The Injured Shoulder

Primary Care Assessment

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Shoulder problems are the second most common orthopedic complaint in primary care medicine. The range of motion, ligamentous and muscular support, and central location of the shoulder are key factors for the successful performance of persons at work or on the playing field. These special attributes also contribute to injury and to difficulty in assessing the painful shoulder. An understanding of the pertinent anatomic structures, the differential diagnosis of shoulder pain (intrinsic and referred pains), and a systematic approach to the evaluation including a complete history and physical examination are necessary in this assessment. Adequate examination consists of inspection, muscle strength and range-of-motion testing, palpation, and neurologic testing of the shoulder, neck, and elbow followed by special tests to detect impingement, instability, or tendinosis. This basic assessment is augmented by the proper use of radiographs, arthrography, computed tomography, ultrasonography, and magnetic resonance imaging. An adequate database and proper assessment of the injured shoulder allow the primary care physician to make a pathoanatomic diagnosis and formulate an appropriate treatment plan and make appropriate use of orthopedic consultants. *Arch Fam Med. 1997;6:376-384*

Shoulder pain is the second most commonly encountered orthopedic problem in primary care sports medicine (second to knee pain).[1] The shoulder is one of the most difficult joints to evaluate because of its unique range of motion (ROM) and central location, which predispose it to referred pain patterns. Proper assessment of the injured shoulder is paramount to formulating a pathoanatomic diagnosis. We review the pertinent anatomic considerations of the shoulder and describe a thorough and complete clinical assessment of shoulder pain in the primary care setting.

CLINICAL ANATOMY

A complete musculoskeletal evaluation necessitates a thorough understanding of the pertinent functional anatomic structures. The limited bony and ligamentous stability of the shoulder affords an unparalleled ROM. The shoulder comprises 3 joints—the sternoclavicular, glenohumeral, and acromioclavicular (AC) joints—and the scapulothoracic complex (**Figure 1**).[2] Injury to any individual component can effect clinical pathologic lesions in all components.

The sternoclavicular joint is the articulation of the medial clavicle with the sternum and the first rib. The inferior half of the clavicle is involved in the articulation, and the superior portion is prominent.

The AC joint is a diarthroidal joint with articular cartilage, an intra-articular fibrocartilaginous disk, and a tough joint capsule. The ability of this joint to support the suspended upper extremity is enhanced by 2 extra-articular coracoclavicular ligaments: the trapezoid lateral and the conoid medial. The glenohumeral joint consists of a round humeral head on a small, flat glenoid. The surface area of the glenoid is 25% to 33% that of the hu-

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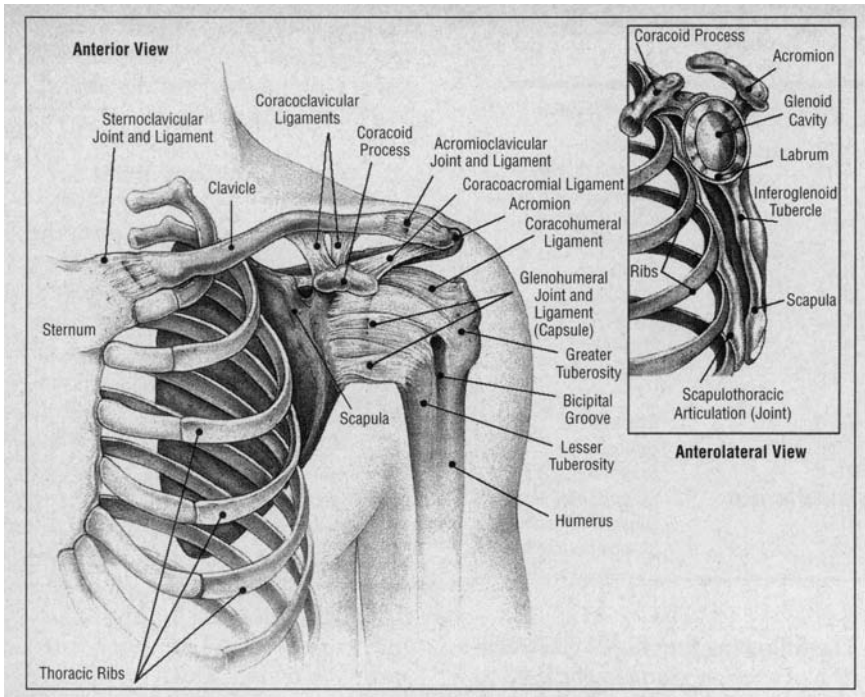

Figure 1. *Anatomy of the shoulder.*

Figure 2. *The rotator cuff.*

meral head. The articular surface of the glenoid is enhanced by a circumferential labrum, which is thought to be a redundant fold of the joint capsule. The glenoid and labrum articulate with 75% of the humeral head. This highly mobile joint is supported by a joint capsule with 3 glenohumeral ligaments: inferior, middle (anterior), and superior. The inferior glenohumeral ligament is the strongest and clinically most important of the 3 ligaments.

The coracoacromial arch is important in the evaluation of the shoulder. As seen from a lateral view, the acromion, the coracoid, and the coracoacromial ligament form a bony and flexible buttress to resist superior translation of the humeral head with abduction.[3]

The scapulothoracic complex represents the gliding relation of the scapula on the rib cage. This articulation has a bursa and is limited only by the actions of the involved musculature: movement superiorly and inferiorly and rotation around the thoracic cage.

The shoulder musculature can be divided into scapulohumeral, scapuloaxial, and axialhumeral groups (**Figure 2**). The scapulohumeral muscles include the rotator cuff muscles and the teres major, coracobrachialis, and deltoid. The rotator cuff consists of the supraspinatus, infraspinatus, and teres minor inserting into the greater tuberosity of the humeral head, and the subscapularis inserting into the lesser tuberosity. The rotator cuff, acting as a force coupler, keeps the humeral head applied to the glenoid through the ROM by depressing the humeral head to counteract the pull of the power muscles (deltoid, pectoralis major, and teres major).[4-6] The tendons of the rotator cuff form a continuous aponeurosis with the joint capsule posteriorly, superiorly, and anteriorly. Between the lesser and greater tuberosities is the bicipital groove, which contains the tendon of the long head of the biceps as it curves over the proximal humerus to insert into the superior aspect of the glenoid. This tendon also assists in limiting upward movement of the humeral head. The deltoid muscle is a major power muscle in the shoulder in abduction, extension, and flexion. The coracobrachialis assists in arm forward flexion (elevation).

The scapuloaxial muscles support and facilitate motion of the scapula to enhance shoulder motion. These muscles are the major and minor rhomboids, levator scapula, trapezius, and anterior and posterior serratus. The axiohumeral muscles enhance the power of shoulder motion and consist of the pectoralis major and latissimus dorsi.

Clinically important bursae of the shoulder include the subacromial, subdeltoid, and subscapular bursae. The subacromial and subdeltoid bursae are confluent and located between the rotator cuff aponeurosis and the coracoacromial arch; they facilitate smooth motion with shoulder motion.

Understanding the relation of the brachial plexus deep to the clavicle and a working knowledge of the innervation of the muscles may help distinguish certain brachial plexus or nerve root problems from musculoskeletal problems. **Table 1** gives a list of the muscles, spinal root, nerves, and action.[4]

Remote bony and soft-tissue structures should be considered in evaluating shoulder complaints, especially in the neck and elbow. Vascular disorders involving the subclavian artery and vein located deep to the clavicle, pleural processes involving the apex of the lung, or referred pain from intra-abdominal processes all can cause shoulder pain.

CLINICAL ASSESSMENT

History

The patient interview is the most important aspect in assessing a pa-

Table 1. Shoulder Musculature

Muscle	Nerve	Spinal Root	Function
Supraspinatus	Suprascapular	C5-6	Abduction
Infraspinatus	Suprascapular	C5-6	External rotation
Teres minor	Axillary	C-5	External rotation
Subscapularis	Subscapular nerves	C5-6	Internal rotation
Deltoid			
Anterior	Axillary	C-5	Elevation
Middle	Axillary	C5-6	Abduction
Posterior	Axillary	C5-6	Extension
Coracobrachialis	Musculocutaneous	C5-6	Elevation
Pectoralis major	Medial and lateral anterior thoracic	C5-8, T-1	Adduction
Latissimus dorsi	Thoracodorsal	C6-8	Extension
Teres major	Lower subscapular	C5-6	Extension
Levator scapula	Dorsal scapular	C3-4	Scapular elevation
Trapezius	Spinal accessory	Cranial nerve XI	Scapular elevation
Rhomboids	Dorsal scapular	C-5	Scapular retraction
Serratus anterior	Long thoracic	C5-7	Scapular protraction

tient with a shoulder complaint. A working differential diagnosis of shoulder pain will help guide questions. Common shoulder diagnoses are given in **Table 2**.[7,8]

The history begins with the identification of the patient's chief complaint. Principal problems include pain, instability (going out), stiffness, weakness, locking, or deformity. Questions should identify whether the injury is related to a single event (macrotrauma), repetitive overload (microtrauma), reinjury of a chronically symptomatic joint, or a systemic problem. Descriptive information such as intensity of the pain, duration of symptoms, and exacerbating and ameliorating maneuvers should be elicited.

For macrotrauma, the examiner should identify the activity or sport being performed at the time of the injury and the exact mechanism of injury. Was there a direct blow to the shoulder or an indirect injury, such as falling on the elbow or arm? Did the patient strike an object, a person, or the ground? Was there immediate pain, swelling, or deformity? When did the injury occur and what treatments have been initiated by the patient or another provider?

For repetitive microtrauma, issues to consider include the sport or occupation; frequency, duration, and intensity of play or work; equipment used; previous injuries; and previous operations or treatments. The following functional classification of overuse pain may be used to grade the severity of injury: type 1, pain only after activity; type 2, pain during activity but not restricting performance; type 3, pain during activity and restricting performance; and type 4, chronic and unremitting pain, even at rest.[9]

The examiner should also ask about problems in other joints, especially the neck and elbow. Night pain or pain when rolling on the shoulder may be observed by the more symptomatic patient but is not specific and may be reported in cases of bursitis, rotator cuff, or injuries with bony origins. Neurologic history for the upper extremity should be reviewed to include paresthesias, weakness, or radiating pains. A review of systems should be performed to detect remote, nonshoulder sources of symptoms. Examples include queries about respiratory or cardiac status, abdominal symptoms, fevers, night sweats, and weight loss.

Patients often have preconceived ideas about the source and cause of their problem. It is important to elicit these with the history to direct the examination and to ensure that these are discussed to improve patient satisfaction and relieve anxiety.

Physical Examination

Examination of the shoulder should include observation, assessment of the active and passive ROM, strength testing, palpation of bony and soft tissues, provocative testing, and selected imaging studies.[4]

Observation and ROM

It is important to fully expose the shoulder for evaluation. Men should have their shirt removed; women can wear a gown with the shoulder exposed, a halter top, or a tube top. Observation for symmetry and motion is best done with the patient standing, facing both toward and away from the examiner. Observe the height of the shoulder and scapulae, the symmetry of the contours, and muscle bulk. It is common for the dominant shoulder to be slightly lower, but this can be exaggerated in the throwing athlete.[10] Observe the patient while he or she slowly goes through full abduction and elevation (forward flexion). Abnormal findings may include limitation of motion, a painful arc, or abnormal scapular motion, indicating muscular weakness or neurologic injury.

Observe the rhythm of glenohumeral and scapulothoracic rotation with abduction. The normal ratio of glenohumeral-to-scapulothoracic rotation is 2:1. Glenohumeral motion can be isolated by fixing the inferior angle of the scapula with the examiner's fingers during abduction. The patient should be able to complete the first 20° to 30° of motion without scapulothoracic motion. Normal abduction with the arm in the palm-down position (internally rotated) is about 120° (60° glenohumeral and 60° scapulothoracic), with palm-up position (external rotation) being required to complete the remainder of the 180° of abduction (120° glenohumeral and 60° scapulothoracic). Additional ROM testing should include elevation (forward flexion) of 180°, extension of 40°, internal rotation of 55°, and external rotation of 45°. If active ROM is limited, the examiner should test the passive ROM with attention to pain response or mechanical block. Functional ROM can include touching the opposite shoulder (cross-chest adduction), which tests internal rotation and ad-

Table 2. Differential Diagnosis of Shoulder Pain

Anterior	Acute Injuries Lateral	Posterior
Joint injuries	Rotator cuff tear	Dislocation
Sternoclavicular	Impingement	Subluxation
Acromioclavicular	Deltoid strain	
Biceps tendon injuries		
Clavicular injury		
Subluxation		
Dislocation		

Anterior	Lateral	Chronic Injuries Posterior	Diffuse
Arthritis	Rotator cuff tendinosis	Instability	Adhesive capsulitis
Acromioclavicular	Subacromial bursitis	Scapulothoracic bursitis	Glenohumeral arthritis
Sternoclavicular	Rotator cuff tear	Myofascial pain	Thoracic outlet syndrome
Osteolysis of distal clavicle		Nerve entrapment	Referred pain from neck
Bicipital tendonitis			
Labral tear			
Rotator cuff tendonitis			
Anterior instability			

Referred From Local Structures	Nonshoulder Shoulder Pain[16] Referred From Internal Organs	Systemic Condition
Spinal cord	Cardiac	Arthritis
Tumor	Angina	Osteoarthritis
Disk	Pericarditis	Rheumatoid
Arthritis	Aortic aneurysm	Crystal-induced
Intrinsic disease	Pulmonary	Gout
Thoracic outlet syndrome	Pancoast tumor	Pseudogout
Venous occlusive disease	Diaphragmatic irritation	Polymyalgia rheumatica
Reflex sympathetic dystrophy	Pneumonia	Bacteremia
	Pulmonary embolism	Lyme disease
	Effusion	Hemoglobinopathy
	Gastrointestinal	Amyloid
	Esophageal	Hematologic neoplasm
	Liver	
	Gallbladder	
	Spleen (Kehr sign)	
	Subphrenic disease	
	Ruptured viscus	
	Abscess	

duction; the Apley scratch test from above (trying to scratch between the scapulae from above), which tests external rotation and abduction; and the Apley scratch test from below (**Figure 3**), which tests internal rotation and adduction. These functional tests can be readily quantified and followed up by observing the spine level attained compared with the opposite side, eg, T-4 or L-4. Common landmarks on the spine include the inferior angle of the scapula at T-7, the spine of the scapula at T-3, and the superior angle of the scapula at T-2.

Strength Testing

Weakness is often both the underlying cause and result of injury. Even a person with full ROM may have notable weakness in the shoulder musculature. Evaluation of these muscle groups should be graded on a standard scale of 0 to 5 as given in **Table 3**. Most results of muscle testing will be in the 4 to 5 range. The examiner should compare the strength with the opposite (presumed normal) shoulder. Eccentric challenge (muscle contraction as it lengthens) is a more sensitive indicator of weakness. All major motions should be tested: abduction, adduction, internal and external rotation, elevation, and extension. Special attention should be given to the strength of the supraspinatus and external rotators (teres minor and infraspinatus), which often are weakened in overuse conditions. The supraspinatus can be isolated for testing by abducting the shoulder to 90° with 30° of forward flexion (in the plane of the scapula) and internal rotation with the thumbs down (**Figure 4**).

Palpation

Palpation should be conducted at rest and with shoulder motion. Palpation during active ROM may detect grinding, popping, and snapping (with or without pain) in the AC or glenohumeral joints, scapulothoracic complex, or subacromial space.

Bony structures and joints should be palpated starting at the sternoclavicular joint, proceeding distally to the AC joint, the acromion, and then posteriorly to the medial border of the spinous process of the scapula. The coracoid

process may be palpated gently, but this area often can be tender in a normal subject if examined too aggressively. These are important landmarks and should be identified for their proper location, relations, evidence of deformity. They also should be compared with the opposite side. Common abnormal findings are atrophy but may also include fractures, separation, or subluxation.

Soft-tissue palpation should focus on muscle groups and important soft-tissue areas as in the subacromial bursa and the bicipital groove. Areas of reported soft-tissue pain should be examined last. Muscles should be palpated for resting tone, spasm, trigger or tender points, and bulk with contraction. All of the musculature, to include the scapular stabilizers, should be palpated from proximal to distal-central to peripheral. Tenderness of soft tissues may indicate acute injury or overuse from muscle imbalance, inflexibility, and repetitive loading.

Provocative Signs and Tests

These specific tests indicate more focused assessment of a particular problem and should be performed after collecting the history, determining the ROM, strength testing, and palpation.

Impingement Signs. Impingement of the soft tissues between the acromion and coracoacromial ligament and the greater tuberosity of the humerus may be caused by rotator cuff weakness that allows the humerus to ride up on the glenoid with abduction or loss of subacromial space from acromial variants and osteoarthritic spurs on the AC joint.[3] Two commonly described impingement signs are the Hawkins and Neer impingement signs. The Hawkins sign, the "pour can" test, is performed with the shoulder at 90° forward flexion and 45° to 90° internal rotation. The examiner then attempts to further internally rotate the shoulder, driving the greater tuberosity into the coracoacromial arch. A positive sign is indicated by a pain response. The Neer impingement sign is performed by internally rotating the arm with the elbow extended and then forward-flexing, attempting to reach 180°. Positive results of pain are often evident well before 180° elevation.

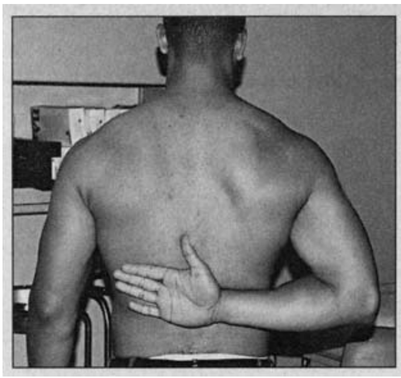

Figure 3. *Apley test from below, testing adduction and internal rotation.*

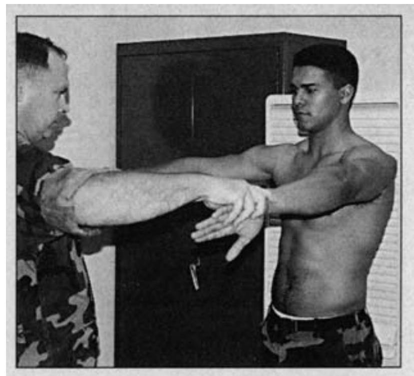

Figure 4. *Supraspinatus strength test.*

Table 3. Muscle Strength Testing

Scale Score	Assessment	Indicator
5	Normal	Full strength; can move against heavy resistance
4	Good	Partial strength; can move against light resistance
3	Fair	Cannot resist load but can move against gravity
2	Poor	Can move if gravity is eliminated
1	Trace	Slight muscle contractility observed
0	Zero	No muscle activity

Speed Test. This test identifies tendonitis or weakness of the long head of the biceps. The arm is forward-flexed to 60° with the forearm neutral, thumbs up. A downward force is applied on the distal forearm. A positive result is indicated by pain in the affected shoulder, although occasionally the examiner may elicit weakness without pain, indicating muscle weakness or rupture.

Yergason Test. The Yergason test is performed to evaluate the stability of the biceps tendon in the bicipital groove. The arm is held in neutral with the elbow flexed to 90° with the thumb up. The patient attempts to supinate the arm and flex the elbow against the resistance of the examiner. Pain or a painful pop indicates biceps tendonitis or instability of the tendon in the biceps groove of the proximal humerus.

Cross-Chest Adduction Test. This test is performed to identify pain in the AC joint. The arm is forward-flexed to 90° and adducted 45° (touch the opposite shoulder). The examiner then hyperadducts the shoulder or pushes down on the patient's elbow as the patient resists. A positive test is indicated by pain in the AC joint. False-positive test results may be found in patients with internal impingement of the anterior labrum or joint capsule.

Drop Arm Test. This test is performed to evaluate for rotator cuff tear. The patient is instructed to lower the fully abducted arm slowly. At about 90° abduction, when the functional status of the deltoid is minimized, the arm will suddenly drop to the side because of the dysfunction of the supraspinatus. If the patient is able to hold the arm at 90°, minimal downward pressure may produce the same result. This test may be dramatic or subtle depending on the size of the tear of the rotator cuff.

Apprehension Test. Apprehension tests have been described for anterior and posterior instability of the shoulder. The anterior apprehension test may be performed with the patient supine or seated, but is usually more successful in the supine position. With the shoulder at 90° abduction and neutral rotation, the examiner applies a slight anterior leverage to the proximal humerus

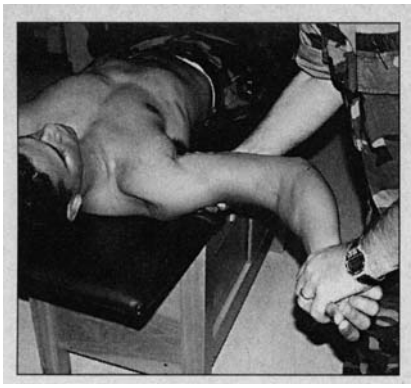

Figure 5. *Anterior apprehension test.*

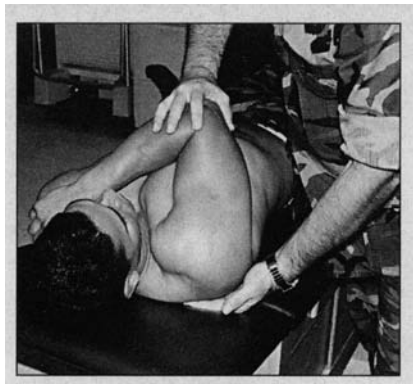

Figure 6. *Posterior apprehension test.*

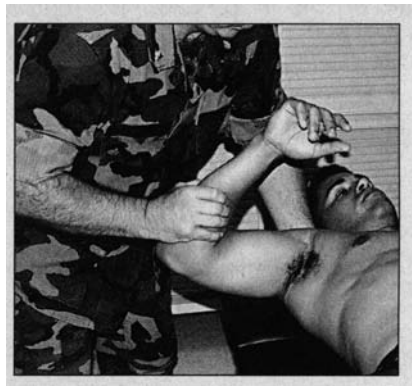

Figure 7. *Leverage-click test.*

while externally rotating the arm, creating an anterior dislocating position (**Figure 5**). The shoulder may be manually rotated, or if the patient is supine, the weight of the arm with the elbow flexed may be used. A positive test result produces verbal and nonverbal clues, such as grimace or muscle tension, indicating that the patient is "apprehensive" about an impending dislocation or subluxation. This should be followed immediately by the relocation test. False-positive apprehension test results for instability can be found in patients with impingement, AC arthritis, or subluxation of the long head of the biceps and are usually evident by the absence of a positive relocation test.[11]

The posterior apprehension test is performed by having the patient forward-flex the shoulder to 90°, flex the elbow, and internally rotate the arm. The examiner then applies a posterior axial load (**Figure 6**). A positive response from the patient includes apprehension or posterior humeral head translation.

Relocation Test. This test is performed after a positive anterior apprehension test. In this maneuver, the examiner applies a posteriorly directed force on the proximal humerus while externally rotating the shoulder, as in the apprehension test. A positive test is indicated by increased ability to tolerate external rotation with a significant decrease of apprehension.

Sulcus Sign. The sulcus sign is diagnostic of inferior instability of the shoulder and should be performed when the examiner is considering a diagnosis of multidirectional instability. With the arm in neutral and the patient relaxed, the examiner pulls down on the wrist while observing the shoulder in the infra-acromial area for depression of the soft tissues, indicating inferior movement of the humeral head in the glenoid. A positive test is indicated by any sulcus compared with the opposite side. Recorded results can be in centimeters or according to the following scale: 0.5 to 1 cm, 1+; 1 to 2 cm, 2+; more than 2 cm, 3+.[12]

Leverage-Click Test. The examiner attempts to subluxate the joint anteriorly or posteriorly and produce a click or clunk as it reduces. The leverage-click test for anterior instability is performed by abducting the arm 90° to 120° with the patient supine. The elbow is secured by the examiner in one hand while the other hand applies an anterior levering force with an axial load. The humeral head should be subluxed and the patient may be symptomatic. The examiner then moves the elbow up and down (**Figure 7**). During this maneuver, a palpable, and perhaps painful or audible, click indicates reduction and subluxation of the humeral head.

The leverage-click test for posterior subluxation is initiated by placing an axial load on the forward-flexed arm, as in the posterior apprehension test. The arm is then adducted across the chest while the other hand is placed behind the shoulder. The shoulder initially should be subluxed, which can be seen or palpated. With this maneuver there may be a palpable, audible, or painful click as the humeral head reduces.

Anterior and Posterior Drawer Test. The anterior and posterior drawer test is an additional instability test. This test may be difficult to perform because of apprehension and increased muscle tension developed during the examination. Although hard to quantify, the examiner may compare the findings with the opposite shoulder and observe for signs of apprehension. The test may be performed with the patient sitting or supine. The humeral head is grasped between the thumb and fingers and gently slid anteriorly and posteriorly in the glenoid while the scapula is secured by grasping the spine and coracoid with the other hand. Displacement of up to 50% the width of the humeral head outside the glenoid may be normal. Positive signs include a painful click or clunk, apprehension, and increased movement compared with the opposite shoulder. Authors have attempted to quantify this test as mild, moderate, and severe, or grades 1 to 3, with grade 1 (1+) for mild or slight shift, grade 2 (2+) if the humeral head rides up to the glenoid rim, and grade 3 (3+) if the head rides up on the glenoid or subluxes.[12] When multidirectional instability is suspected (2 or 3 of 3 positive instability tests), the patient should be examined thoroughly for laxity in other joints or other signs of collagen disorder.

Crank Test. The Crank test is a recently described test for the detection of glenoid labral tears. The test is performed with the patient sitting and supine. The arm is elevated to 160° in the scapular plane. The examiner then applies a load along the axis of the humerus while maximally rotating the humerus internally and externally. A positive test reproduces the patient's symptoms

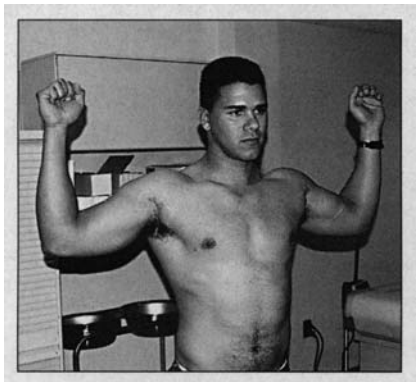

Figure 8. *Roo test (also called the overhead exercise test).*

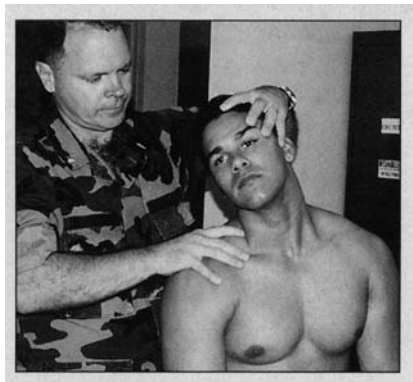

Figure 9. *Spurling test.*

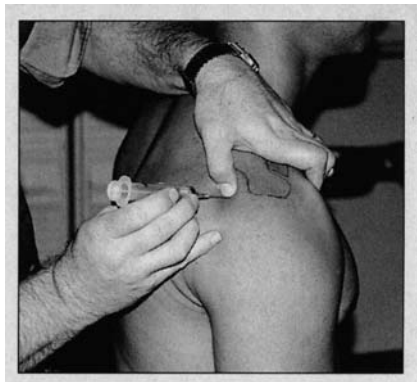

Figure 10. *Diagnostic injection from posterior approach.*

of pain or catching with or without a click. When compared with surgical findings, a recent study reported a sensitivity of 91%, specificity of 90%, a positive predictive value of 94%, and a negative predictive value of 90% for this test.[13]

Adson Test. The Adson test is performed to determine if neurovascular compression is causing shoulder pain. Causes of the thoracic outlet syndrome may be abnormal anatomy (cervical rib or scalene hypertrophy), abnormal scapular suspension (posture), and shoulder instability or subluxation with compression or stretching of the neurovascular bundle. The test is performed with the patient standing and the arm hanging at the patient's side. The radial pulse is recorded and then the arm extended and externally rotated with the patient's head rotated toward or away from the shoulder while the patient holds a deep breath. A positive test is indicated by a decrease or absence of the pulse or reproduction of pain or paresthesia. Other tests for thoracic outlet syndrome include the Wright maneuver and the Roo test.

The Wright maneuver involves abducting and externally rotating the arm, as in the cocked position to throw a ball, while holding a deep breath. A positive test result is indicated by reproduction of symptoms and a decrease in the radial pulse.[11] The Roo test is performed by having the patient abduct both humeri to 90° and externally rotate to 55° and repetitively clasp and unclasp his or her fists for 2 minutes. A positive test result is indicated by paresthesias or ischemic pain in the extremity (**Figure 8**).

Spurling Test. This test for cervical root irritation is performed by placing an axial load on the cervical spine in extension and rotation toward the affected shoulder. A positive test result is indicated by reproduction of neck, shoulder, or arm pain (**Figure 9**).

Diagnostic Injection. Diagnostic injections of local anesthetic may be helpful in the evaluation of shoulder pain. Commonly injected sites include soft-tissue trigger points, the AC joint, and the subacromial space. Injection of the subacromial bursa may be helpful in the evaluation of adhesive capsulitis, impingement, and rotator cuff tears. The impingement test represents one use of such injections. A patient with impingement signs (positive Hawkins and Neer tests) is given an injection in the subacromial bursa through a lateral or posterior approach (**Figure 10**) of 5 to 10 mL of 1% lidocaine without epinephrine or a 50:50 mix of 1% lidocaine and 0.5% marcaine. The shoulder is then moved through the ROM to disperse the injection and, after 5 minutes, the impingement signs are reassessed. A positive test result is indicated by a more than 50% reduction in pain. Similar injections in the AC joint, glenohumeral joint, or soft-tissue trigger points are important diagnostic tools to clarify the examination and have minimal long-term effects when performed properly.[14,15] Risks include infection, bleeding, or exacerbation of pain.

Imaging Studies

Imaging studies enhance the evaluation of any joint but should be considered after an initial assessment to ensure that the appropriate study is obtained to yield the most information. Typical studies used to evaluate the shoulder include radiographs, fluoroscopy, arthrography, computed tomography (CT), magnetic resonance imaging (MRI), ultrasonography, and scintigraphy (bone scan). Cost ranges of such procedures are radiography, $69 to $81; arthrogram, $265 to $320; CT, $590 to $695; MRI, $1055 to $1265; and bone scan, $259 to $309.[16]

Radiographs. The routine radiograph or x-ray film is still the most basic imaging study and should be used before consideration of any of the more expensive studies. The standard views include the anteroposterior and lateral views (**Figure 11** and **Figure 12**). These are anteroposterior views with the humerus externally and internally rotated. These views will disclose basic bony structures but may not adequately view the coracoacromial arch or the glenohumeral joint. The scapular Y (outlet) view (**Figure 13**) is named for the distinct appearance of the scapula on lateral view. The main body of the scapula seen on end forms the base of the Y and the scapular spine and coracoid form the 2 arms of the Y. This view discloses the coracoacromial arch and the supraspinatus outlet.

The West Point axillary view (**Figure 14**) is used to rule out dislocation and assess for bony Bankart lesions, which represent avulsion fractures of the glenoid caused by dislocation. The view is performed with the patient prone and the arm abducted to 90° and externally rotated 90°. The beam is directed from the axilla to the film cassette on top of the shoulder.

Figure 11. *Anteroposterior radiograph of normal shoulder.*

Figure 12. *Lateral radiograph of normal shoulder.*

Figure 13. *Y view of normal shoulder.*

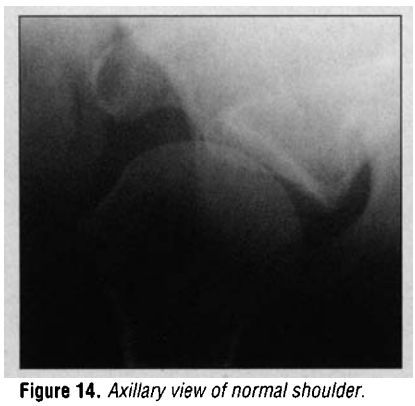

Figure 14. *Axillary view of normal shoulder.*

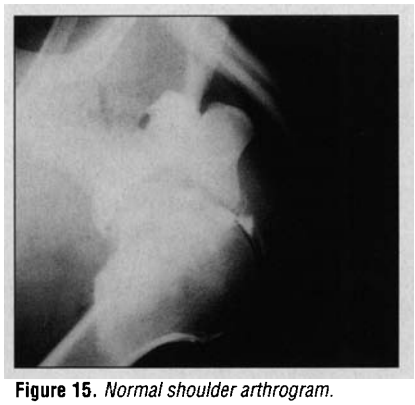

Figure 15. *Normal shoulder arthrogram.*

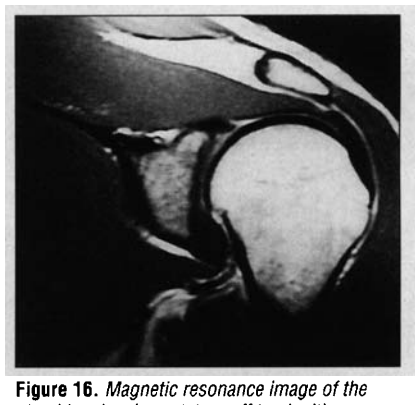

Figure 16. *Magnetic resonance image of the shoulder showing rotator cuff tendonitis.*

The Stryker notch view is the best view to detect Hill-Sach lesions. These defects, identified as notching in the posterior humeral head, are thought to be secondary to avascular necrosis from recurrent dislocation. The Stryker notch view is performed with the patient supine, the arm elevated 90°, and the elbow flexed with the hand on the ipsilateral ear. The beam is directed into the axilla 45° from the horizontal.

Additional films may include anteroposterior views of the shoulders with and without suspended weights to assess for AC separation. Between 4.5 and 5.5 kg should be suspended from the arm, not grasped by the patient, to reduce muscular tension that would minimize radiographic findings.

Many facilities have standard views for trauma, impingement, and instability. Trauma views usually include anteroposterior, lateral, West Point axillary, and occasionally AC joint views, depending on the examination and history. Instability series usually include the anteroposterior, lateral, West Point axillary, and Y view, and occasionally the Stryker notch view. Impingement views include anteroposterior and Y (outlet) views.

Fluoroscopy. Fluoroscopy allows a dynamic view of the bony structures. Dynamic evaluation of the shoulder can assess fracture stability, detection of loose bodies, and a real-time visualization of impingement.

Arthrography. Arthrography (**Figure 15**) was the time-proved study to evaluate for rotator cuff tear before the availability of MRI. It still has a place in the evaluation of cuff tears in cases when MRI is unavailable or the patient has severe claustrophobia. A recent study reported a sensitivity of 93% and specificity of 95% and positive predictive value of 96% and negative predictive value of 91% for diagnosis of rotator cuff tears.[17] Limitations include inability to distinguish partial tears, tendonitis, or the size of a tear.

Arthrography also may be helpful in the diagnosis and management of adhesive capsulitis. A rotator cuff tear can be ruled out and the contracted joint space identified. The normal joint volume is 15 to 20 mL; patients with adhesive capsulitis have volumes of 5 to 10 mL. Arthrography carries the risks of sensitivity to contrast medium and joint infection from poor antiseptic technique.

CT and CT Arthrogram. Computed tomography is widely available and is useful in the evaluation of bony structures. Coupled with intra-articular contrast, CT can be superior in identifying labral tears, Hill-Sach lesions, and rotator cuff tears. Recent radiologic literature report sensitivity of 100% and specificity of 97% for detection of labral tears and sensitivity of 95% and specificity of 100% for detection of rotator cuff tears using coronal oblique sections.[18,19] Computed tomography arthrography carries the same risks of sensitivity reaction to the contrast medium and infection as does routine arthrogram and, in addition, the increased cost and time of the procedure.

Magnetic Resonance Imaging. The use of MRI (**Figure 16**) in the evaluation of the injured shoulder has dramatically increased in recent years. Magnetic resonance imaging is superior in showing soft-tissue pathologic lesions. Magnetic

resonance imaging of the shoulder is more difficult than other joints because of the multiple curves and the unique motions. Shoulder coils have been designed to improve the resolution (decrease noise) in the MRI assessment of the shoulder. Magnetic resonance imaging requires the patient to remain motionless in a confined space for an extended period. A recent study comparing surgical and MRI findings in cases of complete shoulder tears reported that the predictive value of a positive scan was 92% and of a negative scan was 100%. The study also reported positive and negative predictive values of 97% and 81%, respectively, for labral tears and 82% and 85%, respectively, for partial tears or tendon degeneration.[20] However, a recent study of MRI findings in asymptomatic patients reported rotator cuff tears in 34% of patients in all age groups and 54% of patients older than 60 years, which stresses the importance of appropriate use of this study and correlation with the patient's functional status and clinical examination.[21]

Ultrasonography. Ultrasonography has been used in many settings as a noninvasive, inexpensive alternative to other studies. Ultrasonography has been found to be operator-dependent. A recent European study reported a predictive value of a positive test of 95%, but a predictive value of a negative test of only 75%.[17] The accuracy was limited to moderate and large full-thickness tears.

Scintigraphy. Scintigraphy, commonly known as the bone scan, is sensitive for activity involving bone remodeling. Its use in the evaluation of the shoulder is limited but may include the assessment of such problems as metastatic tumors, trauma bone surveillance, nonunion of fractures, osteomyelitis, reflex sympathetic dystrophy, and follow-up of bone grafts.[22]

Adjunctive Testing

In cases of suspected neurologic disorders of the cervical cord or roots, brachial plexus, or peripheral nerve entrapments, electromyography and nerve conduction velocity studies can be helpful. These are electrophysiological studies of the lower motor neuron. The electromyogram is a study of the insertional, spontaneous, and voluntary electrical activity of the muscle conducted by inserting needles into the muscle at rest. Testing may detect myopathic or neuropathic patterns.

The nerve conduction velocity study is conducted by placing surface electrodes along the path of peripheral nerves and applying and electrical stimuli. These studies include motor and sensory conduction, proximal to distal, and H-reflex and F-wave studies. Slow conduction velocities are seen in disorders that affect the myelin sheath, as in compression or demyelinating disorders from disease or toxins.[23] This may help distinguish weakness of myopathic or neurologic origin and may be useful in the assessment of thoracic outlet syndrome.[23]

CONCLUSIONS

The unique anatomy, muscular support, and ROM of the shoulder contribute to the performance of athletes in sports and recreational activities. These factors also contribute to the vulnerability of the shoulder to injury. The goal of primary care physicians is to perform an adequate initial evaluation of the shoulder to arrive at an accurate assessment. Adequate initial evaluation will minimize patients' suffering and lost time from their sport or occupation and allow more appropriate use of adjunctive studies and orthopedic consultants.

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