Physical Examination for Partial Tears of the Biceps Tendon

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Background: The accuracy of the physical examination for tears of the long head of the biceps remains controversial.

Purpose: The goals were 1) to characterize the occurrence of partial tears of the long head of the biceps tendon in a group of consecutive patients, and 2) to analyze the diagnostic value of various clinical tests for pathologic lesions of the proximal biceps tendon.

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

Methods: Of 847 consecutive patients who underwent arthroscopic procedures for a variety of shoulder conditions, 40 were found at the time of arthroscopy to have partial biceps tendon tears. The average age of these 24 men and 16 women was 59 years (range, 18-83). Preoperative physical examinations had included 9 commonly used tests for shoulder examination. Statistical analysis included sensitivity, specificity, negative predictive value, positive predictive value, and likelihood ratios for these tests.

Results: The prevalence rate of partial tears was 5% (40/847) of all arthroscopic procedures. The most commonly associated conditions included rotator cuff tears (85% [34/40]) and anterior instability (7.5% [3/40]). Tenderness on palpation of the long head of the biceps tendon had a sensitivity of 53%, a specificity of 54%, and a likelihood ratio of 1.13. The sensitivity, specificity, positive predictive value, negative predictive value, and likelihood ratios for Speed's test were 50%, 67%, 8%, 96%, and 1.51, respectively.

Conclusion: In patients with rotator cuff abnormality, the diagnosis of partial biceps tears cannot be made reliably with existing physical examination tests. Diagnostic arthroscopy is recommended, if clinically indicated, for potential partial tears of the long head of the biceps tendon. The treating physician should be prepared to treat unsuspected tears of the long head of the biceps tendon at the time of surgery.

Keywords: biceps tendon; partial tears; arthroscopy; Speed's test; diagnosis

Biceps tendon lesions have been long recognized as a potential source of shoulder pain.[15,16,47] Partial tears of the long head of the biceps were first described in 1934 by Gilcreest.[15] He coined the term "common bicipital syndrome" for a variety of pathologic lesions affecting the long head of the biceps tendon, including partial or complete ruptures, dislocation of the tendon, or elongation of the long head of the biceps. He found that these partial ruptures were one of the most difficult disease entities in the shoulder to diagnose and that the pain they produced was similar to that produced by the arthritic shoulder.

Subsequently, numerous studies have suggested that partial tears of the biceps tendon can be a frequent finding in the painful or stiff shoulder.[1,4,7,9,19,27,38] Biceps tendon lesions frequently have been found to be associated with subacromial impingement and rotator cuff tears.[7,10,19,28,29,35] Making the diagnosis of biceps tendon injury is important because the use of biceps tenotomy or tenodesis to treat biceps lesions has been recommended by many authors.[1,3,8,17,19,35,37,41,44] These procedures can be performed via open or arthroscopic techniques.[1,3,8,12,35,37,44]

However, despite advances in the surgical treatment of biceps tendon injuries, and the multitude of studies describing the use of various tests to make the diagnosis during physical examination, few studies[2,20] have evaluated the sensitivity, specificity, and clinical usefulness of such clinical tests in diagnosing partial biceps tendon tears. Two commonly used techniques for making the diagnosis of biceps tendinitis are Speed's test[7,8,15,34,35] and palpation that elicits tenderness over the bicipital groove.[8,34,35]

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Crenshaw and Kilgore[7] attributed the Speed's test to Dr. J. Spencer Speed of the Campbell Clinic, who apparently would experience anterior shoulder pain when performing a straight leg examination on his patients, which he did with his forearm supinated, his elbow extended, and his arm flexed. Dr. Speed attributed this anterior shoulder pain to the biceps tendon but, to our knowledge, he did not describe the test in the literature. In their original description, Crenshaw and Kilgore[7] stated that they had found the test useful for diagnosing bicipital tenosynovitis.

A review of the English literature revealed that no study has evaluated the role of biceps palpation tenderness in making the diagnosis of biceps tendon tear. Various authors merely state that tenderness directly over the biceps tendon in the groove is pathognomic for biceps injury.[7,8,30,34,35,39] Most studies do not specify whether there were coexisting shoulder lesions in their cohorts.[2,7,8,11,17,19]

The aims of the current study were to characterize the occurrence of partial tears of the biceps tendon in a group of consecutive patients and analyze the diagnostic value of various clinical tests for biceps tendon tears, specifically the value of these tests for partial tears of the biceps tendon where definite injury of the tendon could be shown. The hypothesis was that currently available diagnostic tests used during physical examination for biceps tendon injury do not accurately identify biceps tendon lesions.

METHODS

Patient Population

Between 1994 and 2004, 1175 patients underwent shoulder surgery in the senior author's (E.G.M.) practice. All patients underwent a thorough history and physical examination before surgery, and the information was entered into a database. Of these 1175 patients, 328 were excluded from the study for the following reasons: 181 patients did not undergo arthroscopy (fracture, 46; arthroplasty, 94; revision of surgery performed at this institution, 20; or isolated open procedures for any reason, 21); 85 patients had type II, III, or IV superior labrum anterior and posterior (SLAP) lesions; 54 patients had undergone previous surgery on the same shoulder; and 8 patients had subluxation or dislocation of the long head of the biceps tendon. Because our study was designed to evaluate the clinical effectiveness of the examination only for partial tears of the biceps tendon and not for a wide variety of biceps injuries, no patient in this study had surgery to repair complete tears of the biceps tendon, SLAP lesions, or biceps dislocations.

Therefore, the study population consisted of 847 patients who underwent diagnostic arthroscopy of the shoulder by the senior author. Informed consent was obtained from all patients, and this study was approved by our Institutional Review Board. These 847 patients were grouped as no biceps tendon tear (807 [95%]) or partial biceps tendon tear (40 [5%]) patients, as defined by the arthroscopic findings (see below). Table 1 lists the demographic details of these 2 groups.

TABLE 1
Demographic Data[a]

	No Tear Group		Partial Tear Group	
Parameter	Number	Percentage	Number	Percentage
Mean age (years)	44[b]	(SD 17.2)	59[b]	(SD 11.8)
Gender				
Male	431	53	24	60
Female	379	47	16	40
Affected side				
Right only	472	60	20	50
Left only	286	36	18	44
Both	31	4	2	6
Dominant	511	65	22	55
Nondominant	274	35	18	45

[a]SD, standard deviation.
[b]The values of the 2 groups are statistically different ($P < .05$).

Physical Examination

All patients underwent a standardized physical examination before surgery. All examinations and procedures were performed by the senior author or under his direct supervision. In all cases, this examination was within 4 weeks of the operative procedure. The demographic data entered into the database included the patient's occupation and sports activity.

Each patient was examined preoperatively for signs of biceps tendon injury. The physical examination included eliciting point tenderness by palpation of the biceps tendon (Figure 1) in the biceps groove 3 to 6 cm below the anterior acromion with the arm in approximately 10° of internal rotation as recommended by Matsen and Kirby.[26] As the arm is moved through an internal-external range of rotation, the area of point tenderness should move with the arc of motion.[8] A positive test result for bicipital groove tenderness was pain elicited in the bicipital groove to deep pressure in the involved shoulder compared with no pain elicited with similar pressure to the bicipital groove of the opposite shoulder.

Speed's test was performed as described in the literature.[5,7,25,30,32,45] With the patient standing with the elbow extended and the forearm in supination, the arm was elevated to 90° and extended slightly horizontally (Figure 2). The patient was asked to resist the downward force applied by the examiner. The test was considered positive when pain was localized to the bicipital groove area in the anterior shoulder.

It has been suggested that the lift-off test of Gerber and Krushell[14] is positive in patients with biceps tendon injury, and Yamaguchi and Bindra[45] suggested that attempting to lift the affected arm off the back might provoke pain or weakness secondary to biceps tendon tear. This test was performed as described by Gerber and Krushell[14] and was considered positive if the patient could not lift the affected hand off the back. To define subscapularis tendon function, the belly press test, as described by Gerber et al,[13] was

Figure 1. Biceps tenderness was elicited by the examiner palpating the bicipital groove area 3 to 6 cm below the anterior acromion with the arm in approximately 10° of internal rotation. The elbow can be flexed and extended to help feel the tendon move under the examiner's finger.

Figure 2. Speed's test performed during a physical examination.

performed by having the patient place the affected hand on the abdomen and attempt to move the elbow anteriorly. The test was considered positive if the patient could not move the elbow forward.

Other tests performed during the physical examination included those typically used to define other pathologic conditions in the shoulder, such as rotator cuff injuries.[7,10,19,21,24,28,29,33] The Neer impingement sign test[29] was performed with the patient in a standing position. The patient's arm was passively elevated in forward flexion until the patient reported pain. This test was considered positive if there was pain into the deltoid or biceps region, anteriorly or laterally. The Kennedy-Hawkins sign test was performed with the patient standing. The affected arm was forward-flexed 90° and then forcibly medially rotated. This test was considered positive if the patient complained of pain into the deltoid or anterior shoulder during the maneuver.[18]

Several tests that have been proposed for making the diagnosis of SLAP lesions were used. The compression rotation test was performed with the patient supine and by elevating the patient's arm 90° and rotating the arm while applying an axial load.[40] The test was positive if the patient reported pain or a click deep in the shoulder. The active compression test[33] was performed with the affected arm slightly adducted and forward-flexed 90°. The patient tried to elevate the arm with the palm up and then with the thumb pointing downward against resistance. Pain in the front of the arm with either maneuver was noted, recorded, and considered positive. The anterior slide test was performed as reported by Kibler.[21] The patient stood with the hand on the hip of the affected side, and the examiner applied an axial load along the humerus. The test was considered positive when this maneuver produced pain or a click.

Arthroscopy

Diagnostic arthroscopy was performed with the patient in a lateral decubitus position and the affected extremity positioned in an arm holder with 10 lbs of traction. Joint distension was provided with a pump set at 80 mm Hg. The arthroscope was introduced through the posterior portal, and an anterior portal was created for probing the labrum, biceps tendon, and other structures. The rotator cuff, biceps, labrum, ligaments, glenoid, and humeral head were thoroughly examined and documented on a surgical data sheet. The biceps tendon was probed by pulling the intra-articular portion of the tendon into the joint so that the intertubercular portion of the tendon could be visualized. An additional 3 to 5 cm of the long head of the biceps tendon could be visualized with this maneuver.[11]

Under direct visualization of the tendon, an estimate was made of the percentage of the width of the tendon that appeared torn[8]: grade I, less than 25% fraying (minor); grade II, 25% to 50% fraying; grade III, more than 50% fraying, but not completely torn; and grade IV, complete rupture. For the current study, a partial tear of the biceps tendon was defined as a partial disruption of some, but not all, of the biceps tendon fibers visible at the time of arthroscopy.

Statistical Analysis

The demographic data, preoperative physical examination findings, and intraoperative findings were analyzed via a standard computer program (SAS Version 8, SAS, Cary, NC). Because the Curtis and Snyder[8] classification resulted in small numbers in the tear subgroups (17 [42.5%] were grade I, 12 [30%] were grade II, and 11 [27.5%] were grade III), data from patients with tears, regardless of grade, were analyzed together statistically as 1 group. Sensitivity, specificity, positive and negative predictive values, diagnostic accuracy, and likelihood ratio were calculated for each of the 9 clinical tests with the 2 × 2 table method (Table 2). The use of likelihood ratios improves the assessment of the clinical utility of test results.[36] A test outcome with a likelihood ratio of 1.0 would not alter the odds of a suspected diagnosis, implying that the test was of no value in changing the initial diagnostic certainty. The test results with higher likelihood ratios are better discriminators of the disease than those with lower values.[36]

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); overall accuracy = (TP +TN)/(TP + FP + FN + TN); likelihood ratio = sensitivity/(1-specificity).

RESULTS

The aims of the current study were to characterize the occurrence of partial tears of the biceps tendon in a group of consecutive patients and analyze the diagnostic value of various clinical tests for biceps tendon injury.

Characteristics

Thirty-three of the 40 partial tears (82.5%) were intraarticular, ie, they occurred within 1.5 to 2 cm of the origin and did not involve the biceps attachment to the labrum or the superior glenoid tubercle. Seven of 40 patients (17.5%) had partial tears of the biceps near the biceps pulley region that extended into the intertubercular region as seen by pulling the long head tendon. In the 40 patients with partial tears, associated conditions included rotator cuff tears (34 patients [85%]), anterior instability (3 patients [7.5%]), impingement without rotator cuff tear (2 patients [5%]), and degenerative arthritis (1 patient [2.5%]).

Compared with the no tear group, the partial tear group had a significantly lower prevalence of instability of the shoulder (P = .03) and significantly more full-thickness rotator cuff tears (P < .0001) (Table 3). In the partial tear group, 34 patients (85%) had associated rotator cuff tears: full-thickness, 23 patients (57.5%); massive, 7 patients (17.5%); and partial, 4 patients (10%). The 23 full-thickness rotator cuff tears were to the supraspinatus alone (13 patients), the supraspinatus and subscapularis (3 patients), all 3 tendons (4 patients), the supraspinatus and infraspinatus (2 patients), and the subscapularis alone (1 patient).

Diagnostic Test Value

Table 4 summarizes the diagnostic values of the 9 clinical tests used for the partial tear group. The Speed's test had a sensitivity of 50%, a specificity of 67%, an accuracy of 66%, and a likelihood ratio of 1.51. None of the other tests had a sensitivity of more than 68% for partial biceps tears. Overall, tenderness on palpation had a sensitivity of 53%, a specificity of 54%, an accuracy of 54%, and a likelihood ratio of 1.13. If the patient had a positive Speed's test and pain with biceps palpation, the combined positive tests yielded a sensitivity of 68%, a specificity of 49%, an accuracy of 59%, and a likelihood ratio of 1.31.

Only the lift-off test and the belly press test had a likelihood ratio of more than 2.0. These 2 tests had low sensitivities (0.28 and 0.17, respectively) but high specificity (0.89 and 0.92, respectively). None of the examinations for rotator cuff disease or for SLAP lesions was specific or sensitive for partial biceps tendon tears.

DISCUSSION

Our study shows that no single physical examination test can accurately predict the presence of a partial tear of the long head of the biceps tendon and highlights the difficulty of assessing the role of the biceps tendon in pain syndromes of the shoulder. One confounding factor is that there is no known pain pattern specific for the biceps tendon. Although biceps tendon pain can radiate down the front of the shoulder, pain into the front of the shoulder can be secondary to a variety of causes, including rotator cuff injury. The only way to determine the relationship between the biceps tendon lesions and the patient pain pattern would be to perform an isolated biceps tenodesis on patients with and without other pathologic conditions. In addition, the demographics of the tear and no tear groups are dissimilar secondary to the retrospective nature of this study.

Many authors[30,35,39,44] have considered tenderness over the bicipital groove to be pathognomic for partial biceps tendon tears. However, we found that local tenderness was not a discriminating test for such tears. Palpation of the biceps tendon can be difficult because it lies deep in the shoulder and is largely covered by other structures. It can be particularly difficult to palpate in obese or heavily muscled subjects. To our knowledge, there has been no study of the use of local injections or other techniques to validate that tenderness along the bicipital groove is attributable to

TABLE 3
Lesions Associated With Partial Biceps Tears

Diagnosis	Prevalence in Combined Tear and No Tear Groups (N = 847)	No. of Patients Without Partial Biceps Tears	No. of Patients With Partial Biceps Tears	Prevalence in Tear Group (N = 40)	*P* Value
Full-thickness cuff tear	0.27	209	23	0.58	< .0001
Massive cuff tear	0.04	26	7	0.18	< .0001
Partial cuff tear	0.12	97	4	0.10	
Impingement without tear	0.13	106	2	0.05	.09
Anterior or anteroinferior instability	0.18	150	3	0.08	.03
Posterior instability	0.02	20	0	0.00	
Idiopathic frozen shoulder	0.04	37	0	0.00	
Acromioclavicular arthritis	0.09	71	1	0.03	
Osteoarthritis	0.01	11	0	0.00	
Superior labrum anterior and posterior (SLAP) lesion, type I	0.01	5	0	0.00	
Osteonecrosis	0.00	2	0	0.00	
Miscellaneous shoulder conditions	0.02	17	0	0.00	
Total	1.00	807	40	1.00	

TABLE 4
Diagnostic Values of Clinical Tests in the Partial Tear Group (40 Patients)[a]

Clinical Tests	Sensitivity	Specificity	PPV	NPV	AC	LR
Biceps palpation	0.53	0.54	0.06	0.95	0.54	1.13
Speed's test	0.50	0.67	0.08	0.96	0.66	1.51
Neer's sign	0.64	0.41	0.05	0.96	0.43	1.09
Hawkins sign	0.55	0.38	0.05	0.94	0.39	0.89
Crank test	0.34	0.77	0.11	0.93	0.74	1.49
Belly press	0.17	0.92	0.24	0.88	0.82	2.01
Active compression palm down	0.68	0.46	0.08	0.95	0.47	1.24
Active compression palm up	0.40	0.57	0.06	0.93	0.56	0.93
Lift-off test	0.28	0.89	0.15	0.95	0.85	2.61
Kibler test	0.23	0.84	0.09	0.94	0.80	1.40

[a]PPV, positive predictive value; NPV, negative predictive value; AC, overall accuracy; LR, likelihood ratio.

the biceps tendon. Our results are consistent with the observations of Nove-Josserand and Walch,[32] who believe that tenderness on palpation of the biceps tendon is not specific for biceps tendon injury.

The literature reports diverse results regarding the clinical usefulness of the Speed's test, which may be related to differences in study methods and inclusion criteria. Holtby and Razmjou[20] evaluated 50 patients with arthroscopy and found that 10 had partial biceps tendon tears. They determined that the Speed's test had a sensitivity of 32%, specificity of 75%, and an accuracy of 56%. Bennett[2] studied 46 shoulders and considered biceps tendon injury to include partial biceps tendon tears, SLAP lesions, and biceps tenosynovitis. Using these inclusion criteria, he found the Speed's test to be highly sensitive (90%) but nonspecific (13.8%) for this variety of biceps tendon lesions. The relationship of SLAP lesions to pain in the anterior shoulder remains controversial,[22] and our study suggests that tests designed to produce tension on the biceps tendon are not helpful for detecting partial tears of the biceps tendon. Pain with the palm up did not increase the accuracy of the active compression test compared with the test with the thumb down, suggesting that rotation of the arm in elevation may not be an important factor in making the diagnosis of biceps injury using this test. A true positive active compression test in which the pain in the shoulder is relieved with the palm up was seen in 7 patients with partial biceps tendon tears. More study is needed to establish the pain patterns of SLAP lesions of the biceps tendon distal to the attachment to the superior glenoid.

Although these tests are believed to produce tension on the long head of the biceps tendon, it has been shown that active shoulder motion does not produce any electrical activity in the biceps muscle.[23,46] Electromyographic studies show that the long head of the biceps muscle does not contract with shoulder motions but, rather, becomes electrically active with elbow flexion and extension.[23,46] For this reason, we did not include the Yergason test in the examination of our patients. A study by Holtby and Razmjou[20] showed that the Yergason test is not accurate in the diagnosis of biceps tendon injury. However, it is possible that these tests produce pain in the biceps mechanism indirectly or through mechanisms not yet established.

Another issue in any study of biceps tendon tears is the existence of other pathologic conditions. In our study, all patients with partial biceps tendon tears also had other lesions. Bennett[2] suggested that a positive Speed's test could be found with a variety of conditions, including anterior instability, a tight posterior capsule, and impingement disease. Ideally, a study of partial biceps tears would include patients with isolated biceps tendon injury; however, to our knowledge, no such study exists. The association between biceps tendon lesions and rotator cuff lesions has been noted by many authors.[7,10,19,29-31,39] Biceps lesions have been reported to increase with the size of the rotator cuff tear,[31,32,39] a finding confirmed by the current study.

The association between biceps tendon injury and subscapularis tendon tears has been suggested by several studies.[2,42,43] The anatomy of the biceps pulley at the superior bicipital groove includes a contribution of fibers from the anterior fascial sheath, which may explain the association between partial biceps tears and subscapularis dysfunction.[6] We found that there was a higher likelihood of a partial biceps tendon tear in patients with a positive lift-off test. This finding most likely reflects an association between these 2 entities that seems to be independent of the generation of symptoms by the partial biceps tendon tear. Our results suggest that in the presence of signs of subscapularis dysfunction, the physician should carefully evaluate the biceps tendon during arthroscopic assessment of the joint.

Therefore, the findings of this study suggest that physical examination tests reported as being used for making the diagnosis of partial tears of the biceps tendon should be interpreted with caution when examining a patient for biceps injury either before or after a surgical procedure involving the biceps tendon. When a patient has a positive test for a partial biceps tendon tear, the surgeon should be aware of coexisting conditions that may need to be addressed.

REFERENCES

1. Becker DA, Cofield RH. Tenodesis of the long head of the biceps brachii for chronic bicipital tendinitis. Long-term results. *J Bone Joint Surg Am*. 1989;71:376-381.
2. Bennett WF. Specificity of the Speed's test: arthroscopic technique for evaluating the biceps tendon at the level of the bicipital groove. *Arthroscopy*. 1998;14:789-796.
3. Berlemann U, Bayley I. Tenodesis of the long head of biceps brachii in the painful shoulder: improving results in the long term. *J Shoulder Elbow Surg*. 1995;4:429-435.
4. Boileau P, Krishnan SG, Coste JS, Walch G. Arthroscopic biceps tenodesis: a new technique using bioabsorbable interference screw fixation. *Arthroscopy*. 2002;18:1002-1012.
5. Burkhead WZ Jr, Arcand MA, Zeman C, Habermeyer P, Walch G. The biceps tendon. In: Rockwood CA Jr, Matsen FA III, Wirth MA, Lippitt SB, eds. *The Shoulder*. 3rd ed. Philadelphia, Pa: WB Saunders; 2004:1059-1119.
6. Clark JM, Harryman DT II. Tendons, ligaments, and capsule of the rotator cuff. Gross and microscopic anatomy. *J Bone Joint Surg Am*. 1992;74:713-725.
7. Crenshaw AH, Kilgore WE. Surgical treatment of bicipital tenosynovitis. *J Bone Joint Surg Am*. 1966;48:1496-1502.
8. Curtis AS, Snyder SJ. Evaluation and treatment of biceps tendon pathology. *Orthop Clin North Am*. 1993;24:33-43.
9. DePalma AF, Callery GE. Bicipital tenosynovitis. *Clin Orthop Relat Res*. 1954;3:69-85.
10. Dines D, Warren RF, Inglis AE. Surgical treatment of lesions of the long head of the biceps. *Clin Orthop Relat Res*. 1982;164:165-171.
11. Favorito PJ, Harding WG, III, Heidt RS Jr. Complete arthroscopic examination of the long head of the biceps tendon. *Arthroscopy*. 2001;17:430-432.
12. Gartsman GM, Hammerman SM. Arthroscopic biceps tenodesis: operative technique. *Arthroscopy*. 2000;16:550-552.
13. Gerber C, Hersche O, Farron A. Isolated rupture of the subscapularis tendon. Results of operative repair. *J Bone Joint Surg Am*. 1996;78:1015-1023.
14. Gerber C, Krushell RJ. Isolated rupture of the tendon of the subscapularis muscle. Clinical features in 16 cases. *J Bone Joint Surg Br.* 1991;73:389-339.
15. Gilcreest EL. The common syndrome of rupture, dislocation and elongation of the long head of the biceps brachii. *Surg Gynecol Obstet*. 1934;58:322-340.
16. Gilcreest EL. Dislocation and elongation of the long head of the biceps brachii: an analysis of six cases. *Ann Surg*. 1936;104:118-138.
17. Gill TJ, McIrvin E, Mair SD, Hawkins RJ. Results of biceps tenotomy for treatment of pathology of the long head of the biceps brachii. *J Shoulder Elbow Surg*. 2001;10:247-249.
18. Hawkins RJ, Kennedy JC. Impingement syndrome in athletes. *Am J Sports Med*. 1980;8:151-158.
19. Hitchcock HH, Bechtol CO. Painful shoulder: observations of the role of the tendon of the long head of the biceps brachii in its causation. *J Bone Joint Surg Am*. 1948;30:263-273.
20. Holtby R, Razmjou H. Accuracy of the Speed's and Yergason's tests in detecting biceps pathology and SLAP lesions: comparison with arthroscopic findings. *Arthroscopy*. 2004;20:231-236.
21. Kibler WB. Specificity and sensitivity of the anterior slide test in throwing athletes with superior glenoid labral tears. *Arthroscopy*. 1995;11:296-300.
22. Kim TK, Rauh PB, McFarland EG. Partial tears of the subscapularis tendon found during arthroscopic procedures on the shoulder: a statistical analysis of sixty cases. *Am J Sports Med*. 2003;31:744-750.
23. Levy AS, Kelly BT, Lintner SA, Osbahr DC, Speer KP. Function of the long head of the biceps at the shoulder: electromyographic analysis. *J Shoulder Elbow Surg*. 2001;10:250-255.
24. Liu SH, Henry MH, Nuccion SL. A prospective evaluation of a new physical examination in predicting glenoid labral tears. *Am J Sports Med*. 1996;24:721-725.
25. Magee DJ. Shoulder. In: Magee DJ, ed. *Orthopedic Physical Assessment*. 4th ed. Philadelphia, Pa: WB Saunders; 2002:207-319.
26. Matsen FA III, Kirby RM. Office evaluation and management of shoulder pain. *Orthop Clin North Am*. 1982;13:453-475.
27. Meyer AW. Spontaneous dislocation and destruction of long head of biceps brachii. Fifty-nine instances. *Arch Surg*. 1928;17:493-506.
28. Murthi AM, Vosburgh CL, Neviaser TJ. The incidence of pathologic changes of the long head of the biceps tendon. *J Shoulder Elbow Surg*. 2000;9:382-385.
29. Neer CS II. Anterior acromioplasty for the chronic impingement syndrome in the shoulder: a preliminary report. *J Bone Joint Surg Am*. 1972;54:41-50.
30. Neviaser RJ. Lesions of the biceps and tendinitis of the shoulder. *Orthop Clin North Am*. 1980;11:343-348.
31. Neviaser TJ, Neviaser RJ, Neviaser JS, Neviaser JS. The four-in-one arthroplasty for the painful arc syndrome. *Clin Orthop Relat Res*. 1982;163:107-112.
32. Nove-Josserand L, Walch G. Long biceps tendon. In: Wulker N, Mansat M, Fu FH, eds. *Shoulder Surgery: An Illustrated Textbook*. London: Martin Dunitz; 2001:243-259.
33. O'Brien SJ, Pagnani MJ, Fealy S, McGlynn SR, Wilson JB. The active compression test: a new and effective test for diagnosing labral tears

and acromioclavicular joint abnormality. *Am J Sports Med*. 1998; 26:610-613.
34. Patton WC, McCluskey GM III. Biceps tendinitis and subluxation. *Clin Sports Med*. 2001;20:505-529.
35. Post M, Benca P. Primary tendinitis of the long head of the biceps. *Clin Orthop Relat Res*. 1989;246:117-125.
36. Radack KL, Rouan G, Hedges J. The likelihood ratio. An improved measure for reporting and evaluating diagnostic test results. *Arch Pathol Lab Med*. 1986;110:689-693.
37. Romeo AA, Mazzocca AD, Tauro JC. Arthroscopic biceps tenodesis. *Arthroscopy*. 2004;20:206-213.
38. Schrager VL. Tenosynovitis of the long head of the biceps humeri. *Surg Gynecol Obstet*. 1938;66:785-790.
39. Sethi N, Wright R, Yamaguchi K. Disorders of the long head of the biceps tendon. *J Shoulder Elbow Surg*. 1999;8:644-654.
40. Snyder SJ, Karzel RP, Del Pizzo W, Ferkel RD, Friedman MJ. SLAP lesions of the shoulder. *Arthroscopy*. 1990;6:274-279.
41. Walch G, Madonia G, Pozzi I, Riand N, Levigne C. Arthroscopic tenotomy of the long head of the biceps in rotator cuff ruptures. In: Gazielly DF, Gleyze P, Thomas T, eds. *The Cuff*. New York, NY: Elsevier; 1997:350-355.
42. Walch G, Nove-Josserand L, Boileau P, Levigne C. Subluxations and dislocations of the tendon of the long head of the biceps. *J Shoulder Elbow Surg*. 1998;7:100-108.
43. Warner JJP, Higgins L, Parsons IM IV, Dowdy P. Diagnosis and treatment of anterosuperior rotator cuff tears. *J Shoulder Elbow Surg*. 2001;10:37-46.
44. Warren RF. Lesions of the long head of the biceps tendon. *Instr Course Lect*. 1985;34:204-209.
45. Yamaguchi K, Bindra R. Disorders of the biceps tendon. In: Iannotti JP, Williams GR, Jr, eds. *Disorders of the Shoulder: Diagnosis and Management*. Philadelphia, Pa: Lippincott Williams & Wilkins; 1999:159-190.
46. Yamaguchi K, Riew KD, Galatz LM, Syme JA, Neviaser RJ. Biceps activity during shoulder motion: an electromyographic analysis. *Clin Orthop Relat Res*. 1997;336:122-129.
47. Yergason RM. Supination sign. *J Bone Joint Surg*. 1931;13:160.