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# Clinical Examination of the Rotator Cuff

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## Abstract

Rotator cuff tears are the leading cause of shoulder pain and shoulder-related disability accounting for 4.5 million physician visits in the United States annually. A careful history and structured physical examination are often sufficient for diagnosing rotator cuff disorders. We are not aware of a clinical review article that presents a structured physical examination protocol of the rotator cuff for the interested clinician. To fill this void, we present a physical examination protocol developed on the basis of review of prior literature and our clinical experience from dedicated shoulder practices.

Our protocol includes range of motion testing using a goniometer, strength testing using a dynamometer, and select special tests. Among the many tests for rotator cuff disorders that have been described, we chose ones that have been more thoroughly assessed for sensitivity and specificity. This protocol can be used to isolate the specific rotator cuff tendon involved. The protocol can be typically completed in 15 minutes. We also discuss the clinical implications and limitations of the physical examination maneuvers described in our protocol. This protocol is thorough yet time-efficient for a busy clinical practice. It is useful in diagnosis of rotator cuff tears, impingement syndrome, and biceps pathology.

## INTRODUCTION

Rotator cuff tears are the leading cause of shoulder pain and shoulder-related disability accounting for 4.5 million physician visits in the United States annually.[1] The annual cost of treating shoulder pain was $7 billion in the year 2000 in the United States.[2]

The rotator cuff tendons include supraspinatus, infraspinatus, teres minor, and subscapularis (Figures 1 and 2). The long head of the biceps tendon is also often included in rotator cuff pathology. Rotator cuff tears often present with shoulder pain, weakness, and loss of range of motion. These symptoms are not unique to rotator cuff tears and the differential diagnosis includes labral tears, glenohumeral ligament tears or sprains, coracoacromial and acromioclavicular ligament tears and sprains, osteoarthritis, adhesive capsulitis, proximal

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peripheral neuropathies, and cervical radiculopathy. Increasing age and traumatic shoulder injury also increase clinical suspicion of rotator cuff tear.[3] A careful history and structured physical examination can often establish the diagnosis of rotator cuff tear. Nevertheless, clinicians tend to rely heavily on imaging data from MRI[4] and ultrasound to diagnose rotator cuff disorders.

The objective of our clinical review is to provide the practicing clinician with a structured physical examination protocol that the authors use in their shoulder practices. This protocol is based on a review of the published literature and our clinical expertise.

## LITERATURE REVIEW

A review of the literature using MEDLINE was performed for physical examination tests/maneuvers related to the rotator cuff using the terms: rotator cuff, physical examination, sensitiv*, diagnos*, specific*. We also used the article by Hegedus et al.[5] on sensitivity and specificity of shoulder tests for this review. The objective of our study is not to present a systematic review or meta-analysis of special tests but to present a physical examination protocol for the clinician. Based on this review of literature and the clinical experience of two of the authors (NBJ and LDH) who manage over 2,000 patients with shoulder disorders annually, we describe a protocol for physical examination of the rotator cuff. The Appendix includes a patient encounter form with tabular summarization of the physical examination protocol presented in this review. This form can be a useful tool in clinical practice to record findings.

### Inspection and Palpation

Inspection of the rotator cuff assesses supraspinatus and infraspinatus atrophy in the suprascapular and infrascapular fossae, respectively (Figures 1a and b). Muscle atrophy is examined with tactile assessment feeling for loss of muscle bulk and comparison with the contralateral side. In cases of massive rotator cuff tears the humeral head can be appreciated to be superiorly displaced abutting the acromion.

The long head of the biceps tendon in the bicipital groove is palpated for tenderness between the greater and lesser tuberosities of the humeral head. The acromioclavicular joint is also palpated for tenderness by following the distal end of the clavicle to the acromioclavicular junction.

### Range of Motion

The **s**upraspinatus assists in elevation (abduction) of the arm; infraspinatus and teres minor in external rotation, and; subscapularis in internal rotation. Active and passive range of motion is assessed. If time is a constraint, the authors recommend limiting the assessment to active range of motion only since rotator cuff tears lead to loss of active range of motion and passive range of motion is often preserved. Passive motion is typically limited in glenohumeral articular disorders.

Range of motion is measured in degrees and best assessed with a goniometer. Goniometers are commercially available via numerous vendors. If range of motion cannot be assessed with a goniometer due to time constraints, subjective assessment of range of motion and comparison with the contralateral shoulder is recommended.

The protocol outlined below for range of motion measurement is modified from prior studies[6,7] and performed in the standing position. To effectively explain the protocol to the patient, it is helpful for the clinician to demonstrate the range of motion maneuver to the patient before asking the patient to perform the maneuver.

**Forward Flexion—**Flexion is performed by asking the patient to raise the arm straight up in front of them as high as the patient can with the thumb pointing upwards. The flexion angle is formed by aligning the goniometer with the lateral epicondyle of the humerus, the middle of the glenoid fossa, and a vertical line in the coronal plane (Figure 3a).

**Isolated Abduction—**Abduction is performed by asking the patient to raise the arm at the side as high as they can with the examiner stabilizing the scapula by holding it down. The abduction angle is formed by aligning the goniometer with the lateral epicondyle of the humerus, the middle of the posterior glenohumeral joint line, and a vertical line in the sagittal plane (Figure 3b).

**External Rotation at 0 Degrees (in neutral)—**This is performed with the patient in 0 degrees of glenohumeral joint abduction, 90 degrees of elbow flexion, and neutral supination/pronation forearm position. The patient is then asked to keep his elbow to his/ her waist and rotate the arm outwards. The external rotation angle is formed by aligning the goniometer with the ulna styloid process, the olecranon process of the ulna, and a horizontal line in the transverse plane (Figure 3c).

**External/ Internal Rotation at 90 Degrees (in abduction)—**The patient is in 90 degrees of glenohumeral abduction, 90 degrees of elbow flexion, and neutral supination/ pronation of forearm. The patient is then asked to keep the elbow at 90 degrees and move the forearm upwards as high as they can and then downwards as low as they can. The external rotation and internal rotation angles in 90 degrees of abduction are formed by aligning the goniometer with the ulnar styloid process, the olecranon process of the ulna, and a horizontal line in the horizontal plane (Figure 3d).

**Highest Posterior Anatomy Reached with Thumb—**The patient is asked to reach his back with the dorsum (back) of his/ her thumb. The patient is then asked to reach as high as they can along the spine. The highest level that the patient can reach is marked. The bony landmarks adapted from Malanga et al.[8] are the inferior border of the scapula that corresponds to the T7 level and the top of the iliac crests that corresponds to the L4 level. Follow up the spinous processes from L4 to mark the L1 level. The highest point is noted as follows: above T7; between T7 and above L1; between L1 and above L4; L4 and below; and to the body (if the patient cannot reach their back).

## Strength Testing

Strength testing is performed using a portable hand-held dynamometer. Numerous devices are commercially available for this purpose and measure strength in kilograms or pounds. After positioning the shoulder for each of the maneuvers (described below), the patient is told, “This part of the test requires me to match your resistance. Now, please to push into the dynamometer as hard as you can.” Once the examiner feels that they have matched the subject’s resistance so that the muscle contraction is truly isometric the patient is asked to continue pushing into the dynamometer, while the tester resists the force exerted by the subject, maintaining positional equilibrium throughout the 5 second period of exertion. The examiner lets them know when the 5 seconds time is up. The examiner disregards the muscle performance measurement if it is determined that the patient in appropriately used other musculature to complete the desired task. All maneuvers are performed twice on each arm with a 10 second rest between repetitions. The scores are then averaged for each arm and evaluated for symmetry. The protocol below is modified from prior studies[9] and our experience.

**External Rotation (measures force predominately exerted by infraspinatus muscle)—**The patient is instructed to sit with their arm in neutral rotation while holding their elbow and forearm at 90 degrees of flexion. The forearm is in midrange of motion between supinatation and pronation with the thumb directed upward. The tester places the dynamometer on the lateral surface of the distal forearm just proximal to the ulnar styloid process (Figure 4a).

**Abduction (measures force predominately exerted by supraspinatus muscles)—**The patient sits with both shoulders in approximately 90 degrees abduction and approximately 45 degrees of horizontal abduction (elbows are fully extended with palms facing down). The tester places dynamometers on each distal arm at the lateral humeral epicondyle (Figure 4b).

**Internal Rotation (measures force predominately exerted by subscapularis muscle)—**The subject sits with their arm at approximately 90 degrees of forward flexion and their elbow at 90 degrees of flexion. The tester places the dynamometer under the subject's hand. The tester places one finger tip of the hand not holding the dynamometer on the subject's olecranon process to ensure the patient is producing an internal rotation moment and not an adduction moment (Figure 4c).

## Special Tests

Over twenty-five special tests are described for examination of the rotator cuff[10–25]. It is not feasible to perform all of these tests in clinical practice. Therefore, we present selected special tests for each of the rotator cuff tendons that have been more rigorously assessed for sensitivity and specificity[10,12,14,19,22,23,26–32] and are useful in clinical practice to diagnose rotator cuff tears. In table 1, we present data on sensitivity and specificity of select special tests. The purpose of this table is not to present a comprehensive review of sensitivity and specificity of special tests but to familiarize the reader with some of the data on these tests and our rationale for their selection. We also present selected tests for impingement syndrome. This syndrome was described by Neer[21,33] as impingement of the supraspinatus and possibly of the long head of the biceps tendon against the anterior edge and undersurface of the anterior third of the acromion, the coracoacromial ligament, and the acromioclavicular joint. Several authors[34–36] have also described this phenomenon as "supraspinatus syndrome" prior to Neer's description. A positive test of the rotator cuff below implies that the respective tendon is torn. A positive test for the biceps tendon implies biceps tendonitis/tenosynovitis.

## Tests for Subscapularis

**Lift-off Test[12]—**The examiner assists the patient to get in a position where he/ she touches their lower back with the arm fully extended and internally rotated (Figure 5a). A test is judged positive if the patient is unable to lift the dorsum of his hand off his/her back reflecting weakness of the subscapularis.

**Passive Lift Off (Lag Sign)[11]—**The examiner passively brings the patient's arm behind the body into maximal internal rotation (around the lower back region and pull it backwards away from the back). The result of this test is considered normal if the patient maintains maximum internal rotation after the examiner releases the patient's hand. The test is positive if the patient cannot maintain this position due to weakness of the subscapularis.

**Belly Press Test[11]—**The examiner instructs the patient to press the abdomen with the hand flat and attempts to keep the arm in maximum internal rotation. The test result is normal when the elbow does not drop backward, meaning that it remains in front of the trunk (Figure 5b). A positive test, sign of subscapularis weakness, is when the elbow drops back behind the trunk.

**Belly-Off Sign[23]—**The examiner assesses the subscapularis in this test by passively bringing the shoulder of the patient into flexion and maximum internal rotation with the elbow 90° flexed. The elbow of the patient is supported by one hand of the examiner while the other hand brings the arm into maximum internal rotation placing the palm of the hand on the abdomen. The patient is then asked to keep the wrist straight and actively maintain the position of internal rotation as the examiner releases the wrist (Figure 5c). If the patient cannot maintain the above position, lag occurs and the hand lifts off the abdomen resulting in a positive belly-off sign. Otherwise, the test is negative.

**Bear Hug Test[10]—**The examiner instructs the patient to place the palm of the involved side on the opposite shoulder, extend the fingers (so that the patient could not resist by grabbing the shoulder), and position the elbow anterior to the body. The examiner then asks the patient to hold that position (resisted internal rotation) as the examiner tries to pull the patient's hand from the shoulder with an external rotation force applied perpendicular to the forearm (Figure 5d). The test is considered positive indicating subscapularis weakness if the patient cannot hold the hand against the shoulder or if he or she shows weakness of resisted internal rotation of greater than 20% compared with the opposite side. If the strength is comparable to that of the opposite side, without any pain, the test is negative.

## Tests for Supraspinatus and Infraspinatus

**External Rotation Lag Sign at 0 Degrees[14]—**The patient is seated with his or her back to the physician. The elbow is passively flexed to 90°, and the shoulder is held at 20° elevation (in the scapular plane) and near maximum external rotation (i.e., maximum external rotation minus 5° to avoid elastic recoil in the shoulder) by the physician. The patient is then asked to actively maintain the position of external rotation as the physician releases the wrist while maintaining support of the limb at the elbow (Figure 6a). The sign is positive when a lag, or angular drop, occurs. The magnitude of the lag is recorded to the nearest 5°. A positive test indicates postero-superior cuff (supraspinatus and infraspinatus) deficiency[37].

**External Rotation Lag Sign at 90 Degrees (Drop Sign)[14]—**The patient is seated with his or her back to the physician, who holds the affected arm at 90° of elevation (in the scapular plane) and at almost full external rotation, with the elbow flexed at 90° (Figure 6b). In this position the maintenance of the position of external rotation of the shoulder is a function mainly of the infraspinatus. The patient is asked to actively maintain this position as the physician releases the wrist while supporting the elbow. The sign is positive if a lag or 'drop' occurs. The magnitude of the lag is recorded to the nearest 5°. A positive test indicates postero-inferior cuff deficiency[37].

**Jobe's Test (Empty Can Test)[15]—**This test is performed by first assessing the deltoid with the arm at 90° of abduction and neutral rotation. The shoulder is then internally rotated and angled forward 30°; the thumbs should be pointing toward the floor (Figure 6c). Manual muscle testing against resistance is performed with the examiner pushing down at the distal forearm. This test is regarded as positive when there is weakness to resistance with arm in 90° of abduction as compared with when it is angled forward 30°, and is indicative of supraspinatus pathology.

**Drop Arm Test[25]—**This test assesses the supraspinatus and is performed by passively abducting the patient's shoulder to 180 degrees and then observing as the patient slowly lowers the arm to the waist. This test is positive when the arm drops to the side. The patient may be able to lower the arm slowly to 90 degrees (because this is a function mostly of the deltoid muscle as opposed to the supraspinatus) but will be unable to continue the maneuver as far as the waist. In this case, too, the test is positive.

### Test for Teres Minor

**Hornblower's Sign[38]—**The examiner supports the patient's arm at 90 degrees of abduction in the scapular plane with elbow flexed at 90 degrees. The patient then attempts external rotation of the forearm against resistance of the examiner's hand. If the patient cannot externally rotate, they assume a position characteristic of a positive hornblower's sign (Figure 7).

### Test for Biceps Tendon

**Speed's Test[39]—**The patient is asked to flex his shoulder (elevate it anteriorly) against resistance (from the examiner) while the elbow is extended and the forearm supinated (Figure 8). The test is positive when pain is localized to the bicipital groove for biceps tendon pathology.

### Impingement Signs

**Neer's Sign[21]—**The impingement sign is elicited with the patient seated and the examiner standing. Scapular rotation is prevented with one hand while the other hand raises the arm in forced forward elevation, causing the greater tuberosity to impinge against the acromion (Figure 9). A positive test is if the maneuver produces pain.

**Hawkin's Sign[13]—**The examiner forward flexes the humerus to 90° and forcibly internally rotates the shoulder. This maneuver drives the greater tuberosity farther under the coracoacromial ligament. Pain with this maneuver is considered positive for impingement.

## DISCUSSION

We present a structured physical examination protocol for evaluation of the rotator cuff. The protocol is based on prior literature and the clinical experience of the authors. The examination will assist in diagnosis of impingement syndrome, rotator cuff tears, and biceps tenosynovitis. Structural diagnosis of rotator cuff tear requires imaging.

Shoulder pain is a common presenting symptom in musculoskeletal clinics. Rotator cuff disorders are often the cause of shoulder pain. The available literature on special tests and other physical examination maneuvers is extensive and focuses on specific tests. Often, tests described in the literature have limited data to support their use. As a result, it is difficult for a practicing clinician to discern what tests are most useful. Clinicians heavily rely on MRI for diagnosis of rotator cuff disorders. MRI is not only expensive but also difficult to put into clinical context since more than 40 percent of asymptomatic individuals who are 50 years and older have abnormalities on shoulder MRI[40,41]. Diagnostic shoulder ultrasound is a less expensive alternative to MRI in the diagnosis of rotator cuff disorders[42]. Tennent et al. presented a review of the special tests associated with rotator cuff tears[24]. Our study focuses on providing the clinician with a tool to diagnose rotator cuff tears and includes several examination maneuvers in addition to special tests. Our study synthesizes data from prior literature and presents a physical examination protocol including select tests. In our practices, this protocol takes 10–15 minutes to complete. In some cases if the clinician cannot dedicate 10–15 minutes for physical examination, we suggest that they select from the presented tests based on their clinical judgment and suspicion.

The protocol presented in this review has important clinical implications and limitations. Rotator cuff disorders can be localized to the specific tendon that is involved from the plane of range of motion or muscle group strength that is limited. Supraspinatus assists in elevation (abduction) of the arm; infraspinatus and teres minor in external rotation, and; subscapularis in internal rotation. Range of motion and strength testing can also be used to follow patients longitudinally and assess for improvement after non-operative or operative intervention. Usually the active range of motion is limited in rotator cuff tears whereas both active and passive ranges of motions are restricted in glenohumeral osteoarthritis and adhesive capsulitis. Age standardized values for dynamometry testing are available.[43] However, this data has not been validated in subsequent studies and is not specific for rotator cuff disorders. Kim et al. have presented data on shoulder strength using dynamometry for abduction and external rotation in subjects with and without rotator cuff tears[44]. However, this data has also not been reproduced in other studies. We recommend comparison to the contralateral side for strength measurements and range of motion testing.

The special tests described in this review evaluate specific tendons of the rotator cuff. The Jobe's test and drop arm test evaluate the supraspintus whereas the lift-off test, passive lift-off, and external rotation lag signs assess the infraspinatus and teres minor. The belly press test, belly-off sign, and bear hug test are specific to the subscapularis. Neer's sign and Hawkin's sign test for impingement that may result from outlet obstruction or non-outlet impingement syndrome[21]. Internal impingement of the shoulder has also been described as a distinct entity due to excessive or repetitive contact of the greater tuberosity of the humeral head with the postero-superior aspect of the glenoid[45]. The causes of internal impingement include articular-sided rotator cuff tears and labral tears/fraying. There is little to no data on differentiating partial-thickness tears from full-thickness tears for these tests.

The biceps tendon is often affected in rotator cuff disorders and there are surgical and interventional implications for associated biceps pathology[46–48]. Speed's test and tenderness in the bicipital groove assess biceps tenosynovitis/biceps tendonitis. If the biceps tendon/tendon sheath is invloved, a biceps tenodesis/tenotomy is often indicated during surgical intervention[47,49]. If non-surgical intervention is pursued, physical therapy or an ultrasound guided injection of steroid in the biceps tendon sheath is an option[50,51]. Similarly if the acromioclavicular joint is tender, a distal clavicle excision or acromioclavicular joint injection may be indicated[52,53].

We present special tests that have better sensitivity and specificity for rotator cuff tears. However, overall the studies[5,8,10–12,17–19,22,23,26–30,54,55] in this area have numerous drawbacks. These include retrospective study design, recruitment of patients from surgical clinics, and use of arthroscopic findings as gold standard that leads to biased estimates for sensitivity and specificity due to inclusion of only patients undergoing surgery who have a high probability of rotator cuff tear. The sensitivities and specificities of special tests have wide ranges from different studies and in some cases are low. This may lead to missed cases. Therefore, the clinician should also rely on their clinical judgment and not solely on these tests. Further discussion on sensitivity and specificity of special tests is beyond the scope of this manuscript.

## Conclusion

In this clinical review, we present a thorough evaluation of the rotator cuff for a musculoskeletal/sports medicine practitioner. This review can also be a useful teaching tool for practicing clinicians, fellows, and residents. The physical examination should also be put in clinical context with patient's presentation and imaging findings. The physical examination protocol can be used in patients where rotator cuff tears, impingement syndrome, and biceps tenosynovitis are suspected.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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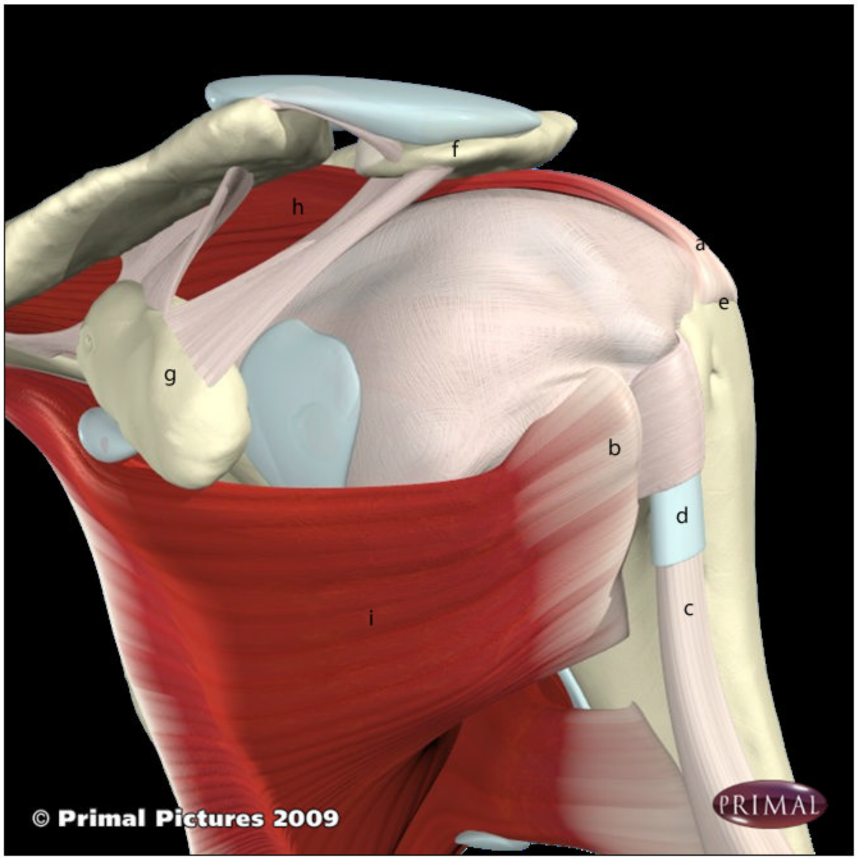


**Figure 1. Anatomy of the anterior rotator cuff (reproduced and modified with permission from Primal Pictures Limited)**

a=Supraspinatus tendon; b=Subscapularis tendon; c=Long head of biceps brachii tendon; d=Long head of biceps brachii tendon sheath; e=Greater tuberosity of the humerus; f=Acromion; g=Coracoid; h=Supraspinatus muscle; i=Subscapularis muscle

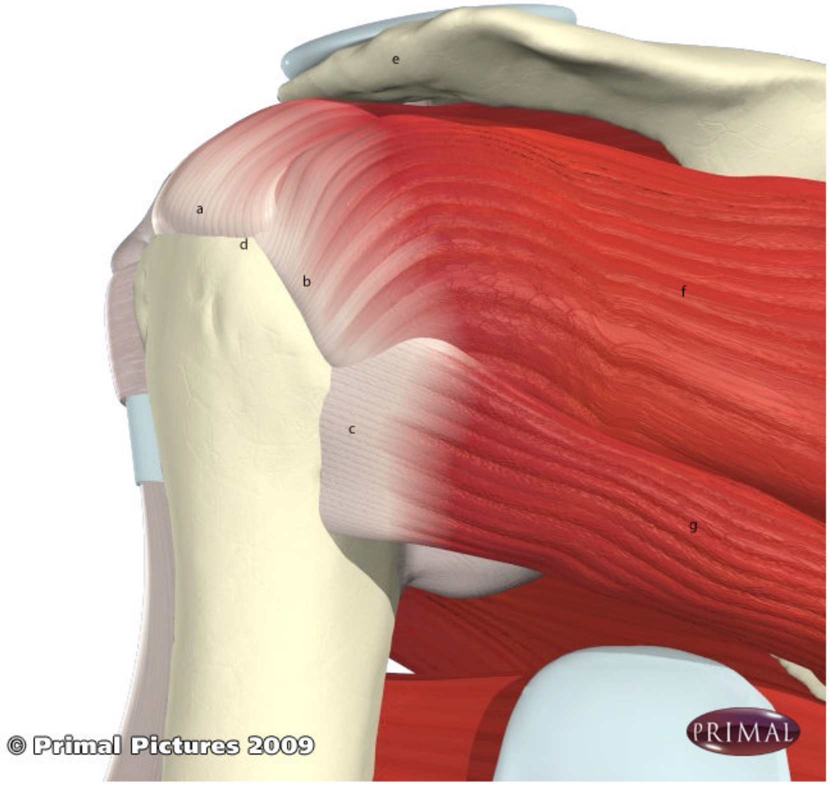


**Figure 2. Anatomy of the posterior rotator cuff (reproduced and modified with permission from Primal Pictures Limited)**

a=Supraspinatus tendon; b=Infraspinatus tendon; c=Teres Minor tendon; d=Greater tuberosity; e=Acromion; f=Infraspinatus muscle; g=Teres Minor muscle


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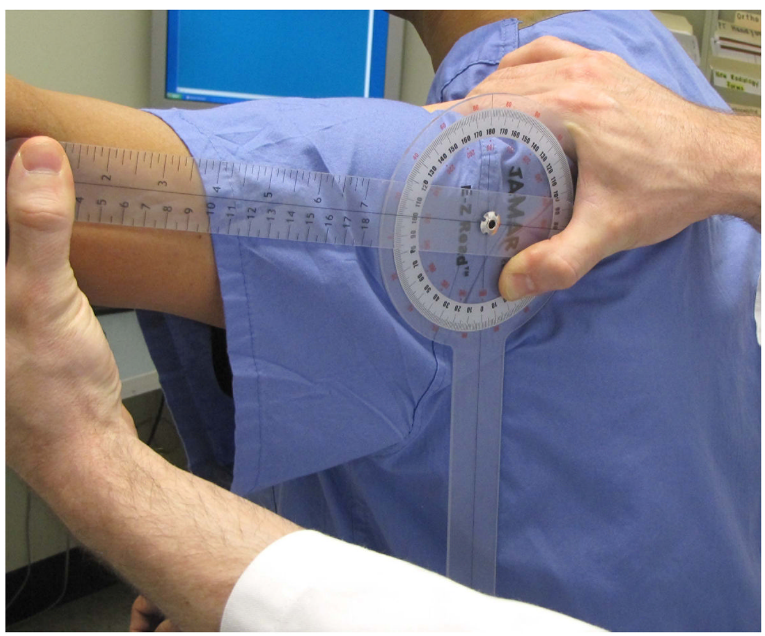
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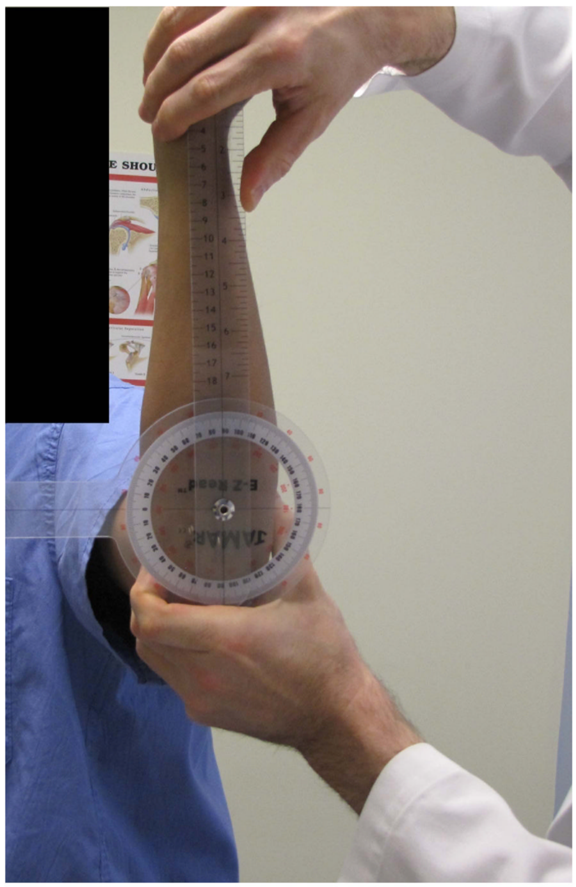

**Figure 3. Range of motion testing**

a. Forward flexion

b. Isolated abduction

c. External rotation in neutral

d. External rotation in abduction

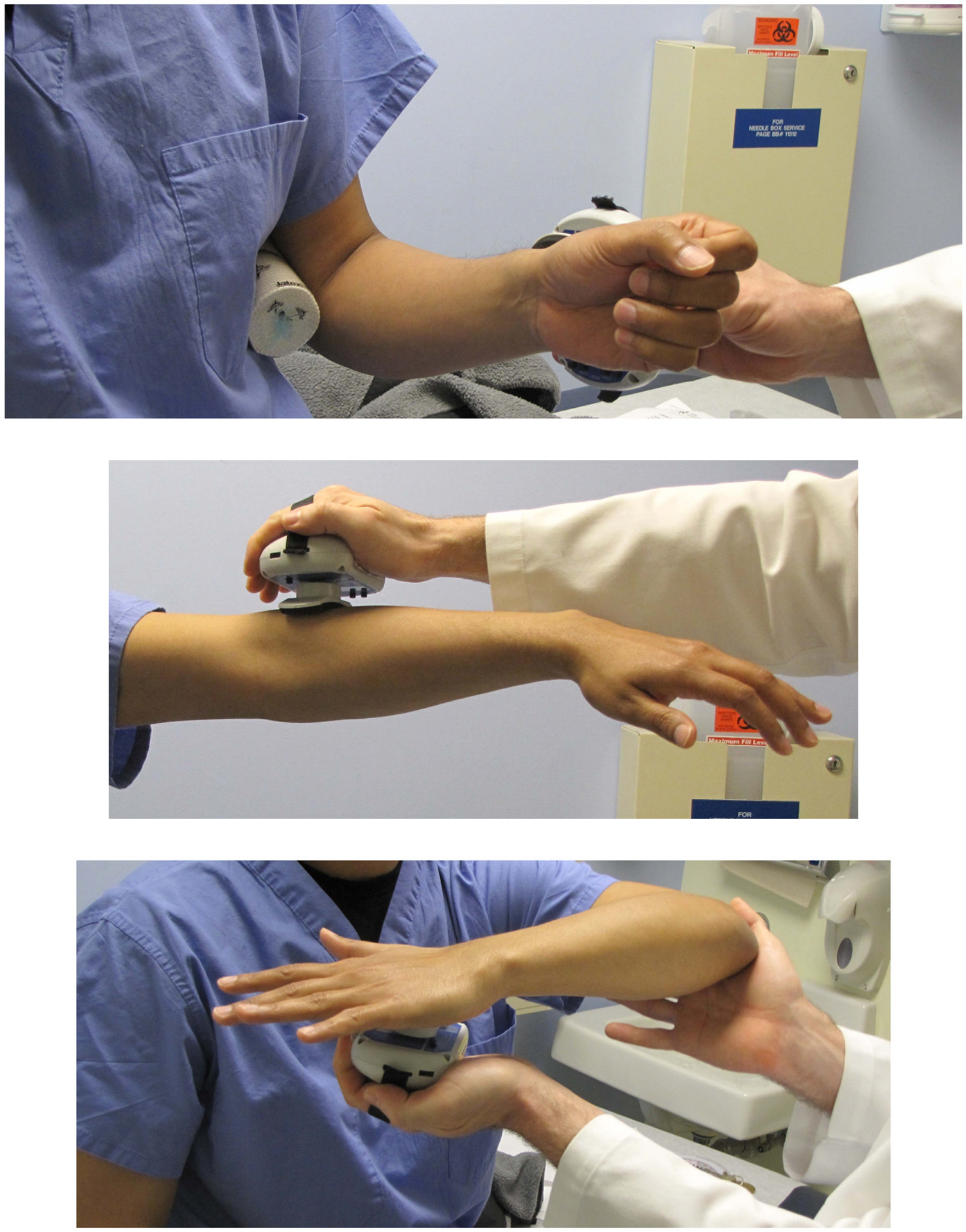

**Figure 4. Strength testing using a dynamometer**

a. External rotation

b. Abduction

c. Internal rotation


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**Figure 5. Special tests for subscapularis**

a. Lift-off test

b. Belly-press test

c. Belly-off sign

d. Bear hug test

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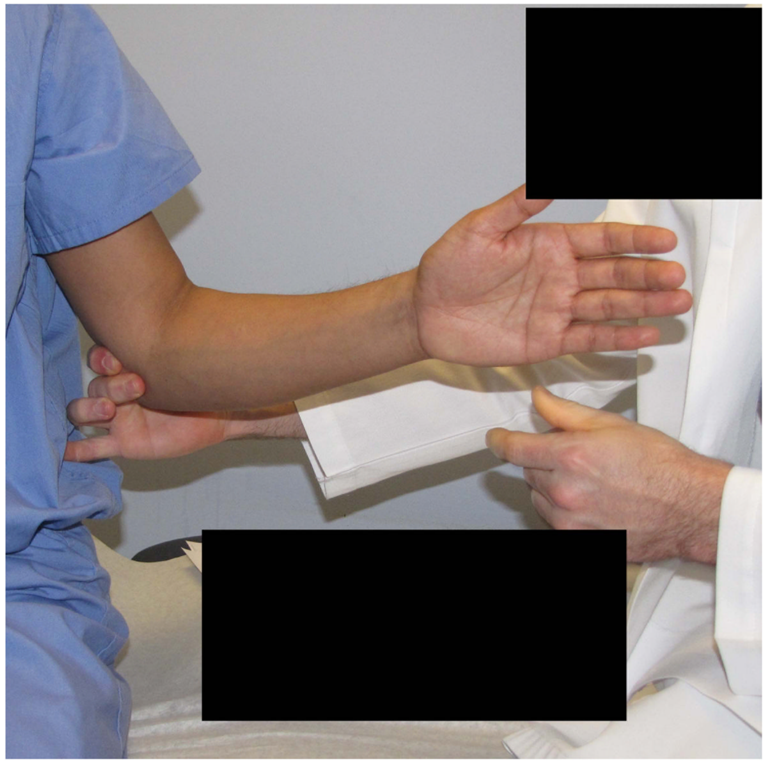

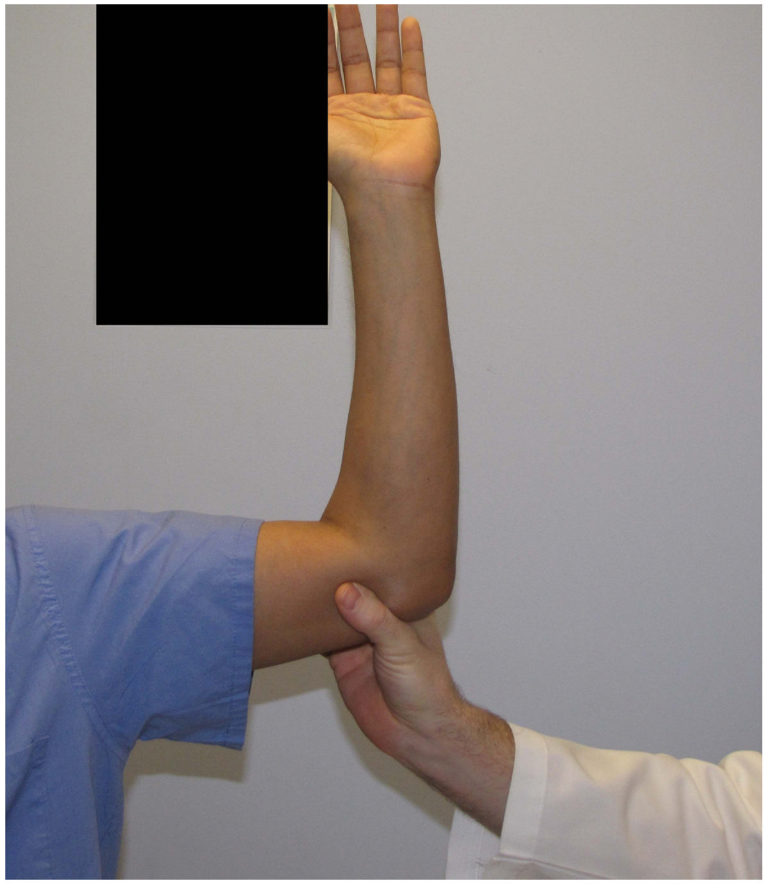

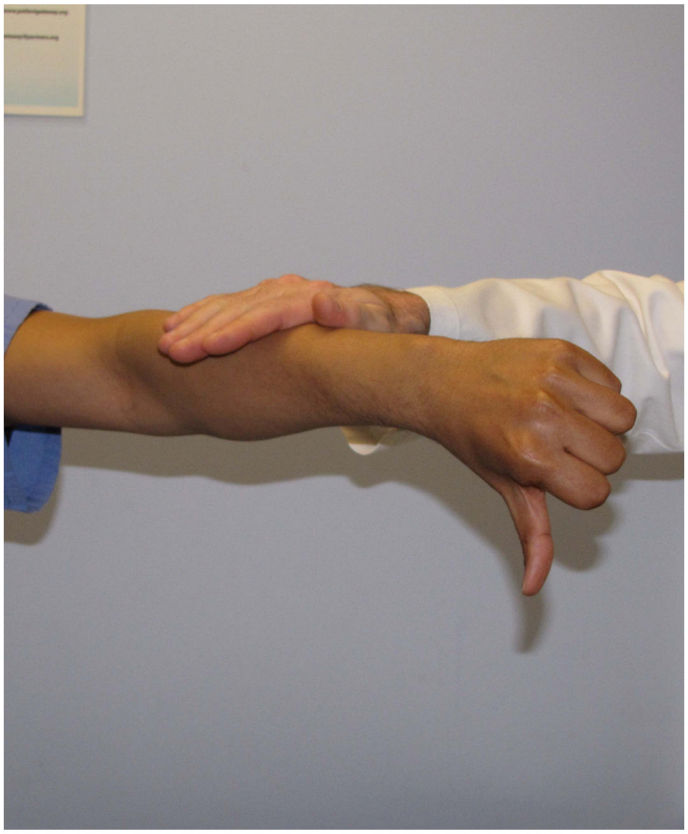

**Figure 6. Special tests for supraspinatus and infraspinatus**

a. External rotation lag sign in neutral

b. External rotation lag sign in abduction

c. Jobe's test

**Figure 7. Hornblower's Sign**

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**Figure 8. Speed's test**

**Figure 9. Neer's sign**

## Table 1

Sensitivity and Specificity of Special Tests for Rotator Cuff Tears

| Test | Range of Diagnostic Values (%) | References |
|---|---|---|
| **Subscapularis** | | |
| Life-off test (and lag sign) | Sensitivity: 17–100<br>Specificity: 60–98 | 10,12,14,19,23,56 |
| Belly press test | Sensitivity: 40–43<br>Specificity:93–98 | 10,57 |
| Belly-off sign | Sensitivity: 14–86<br>Specificity: 91–95 | 23,57,58 |
| Bear hug test | Sensitivity: 60<br>Specificity: 92 | 10 |
| **Supraspinatus and Infraspinatus** | | |
| External rotation lag sign | Sensitivity: 46–98<br>Specificity: 72–98 | 14,19,38 |
| Jobe's test | Sensitivity: 53–89<br>Specificity: 65–82 | 22,57,59,60 |
| Drop arm test | Sensitivity: 10–73<br>Specificity: 77–98 | 19,22,57,61 |
| **Teres Minor** | | |
| Hornblower's sign | Sensitivity: 100<br>Specificity: 93 | 38 |
| **Biceps Tendon** | | |
| Speed's test | Sensitivity: 53<br>Specificity: 67 | 62 |
| **Impingement Signs** | | |
| Neer's sign | Sensitivity: 68–89<br>Specificity: 49–98 | 17,22,56 |
| Hawkin's sign | Sensitivity: 72–92<br>Specificity: 44–78 | 17,22,56 |