Are Pain Location and Physical Examinations Useful in Locating a Tear Site of the Rotator Cuff?

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Background: Pain is the most common symptom of patients with rotator cuff tendinopathy, but little is known about the relationship between the site of pain and the site of cuff pathologic lesions. Also, accuracies of physical examinations used to locate a tear by assessing the muscle strength seem to be affected by the threshold for muscle weakness, but no studies have been reported regarding the efficacies of physical examinations in reference to their threshold.

Hypothesis: Pain location is useful in locating a tear site. Efficacies of physical examinations to evaluate the function of the cuff muscles depend on the threshold for muscle weakness.

Study Design: Case series; Level of evidence, 4.

Methods: The authors retrospectively reviewed the clinical charts of 160 shoulders of 149 patients (mean age, 53 years) with either rotator cuff tears (140 shoulders) or cuff tendinitis (20 shoulders). The location of pain was recorded on a standardized form with 6 different areas. The diagnostic accuracies of the following tests were assessed with various thresholds for muscle weakness: supraspinatus test, the external rotation strength test, and the lift-off test.

Results: Lateral and anterior portions of the shoulder were the most common sites of pain regardless of existence of tear or tear location. The supraspinatus test was most accurate when it was assessed to have positive results with the muscle strength less than manual muscle testing grade 5, whereas the lift-off test was most accurate with a threshold less than grade 3. The external rotation strength test was most accurate with a threshold of less than grade 4+.

Conclusion: The authors conclude that pain location is not useful in locating the site of a tear, whereas the physical examinations aiming to locate the tear site are clinically useful when assessed to have positive results with appropriate threshold for muscle weakness.

Keywords: physical examination; pain; rotator cuff tendinitis; rotator cuff tear

Rotator cuff tendinopathy (tendinitis and tear) is a common shoulder disease. Magnetic resonance imaging is the gold standard to visualize the existence of a tear and its location.[11,24] Ultrasonography may be a solution to save cost and time.[9,22] Without these imaging modalities, how accurately are we able to estimate the existence and location of a tear just from the signs and symptoms of patients? Pain is the most common initial symptom about the shoulder.[18] Pain from the acromioclavicular joint is often observed above the acromioclavicular joint, as well as in the lateral neck and lateral portion of the shoulder.[4,32] Also, pain caused by the long head of the biceps tendon is usually localized in the anterior part of the proximal humerus.[1] These pains are location specific. However, little is known about pain in reference to the location of a cuff tear. Like pain from the acromioclavicular joint and pain from the long head of the biceps tendon, we hypothesized that pain observed in patients with cuff tendinopathy was location specific. The first purpose of this study was to determine the relationship between the location of pain and location of cuff tears. Another method of locating a cuff tear in the examination room is to use various physical examinations introduced to estimate the function of each of the rotator cuff muscles. Commonly used are the supraspinatus test for a supraspinatus tendon tear,[15,16] the external rotator strength test for an infraspinatus tendon tear,[17,18] and the lift-off test for a subscapularis tendon tear.[6] The

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supraspinatus test, also known as an empty can test, was first introduced by Jobe and Moynes.[16] They reported that the function of the supraspinatus muscle could be isolated to some degree with the arm in 90° of elevation in the scapular plane (scaption) and in full internal rotation (empty can). Muscle testing against resistance in this position demonstrates a weakness secondary to a tear of the supraspinatus tendon or pain associated with rotator cuff impingement.[15] Kelly et al[17] later reported a modified version of this test (full can test) to reduce pain during the test. The interpretation of this test was somewhat controversial. Some interpreted this test as having a positive result when there was weakness or pain[14,23] or when there was weakness and/or pain,[3] whereas others recognized this test as a pure manual muscle test (MMT).[10,17] Comparing the full can and empty can tests, Itoi et al[12] recommended that both tests be interpreted by muscle weakness. The question is how much weakness should be interpreted as muscle weakness. In their report, muscle weakness was defined as grade 4 or less in MMT. In other words, grade 4+ and grade 5– were interpreted as normal. Interpretation of muscle weakness (threshold) seems to affect the sensitivity, specificity, and accuracy of these tests. However, it is not clear at this moment which grade of MMT is to be used to define muscle weakness. On the other hand, the lift-off test detects the ability to lift the hand off the back, which requires the strength of at least MMT grade 2. In other words, only those with less than grade 2 strength are detectable with this test. This test is thought but not proved to be further refined by having the patient resist in the lift-off position to provide a quantitative estimate of subscapularis strength.[17,18] In this way, physical examinations seem to be dependent on the threshold of muscle weakness interpreted as abnormal, but no studies have been reported in the literature clarifying this relationship. We hypothesized that there was a threshold for muscle weakness in each physical examination to make the test most accurate. The second purpose of this study, therefore, was to determine the most appropriate threshold for muscle weakness during the supraspinatus test, external rotation strength test, and the lift-off test to achieve the highest performance of these tests in detecting cuff injury.

MATERIALS AND METHODS

Patients

Between January 2000 and December 2004, we used a standardized form to prospectively collect the data regarding signs and symptoms of shoulder patients at our clinic (see the Appendix). The charts of patients with rotator cuff injuries were retrospectively analyzed for this study. There were 160 shoulders of 149 patients whose mean age was 53 years (range, 16-86 years). The definitive diagnoses were made based on arthroscopic findings. All patients had a passive range of elevation at least 90° or greater. The range of motion in external rotation was more than 0° in all the shoulders, and that of internal rotation was more than the sacrum level in all the shoulders but 1. Cuff tendinitis was diagnosed when all 3 criteria were met: (1) a positive painful arc during active elevation, (2) a positive impingement test result (pain caused by impingement maneuver that disappeared after subacromial injection of local anesthetics), and (3) no detectable tears of the rotator cuff on arthroscopic examination. There were 20 shoulders with rotator cuff tendinitis and 140 shoulders with rotator cuff tears (95 full-thickness tears and 45 partial-thickness tears). Rotator cuff tears involved the supraspinatus tendon in 130 shoulders, the infraspinatus tendon in 80 shoulders, and the subscapularis tendon in 28 shoulders. There were 54 shoulders with 1-tendon tears (44 supraspinatus tears, 5 infraspinatus tears, 5 subscapularis tears), 67 shoulders with 2-tendon tears (63 supraspinatus + infraspinatus tears, 4 supraspinatus + subscapularis tears), and 19 shoulders with 3-tendon tears. Arthroscopic examination revealed concomitant injuries other than cuff tendinopathy: 12 superior labral anterior posterior lesions (11 type II and 1 type VI) and 22 lesions of the long head of the biceps (10 partial tears, 5 complete tears, 5 dislocations, and 2 subluxations). All 22 shoulders with pathologic abnormalities of the long head of the biceps had rotator cuff tears (15 massive tears), and 18 of them involved the subscapularis tendon. There were neither acromioclavicular joint lesions nor osteoarthritis of the glenohumeral joint.

Pain Location

Pain was assessed using 6 areas around the shoulder: anterior, lateral, posterior, superior, central, and distal (Figure 1). The examiner recorded the pain area that the patient indicated on his or her body. If a patient felt pain in more than one area, all the areas the patient indicated were recorded. The pain location was recorded separately for motion pain, rest pain, and night pain by a single examiner (E.I.) for all the patients.

Physical Examinations

The full can test[17] and empty can test[16] were performed to assess the function of the supraspinatus muscle. For each test, the muscle strength was determined by MMT graded from 0 to 5: 5, normal amount of resistance to applied force; 4, lesser amount of resistance than 5 but greater than 3; 3, ability to move the segment (the arm) through its range of motion against gravity; 2, ability to move the segment through its range of motion with decreased gravity; 1, presence of a contraction in the muscle without joint motion; 0, no muscle contraction.[2] Each grade was further divided by adding "+" or "–" (eg, 4+, 3–). The external rotation strength with the arm at the side was measured and recorded to assess the function of the infraspinatus muscle.[2] Also, the strength to lift the hand off the back was recorded to assess the function of the subscapularis muscle.[6] We performed this test when a patient could reach the sacral region or above. This test was feasible in all the patients except 1 patient who could reach only the buttock level because of restricted motion of internal rotation. This patient was excluded from the analysis of the lift-off test for the

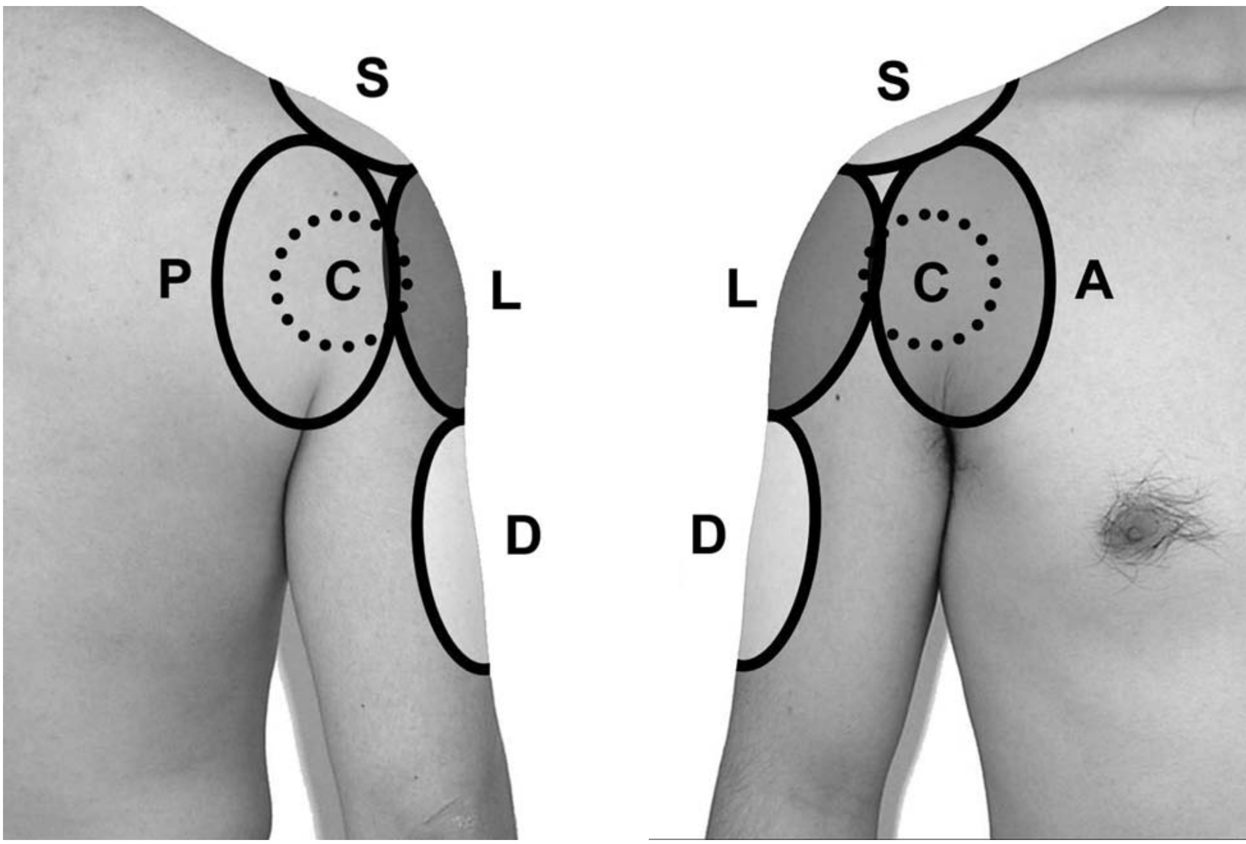

Figure 1. Location of pain. The shoulder was divided into 6 areas: anterior (A), lateral (L), posterior (P), superior (S), central (C), and distal (D) (arm).

subscapularis tendon tears. During these physical examinations, we recorded not only the MMT grading but also the presence or absence of pain. All the physical examinations were performed by a single examiner. We evaluated the intraobserver reliability of MMT grading in another series of 184 patients whose abduction strength was measured both by MMT and by an isometric dynamometer (Isobex 2.0, Veribor, Germany). The intraobserver correlation coefficient was 0.712.

Data Analysis

The frequency of pain was compared between the motion pain, rest pain, and night pain for each rotator cuff diagnosis using the Cochran *Q* test because the frequencies were compared between the dependent samples. The frequencies of pain in those with torn supraspinatus tendons and those with intact supraspinatus tendons were compared with use of the χ^2 test because they represented the independent samples. The same method was used for the infraspinatus and subscapularis tendons.

We defined muscle weakness at various grades of MMT. First, we defined only MMT grade 5 as normal and all others less than grade 5 as muscle weakness. Then, we gradually lowered the threshold from grade 5 all the way down to grade 3 (ie, grades 4+, 4, 3+, and 3). For the lift-off test, we further lowered the threshold down to grade 2 because the lift-off test without resistance detects the muscle strength less than grade 2.[6] We calculated the sensitivity, specificity, and accuracy of each examination for corresponding cuff diagnosis. Sensitivity is defined as the percentage of times that the test has a positive result in patients who have the pathologic entity (ie, the supraspinatus tear). It was calculated by dividing the number of true-positive results by the total number of true-positive and false-negative results. Specificity is defined as the percentage of times that the test has a negative result in patients who do not have the pathologic entity. It was calculated by dividing the number of true-negative results by the total number of true-negative and false-positive results. Accuracy is defined as the percentage of times that the test has a positive result in patients with the lesion and that the test has a negative result in patients without the lesion. It was calculated by dividing the number of true-positive and true-negative results by the total number of results. We assessed the test as having a positive result when (1) the examination induced pain regardless of muscle weakness or (2) there was muscle weakness as defined above regardless of pain. Sensitivity, specificity, and accuracy of these 4 or 5 different thresholds of muscle weakness were compared with use of the Cochran *Q* test because these parameters represented

TABLE 1
Pain Location and Cuff Tendinitis/Supraspinatus Tear

	Pain Location											
	Anterior		Lateral		Posterior		Superior		Central		Distal	
	n	%	n	%	n	%	n	%	n	%	n	%
Cuff tendinitis (n = 20)												
Motion pain	8	40	9	45	1	5	4	20	2	10	1	5
Rest pain	2	10	4	20	1	5	1	5	0	0	1	5
Night pain	2	10	3	15	0	0	0	0	2	10	1	5
P^a	.0058		.0119		.6065		.0388		.1354		–	
Torn supraspinatus tendon (n = 130)												
Motion pain	67	52	70	54	9	6.9	8	6.2	3	2.3	3	2.3
Rest pain	41	32	38	29	4	3.1	6	4.6	1	0.8	1	0.8
Night pain	46	35	44	34	9	6.9	7	5.4	2	1.5	6	4.6
P^a	< .0001		< .0001		.1462		.7613		.5488		.0663	
Intact supraspinatus tendon (n = 30)												
Motion pain	13	43	13	43	3	10	5	17	3	10	1	3.3
Rest pain	4	13	6	20	3	10	2	6.7	1	3.3	2	6.7
Night pain	5	17	5	17	2	6.7	0	0	2	6.7	2	6.7
P^a	.0013		.0018		.6065		.0224		.3679		.3679	
Comparison between torn and intact supraspinatus tendons (P values)[b]												
Motion pain	.4158		.2967		.5630		.0577		.0458		.7429	
Rest pain	.0458		.3050		.0915		.6412		.2521		.0319	
Night pain	.0475		.0660		.8042		.1907		.1018		.6412	

[a]Cochran Q test.
[b]χ^2 test.

dependent samples. For the supraspinatus test, the sensitivity, specificity, and accuracy were compared between the full can test and empty can test using the McNemar test because these parameters represented dependent samples. The statistical significance was set at the 5% level.

RESULTS

Pain Location

Motion pain was significantly more common than was rest pain or night pain in the anterior and lateral regions of the shoulder. This finding was true in shoulders with cuff tendinitis ($P < .0119$) and shoulders with torn rotator cuffs ($P < .0183$). Regarding pain in the anterior area, rest pain and night pain were more commonly observed in shoulders with torn supraspinatus tendons than in those with intact supraspinatus tendons ($P < .0475$). On the other hand, central motion pain ($P = .0458$) and distal rest pain ($P = .0319$) were less commonly observed in shoulders with rotator cuff tears. In shoulders with cuff tendinitis, the most common location of pain was the lateral region (45%) followed by the anterior region (40%). In shoulders with rotator cuff tears, the lateral and anterior regions were also the most common location of pain regardless of tear site (54% and 52% for supraspinatus tendon tears, 59% and 50% for infraspinatus tendon tears, and 50% and 54% for subscapularis tendon tears, respectively). From these findings, the existence of tear and the location of tear did not influence the location of pain in this series of patients with cuff tendinopathy (see Tables 1 and 2).

Physical Examinations

In the assessment of supraspinatus tendon tears (Table 3), the full can test had a sensitivity of 80%, specificity of 50%, and accuracy of 74% when assessing the provocation of pain as positive. The empty can test also had similar values: sensitivity of 78%, specificity of 40%, and accuracy of 71%. There were no significant differences between these tests when assessed by the provocation of pain. Assessing the test with muscle weakness, both the full can test and empty can test showed the highest accuracies (78% for the full can test and 79% for the empty can test) when muscle weakness was defined as MMT less than grade 5. The lower the threshold of muscle weakness, the lower the sensitivity and the higher the specificity. Accordingly, the lower the threshold, the lower the accuracies for both tests ($P < .0001$). Here again, there were no significant differences in the accuracies between these 2 tests.

For the assessment of infraspinatus tendon tears (Table 4), the external rotation strength test showed an accuracy of 50% using pain and between 58% and 74% using muscle weakness. In this test, the accuracy was the highest

TABLE 2
Pain Location and Infraspinatus Tear/Subscapularis Tear

	Anterior n	Anterior %	Lateral n	Lateral %	Posterior n	Posterior %	Superior n	Superior %	Central n	Central %	Distal n	Distal %
Torn infraspinatus tendon (n = 80)												
Motion pain	40	50	47	59	7	8.8	6	7.5	2	2.5	1	1.3
Rest pain	22	28	25	31	3	3.8	6	7.5	2	2.5	1	1.3
Night pain	25	31	29	36	6	7.5	4	5.0	1	1.3	5	6.3
P^a	< .0001		< .0001		.1969		.5647		.7165		.0695	
Intact infraspinatus tendon (n = 80)												
Motion pain	40	50	36	45	5	6.3	7	8.8	4	5.0	3	3.8
Rest pain	23	29	19	24	4	5.0	2	2.5	0	0	2	2.5
Night pain	26	33	20	25	5	6.3	3	3.8	3	3.8	3	3.8
P^a	.0001		< .0001		.8669		.0970		.0743		.6065	
Torn subscapularis tendon (n = 28)												
Motion pain	15	54	14	50	1	3.6	1	3.6	0	0	0	0
Rest pain	9	32	8	29	1	3.6	2	7.1	0	0	0	0
Night pain	8	29	8	29	1	3.6	0	0	0	0	1	3.6
P^a	.0136		.0183		–		.2231		–		.3679	
Intact subscapularis tendon (n = 132)												
Motion pain	65	49	69	52	11	8.3	12	9.1	6	4.5	4	3.0
Rest pain	36	27	36	27	6	4.5	6	4.5	2	1.5	3	2.3
Night pain	43	33	41	31	10	7.6	7	5.3	4	3.0	7	5.3
P^a	< .0001		< .0001		.2466		.1092		.2231		.1561	
Comparison between torn and intact infraspinatus tendons (P values)^b												
Motion pain	1.0		.0821		.5477		.7712		.4039		.3086	
Rest pain	.8608		.2854		.7496		.1437		.1516		.5585	
Night pain	.8697		.1196		.7197		.6986		.3086		.4662	
Comparison between torn and intact subscapularis tendons (P values)^b												
Motion pain	.6775		.8265		.3826		.3293		.2476		.3482	
Rest pain	.6013		.8898		.8166		.5652		.5097		.4186	
Night pain	.6792		.7954		.4451		.2099		.3482		.7023	

[a]Cochran Q test.
[b]χ^2 test.

(74%) when muscle weakness was defined as MMT less than grade 4+ ($P = .0044$).

For the assessment of subscapularis tendon tears (Table 4), the accuracy of the lift-off test was 65% when assessed by pain and between 62% and 85% when assessed by muscle weakness. Contrary to the full can and empty can tests, the lower the threshold for muscle weakness, the higher the accuracy ($P < .0001$). The accuracy was almost the same when muscle weakness was defined as MMT less than grade 3 (85%) and less than grade 2 (lift-off test without resistance; 84%).

DISCUSSION

Pain location was mainly the lateral and anterior portions of the shoulder. We could not find any influence of tear location on pain location. This finding is probably because the pain observed in shoulders with rotator cuff tears most likely is associated with subacromial bursitis. Free nerve endings are more richly supplied in the subacromial bursa than in the rotator cuff tendon proper.[26] Injection of hypertonic saline solution into the subacromial bursa causes pain in the anterior and lateral portions of the deltoid.[4] This location was exactly where the patients with rotator cuff tendinopathy in our series indicated as the most common site of pain. Therefore, it is likely that pain observed in patients with rotator cuff tendinopathy is related to the subacromial bursa, not to the site of tear. This theory might also explain why a subacromial injection of steroid will reduce pain in a patient with a rotator cuff tear. In any event, this study clearly showed that location of pain was not useful in locating a lesion of the rotator cuff.

Both the full can test and the empty can test showed higher accuracy when assessed with muscle weakness (78% and 79%, respectively) than when assessed with pain (74% and 71%, respectively). This finding coincides with findings of the previous report.[12] The present study further demonstrated that the higher the threshold for muscle

TABLE 3
Physical Examinations for Torn Supraspinatus Tendon

	Sensitivity (n = 130)		Specificity (n = 30)		Accuracy (n = 160)	
	n	%	n	%	n	%
Supraspinatus tendon tear						
Full can test						
Pain	104	80	15	50	119	74
Muscle weakness						
< Grade 5	108	83	16	53	124	78
< Grade 4+	94	72	21	70	110	69
< Grade 4	72	55	26	87	98	60
< Grade 3+	48	37	28	93	76	48
< Grade 3	8	6.2	30	100	38	24
P^a	< .0001		< .0001		< .0001	
Empty can test						
Pain	101	78	12	40	113	71
Muscle weakness						
< Grade 5	113	87	13	43	126	79
< Grade 4+	96	74	21	70	117	73
< Grade 4	80	62	24	80	104	65
< Grade 3+	55	42	26	87	81	51
< Grade 3	12	9.2	30	100	42	26
P^a	< .0001		< .0001		< .0001	
Comparison between full can and empty can tests[b]						
Pain	.6268		.4482		.3050	
Muscle weakness						
< Grade 5	.1275		.2459		.7519	
< Grade 4+	.7217		.4778		.1182	
< Grade 4	.1144		.4778		.2838	
< Grade 3+	.0707		.4778		.2647	
< Grade 3	.1304		–		.1304	

[a]Cochran *Q* test.
[b]McNemar test.

weakness, the higher the accuracy of these tests. In other words, it appears best to use any detectable degree of weakness as the criterion for judging a positive test result. Leroux et al[21] reported that the supraspinatus test had high sensitivity (86%) and low specificity (50%). These values were quite similar to the ones in our study when muscle weakness was defined as MMT less than grade 5 (83% and 53% for full can test and 87% and 43% for empty can test, respectively). Although they did not define the threshold for muscle weakness, we assume that they used the highest threshold (MMT less than grade 5), judging from the similarity in the values of sensitivity and specificity. As far as the supraspinatus test is concerned, any detectable decrease in muscle strength should be interpreted as abnormal.

Itoi et al[12] compared the efficacy of the full can test and empty can test in detecting rotator cuff tears. They concluded that the full can test might be a little better than the empty can test in terms of accuracy and pain provocation, although the differences did not reach the statistically significant level. The electromyographic activities of the supraspinatus muscle in both the full can and empty can tests were similar.[17] Also, the activities of the supraspinatus muscle measured by T2 relaxation time on MRI were similar during these tests.[27] In the present study, the full can and empty can tests showed no significant difference in pain provocation and in accuracy at its highest level. Judging from these results, both tests seem to be equally useful.

The supraspinatus test is thought to be best in isolating the function of the supraspinatus muscle.[16,17] During the empty can test, the supraspinatus muscle fires 74% of the maximum voluntary contraction (MVC).[29] However, significant contraction is also observed in the anterior and middle deltoid muscles (72% and 83% of MVC, respectively) as well as the subscapularis muscle (62% of MVC). We can calculate a theoretical contribution of each muscle to the entire shoulder elevation torque during the empty can test using the data of moment arms[19] and physiologic cross-sectional areas.[30] The calculated contribution is 77% for the deltoid muscle, 13% for the subscapularis muscle, and only 10% for the supraspinatus muscle. Patients with isolated tears of the supraspinatus tendon show 19% to 24% loss of abduction torque after pain elimination.[13] From these

TABLE 4
Physical Examinations for Torn Infraspinatus and Subscapularis Tendons

	Sensitivity		Specificity		Accuracy	
	n	%	n	%	n	%
Infraspinatus tendon tear						
External rotation strength test	n = 80		n = 80		n = 160	
Pain	37	54	43	54	80	50
Muscle weakness						
< Grade 5	67	84	42	53	109	68
< Grade 4+	62	78	56	70	118	74
< Grade 4	45	56	67	84	112	70
< Grade 3+	34	43	72	90	106	66
< Grade 3	13	16	80	100	93	58
P^a	< .0001		< .0001		< .0044	
Subscapularis tendon tear						
Lift-off test	n = 28		n = 131		n = 159	
Pain	13	46	91	69	104	65
Muscle weakness						
< Grade 5	22	79	77	59	99	62
< Grade 4+	21	75	84	64	105	66
< Grade 4	11	39	111	85	122	76
< Grade 3+	11	39	113	86	124	78
< Grade 3	4	14	131	100	135	85
< Grade 2	2	7.1	131	100	133	84
P^a	< .0001		< .0001		< .0001	

[a]Cochran Q test.

studies, we know that the major elevator is still the deltoid muscle, and the contribution of the supraspinatus muscle to shoulder elevation is quite limited. In cases with deltoid weakness caused by lesions other than rotator cuff tears, a false-positive result is expected to occur. On the other hand, in cases with a very strong deltoid muscle, MMT may not reveal muscle weakness caused by a supraspinatus tear, and a false-negative result is expected to occur. Under these circumstances, 78% to 79% of accuracy is well acceptable as a useful clinical test at community setting.

The external rotation strength test also showed higher accuracy when assessed using muscle strength than when using pain. Different from the supraspinatus test, external rotation strength is mainly provided by the infraspinatus and teres minor muscles. The contribution of these muscles to external rotation strength is calculated to be 90% with the arm at the side.[20,29] This finding would suggest that false-positive and false-negative results are less likely to occur. However, the highest accuracy of the external rotation strength test was slightly less than that of the supraspinatus test, and the highest accuracy was observed with the threshold less than grade 4+. We do not know the exact reason. One possible explanation is that the functional loss of the torn infraspinatus tendon is sometimes compensated for by the hypertrophic teres minor muscle.[25,31] In shoulders with combined tears of the supraspinatus and infraspinatus tendons, external rotation strength and shoulder function were better preserved in those with teres minor hypertrophy than in those without.[25] This compensatory change of the teres minor muscle may affect the accuracy of this test.

Similar to the previous tests, the lift-off test also showed higher accuracy when assessed with muscle strength than with pain. The subscapularis muscle is one of the internal rotators. Using the data of electromyography,[7] moment arms,[20] and physiologic cross-sectional areas,[30] contribution of the subscapularis muscle to internal rotation strength is calculated to be approximately 50% with the arm at the side. With the arm in full internal rotation (lift-off position), the contribution of this muscle increases up to almost 90%. This is the reason full internal rotation is chosen as a position to test the function of the subscapularis muscle.[6] We expected that assessing the muscle strength during the lift-off test would further increase the accuracy of this test. Contrary to our expectation, however, the resisted lift-off test showed the highest accuracy with the threshold of MMT less than grade 3, which was almost the same as that of the lift-off test without resistance (original lift-off test). Again, the calculated contribution of the subscapularis muscle to the strength of the resisted lift-off test is approximately 80%, which is slightly less than the lift-off test without resistance (90%). This decrease in relative contribution of the subscapularis muscle occurs because muscles other than the subscapularis muscle are also activated during the lift-off maneuver with resistance. This finding may explain why the accuracy of the resisted lift-off test was not higher than that of the lift-off test without resistance.

This is the first study to demonstrate that the location of pain is not useful in detecting a cuff tear or locating a tear. Also, this is the first study to compare the physical examinations using different thresholds for muscle weakness. One may argue that a dynamometer is more accurate and objective than is MMT. That is true. However, contrary to MMT grading done by an examiner, a dynamometer is not always available. We are interested in how much we can assess the shoulder using our own hands, not with a dynamometer or imaging modalities. There were several limitations in this study. First, we prospectively collected patients' data but retrospectively selected only the shoulders with arthroscopic diagnosis of cuff tendinopathy for this study. This factor may have caused a bias in patient selection. Also, we included only those with rotator cuff abnormalities. This component may have affected the sensitivity, specificity, and accuracy of these tests. Second, some shoulders had concomitant lesions of the labrum or the long head of the biceps. In these patients, it may be difficult to state that all the pain was owing to rotator cuff injury. The pain observed in these patients may have been related to these concomitant lesions to some extent. Third, only 1 patient was excluded from the analysis of lift-off test owing to limited range of motion in internal rotation. This exclusion indicates that our inclusion criteria might have been too loose. This factor might have affected the accuracy of the lift-off test. Also, inclusion of shoulders with limited internal rotation might have affected the diagnosis of rotator cuff tendinitis because impingement sign is affected by the limited range of internal rotation.[8] Fourth, there are some other physical examinations that were not included in this study. For example, the belly-press test, which is useful in patients who have limitation in internal rotation,[5] is reported to activate the upper portion of the subscapularis muscle more than the lift-off test.[28] The external rotation lag sign and internal rotation lag sign are reported to be useful in estimating the degree and extent of a tear.[10] These tests had not been included in our clinical chart, and thus, we were unable to assess or compare the efficacies of these tests with the ones presented in this study.

We conclude that in patients with cuff tendinopathy,

1. motion pain is more common than is rest pain or night pain,
2. lateral and anterior portions of the shoulder are the most common locations of pain regardless of tear site, and
3. the supraspinatus test is most accurate when interpreted as positive with MMT less than grade 5, whereas the external rotation strength test is most accurate with MMT less than grade 4+, and the lift-off test is most accurate with MMT less than grade 3.

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APPENDIX

Shoulder Chart[a]

[a]M, male; F, female; R, right; L, left; JOA, Japanese Orthopaedic Association; ADL, activities of daily living; SSP, supraspinatus; ISP, infraspinatus; Delt, deltoid; Trap, trapezius; GT, greater tuberosity; LT, lesser tuberosity; B.groove, bicipital groove; RI, rotator interval; CP, coracoid process; CHL, coracohumeral ligament; ACJ, acromioclavicular joint; QLS, quadrilateral space; SAB, subacromial bursa; ER, external rotation; MMT, manual muscle test; PAS, physical activity score; ROM, range of motion; Flex, flexion; Abd, abduction; Ext, extension; IR, internal rotation.

SHOULDER CHART ***Akita University***

Name______________(M, F) Age______y/
Date of exam : 20___-___-___
Involved side : R, L   Dominant side : R, L   amount/yrs
Occupation : 1 heavy, 2 medium, 3 light, 4 none   tobacco___/___yrs
Date of onset : 20___-___-___, trauma : +, −   alcohol___/___yrs

site   pain scale
Pain : motion pain (: |—|—|—|—|—|—|—|—|—|—|)
(which motion   )
rest pain (: |—|—|—|—|—|—|—|—|—|—|)
night pain (: |—|—|—|—|—|—|—|—|—|—|)

Pain score :   JOA_____

ADL score :

Combing	1 0.5 0,	Knot	1 0.5 0
Mouth	1 0.5 0,	Sleep	1 0.5 0
Side pocket	1 0.5 0,	Axilla	1 0.5 0
Sliding door	1 0.5 0,	Shelf	1 0.5 0
Hygienic	1 0.5 0,	Jacket	1 0.5 0

Muscle atrophy(+,±,−) : SSP ( ), ISP ( ), Delt ( ), Trap ( )
Tenderness (+,±,−) : GT ( ), LT ( ), B.groove ( ), RI ( ),
CP ( ), CHL ( ), ACJ ( ), SSP ( ), ISP ( ), QLS ( )

Delle	(+,±,−)		
SAB effusion	(+,±,−)		
Crepitus	(+,±,−)		
		pain	MMT
SSP test	thumb-up	(+,±,−)	____
	-down	(+,±,−)	____
ER strength	0° abd	(+,±,−)	____
	90° abd	(+,±,−)	____
Lift off test		(+,±,−)	____
Painful arc palm-up	up	(+,±,−)	____°-____°
	down	(+,±,−)	____°-____°
Painful arc palm-down	up	(+,±,−)	____°-____°
	down	(+,±,−)	____°-____°

PAS : Housework____, Job_____, Sports_____.

ROM&MMT	R	L
Flex	________( )	________( )
Abd	________( )	________( )
Ext	________( )	________( )
ER	________( )	________( )
IR	________( )	________( )
ER (abd)	________( )	________( )
IR (abd)	________( )	________( )
Muscle endurance :	5, 3, 1, 0	5, 3, 1, 0
Grip strength :	_______kg	_______kg

Impingement sign :
N-IR (+,±,−), -ER (+,±,−), F-IR (+,±,−), A-IR (+,±,−)

Scapular winging	(+,±,−)
Speed's test	(+,±,−)
Labral lesion	
crank test	(+,±,−)
Mimori test	(+,±,−)
horizontal adduction test	(+,±,−)
ant slide test	(+,±,−)
inf slide test	(+,±,−)
O'Brien sign	(+,±,−)

Laxity :	R	L
ant drawer test	(+,±,−)	(+,±,−)
post drawer test	(+,±,−)	(+,±,−)
sulcus test	(+,±,−)	(+,±,−)
ABIS test	(+,±,−)	(+,±,−)
Instability		
relocation test	(+,±,−)	(+,±,−)
ant apprehension 120°	(+,±,−)	(+,±,−)
90°	(+,±,−)	(+,±,−)
60°	(+,±,−)	(+,±,−)
post apprehension	(+,±,−)	(+,±,−)
post stress test	(+,±,−)	(+,±,−)