The Rational Clinical Examination

Does This Patient With Shoulder Pain Have Rotator Cuff Disease?
The Rational Clinical Examination Systematic Review

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IMPORTANCE Rotator cuff disease (RCD) is the most common cause of shoulder pain seen by physicians.

OBJECTIVE To perform a meta-analysis to identify the most accurate clinical examination findings for RCD.

DATA SOURCES Structured search in MEDLINE, EMBASE, and CINAHL from their inception through May 2013.

STUDY SELECTION For inclusion, a study must have met the following criteria: (1) description of history taking, physical examination, or clinical tests concerning RCD; (2) detailing of sensitivity and specificity; (3) use of a reference standard with diagnostic criteria prespecified; (4) presentation of original data, or original data could be obtained from the authors; and (5) publication in a language mastered by one of the authors (Danish, Dutch, English, French, German, Norwegian, Spanish, Swedish).

MAIN OUTCOMES AND MEASURES Likelihood ratios (LRs) of symptoms and signs of RCD or of a tear, compared with an acceptable reference standard; quality scores assigned using the Rational Clinical Examination score and bias evaluated with the Quality Assessment of Diagnostic Accuracy Studies tool.

RESULTS Twenty-eight studies assessed the examination of referred patients by specialists. Only 5 studies reached Rational Clinical Examination quality scores of level 1-2.The studies with quality scores of level 1-2 included 30 to 203 shoulders with the prevalence of RCD ranging from 33% to 81%. Among pain provocation tests, a positive painful arc test result was the only finding with a positive LR greater than 2.0 for RCD (3.7 [95% CI, 1.9-7.0]), and a normal painful arc test result had the lowest negative LR (0.36 [95% CI, 0.23-0.54]). Among strength tests, a positive external rotation lag test (LR, 7.2 [95% CI, 1.7-31]) and internal rotation lag test (LR, 5.6 [95% CI, 2.6-12]) were the most accurate findings for full-thickness tears. A positive drop arm test result (LR, 3.3 [95% CI, 1.0-11]) might help identify patients with RCD. A normal internal rotation lag test result was most accurate for identifying patients without a full-thickness tear (LR, 0.04 [95% CI, 0.0-0.58]).

CONCLUSIONS AND RELEVANCE Because specialists performed all the clinical maneuvers for RCD in each of the included studies with no finding evaluated in more than 3 studies, the generalizability of the results to a nonreferred population is unknown. A positive painful arc test result and a positive external rotation resistance test result were the most accurate findings for detecting RCD, whereas the presence of a positive lag test (external or internal rotation) result was most accurate for diagnosis of a full-thickness rotator cuff tear.

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Rotator cuff disease (RCD) consists of tendinopathy of 1 or more of the 4 muscles that together form the rotator cuff, full- or partial-thickness tears of these rotator cuff tendons, or bursitis of the subacromial bursa. Subacromial bursitis, tendinopathy, or both can lead to a clinical entity known as subacromial impingement syndrome[1,2] that is often characterized by shoulder pain during abduction of the arm between 60° and 120°. This characteristic, known as a painful arc, suggests a subacromial or rotator cuff disorder.[3] The exact mechanism of injury causing these conditions is unknown, precluding a uniform case definition (eAppendix in Supplement, Mechanisms of Injuries Leading to Rotator Cuff Disease).[4,5]

Clinical Scenarios

In the following cases, the physician wants to determine if the patient has RCD.

Case 1

A 60-year-old cleaning woman with left-sided shoulder pain for some years reports that her shoulder pain worsened during the last few weeks, although she has not sustained apparent trauma. Her left arm is her dominant arm. Despite pain, she abducts her arm to 180° in the scapular plane. With passive arm abduction, her pain begins at about 90°. She has no neck pain, shoulder muscle atrophy or weakness, or sensory deficits in the arm. Her upper extremity reflexes are normal. Her shoulder radiographs show no abnormalities.

Case 2

A 55-year-old man injured his left arm. He uses a sling for this arm and reports difficulties performing simple activities such as brushing his teeth and combing his hair. During a skiing holiday in France 1 week ago, he fell and developed immediate pain in his shoulder. On examination, he is almost unable to move his left arm in any upward or sideways direction without supporting it with his other arm. The radiographs he brought show no signs of shoulder osteoarthritis, dislocation, or fracture.

Why Is This Question Important?

Shoulder pain is the third most common musculoskeletal reason for seeking medical care,[6,7] affecting between 7% and 26% of adults at any time.[8] It results in substantial impact on quality of life[9] and may lead to sick leave in the working population.[10] Rotator cuff disease is the most common cause of shoulder pain seen by physicians. The prevalence of symptomatic RCD increases with age, occurring in about 2.8% of those older than 30 years and in 15% of those older than 70 years.[11,12] In the United States, rotator cuff disorders lead to 4.5 million yearly physician visits.[13] The majority of patients with RCD improve with nonoperative treatment, and some patients with full-thickness rotator cuff tears can compensate to recover function with nonoperative treatment, even though the tear does not heal without surgery.[14] Although smaller tears are less likely to propagate, larger tears tend to progress with time and eventually may become irreparable because of significant tendon retraction, muscle atrophy, or both or when tendon tissue quality does not allow repair.[15]

Anatomy of the Shoulder

Shoulder movement is created by the 4 rotator cuff muscles,[16] the first letters of which form the mnemonic SITS: supraspinatus, infraspinatus, teres minor, and subscapularis (**Figure 1**A). The supraspinatus muscle initiates abduction; the infraspinatus initiates external rotation; the teres minor initiates external rotation and some adduction; and the subscapularis initiates adduction and internal rotation (Figure 1B).[17] Movement in the shoulder joint is facilitated by a subacromial bursa that lies just above the supraspinatus muscle.[18] In addition to its role in shoulder movement, the rotator cuff plays a significant role in stabilizing the glenohumeral joint.[17,19]

Of all joints, the shoulder has the widest range of motion. The small concave glenoid fossa that supports the large humeral head allows this wide range of motion (Figure 1A).The shoulder consists of 3 bony structures: the scapula, including the coracoid process and acromion; the clavicle; and the humerus. Motion of the upper arm is the result of simultaneous motions in the glenohumeral joint, the acromioclavicular joint, the sternoclavicular joint, and the scapulothoracic junction (Figure 1A).

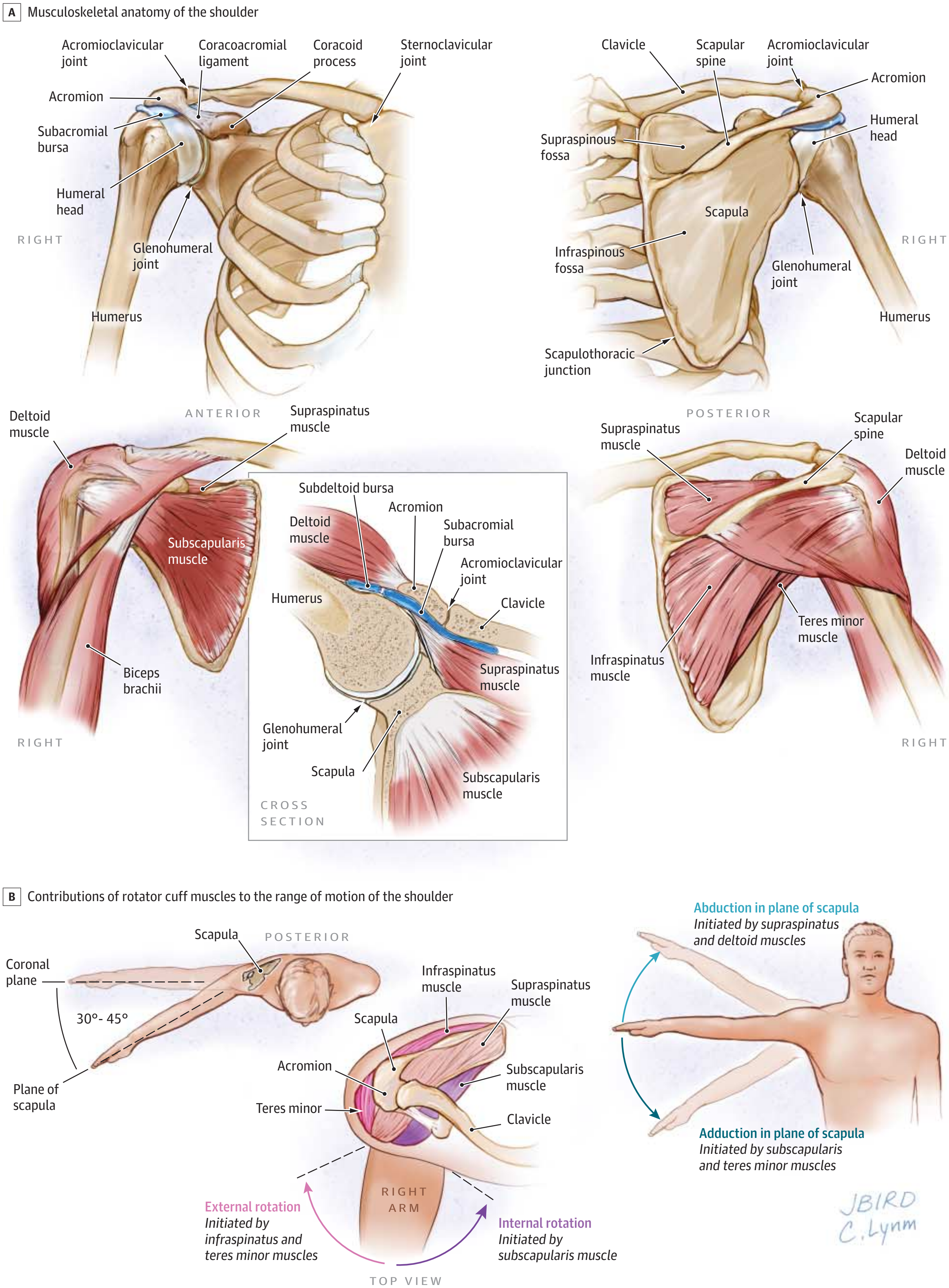
Clinical Presentation

The clinical evaluation helps distinguish RCD from other causes of shoulder pain. During the examination, the physician should evaluate for referred pain from the cervical spine along with other glenohumeral disorders such as instability, osteoarthritis, or adhesive capsulitis.[20,21] When the patient presents with recurrent shoulder pain, the physician should review results of prior conservative treatments or surgeries.

The most common symptom of RCD is shoulder and arm pain, especially during overhead activities. This sensation is described as dull pain that becomes sharp and stabbing during overhead motion. The pain is often located in the region of the deltoid muscle, ranging from its origin at the clavicle, acromion process, and scapular spine to its insertion at the middle part of the humerus. Other symptoms are night pain, weakness, stiffness, or crepitus that may be heard during shoulder movement. Weakness and loss of motion may be challenging to interpret, because these symptoms could be the result of pain or attributable to true muscle weakness and joint stiffness. The presence of pain is not required to diagnose RCD, because patients with a chronic full-thickness rotator cuff tear may have painless loss of active motion.

Inspection of the supraspinatous and infraspinatus fossae above and below the scapular spine can show atrophy. Swelling seldom occurs but can be a sign of inflammatory or traumatic changes. Passive and active range of motion should be compared with the contralateral side. Adhesive capsulitis is caused by chronic inflammation of the shoulder capsule, resulting in pain and restricted limits in both active and passive range of motion, a condition described as a frozen shoulder, which is also characterized by joint stiffness, pain, or both or by glenohumeral arthritis. A limitation that occurs only with active motion suggests impairment of the rotator cuff muscles. In

Figure 1. Musculoskeletal Anatomy of the Shoulder and Range of Motion Created by the Rotator Cuff Muscles



general, clinical tests for RCD can be divided into pain provocation tests and strength tests.

Results of pain provocation tests are considered positive if shoulder pain is induced when the rotator cuff and subacromial bursa are compressed between the humeral head, acromion, or coracoid process. Well-known pain provocation tests are the painful arc (**Figure 2**A),[3] Neer test,[22] and the Hawkins test[2] for subacromial impingement. Strength tests, such as the external[23] and internal[23] rotation lag test (Figure 2B), assess muscle function of a specific rotator cuff muscle. During such tests, the patient either moves the arm toward a certain position or maintains a certain position of the arm or shoulder against gravity. Strength testing can produce weakness, pain, or both, especially when the patient has a partial rotator cuff tear. Likewise, pain during a provocation test can be accompanied by impaired strength. Frequently used composite tests or signs that are considered positive when inducing either pain or weakness are the empty can test (evaluates the supraspinatus muscle)[24] and the external rotation resistance test (evaluates the infraspinatus muscle (Figure 2C).[25] Because the total spectrum of clinical tests for RCD is extensive,[2,22,24,26-28] we systematically reviewed the literature for the most accurate clinical findings for RCD.

Methods

Literature Search Strategy

A structured search was performed to identify relevant studies in MEDLINE, EMBASE, and CINAHL from their inception through May 2013 (eAppendix in Supplement, Search Strategy). Four of the investigators (J.H., D.E.M., M.R., S.M.A.B-Z.) independently analyzed the results of the search strategy for suitable articles. When reviewers did not reach consensus on article inclusion, we used the opinion of a fifth reviewer (J.J.L.). We reviewed the references in eligible articles to identify additional suitable studies.

Study Selection

A study was eligible if it met the following criteria: (1) description of history taking, physical examination, or clinical tests concerning RCD; (2) detailing of sensitivity and specificity; (3) use of a reference standard with diagnostic criteria prespecified; (4) presentation of original data, or original data could be obtained from the authors; and (5) publication in a language mastered by one of the authors (Danish, Dutch, English, French, German, Norwegian, Spanish, Swedish). We excluded studies of shoulder disorders secondary to rheumatoid arthritis, fibromyalgia, shoulder instability, labral lesions, fractures, adhesive capsulitis, tumors, complex regional pain syndrome, and disorders resulting from the consequences of stroke. Two pairs of reviewers (J.H. and S.M.A.B.-Z.; J.J.L. and M.R.) independently assigned levels of evidence using The Rational Clinical Examination approach (eTable 1 in Supplement)[29]and assessed risk of bias on eligible studies using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) criteria (eAppendix in Supplement; QUADAS Tool and QUADAS Tool Results).[30,31]

Surgical observations are the reference standard for confirming a diagnosis of rotator cuff tear, although only a selection of patients suspected of having RCD require surgery. To decrease verification bias whereby not all patients suspected of having RCD undergo surgery, diagnostic imaging techniques for RCD (magnetic resonance imaging or ultrasound)[32-37] were accepted as reference tests. Because tendinopathy and bursitis do not typically require surgery, imaging is a pragmatic reference standard for these conditions. A recent meta-analysis showed that diagnostic ultrasound adequately rules in full- and partial-thickness tears,[38] with sensitivity and specificity similar to that of magnetic resonance imaging.[32,39,40] For tendinopathy and subacromial bursitis, evidence concerning the best imaging technique is less clear.[38]

Data Extraction and Analyses

Two reviewers (J.H., J.J.L.) extracted study characteristics (design, population characteristics, and diagnosis) and diagnostic accuracy data for the index and reference tests of each study. For each finding, we recalculated the sensitivity, specificity, and likelihood ratios (LRs) with their 95% CIs from data reported in the article.[41,42] When the data for the 2 × 2 table were not published in the original report, we contacted the authors. For findings evaluated in 3 studies, we used univariate random-effects measures and quantified heterogeneity with the I^2 statistic and P value (Comprehensive MetaAnalysis version 2.2.057; Biostat).[43] Findings evaluated in only 2 studies are reported as a simple range, whereas the results from single studies are shown as point estimates with their CIs. The results are shown for RCD (including the whole spectrum of RCD) and full-thickness rotator cuff tears when investigated separately. Data from level IV studies were retained when they were the only evidence for certain findings, but they were not combined with data from higher-quality studies, and we used the range to summarize the results.

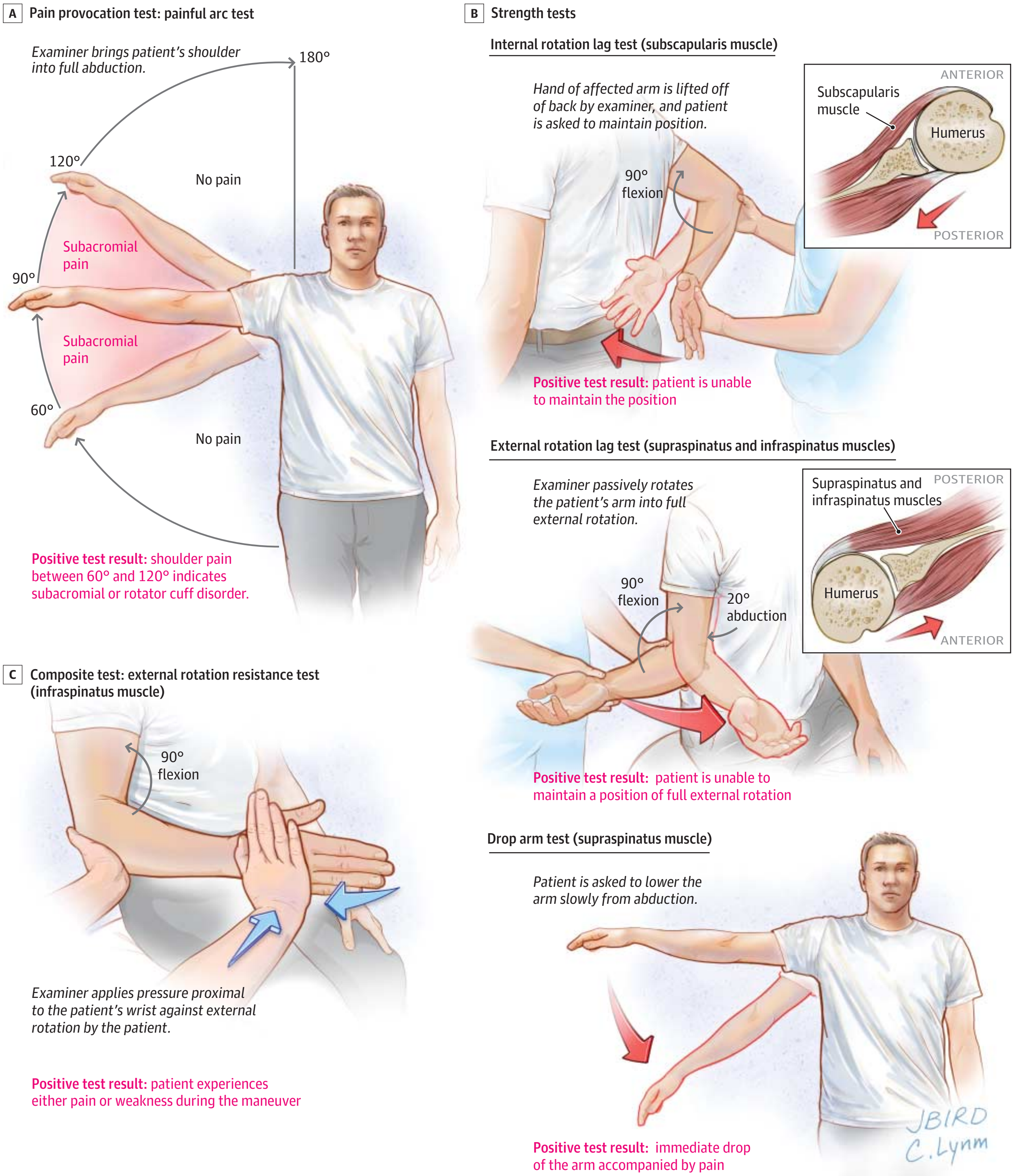
Results

Study Characteristics

The search strategy yielded 4641 unique results (eAppendix in Supplement, Flowchart for Literature Search), from which we identified 76 articles for full text review. This process yielded included articles, of which 5 were assigned a level of evidence I-II (**Table 1**).[44-48] We also reviewed 23 studies of level IV quality[23,25,26,49-68] because they assessed findings not reported in higher-quality studies. No level III studies were identified. The sources of bias for the studies of level I-II quality are reported in the eAppendix (Supplement, QUADAS Tools) and eTable 1 (Supplement, QUADAS Tool Results).

The prevalences of RCD, based on the reference standard test, were higher than those found in epidemiologic studies (Table 1) because all of the included studies were conducted by specialists among referred patients. These studies varied by whether the reference standard was considered positive for any RCD as opposed to considering the imaging positive only when it confirmed involvement of the shoulder structure that a test was designed to detect (**Table 2**). The prevalence values shown in Table 1 for each study reflect the prevalence of any rotator cuff structure rather than the prevalence of the specific structure the finding was designed to test.

Figure 2. Recommended Clinical Tests for the Evaluation of Rotator Cuff Disease



A, The positive result of the painful arc test, a pain provocation test, is characteristic shoulder pain during abduction of the arm between 60° and 120°, suggesting a subacromial impingement syndrome or rotator cuff disorder due to compression of the rotator cuff muscles and subacromial bursa between the humeral head, acromion, or coracoid process. B, Strength tests assess muscle function of a specific rotator cuff muscle, producing weakness, pain, or both, especially when the patient has a partial rotator cuff tear. During such tests, the patient either moves the arm toward a certain position or maintains a certain position of the arm or shoulder against gravity. The internal rotation lag test evaluates the subscapularis muscle. The external rotation lag test assesses both the supraspinatus and infraspinatus muscles. The drop arm test assesses the integrity of the supraspinatus muscle. A positive test result is an immediate drop of the arm accompanied by pain. C, The external rotation resistance test is a composite test of the infraspinatus muscle. The test is positive when the patient experiences either pain or weakness during the maneuver.

Table 1. Study Characteristics of Included Studies Assigned Level of Evidence I-II[a]

Source	Level of Evidence	Participants (Shoulders), No.[a]	Prevalence of RCD, %	Age, Mean (Range), y	Selection Criteria	Included Index Test for RCD	Reference Test
Salaffi et al, 2010[44]	I	203 (203)	81[b]	58 (23-81)	Shoulder pain Exclusion: pain after trauma or surgery or radiation therapy, diabetes mellitus, inflammatory rheumatic arthritis	External rotation resistance test,[c] Gerber test, empty can test, Hawkins test	Ultrasound
Chew et al, 2010[45]	II	104 (104)	61[b]	44 (SD, 16.2)	History of chronic shoulder pain >3 mo Exclusion: inflammatory, systemic, and metabolic diseases; fractures; postoperative conditions; cervical trauma/radiculopathy; neurologic conditions causing muscle weakness; musculoskeletal conditions involving the elbow	Drop arm test, full can test, Neer test, cross-body adduction test, painful arc test, Hawkins test, empty can test	Ultrasound
Ardic et al, 2005[46]	II	58 (59)	79[b]	56 (SD, 12.4)	Shoulder pain suspicious for impingement >3 mo, waiting for physiotherapy, not responding to pain medication Exclusion: history of shoulder or cervical spine trauma, cervical diskopathy, neurologic muscle disorder, other musculoskeletal disorder, systemic, metabolic or inflammatory diseases, contraindication for ultrasound or MRI	Hawkins test, Neer test	Ultrasound and MRI in all patients
Miller et al, 2008[47]	II	37 (46)	33[d]	56 (20-86)	Shoulder pain, full passive range of motion	Dropping sign, external rotation lag test, internal rotation lag test	Ultrasound
Silva et al, 2008[48]	II	30 (30)	66[b,e]	55 (24-82)	Shoulder pain Exclusion: history of trauma	Empty can test, passive abduction test, resisted abduction test, Gerber test, Hawkins test, Neer test, Patte test, Yocum test	MRI

Abbreviations: MRI, magnetic resonance imaging; RCD, rotator cuff disease.

[a] See eAppendix in Supplement for levels of evidence.

[b] Rotator cuff disease (bursitis, tendinopathy, full- or partial-thickness tear).

[c] Described as Patte test in Salaffi et al,[44] executed as external rotation resistance test.[25]

[d] Full-thickness tear.

[e] Impingement, 66%; bursitis, 52%.

The investigated physical examination maneuvers are shown in Table 2. The Hawkins test was the pain provocation test investigated most frequently (3 studies),[44,45,48] whereas the empty can test was the most frequently investigated strength test (3 studies).[44,45,48]

Accuracy of History and Physical Examination for RCD

The accuracy of history taking for RCD was evaluated in only 2 level IV studies.[57,61] The presence or absence of rest pain or pain during sleep (positive LR range, 0.12-5.0; negative LR range, 0.57-1.1) or pain during motion (positive LR range, 0.23-1.4; negative LR range, 0.75-1.1) do not help identify patients with rotator cuff tears.[57,61]

Inspection of the infraspinatus muscle for atrophy was investigated in 1 level IV study,[61] and its presence makes RCD more likely (positive LR, 2.0 [95% CI, 1.5-2.7]; negative LR, 0.61 [95% CI, 0.52-0.72]). Palpation techniques of the rotator cuff muscles to manually identify rotator cuff tears were evaluated in 3 level IV studies[62,66,67] (positive LR range, 0.60-30; negative LR range, 0.04-1.0). No studies reported data that allowed us to calculate LRs related to age, hand dominance, or performance of heavy labor.

Accuracy of Physical Examination Maneuvers for RCD

Pain Provocation Tests

A positive painful arc test result is the only 1 of 6 pain provocation results that were evaluated in studies of level I-II quality and that has an LR greater than 2.0 (LR, 3.7 [95% CI, 1.9-7.0]).[45] Positive results on the more frequently studied Hawkins test (summary LR, 1.5 [95% CI, 1.1-2.0]) or Neer test (LR range, 0.98-1.6) had little value.[44,45,48] A normal result on painful arc tests was the only finding with a negative LR less than 0.50 (negative LR, 0.36 [95% CI, 0.23-0.54]), although the absence of pain on the Hawkins test came close to that threshold (summary negative LR, 0.51 [95% CI, 0.39-0.66])[44,45,48] (**Table 3**).

Specialists often repeat physical examination maneuvers immediately after shoulder injections. A study of level IV quality that investigated the Neer test immediately after a subacromial injection with a local anesthetic[22] resulted in a positive LR of 1.7 and a negative LR of 0.32 (CIs not calculable from the data).[64]

Strength Tests

Of the 5 strength tests evaluated in studies of level I-II quality,[44,45,47,48] 3 were used as a test for detecting a full rotator cuff tear, whereas 1 was used to assess the presence of any RCD. A positive external rotation lag test result (LR, 7.2 [95% CI, 1.7-31])[47] and internal rotation lag test (positive LR, 5.6 [95% CI, 2.6-12])[47] were the most accurate strength tests for a full rotator cuff tear, whereas the internal rotation lag test was the most accurate finding when negative (negative LR, 0.04 [95% CI, 0.0-0.58]).[47] A positive drop arm test result increased the likelihood of any RCD (positive LR, 3.3 [95 CI, 1.0-11])[45] (Table 3).

Composite Tests

Composite tests are positive when the patient experiences either pain or weakness during the maneuver. When positive, the external rotation resistance test (LR, 2.6 [95% CI, 1.8-3.6]) was the most

Table 2. Clinical Tests for Rotator Cuff Disease

Tested Item in Included Studies	Scope of Test	Test Execution	Positive Test
Pain provocation tests			
Cross-body adduction[45]	Impingement	Arm in 90° elevation, adduction of elevated arm toward contralateral shoulder[69]	Pain during adduction
Neer[45,46,48]	Impingement	Elbow in extension, internal rotation by examiner, then passive elevation by examiner while stabilizing scapula[22]	Pain during passive abduction
Painful arc[45]	Impingement	Examiner brings shoulder in full abduction[3]	Pain between 60° and 120° abduction
Passive abduction[48]	Impingement	Examiner brings shoulder in full abduction[48]	Painful passive abduction
Hawkins[44-46,48]	Impingement	Arm in 90° elevation, elbow in 90° flexion, examiner stabilizes elbow and brings arm into internal rotation[2]	Pain during internal rotation
Yocum[48]	Impingement	Elbow in flexion, hand on contralateral shoulder, patient elevates elbow without raising ipsilateral shoulder[48]	Pain while elevating elbow
Strength tests			
Drop arm[45]	Supraspinatus muscle	Arm in 90° abduction, slow descent of arm[70]	Immediate drop of arm accompanied by pain
Dropping sign[47]	Infraspinatus muscle	Shoulder in 90° abduction, elbow in 90° flexion, full external rotation by examiner[23]	Unable to maintain position of external rotation
External rotation lag[47]	Infraspinatus muscle/ supraspinatus muscle	Elbow in 90° flexion, arm in 20° abduction, passive rotation by examiner to full external rotation[23]	Unable to maintain position at full external rotation
Internal rotation lag[47]	Subscapularis muscle	Hand of affected arm on back, elbow in 90° flexion, hand is lifted off the back by examiner, patient is asked to maintain position[23]	Unable to maintain position
Gerber (lift-off test)[44,48]	Subscapularis muscle	Hand of affected arm on back, elbow in 90° flexion, patient is asked to lift hand off the back[71]	Unable to lift arm toward posterior
Composite test for pain or weakness			
External rotation resistance[44a]	Infraspinatus muscle	Elbow in 90° flexion, examiner applies pressure proximal to wrist against external rotation[25]	Pain or muscle weakness during appliance of pressure
Full can[45]	Supraspinatus muscle	Elbow in extension, arms in 90° abduction, 30° horizontal adduction, and 45° external rotation, thumb points upward, patient resists downward pressure (proximal from elbow) from examiner[72]	Pain or muscle weakness while resisting downward pressure
Resisted abduction[48]	Impingement	Arm abduction 90°, examiner applies downward pressure[48]	Pain or muscle weakness while resisting downward pressure
Empty can (Jobe)[44,45,48]	Supraspinatus muscle	Arm in 90° abduction, 30° horizontal adduction, and 90° internal rotation, elbow extended, thumb pointing toward floor, patient resists downward pressure (proximal from elbow) from examiner[24]	Pain or muscle weakness or while resisting downward pressure
Patte[48]	Infraspinatus muscle/ teres minor muscle	Arm in 90° abduction, elbow in 90° flexion, external rotation against resistance of examiner[73]	Pain or muscle weakness during external rotation

[a] Described as Patte test in Salaffi et al,[44] executed as external rotation resistance test.[25]

accurate composite finding (level II quality), whereas the absence of pain or weakness identified patients less likely to have RCD (LR, 0.49 [95% CI, 0.33-0.72])[44] (Table 3).

Accuracy of Combinations of Clinical Tests for RCD

Because of the relatively low diagnostic accuracy of commonly performed individual tests, combinations of findings for RCD have been evaluated.[25,46,51,53,54,63] However, a positive Hawkins test result together with a positive Neer test result (LR, 1.6 [95% CI, 0.87-2.8])[42,46] has a CI with substantial overlap compared with the individual tests. The negative LR for a normal response to each finding (LR, 0.43 [95% CI, 0.20-0.96])[42,46] might perform better than either finding alone but has broad CIs (Table 3).

In a level IV study, the positive LR was only 1.5 (95% CI, 1.1-2.0) for 3 or more of 7 positive test findings (Hawkins test, Neer test, horizontal adduction test, speed test, Yergason test, painful arc test, and drop arm test), whereas fewer than 3 positive findings confer an LR of 0.37 (95% CI, 0.20-0.68).[51] That combination of findings included the Speed test and the Yergason test, which are primarily tests of biceps tendon pathology. Among a smaller set of 5 findings designed to detect RCD, another level IV study showed a positive LR of 2.9 (95% CI, 1.6-5.4) for 3 or more positive findings (Hawkins test, Neer test, external rotation resistance test, empty can test, painful arc test), whereas fewer than 3 positive findings conferred an LR of 0.34 (95% CI, 0.14-0.80).[25]

Discussion

There is a lack of data from primary care settings for findings that could be used to diagnose RCD among patients with shoulder pain. All of the studies we found came from patients referred to a specialist for evaluation of their shoulder discomfort. It is uncertain if examinations performed by generalist physicians would have the same results as those performed by specialists, because differences may be attributable to the skill of the examiner as well as to the patient populations. Without a direct comparison of patients evaluated at the same time, we cannot be certain that results from a generalist physician's examination would agree with those from a specialist's examination. However, the findings we describe are

Table 3. Accuracy of Physical Examination Maneuvers for Rotator Cuff Disease or Full Rotator Cuff Tears From Quality Level 1-2 Studies[a]

Finding	Rotator Cuff Condition	Studies, No.	% (95% CI)		LR (95% CI)	
			Sensitivity	Specificity	Positive	Negative
Pain provocation tests						
Painful arc[45]	Disease	1	71 (60-83)	81 (68-93)	3.7 (1.9-7.0)	0.36 (0.23-0.54)
Cross-body adduction[45]	Disease	1	75 (64-85)	61 (46-76)	1.9 (1.3-2.9)	0.42 (0.26-0.68)
Hawkins[44,45,48]	Disease	3[b]	76 (56-89)	48 (23-74)	1.5 (1.1-2.0)[c]	0.51 (0.39-0.66)[d]
Neer[45,48]	Disease	2[e]	64-68	30-61	0.98-1.6	0.60-1.1
Yocum[48]	Disease	1	79 (61-97)	40 (10-70)	1.3 (0.75-2.3)	0.53 (0.17-1.7)
Passive abduction[48]	Disease	1	74 (54-93)	10 (0-29)	0.82 (0.58-1.1)	2.6 (0.35-20)
Strength tests						
External rotation lag[47]	Full tear	1	47 (21-71)	94 (85-100)	7.2 (1.7-31)	0.57 (0.35-0.92)
Internal rotation lag[47]	Full tear	1	97 (88-100)	83 (70-96)	5.6 (2.6-12)	0.04 (0.0-0.58)
Drop arm[45]	Disease	1	24 (13-34)	93 (85-100)	3.3 (1.0-11)	0.82 (0.70-0.97)
Dropping sign[47]	Full tear	1	73 (51-95)	77 (62-92)	3.2 (1.6-6.5)	0.35 (0.15-0.83)
Gerber (lift-off test)[44,48]	Disease	2[e]	34-68	50-77	1.4-1.5	0.63-0.85
Composite test for pain or weakness						
External rotation resistance[44f]	Disease	1	63 (49-77)	75 (69-82)	2.6 (1.8-3.6)	0.49 (0.33-0.72)
Full can[45]	Disease	1	75 (64-85)	68 (54-83)	2.4 (1.5-3.8)	0.37 (0.23-0.60)
Patte[48]	Disease	1	58 (36-80)	60 (30-90)	1.4 (0.62-3.4)	0.70 (0.34-1.5)
Empty can (Jobe)[44,45,48]	Disease	3[b]	71 (49-86)	49 (42-56)	1.3 (0.97-1.6)[c]	0.64 (0.33-1.3)[g]
Resisted abduction[48]	Disease	1	58 (36-80)	20 (0-45)	0.72 (0.55-8.1)	2.1 (0.55-8.1)
Combinations of findings						
Hawkins and Neer (both positive)[46]	Disease	1	78 (66-90)	50 (22-78)	1.6 (0.87-2.8)	0.43 (0.20-0.96)

Abbreviation: LR, likelihood ratio.

[a] See eTable 2 in Supplement for results evaluated in 1 or more studies.

[b] Random-effects univariate estimates used because there were only 3 studies.

[c] I^2 = 45%, P = .16.

[d] I^2 = 0%, P = .75.

[e] Range because the test was only evaluated in 2 sets of data.

[f] Described as Patte test in Salaffi et al,[44] executed as external rotation resistance test.[25]

[g] I^2 = 70%, P = .04.

simple to perform, and we believe they could be mastered with practice by the generalist physician. The approach we present of pain provocation tests, strength tests, and composite tests provides a framework for thinking about the physical examination findings and for interpreting the results.

The second question about external validity pertains to the study populations, because we found no studies from primary care settings. A recent meta-analysis by Alqunaee et al[74] that required arthroscopy as the reference standard also found no studies of the shoulder examination in a primary care setting. External validity is important because the generalist physician needs to know if the likelihood ratios of the clinical findings generalize to all patients initially seen in the generalist's clinic, only some of whom will be later referred. The study populations comprised patients reporting shoulder problems and visiting the orthopedic department, rheumatology department, or a sports medicine center, resulting in high prevalence of RCD (33%-81%) compared with estimated prevalence values of symptomatic RCD in a general population (2.8%-15%).[11,12]This suggests verification bias that could occur when patients who respond to conservative therapy are less likely to be referred, whereas those with more severe RCD or those for whom conservative treatment has failed are referred and undergo a reference standard test. Verification bias typically leads to an overestimation of sensitivity and underestimation of specificity,[75] allowing the inference that an increasing number of positive findings on a generalist physician's examination could identify patients much more likely to have RCD than are suggested by these data (eAppendix in Supplement, Verification Bias in Shoulder Studies, eTable 3). Thus, we infer that the maneuvers most useful when positive as performed by orthopedists would also be the maneuvers of most value to a generalist physician.

Our meta-analysis included only studies of level I-II quality using the quality scheme of the Rational Clinical Examination,[29] and we used imaging as a reference standard to obtain studies with less selected patient populations. There was no overlap in the 5 level I-II studies we included and the 10 studies retained by Alquanee et al[74] for meta-analysis. Because both studies show the results of applying the QUADAS criteria,[30] it is evident that the major difference is that the studies we retained showed that the reference standard results were interpreted without knowledge of the results of the index test, whereas that was true in only 2 of the 16 studies in the review by Alquanee et al. Despite these differences, our estimates for sensitivity and specificity have CIs that overlap the 5 findings reported by Alquanee et al (Hawkins-Kennedy test, Neer test, empty can test, drop arm test, lift-off test). The contribution of frequently used clinical tests was also assessed in a study by Beadreuil et al[76] in which 8 of 9 studies included patients scheduled for shoulder surgery, for which we assigned a quality level of IV.

Scenario Resolution

Case 1

This patient's chronic shoulder pain should prompt a consideration of RCD. She is younger than 70 years, and the population prevalence for RCD ranges from 2.8% to 15%,[11,12]with a prevalence of 15% in patients older than 70 years.[12] Her work requires specific physical demands from the shoulder. Assuming a prior probability of 10%, the pain response signifies a painful arc test (LR, 3.6), which confers a posttest probability of RCD of at least 28%. Additional pain provocation tests such as a Hawkins test (positive LR, 1.5) or Neer test (positive LR, 1.3) assess the presence of subacromial impingement but would not raise the probability of RCD much higher. Strength should be assessed using any of the studied signs, recognizing that there is substantial overlap in the negative LR but also that maintained strength argues against a significant full-thickness tear of the rotator cuff. The initial treatment for this chronic rotator cuff problem involves the use of nonsteroidal analgesics, physical therapy, and/or possibly subacromial corticosteroid injection. Referral to an orthopedic surgeon should be considered when treatment does not lead to satisfactory improvement.

Case 2

This patient seems most similar to those in referred populations in which the probability of RCD is greater than 30%. The history, symptom severity, and overall observation indicate that the probability of a rotator cuff tear in this patient is likely to be high. The acute traumatic onset and the patient's inability to move his arm in an upward and sideways direction should alert the physician to a full-thickness tear of 1 or more rotator cuff tendons. With the patient unable to move his arm adequately in any direction because of pain, results of the painful arc test would certainly be positive (LR, 3.7), as would results of the other pain provocation and strength tests. With the painful arc test alone, there is a posterior probability of at least 61% for RCD. A cervical and neurologic examination is important to exclude concomitant injuries with acute radiculopathy. Radiographs are important to review for ruling out a fracture. If possible, the physician who evaluated the patient initially should be contacted to determine if a shoulder dislocation was present.[77] Although the findings on most of the pain provocation tests and strength tests are likely to be positive, the drop arm test will assess the integrity of the supraspinatus muscle and the external rotation lag test assesses both the supraspinatus and the infraspinatus muscles, although the patient may not be able to perform the maneuvers. A consultation with an orthopedic surgeon is recommended to confirm the diagnosis and optimize treatment strategies.

Bottom Line

Positive findings on the internal and external rotation lag tests and presence of a painful arc have the highest positive LR for RCD and rotator cuff tears, but the accuracy of history taking and physical examination[57,61,62,67] performed prior to referral for shoulder pain has not been reported in high-quality studies. Although combinations of positive clinical test findings did not show that they were consistently better than individual findings, most experts consider RCD more likely with increasing numbers of positive findings. Rotator cuff disease is considered much less likely when the findings on more tests are normal. Because of this, patients with normal pain provocation and strength testing maneuvers who have persistent shoulder discomfort may need referral to orthopedists to establish the diagnosis.

Although the current literature has limitations, the studies we retained represent the best available evidence. The findings in our review, which used an imaging reference standard, together with the review of Alqunaee et al,[74] which used an arthroscopy standard, suggest that future studies conducted by orthopedists would likely lead to results within the summary CIs we found. Larger studies would be useful to narrow the CIs.

We suggest that generalist physicians develop proficiency in the findings that have the best LRs with the narrowest CIs (either independently or in combinations), as performed by specialists. For patients with shoulder pain, the physician could perform a single pain provocation test (painful arc test), 3 strength tests (internal rotation lag test, external rotation lag test, and drop arm test), and 1 composite test (external rotation resistance test) (Figure 2). There are many possible combinations of findings with these 5 tests, so most of the combinations have not been studied for their independence, making the selection of an appropriate LR difficult.[78] Based on the available evidence, a positive painful arc test finding along with other positive findings suggests an LR of 3.7 or greater. Using the population prevalence of RCD, which increases with age (2.8%-15%),[11,12] the posterior probability of disease would be 9.6% (for patients older than 30 years) to more than 40% (for patients 70 years and older). Among patients referred to shoulder specialists, the prior probability of RCD is much higher (>30%), which means that the presence of pain during the painful arc test in those patients confers a more than 60% probability of disease. The absence of pain during the painful arc tests along with increasing numbers of negative findings should result in an LR less than 0.36. General medical patients with no pain during the painful arc test would have a low posterior probability of rotator cuff disease (1%-6%). Because of the high probability of disease among patients referred to shoulder specialists, the absence of pain during a painful arc test in a referred patient does not rule out RCD, because the posterior probability could still be as high as 13%.

ARTICLE INFORMATION

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