity*	60	74	26	92	72	2.28	0.54	0.26	0.08

*The grade of laxity was determined with use of a modification[15] of the scale described by Hawkins and Bokor[5].

head. Thirty-four patients had Bankart and Hill-Sachs lesions, four had only a Hill-Sachs lesion, five had only a Bankart lesion, and three patients had neither lesion. Of those three patients, one had a humeral avulsion of the glenohumeral ligament found at the time of surgery, one had radiographic documentation of an anterior shoulder dislocation after trauma, and one had both a humeral avulsion of the glenohumeral ligament noted at the time of arthroscopy and radiographic documentation of an anterior shoulder dislocation. The forty-six patients with one or more of these lesions were considered to have traumatic anterior instability.

Data Analysis

The Statistical Package for the Social Sciences software package (version 10.0; SPSS Science, Chicago, Illinois) was used for statistical analysis and for calculating the diagnostic values. Significance was determined for the differences in the proportions of positive results of the three tests between the study group and the comparison group. The chi-square test was used for categorical variables, and the Student t test was used for continuous variables. Significance was set at $p < 0.05$. Diagnostic values were calculated with a two-by-two table for sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy. Likelihood ratios and post-test probabilities also were calculated[26]. The positive likelihood ratio is an expression of how many times more likely a patient with the disease is to have a positive test than is a patient without the disease. Conversely, the negative likelihood ratio shows how many times less likely a patient without the disease is to have a negative test than is a patient with the disease. Positive or negative post-test probabilities are the actual probabilities of a subject having or not having the disease given a positive or negative test result, respectively.

Results

We found no significant difference between the percentage of patients who reported apprehension during anterior apprehension testing in the standing position and that of patients who reported apprehension while tested in the supine position. The anterior apprehension test was positive for (caused) apprehension in thirty-three (72%) of the forty-six patients, and the relocation test was positive for (relieved) apprehension in thirty-two (70%) of the forty-six patients.

In general, the sensitivity of the physical examination tests was low (81%), whereas the specificity varied depending on whether pain or apprehension was used as the criterion for diagnosis (Table II). When apprehension was used as the criterion for a positive test, the likelihood ratio of a patient with a positive apprehension test having anterior instability was 20.2 and the likelihood ratio of a patient with a positive relocation test having anterior instability was 10.4. In contrast, when pain was used as the criterion for a positive test, the likelihood ratios were only 1.1 and 3.0, respectively. This finding indicates that when these tests elicit (or relieve) pain, the likelihood of the patient having anterior shoulder instability is not much higher than the likelihood of the patient not having anterior shoulder instability.

In the office setting, the anterior drawer test was performed successfully for forty (87%) of the forty-six patients in the study group (with anterior instability) and for 262 (83%) of the 317 patients in the comparison group (Table III). A reliable examination could not be performed for the remaining patients in each group because of the patient's inability to relax secondary to pain, fear of instability, or a combination thereof.

Of the twenty-four patients with documented anterior instability and grade-II laxity, eighteen (75%) reported that their symptoms of instability were reproduced by the anterior drawer test and six (25%) reported that their symptoms were not reproduced by that test. Of the sixteen patients with documented anterior instability and grade-I laxity, four had a sense of instability with anterior drawer testing and twelve did not. Of the forty patients for whom the anterior drawer test was performed successfully, twenty-six (65%) had the same degree

TABLE III Anterior Laxity During Anterior Drawer Testing in Awake Patients with Anterior Shoulder Instability

Laxity Grade	Study Group* (Traumatic Anterior Instability) (N = 46)	Comparison Group* (No Anterior Instability) (N = 317)	P Value†
Patient not relaxed‡	6 (13)	55 (17.4)	0.53
Grade I	16 (35)	193 (60.9)	<0.001
Grade II	24 (52)	68 (21.5)	<0.001
Grade III	0 (0)	1 (0.3)	0.99

*The data are given as the number of subjects, with the percentage in parentheses. †Significance was determined with the chi-square test.
‡The patient could not relax enough for laxity testing to be performed accurately.

TABLE IV Diagnostic Value of Combined Physical Tests for Anterior Shoulder Instability*

Tests*	Sensitivity (%)	Specificity (%)	Predictive Value (%)		Overall Accuracy (%)	Likelihood Ratio		Post-Test Probability	
			Pos.	Neg.		Pos.	Neg.	Pos.	Neg.
Apprehension, relocation, and anterior drawer	48	99	82	94	93	39.10	0.52	0.82	0.06
Apprehension and relocation	81	98	81	98	96	39.68	0.19	0.81	0.02
Relocation and anterior drawer	48	96	61	94	91	13.03	0.54	0.61	0.06
Apprehension and anterior drawer	46	98	77	92	91	23.06	0.55	0.77	0.08

*The apprehension test was considered positive in the presence of apprehension, the relocation test was considered positive with the relief of apprehension, and the anterior drawer test was considered positive if the symptoms of instability were reproduced.

of laxity bilaterally and fourteen (35%) had laxity that was one or more grades greater in the affected shoulder than in the contralateral shoulder; no patient had less laxity in the affected shoulder than in the contralateral shoulder. As measured with the anterior drawer test, only seventeen (43%) of the forty patients had more shoulder laxity while they were under anesthesia than when they were awake; the laxity was one grade greater in fourteen of these patients and two grades greater in the other three.

If the shoulder could be subluxated over the glenoid rim and the subluxation reproduced the symptoms of instability, then the likelihood ratio was 3.6 that the patient had anterior instability. If the patient had only pain with the anterior drawer test, then the diagnosis of anterior instability could not be confirmed.

Combining the tests resulted in increased specificity, likelihood ratios, and post-test probabilities, but it decreased the tests' sensitivity (Table IV). These findings were relevant only when apprehension was used as the diagnostic criterion for the apprehension and relocation tests and when reproduction of instability symptoms was used as the criterion for the anterior drawer test.

Discussion

Our study showed that physical examination tests commonly used for diagnosing anterior shoulder instability generally are specific but not sensitive for traumatic instability. On the basis of our findings, we recommend the use of apprehension rather than pain as the diagnostic criterion for instability[13,14]. To our knowledge, this is the first study to show the utility of using an anterior drawer test for making the diagnosis of anterior instability. We found that the test is diagnostic when it reproduces symptoms of instability but not when it produces only pain. Although Cofield et al.[27] preferred to use this test with the patient under anesthesia, we believe that we are the first to examine the role of an anterior drawer test in the preoperative evaluation of patients with anterior shoulder instability[12].

Our results could have been influenced by several factors. First, we performed the anterior drawer test with the arm abducted 60° to 80°, which is different from the 70° to 90° arm position originally described by Gerber and Ganz[11]. The position that we utilized also differs from that used for the load-and-shift test, in which the arm is abducted approximately 20°[8]. It may be that laxity testing with the arm in other positions yields results that differ from those obtained in our study. Second, we found that not all of the patients would relax enough to allow an effective examination, and our results might have been influenced by the criterion used to define "relaxed." One way to evaluate the effect of muscle contraction on shoulder laxity testing in the physician's office would be to reexamine the patient under anesthesia in the operating room. Several investigators have shown that laxity of the shoulder increases when the patient is under anesthesia, but to our knowledge none have studied the impact

of preoperative compared with intraoperative laxity testing on the final diagnosis[28,29]. Although we found that seventeen patients had a higher degree of anterior shoulder laxity under anesthesia than during the office examination, the diagnosis of instability was not predicated on the degree of laxity on examination. The goal of our study was not to evaluate the role of laxity testing with the patient under anesthesia but to assess its usefulness in the physician's office, as it is typically performed by the clinician. We did not use local anesthesia or oral medication in the office to relax the patient for laxity testing.

Our findings with regard to the apprehension test are similar to those of Lo et al.[14], who evaluated the anterior apprehension sign in forty-six patients with a variety of diagnoses. They found that, with this test, the demonstration of apprehension was a better predictor of anterior instability than was the presence of pain (see Appendix). They also found no significant differences among the results of four examiners using this test, indicating that it has good interexaminer reliability. As was the case in their study, our examiners were not blinded to the diagnosis preoperatively, which may have introduced bias.

The results of our study and those of others[13,14] show that the apprehension and relocation tests for anterior instability of the shoulder have low sensitivity and specificity when pain is used as the criterion for a positive test. The exact source of pain that occurs when the arm of a patient with anterior instability is placed in abduction and external rotation has not been established. We found that such a patient may have a variety of diagnoses. Our finding that pain was a less satisfactory criterion for a positive test also suggests that, if a patient has had surgery for anterior instability, then pain with the arm in a position of abduction and external rotation is not a reliable way to determine the failure or success of that surgery.

Several factors may have influenced our results. First, the study included only patients who were sufficiently symptomatic to undergo surgery for the instability or other shoulder condition. One of the inherent problems with a case-control study is the selection of an appropriate control group[30]. The fact that our comparison group did not match the study group demographically may have influenced our results. An ideal control group would have included age-matched patients without any shoulder problems who had undergone arthroscopy of the shoulder, but it would not be practically or ethically possible to obtain such a group. Because this was a consecutive case series, an arbitrary selection of patients to create an age-matched control group would not represent the true clinical application of these tests across a wide gamut of patients as is typically seen in the clinical situation. Also, it was not possible to create a control group matched for the age and sex of the patients with a traumatic etiology of their shoulder condition.

Similarly, we limited our study to patients with traumatic anterior instability from one physician's practice in an academic medical center. The usefulness of these examination techniques for diagnosing other types of shoulder instability, such as multidirectional instability or occult instability in an overhead-throwing athlete, were not addressed specifically[17,22,31]. The results of these tests in other patient populations with shoulder symptoms and other instability patterns require additional study. Another factor to consider in our study is that we did not evaluate other tests for anterior instability, such as the "surprise" test or the "release test"[8,14,32]. Furthermore, although radiographic studies might have been useful for determining the diagnosis in our series, our goals did not include evaluation of the role of imaging studies in the diagnosis of anterior shoulder instability.

In summary, when apprehension is used as a criterion for a positive apprehension or relocation test and when reproduction of instability symptoms rather than pain is used as a criterion for a positive anterior drawer test, these three tests are valuable examination techniques for diagnosing traumatic anterior shoulder instability. A positive test based on apprehension or reproduction of a sense of instability increases the chances that the patient has anterior shoulder instability, but these tests have low sensitivity. If there is no radiographic evidence of a dislocation, we do not rely on these examinations alone; we recommend diagnostic arthroscopy for any patient with suspected anterior instability of the shoulder. The presence of pain with these tests should not be used as a criterion for the diagnosis of traumatic anterior instability. Finally, laxity testing of the shoulder with an anterior drawer test can be a valuable diagnostic tool in the office setting for patients who can relax enough for the test to be performed.

Appendix

eA A table showing diagnostic values of tests for anterior shoulder instability as reported in the literature is available with the electronic versions of this article, on our web site at jbjs.org (go to the article citation and click on "Supplementary Material") and on our quarterly CD-ROM (call our subscription department, at 781-449-9780, to order the CD-ROM). ■

Adam J. Farber, MD
Renan Castillo, MS
Mark Clough, MD
Michael Bahk, MD
Edward G. McFarland, MD
c/o Elaine P. Henze, Medical Editor, Department of Orthopaedic Surgery, Johns Hopkins Bayview Medical Center, 4940 Eastern Avenue, #A672, Baltimore, MD 21224. E-mail address for E.P. Henze: ehenze1@jhmi.edu

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