Shoulder Examination

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Introduction

Shoulder disease ranks among the most common musculoskeletal disorders, being the third cause of musculoskeletal disease (16 %), after the back (23 %) and knee (19 %) [1].

They represent one of the main reasons for orthopedic consult. Modern imaging studies help the specialists in the diagnosis, but an accurate history and physical examination should be the first step to determine which pathology is primarily responsible for the patient's complaints.

The shoulder is one of the most complex joints in the human body. Its evaluation is a challenge because different joints participate to the motion and direct observation of those simultaneous movements is obscured by muscles [2].

Physical examination consists of different phases: inspection and palpation, evaluation of joint motion, and specific tests. Depending on the suspected pathology, the clinician should perform tests to assess shoulder stability, rotator cuff deficiency, impingement, biceps tendon diseases, and SLAP lesion.

It is necessary to premise that many tests are eponymous, and several investigators have described more than one test leading to confusion [3]. Moreover, some tests are not sufficiently evaluated and rarely compared with a diagnostic gold standard (e.g., arthroscopic or open-shoulder surgery) [2]. Misquoting or misinterpretation of tests by subsequent investigators has compounded this problem. For these reasons, it is important to know the proper way to perform tests, as well as their sensibility and specificity, in order to rationally use them to assess shoulder diseases.

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Inspection and Palpation

Shoulder examination starts with the inspection and palpation. Both shoulders should be observed in order to identify deformity of the clavicle and difference in shoulder height. A prominent acromioclavicular joint is often secondary to osteoarthritis, while a prominent sternoclavicular joint can also be due to anterior dislocation, inflammation of the synovium, infection, or condensing osteitis. Difference in shoulder height can be correlated with scapulothoracic or glenohumeral problems. Scapular positioning is observed at rest, comparing the medial border and the inferior edge with that of the unaffected shoulder. Scapular asymmetry has been described in athletes (tennis shoulder or protracted scapula) [4–6], and some authors suggested it predisposes to rotator cuff impingement [7]. Scapular winging (prominence), resulting from lesion of the spinal accessory nerve (lateral) or lesion of the long thoracic nerve (medial), is accentuated by forward flexion of both arms to 90° [8, 9]. Evaluation of scapular motion is also important to screen for dyskinesis [10, 11].

Muscle inspection requires evaluation at rest and during motion. It will allow to better point out deficiencies in the posterior or middle deltoid. Atrophy of the muscle in the supraspinatus fossa or below the spine of the scapula is typical of patients with chronic rotator cuff tears. Palpation of the muscle belly is useful to distinguish a pathologic muscle contraction. It is needed especially for patients with large amount of subcutaneous tissue.

The sternoclavicular and acromioclavicular joints, the acromion, the greater tuberosity, the bicipital groove, the trapezius, the superior-medial tip of the scapula, and the posterior glenohumeral joint line are palpated for deformity and tenderness.

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Joint Motion

All joints around the shoulder girdle (glenohumeral, scapulothoracic, acromioclavicular, and sternoclavicular) participate to the shoulder motion. In measuring the ROM, the total motions are recorded. The unaffected shoulder should be examined at first to compare the deficit. Both passive and active motion should be valued in the cardinal planes: elevation in the scapular plane, external rotation with the elbow at the side, and internal rotation. In patients with isolated rotator cuff pathology, only active motion is affected.

Stability is assessed by external and internal rotation with the arm in 90° of abduction.

Stability Assessment

Specific tests can be used to diagnose pathologic instability. They include sulcus test, glenohumeral translation, anterior and posterior drawer tests [12], apprehension tests [13], relocation test [14], release test [15], and jerk test.

Sulcus Test

The *sulcus test* is performed with the arm adducted. The arm is pulled down by the examiner who measures the translation of the humeral head from the acromion (1+ for 1 cm, 2+ for 2 cm).

Glenohumeral Translation

The glenohumeral translation is assessed with the arm at rest and the examiner stabilizing the scapula. The examiner, with the other hand, applies an anterior and posterior translation force to the humeral head and defines the percentage of subluxation (Fig. 3.1). The test can be repeated for different degrees of internal and external rotation as well as different degrees of abduction.

Drawer Tests

The *drawer test* is performed with the patient supine and the arm abducted to 60° [12]. The examiner applies an axial force to hold the arm in neutral rotation and, with the other hand, translate the humeral head both anteriorly and posteriorly. Grade I is a translation over the rim, grade II is a translation that spontaneously reduces, and grade III is a dislocation without spontaneous reduction.

Fig. 3.1 Assessment of humeral head translation on the glenoid

Apprehension, Relocation, and Release Tests

The *apprehension test* is performed with the patient supine [13]. The examiner abducts the arm to 90° and slowly externally rotates the shoulder to 90° (Fig. 3.2). The test is positive if it causes any apprehension. From this position the *relocation test* can be performed [14]. The examiner applies a posterior force against the humeral head (Fig. 3.3). It moves from an anteriorly subluxed position to the center of the glenoid. The test is positive if the maneuver decreases patient's apprehension.

The sensitivity and specificity of these tests were reported to be 72 and 96 % for the apprehension test and 81 and 92 % for the relocation test [16].

The *release test*, or *surprise test*, consists in the sudden removal of the posteriorly directed force from the relocation test [15]. This maneuver stresses maximally the anterior structures. The test is positive when the patient feels again apprehension. This test has been reported as the most

Fig. 3.2 The position of apprehension for patients with anterior instability

Fig. 3.3 The relocation test

accurate individual examination maneuver [17]. However, the predictability of anterior glenohumeral instability is higher when all three tests are positive.

Jerk Test

Posterior instability is valued by the *jerk test*, also known as *Jahnke test* or *posterior load test*. It is performed with the patient standing or sitting. The examiner holds patient's elbow with one hand and stabilizes the scapula with the other hand. The shoulder is flexed to 90°, internally rotated and adducted, applying a posterior load. The test is positive when the humeral head relocates into the glenoid determining a clunk.

Rotator Cuff Tests

Several clinical tests have been described to investigate rotator cuff deficiency. It is not feasible to use all of them at every examination. They should be used selectively and should be tailored to the clinical condition suspected [18]. However, there is lack of consensus from the available literature on the contribution of each test in the differential diagnosis of shoulder pain [3]. Only few tests show both high sensitivity and specificity. The reason for poor accuracy may be related to close relationships of structures in the shoulder [19], lack of understanding of the anatomical basis of the test [20], and lack of reproducibility.

The combination of information about mechanism of injury, pain behavior, and location of pain with conventional radiographic signs might provide a more accurate evaluation of clinical conditions.

Supraspinatus Tendon Tests

The supraspinatus is a long, thin muscle, whose function is to elevate the humerus. It arises from the dorsal surface of the scapula, in the supraspinatus fossa, and from the fascia covering the muscle. It passes over the top of the shoulder joint and its tendon inserts on the upper aspect of the greater tuberosity. It acts as an elevator of the shoulder, as the deltoid. For this reason, it is difficult to distinguish their activities. Moreover, physical examination can be hindered by patient's pain. In this case, subacromial lidocaine injection can help distinguish patient's weakness due to this factor.

The following are some of the main tests for the supraspinatus tendon.

Empty Can Test

The *empty can test* is also known as the *supraspinatus test* or the *Jobe test* [21]. Patient's shoulder is abducted of 90° in the scapular plane and internally rotated (thumb pointing downward). The examiner pushes patient's arm downward asking the patients to resist the pressure. The test is positive when pain or weakness arises (Fig. 3.4).

Fig. 3.4 The empty can test (or Jobe test) is performed placing patient arms in 90° abduction and 30° horizontal adduction (in the plane of the scapula) with thumbs pointing downward so as to produce internal rotation of the shoulder. The examiner then pushes the patient's arms downward while asking the patient to resist the pressure. Pain or weakness is indicative of a positive test

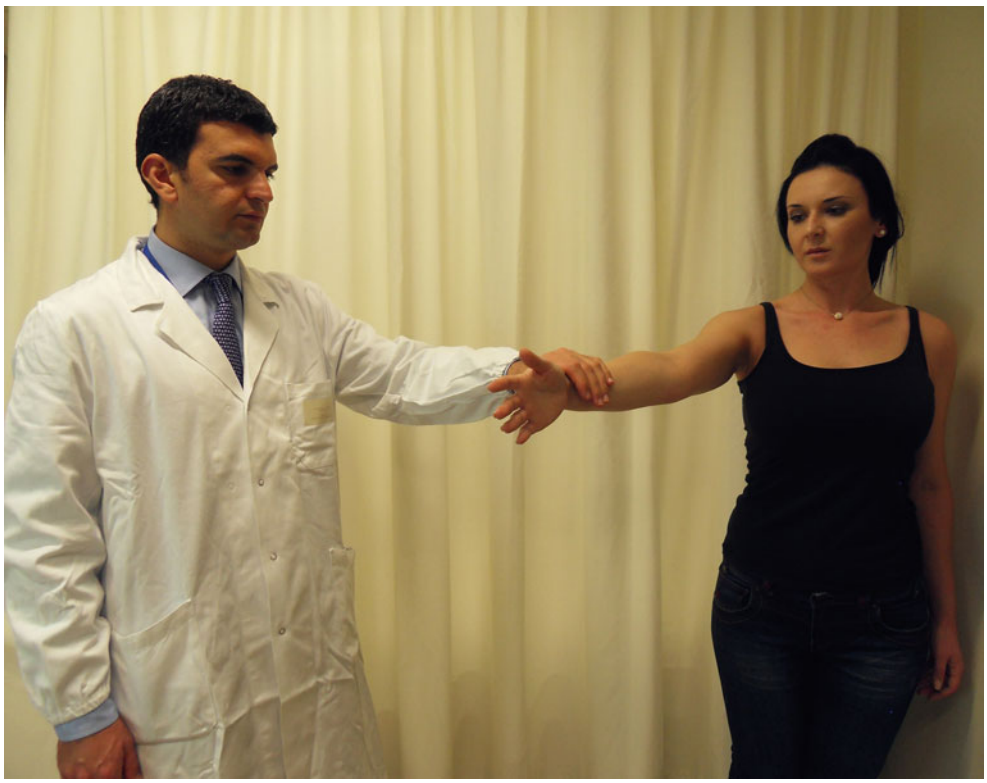

Fig. 3.5 The full can test is performed with patient's arms in 90° abduction in the scapular plane and rotated 45° externally, with the thumb pointing upwards. The sign is positive when there is pain or weakness at the downward pressure applied by the examiner

Sensitivity and specificity of the empty can test were reported to be greater than 80 % in different studies [22–30].

Full Can Test

The *full can test* is performed with patient's shoulder abducted to 90° in the scapular plane and externally rotated (thumb pointing upward). As for the empty can test, patient is asked to maintain the position while the examiner apply a downward force. The test is positive when pain or weakness arises (Fig. 3.5). Studies reported a sensitivity from 34.5 [23, 31] to 83 % [23] and a specificity from 30.8 [31] to 81 % [25].

Resisted Isometric Abduction

The resisted isometric abduction [32] is performed with patient's shoulder abducted to 90° and arm in neutral rotation. The examiner applies a downward force asking the patients to resist. Pain or weakness indicates a positive test. This test was reported among the most sensitive tests for the diagnosis of full-thickness tears [31].

Resistance Test

The *resistance test*, or the *gum-turn test* [33], is performed with the shoulder at 90° of abduction, 20–30° forward elevation and external rotation. Patient is asked to follow the path of a drawn spiral (width = 20 cm) for 20 times. If patient is not able to conclude it, because of weakness or pain, the test is positive. The resistance test was introduced and evaluated by Gumina et al. [33], who reported 55 % of sensitivity and 98 % of specificity.

Painful Arc Test

Patient is standing and is asked to abduct the arm with the shoulder externally rotated (palm facing up). If pain is experienced between 60° and 120°, the test is considered positive. Sensitivity ranges from 9.5 [34] to 97.7 % [35] and specificity from 9.9 [35] to 88.4 % [34].

Palpation of the Supraspinatus

With the elbow flexed to 90°, the shoulder is externally and internally rotated and then hyperextended. Palpating the top of the humeral head, a "sulcus" can be felt. The maneuver was first described by Codman [36]; subsequent studies reported good sensitivity and specificity (95.7 and 96.8 %, respectively) [34].

Drop-Arm Test for Supraspinatus

The *drop-arm sign* was described by Codman [37]. Patient elevates the arm fully and then slowly reverses the motion. A sudden drop or onset of pain is indicative of a positive test. Sensitivity was reported from 4.4 [38] to 73 % [39] and specificity from 77 [39] to 100 % [38].

Infraspinatus and Teres Minor Tendon Tests

The infraspinatus is a thick triangular muscle, with three pennate origins that arise from the infraspinatus fossa and insert on the greater tubercle, below the footprint of the supraspinatus.

The teres minor arises from the upper two-thirds of the dorsal surface of the lateral border of the scapula and from the septa between it and the infraspinatus. It inserts on the greater tuberosity below the insertion of the infraspinatus.

The infraspinatus and the teres minor externally rotate the shoulder. Their action is more easily differentiable from that of the deltoid that has a limited ability to externally rotate the humerus.

External Rotation Strength Test

The *external rotation strength test*, also known as *Patte test* [40], is performed with the examiner holding patient's elbow in 90° of forward elevation in the plane of the scapula. The patient is asked to externally rotate the arm against resistance.

External Rotation Lag Sign (ERLS)

The examiner externally rotates patient's arm as far as it will go passively, with the elbow flexed to 90° and the shoulder elevated to 20° in the scapular plane. Then, the examiner asks the patient to maintain the external rotation while supporting only the elbow. The test is positive when a lag or angular drop occurs. The external rotation lag sign has good specificity, from 91 [41] to 100 % [28].

Drop Sign

The *drop sign* is similar to the external rotation lag sign. They differ in the degrees of shoulder elevation. In this case the shoulder is placed at 90° of elevation in the scapular plane.

Dropping Sign

Patient's shoulder is adducted and the elbow is flexed to 90°. The examiner externally rotates patient's arm to 45° and then asks the patient to maintain the position. The test is positive when he fails to maintain external rotation and the forearm drops back to 0°. The sign was described as extremely sensible (100 %) and specific (100 %) [42].

Weakness with External Rotation

Patient's arms are alongside the body, elbows are flexed to 90° with thumbs up, and the shoulders are internally rotated to 20°. The examiner places his hands on the back of patient's hands and pushes the forearm internally (Fig. 3.6).

Subscapularis Tendon Tests

The subscapularis muscle arises from the subscapularis fossa and inserts on the lesser tuberosity of the humerus. It is an internal rotator of the shoulder, but its function is difficult to isolate with a single test because of the contribution of others muscles to this motion.

Lift-Off Test

The *lift-off test* was described in 1991 by Gerber and Krushell [43]. Patient places the hand on the back at waist level and then lifts the hand away from the body. The test is positive if he/she can perform this maneuver (Fig. 3.7). However,

Fig. 3.6 Weakness with external rotation is evaluated with the patient sitting or standing with the arms alongside the body. The elbows are flexed to 90° with the thumbs up, with the shoulders rotated internally 20°. The examiner places his hands outside those of the patient's and directs the patient to resist attempts at pushing the forearm internally

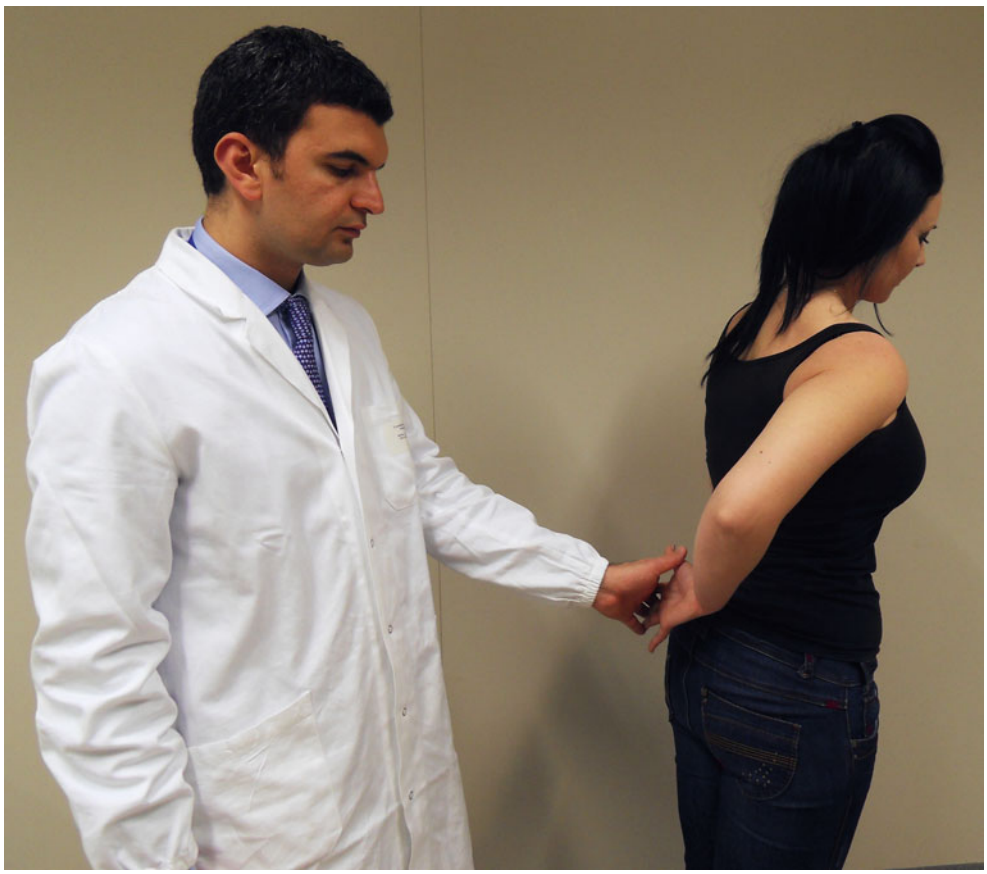

Fig. 3.7 The lift-off test is performed by placing the hand of the affected arm on the back (at the position of the midlumbar spine) and asking the patient to internally rotate the arm to lift the hand posteriorly off of the back. The test is considered positive if the patient is unable to lift the arm posteriorly off of the back or if he/she performs the lifting maneuver by extending the elbow or the shoulder

frequently patients have an internal rotation contracture that prevents from passively placing the hand behind his/her back.

The lift-off test reported a wide range of sensitivity, from 17.6 [35] to 94 [44], and good specificity, from 69 [35] to 100 [45].

Internal Rotation Lag Sign (IRLS)

The *internal rotation lag sign* is similar to the lift-off test. In this case the examiner lifts patient's hand from the back until full internal rotation. Then, the patient is asked to maintain this position while the examiner holds the elbow. The test is positive when a lag occurs.

Studies showed good sensitivity (97–100 %) and specificity (84–96 %) [28, 39, 44].

Belly Press Test

The *belly press test* was described by Gerber et al. in 1996 [46]. It requires less internal rotation than the lift-off test because the hand is not rotated behind the back. Patient's arm is at the side, the elbow is flexed to 90°, and the palm is placed on the belly. The patient should push the palm into his/her abdomen by internally rotating the shoulder. The test is positive if he/she shows weakness or needs to extend the elbow or the shoulder to exert force (Fig. 3.8).

This test seems to be a specific test for subscapularis muscle tendon tear [35, 44], even if its specificity is lower than the lift-off test.

Napoleon Test

The *Napoleon test* is a variation of the belly press test. Starting with the hand placed on the belly, patient should bring the elbow anteriorly without moving the entire shoulder girdle forward. The examiner can also test muscle strength by holding resistance against patient's elbow. The test is positive if the maneuver produces pain and/or weakness.

The sensitivity ranges from 25 to 98 %, while specificity is around 97 % [35, 44].

Bear-Hug Test

The bear-hug test was described by Barth et al. in 2006 [35]. Patient places the hand on the contralateral shoulder with the examiner holding the elbow anterior to the body. Patient should resist examiner's attempt to raise the hand. The test showed good specificity, even if lower than that of the lift-off test [35, 44].

Impingement Tests

Neer Impingement Sign and Test

The *Neer impingement sign* was first reported in 1972 and later fully described in 1983 [47]. It was originally performed with the examiner stabilizing the scapula with one

Fig. 3.8 Belly press test is performed with the arm at the side and the elbow flexed to 90°, by having the patient press the palm into his or her abdomen by internally rotating the shoulder. The test is considered positive (1) if the patient shows a weakness in comparison to the opposite shoulder or (2) if the patient pushes the hand against the abdomen by means of elbow extension or shoulder extension, indicating inability to exerting a force against the abdomen by active internal rotation produced by the subscapularis

hand and the other hand elevating patient's arm in the plane of the scapula. The maneuver was modified placing the patient supine to minimize scapular rotation. The arm is brought into full forward flexion and internal rotation to further accentuate supraspinatus impingement underneath the coracoacromial arch. Even if the sign has good sensitivity, its specificity is limited because other shoulder pathologies, especially Bankart lesions, SLAP lesions, and acromioclavicular joint arthritis, often cause pain with this maneuver [48].

The *Neer impingement test* is performed after a positive Neer sign by injecting 5 mL of 1 % lidocaine into the subacromial space. It will reduce or avoid pain when the Neer sign is repeated after few minutes.

Hawkins-Kennedy Impingement Test

The *Hawkins-Kennedy impingement test* was described in 1980 [49]. It is based on the same principle of the Neer sign [50]. In this case patient's shoulder is placed in 90° of forward flexion with the elbow bent 90°, and the examiner then forcibly internally rotates the arm. As for the Neer sign, it is sensitive but lacks specificity.

Internal Rotation Resistance Stress Test

Internal rotation resistance stress test should be performed in patients with a positive Neer impingement sign to differentiate subacromial and internal impingement [51]. Patient's arm is positioned in 90° of abduction in the coronal plane and 80° of external rotation. Then, isometric external and internal rotations are tested. Weakness in resisted external rotation indicates subacromial impingement, while weakness in resisted internal rotation indicates internal impingement.

Biceps Tendon Tests

There is a significant crossover between rotator cuff tears and pathology of the long head of the biceps. An accurate history and physical examination are fundamental, especially in the case of biceps tendinitis and instability. Several tests have been described for isolated lesions of the biceps tendon. However, little literature is available on sensitivity and specificity of these tests.

Yergason's Test

Patient's arm is place at side, with the elbow flexed to 90° and hand in pronation. It is asked to supinate the hand against resistance (Fig. 3.9). The test is indicative of biceps tendinopathy if pain rises anteriorly along the bicipital groove or in the anterior shoulder. As the shoulder is not moving, the test allows a more isolated examination of the biceps. In patients with biceps tendinopathy, it was found an incidence of 50 % positivity with this sign [52].

Speed's Test

The Speed's test was first described in 1966 [53]. It is performed with patient's arm placed in 60–90° of forward flexion, the elbow extended, and the hand in full supination. It is asked to resist a downward force at the wrist. The test is positive if it induces pain at the anterior shoulder or in the bicipital groove. Its specificity and sensitivity were reported to be 14 and 90 %, respectively [54].

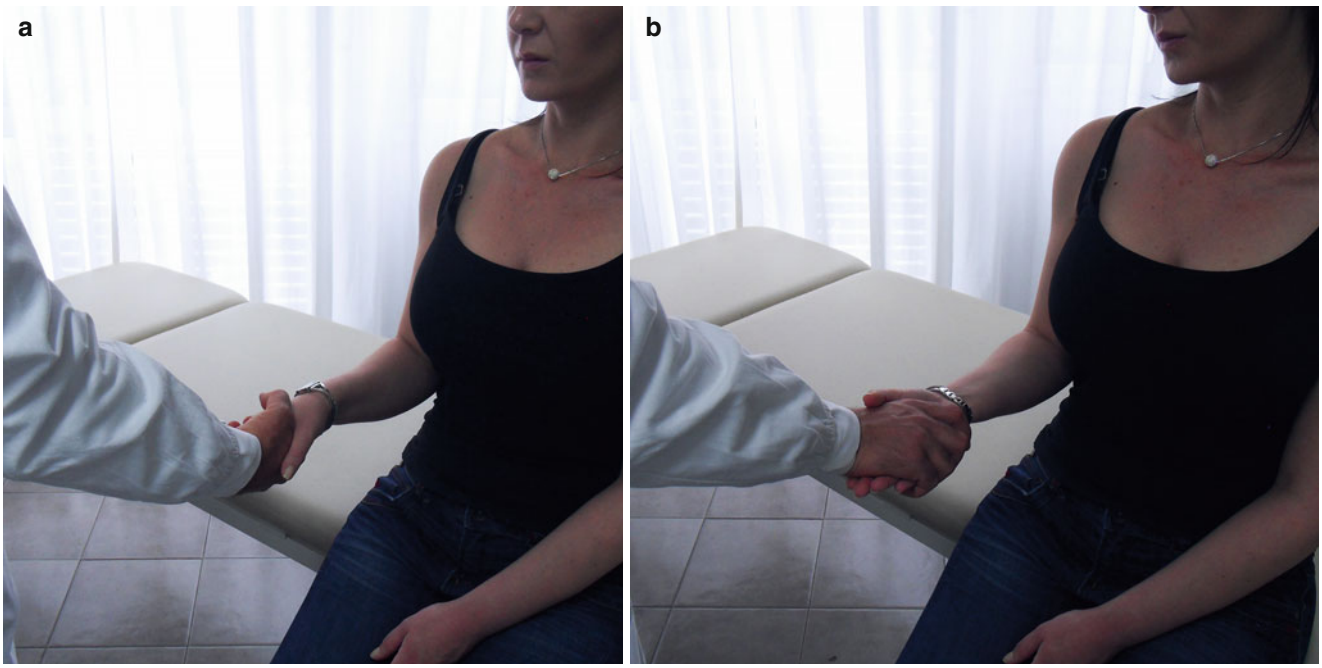

Fig. 3.9 The Yergason's test. Starting from full pronation (**a**), the patient is asked to supinate the hand against resistance (**b**)

DeAnquin's Test

The examiner rotates patient's arm while having his or her finger in the most tender spot in the bicipital groove. The test is indicative of biceps tendinitis if pain rises when tendon glides beneath the finger.

Biceps Instability Test

The *biceps instability test* was described by Abbott and Saunders to identify a complete or incomplete dislocation of the tendon [55]. Patient's shoulder, fully abducted, is slowly brought from complete external rotation to internal rotation. If the biceps tendon subluxates or dislocates from the groove, a painful click can be palpated or audible.

Lippmann's Test

The examiner displaces the tendon from one side to the other, with the elbow flexed. It is necessary to pay attention to roll the subluxed tendon and not the deltoid muscle [56].

Ludington's Test

The *Ludington's test* is performed with patient's hands on top of the head, with palms down and fingers interlocked. Biceps contraction can produce pain in the bicipital groove in the case of tendinitis, or subluxation can sometimes be palpated in the groove.

Superior Labrum Tests

O'Brien Test

The *O'Brien test*, or *active compression test*, was described in 1998 to differentiate acromioclavicular joint pathology and superior labral pathology. It is performed with the shoulder forward flexed to 90° and adducted 15° toward the midline. The examiner produces a downward force with the arm internally rotated (thumb pointing to the floor) and then with the arm in full supination and external rotation (Fig. 3.10). The test is indicative of superior labral pathology when anterior shoulder pain increases with the arm internally rotated and decreases when the arm is externally rotated. In their original study, O'Brien et al. reported sensitivity of 100 % and specificity of 99 % for this test [57].

SLAPprehension Test

The *SLAPprehension test* is a modification of the O'Brien test. In this case the maneuver is performed with patient's shoulder adducted to 45°.

Anterior Slide Test

The *anterior slide test* was introduced in 1995 by Kibler et al. [58]. It is performed with patient's arms akimbo. The examiner places one hand over the top of the acromion and the other hand on patient's elbow where an anterosuperior directed force is exerted. The test is positive if pain or a click is felt over the anterior shoulder. Kibler et al. reported higher specificity (91 %) than sensibility (71 %) for this test [58].

Fig. 3.10 The O'Brien test (active compression test)

Crank Test

The *crank test* is performed with the patient either supine or sitting, the arm axially loaded in 160° of flexion and then internally and externally rotated in an attempt to catch labrum tears between the two joint surfaces. The test is positive if it produces pain, catching, or a click. Sensitivity and specificity have been reported to be 91 and 93 %, respectively [59].

Pain Provocation Test

The *pain provocation test* is performed with the arm abducted to 90° and externally rotated. Patient is asked to place the hand in full supination and then in full pronation (Fig. 3.11). The test is positive if pain increases while the hand is in pronation. The sensitivity of the test is 100 % and its specificity is 90 % [60].

Biceps Load Test I

The *biceps load test I* was first described in 1999 for patients with history of recurrent anterior instability [61]. It is performed in the position of apprehension (90° of abduction and

Fig. 3.11 The pain provocation test. With the arm in 90° of abduction and full external rotation, the hand is placed in full supination (**a**) and then full pronation (**b**). Increased pain in full pronation suggests a SLAP lesion

Fig. 3.11 (continued)

Fig. 3.12 The biceps load test I

full external rotation). The examiner holds patient's arm at that position and exerts a resistance against elbow flexion (Fig. 3.12). The test is suggestive of SLAP lesion if biceps contraction does not change patient's pain and apprehension. It has a sensibility of 91 % and a specificity of 97 % [61].

Biceps Load Test II

The *biceps load test II* was described in 2001 for patients without history of anterior instability. It is performed with patient supine, arm elevated to 120°, in full external rotation, elbow flexed to 90°, and forearm supinated. The patient is asked to flex the elbow against resistance. If the maneuver increases pain, the test is positive. The sensibility has been reported to be 90 % and the specificity 97 % [62].

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