Evaluation of the patient with shoulder complaints

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INTRODUCTION — Shoulder pain is a common musculoskeletal complaint that may be due either to intrinsic disorders of the shoulder or referred pain. The former include injuries and acute or chronic inflammation of the shoulder joint, tendons, surrounding ligaments, or periarticular structures [1].

This Topic will provide an overview of the evaluation of patients with shoulder pain, including discussions of musculoskeletal etiologies and examination techniques. In addition, a basic clinical approach to diagnosis is provided. In-depth discussions of the diagnosis and treatment of specific disorders of the shoulder are found separately.

ANATOMY AND BIOMECHANICS — A complex network of anatomic structures endows the human shoulder with tremendous mobility, greater than any other joint in the body. The shoulder girdle is composed of three bones (the clavicle, scapula, and proximal humerus) and four articular surfaces (sternoclavicular, acromioclavicular, glenohumeral, and scapulothoracic) (figure 1A-C). The glenohumeral joint, commonly referred to as the shoulder joint, is the principal articulation.

Glenohumeral structures — The glenohumeral joint is loosely constrained within a thin capsule bounded by surrounding muscles and ligaments (figure 1A-C). The shoulder's great mobility is due in large part to the shallow depth of the glenoid and the limited contact between the glenoid and the humeral head. Only 25 percent of the humeral head surface makes contact with the glenoid. The labrum, a fibrocartilaginous ring attached to the outer rim of the glenoid, provides some additional depth and stability. The shallowness and small surface area of the glenohumeral joint make it susceptible to instability and injury, and require that stability be provided primarily by extrinsic supports.

Surrounding muscles and ligaments provide these supports. The glenohumeral ligament serves as the primary static stabilizer. The rotator cuff serves as the primary dynamic stabilizer. The rotator cuff is composed of four muscles (supraspinatus, infraspinatus, subscapularis, and teres minor) that form a cuff around the head of the humerus, to which these muscles attach.

Shoulder pain is frequently caused by an acute or chronic injury of the rotator cuff, most often the supraspinatus muscle or tendon. The supraspinatus originates on the supraspinous fossa of the superior-posterior scapula, superior to the scapular spine, and inserts on the greater tubercle of the superior-lateral humeral head, just posterior to the biceps tendon. Proximal to its insertion it passes, along with the subacromial bursa, through the narrow space between the acromion process and the

humeral head.

The acromion is a projection of the scapular spine that extends superiorly and anteriorly over the humeral head. Thus, with the shoulder in abduction, the supraspinatus is susceptible to impingement between the greater tubercle and the acromion. Activities involving repeated abduction with impingement can cause repetitive muscle and tendon trauma and ischemic compression of the tendon.

The sole, vital function of the subacromial bursa, also referred to as the subdeltoid bursa, is to lubricate and protect the rotator cuff tendons from the pressure and friction of the underside of the acromion.

Three other muscles contribute to the rotator cuff. The infraspinatus arises from the infraspinatus fossa of the posterior scapula and inserts on the lateral humeral head (greater tuberosity), just posterior to the supraspinatus where their insertions blend. The teres minor arises from the inferior-posterior scapula and blends with the infraspinatus to attach on the lateral humeral head (greater tuberosity). The subscapularis, the largest of the four cuff muscles, arises from the anterior scapula, inferior to the coracoid, and attaches to the anterior humeral head (lesser tuberosity).

The rotator cuff muscles rotate the humerus internally (subscapularis) and externally (infraspinatus primarily and teres minor), and contribute to abduction (supraspinatus), along with the deltoid muscle [2]. The deltoid is the most superficial muscle overriding the glenohumeral area, and it acts as the primary shoulder abductor. It arises from the acromion and attaches to the mid humerus.

The rotator cuff compresses the humoral head in the glenoid fossa, thereby stabilizing the glenohumeral joint, and serves to counterbalance the elevating forces of the deltoid, as well as the forces of other muscles acting on the humerus [3,4]. Weakness of the rotator cuff can lead to superior subluxation of the humeral head when the shoulder is abducted beyond 90 degrees, predisposing to impingement syndromes.

The suprascapular nerve innervates the supraspinatus and infraspinatus muscles. Suprascapular nerve injury causes a peripheral neuropathy that is estimated to account for one to two percent of pathologic shoulder conditions [5,6]. Injuries to the suprascapular nerve arise most often from mechanical compression by cysts or tumors. Suprascapular neuropathy causes pain, progressive atrophy, and weakened abduction and external rotation of the shoulder, and can be difficult to distinguish from rotator cuff tears.

Extraglenohumeral structures — Shoulder motion is also dependent upon the acromioclavicular (AC) and sternoclavicular (SC) joints and the scapulothoracic articulation (figure 1A-C). Together, they are capable of compensating significantly for decreased motion at the glenohumeral joint due to injury. The acromioclavicular joint is a common site of injury.

Coordination between glenohumeral and scapulothoracic motion is particularly important for shoulder function. Proper scapular motion and stability allows the humeral head to remain properly seated in the glenoid during abduction, provides a solid base from which the rotator cuff muscles can move the humerus, and enables proper elevation of the coracoacromial arch, thereby diminishing the risk of impingement syndrome. The muscles primarily responsible for scapular stability and motion are the trapezius, serratus anterior, rhomboids, and levator scapulae.

The tendon of the long head of the biceps runs in the bicipital groove between the greater and lesser tubercles of the anterior proximal humerus. Transverse tendinous structures (either a continuation of the subscapularis tendon or a distinct transverse humeral ligament [7]) prevent subluxation of the tendon. Anterior shoulder pain can be caused by inflammation or injury to the biceps tendon.

Although the neural networks of the brachial plexus form proximally to the glenohumeral joint, the

major peripheral nerves emanating from the plexus pass inferiorly to the joint. Pain from an injury to the plexus or related peripheral nerves from acute or chronic injury can present as shoulder pain. (See "Overview of upper extremity peripheral nerve syndromes".)

PATIENT HISTORY AND PAIN PATTERNS

General approach — Patients with acute shoulder pain often seek treatment following an episode of trauma. Diagnosis in this case can often be made by observation, gentle palpation, and x-ray. Next, the clinician must distinguish between extrinsic and intrinsic causes of shoulder pain. (See 'Stepwise clinical approach' below.) Once traumatic injury and potentially dangerous extrinsic causes have been excluded (table 1), the clinician is generally faced with one of several common patterns of shoulder pain, which are described below.

Patients experiencing a problem intrinsic to the shoulder present either with complaints of pain provoked by specific movement(s), stiffness or lack of flexibility, weakness or loss of function, instability, or a combination of these symptoms.

A standard pain history (ie, onset, duration, palliation/provocation, quality, location, and radiation) aids diagnosis. The clinician should inquire about activities that exacerbate symptoms either at work (eg, lifting overhead, painting) or leisure (eg, racquet sports, swimming). In addition, questions about previous injuries and treatment, including past surgery, and about comorbidities such as diabetes (increased risk of adhesive capsulitis) are important.

Anterolateral shoulder pain — Anterolateral shoulder pain aggravated by reaching overhead is a common pain pattern. It is often associated with impingement syndrome and the various stages of rotator cuff tendinopathy (simple strain, uncomplicated tendinopathy, chronic calcific tendinopathy, tendinopathy complicated by tear). Rotator cuff tendinopathy with tendon tear is suspected when pain is complicated by weakness and a notable loss of strength in external rotation or abduction (a loss that is not attributable to poor effort). Adhesive capsulitis (ie, frozen shoulder) is the most likely diagnosis when pain is accompanied by stiffness and a significant loss of movement in external rotation or abduction. Labral tears may present with anterolateral pain, although pain may be deep and poorly localized, and may be associated with instability and a catching sensation.

Conditions affecting the acromioclavicular (AC) joint, such as AC separation, if trauma has occurred, or osteoarthritis, are suspected when pain is well localized (the patient often uses one finger to point to the end of the clavicle). Involvement of the glenohumeral joint is suspected when pain is aggravated by movement in multiple directions. Pain originating from the tendon of the long head of the biceps can create well-localized anterior shoulder pain aggravated by lifting or carrying objects like shopping bags.

Posterior shoulder pain — Posterior shoulder pain is the least common pattern of the intrinsic conditions affecting the shoulder. Rotator cuff tendinopathy involving the external rotators (teres minor and infraspinatus) can cause focal pain, or sometimes referred pain over the scapula. More diffuse pain over the general area of the superior trapezius can be referred from the cervical spine (cervical strain or radiculopathy).

Poorly localized pain — Pain that is poorly localized or vaguely described is often extrinsic. Cervical nerve root impingement can produce sharp pain radiating from the neck into the posterior shoulder area and arm. Shoulder pain can be referred from the neck or abdomen, results from a compression neuropathy, or arises from the bone (table 1). Poorly localized shoulder pain in the setting of a normal shoulder examination should raise concern for intraabdominal or other extrinsic pathology. Although uncommon, elbow pathology may refer to the shoulder.

Shoulder pain may also reflect psychological overtones of cases under litigation or malingering, however, such diagnoses should be entertained only after true pathology has been ruled out. Intrinsic

pathology may cause poorly localized pain. Examples include large rotator cuff tears and avascular necrosis of the humoral head. A large Finnish survey found nonspecific shoulder complaints without clinical findings to correlate with depressive illness and not to correlate with rotator cuff tendinopathy [8].

Trauma — Fractures and dislocations of the shoulder often occur as a result of blunt trauma. Falls directly onto the shoulder can cause acromioclavicular separation. (See "Acromioclavicular joint injuries".) Falls or direct blows can cause a clavicle fracture. Falls onto an outstretched arm are the most common cause of proximal humerus fractures. Blunt trauma and, less often, violent muscular contractions, such as those that occur with generalized seizures, can cause glenohumeral dislocations. Generally, the patient can localize pain to the site of injury, and deformity may be present. Post-traumatic shoulder pain can also be referred from intraabdominal injuries causing diaphragmatic irritation (eg, bleeding from liver or spleen).

Sometimes patients present several weeks or months following an injury. Pain may cause the patient not to use the shoulder in the interim leading to adhesive capsulitis. (See 'Adhesive capsulitis' below.)

ETIOLOGY — The majority of patients who present to primary care clinics with shoulder pain have an intrinsic disorder. Acute symptoms (less than two weeks duration) in patients with a history of recent shoulder trauma are typically due to an acromioclavicular (AC) separation, glenohumeral dislocation, fracture, or rotator cuff tear [9]. In addition to pain, patients may complain that the shoulder is discolored, deformed, or swollen. Significant medical problems, however, such as cardiac ischemia, hepatobiliary disease, and intraabdominal injury, can present with referred shoulder pain (table 1).

Patient age — In addition to location (see 'Patient history and pain patterns' above), several other historical factors can help to differentiate among the intrinsic causes of shoulder pain. Patient age is one such factor (table 2):

- Sports injuries due to overuse ("muscular strain") and subluxation of the glenohumeral joint are most common in adolescents and young adults [9]. "Shoulder separation," due to a sprain of the acromioclavicular ligaments, is also more common in younger patients. It is seen following a fall, with the arm adducted, directly onto the acromion, commonly referred to as the point or tip of the shoulder. (See "Acromioclavicular joint injuries".)
- Middle-aged and older individuals more often develop shoulder pain due to rotator cuff lesions, such as supraspinatus tendinopathy and partial or full-thickness tendon tears [10,11].
- Frozen shoulder syndrome and symptomatic osteoarthritis also occur predominately in older patients. Bilateral shoulder involvement, also more common among older patients, suggests an inflammatory process such as polymyalgia rheumatica or rheumatoid arthritis, or rarely hyper or hypothyroidism.

Rotator cuff injury — Rotator cuff injury is among the most common causes of shoulder pain. The rotator cuff tendons, particularly the supraspinatus tendon, are uniquely susceptible to the compressive forces of subacromial impingement (see 'Anatomy and biomechanics' above) and dominate the conditions affecting the shoulder, especially in patients over the age of 30 [12]. Improper athletic technique, poor muscular conditioning, poor posture, and failure of the subacromial bursa to protect adequately the supporting tendons may result in a progression of injury from acute inflammation, to calcification, to degenerative thinning, and finally to tendon tear. (See "Rotator cuff tendinopathy" and "Presentation and diagnosis of rotator cuff tears".)

Impingement syndrome — Impingement syndrome is the term used to describe symptoms and signs that result from compression of the rotator cuff tendons and the subacromial bursa between the

greater tubercle of the humeral head and the lateral edge of the acromion process [13].

The symptoms of impingement syndrome are nearly identical to those of rotator cuff tendinopathy (see 'Tendinopathy' below). Overhead reaching and positioning cause pain over the outer deltoid. Atrophy of the muscles around the top and back of the shoulder may be apparent if symptoms are longstanding. Crepitus may be felt with attempts to abduct the arm beyond 60 degrees. Patients with rounded shoulders (a down-sloping acromial angle), poor muscular development, and occupations that require repetitive work at or above the shoulder are at greatest risk. (See "Shoulder impingement syndrome".)

Tendinopathy — Rotator cuff tendinopathy almost always represents chronic injury to the supraspinatus (abduction) and/or infraspinatus (external rotation) tendons. Tendinopathy usually develops as a consequence of repetitive activity, generally at or above shoulder height, which leads to tendon degeneration and microvascular insult.

Patients complain of shoulder pain aggravated by reaching, pushing, pulling, lifting, positioning the arm above the shoulder level, or lying on the affected side. Most patients do not describe an injury or fall. The patient typically places the hand over the outer deltoid, rubbing the muscle in an up-and-down direction when describing the pain. Common shoulder tendinopathy must be distinguished from frozen shoulder (loss of range of motion), rotator cuff tendon tear (persistent weakness), and biceps tendinopathy (painful arm flexion). (See "Rotator cuff tendinopathy".)

Tendon tear — Rotator cuff tendon tears (ie, loss of the normal integrity of the supraspinatus tendon, the infraspinatus tendon, or both) occur as the end result of chronic subacromial impingement, progressive tendon degeneration, traumatic injury, or a combination of these factors. Tears occur primarily in the supraspinatus tendon. (See "Presentation and diagnosis of rotator cuff tears".)

Patients complain of shoulder weakness, pain over the anterolateral shoulder, or sometimes the upper back, and a popping or catching sensation when the shoulder is moved. Night pain is common and often affects sleep because the patient is unable to keep the arm in a position that does not elicit pain (ie, adducted without rotation).

Injuries most commonly associated with acute rotator cuff tendon tears include falls onto the outstretched arm, falls directly onto the outer shoulder, vigorous pulling (such as on a lawn mower cable), and unusual heavy pushing and pulling. Acute, subacute, and chronic tears all occur most often in patients over the age of 40 with a history of impingement [10,11].

Shoulder function will be preserved if the tear parallels the direction of the tendon fibers or is small in size, and the patient will complain only of shoulder pain, pain with direct pressure, and pain aggravated by active reaching, lifting, pushing, and pulling. However, if the tear is large, affecting both the supraspinatus and infraspinatus tendons, and is transverse in direction (total interruption of the tendon with muscle retraction), the patient will complain of weakness, the typical symptoms of tendinopathy, and dramatic loss of function - an inability to reach overhead, lift with an outstretched arm, and an impairment of pushing and pulling.

Labral tear — Many of the same mechanisms that produce rotator cuff injury can also produce tears of the labrum. Athletes who engage in repetitive overhead activities that load the shoulder (eg, baseball pitching, tennis serving, swimming) are at greater risk for such injuries. Symptoms include deep shoulder pain, catching sensation, instability, and crepitus.

Adhesive capsulitis — Adhesive capsulitis (commonly referred to as frozen shoulder) refers to a stiffened glenohumeral joint that has lost significant range of motion (abduction and rotation). It is a reversible contraction of the joint capsule in almost all cases. (See "Frozen shoulder (adhesive capsulitis)".) Any shoulder pain or disability that causes the patient not to use his or her shoulder can

lead to diminished joint mobility and ultimately adhesive capsulitis.

The most common cause is rotator cuff tendinopathy. Diabetes mellitus also puts patients at significantly increased risk of developing adhesive capsulitis [14-16]. Other diseases that increase the risk for frozen shoulder, most likely due to immobility, include stroke, Parkinson disease, and chronic pulmonary disease. Low pain tolerance, poor compliance with exercise therapy, and immobilization in a sling (eg, for treatment of a shoulder or elbow injury) can also contribute to the development of a frozen shoulder.

While the symptoms and signs of adhesive capsulitis and rotator cuff tendinopathy overlap, presentation often differs. Patients with adhesive capsulitis complain primarily of stiffness, although they may have pain, and always demonstrate diminished passive range of motion. Patients with rotator cuff tendinopathy typically complain of pain with active motion, while passive motion remains normal (in the absence of guarding). The loss of motion associated with a frozen shoulder causes various degrees of impaired function, including limited reaching (eg, overhead, across the chest) and limited rotation (eg, unable to scratch the back, difficulty putting on a coat). Patients with rotator cuff tendinopathy suffer similar restrictions, but their limitations are due more to pain than an absolute loss of movement. Patients with either condition may experience increased pain at night either from direct pressure or shoulder movement.

Acromioclavicular pain — The acromioclavicular (AC) joint is another common site of pathology in patients with shoulder complaints. The joint is susceptible to arthritic change and trauma ("shoulder separation"). (See "Acromioclavicular joint injuries".)

Patients complain of anterior shoulder pain, deformity, or both and often point to the AC joint when describing their symptoms. Patients with osteoarthritis may describe a grinding or popping sensation when reaching overhead or across the chest. The adduction part of the Apley scratch test can elicit this sign. (See 'Joint rotation' below.) Patients with an acute separation usually relate a history of falling directly onto the shoulder. Those with second and third-degree sprains typically have a palpable step-off deformity at the AC joint. They often hold their arm close to the chest and resist rotation and elevation.

Biceps tendinopathy/rupture — Biceps tendinopathy is an inflammation of the long head of the biceps tendon as it passes through the bicipital groove of the anterior proximal humerus. Repetitive lifting and to a lesser extent, overhead reaching, leads to inflammation, micro-tearing, and if untreated, degenerative change. Unusual or vigorous lifting in the setting of a chronically inflamed tendon can lead to spontaneous rupture. (See "Biceps tendinopathy and tendon rupture".)

The patient complains of anterior shoulder pain aggravated by lifting, carrying objects like shopping bags, and overhead reaching. A dramatic worsening of symptoms and description of a lump just above the antecubital fossa suggests an acute long head tendon rupture. Weakness is most often attributed to the pain of active tendinopathy. Rupture of the long head of the biceps rarely is associated with significant weakness; the brachioradialis and the short head of the biceps account for 80 to 85 percent of the strength of elbow flexion.

Multidirectional shoulder instability — Multidirectional instability of the shoulder is synonymous with "subluxation," "loose" shoulder, or partial dislocation. It is more common in young women with poor muscular development, patients with large rotator cuff tendon tears (loss of muscular support), and in athletes under the age of 40, especially swimmers and throwers. The symptoms are often vague and nonspecific ("dead arm," looseness, or crepitation) unless the condition is complicated by rotator cuff tendinopathy. Typically the patient has an excessive range of motion, particularly with internal and external rotation. (See "Multidirectional instability of the shoulder".)

Glenohumeral osteoarthritis — Osteoarthritis of the glenohumeral joint represents wear-and-tear

of the articular cartilage of the glenoid, labrum, and humeral head. It is an uncommon problem that is generally preceded by trauma, although the injury may have occurred years earlier. Injuries that are associated with the development of osteoarthritis include previous dislocation, humeral head or neck fracture, large rotator cuff tendon tears (loss of musculotendinous support), and rheumatoid arthritis. Patients complain of the gradual development of anterior or deep shoulder pain and stiffness over a period of months to years. Both active and passive motion, particularly abduction and external rotation, become diminished as articular degeneration grows more severe. (See "Glenohumeral osteoarthritis".)

Because osteoarthritis of the shoulder is so rare, clinicians should also consider the possibility of metabolic disease (eg, hemochromatosis) as a cause.

Scapular instability — Weakness of the muscles that stabilize the scapula predisposes the patient to impingement syndrome. (See 'Anatomy and biomechanics' above.)

Although a difficult diagnosis to make, scapular instability may manifest with abnormal shoulder motion, shoulder weakness, or mild scapular winging in patients with symptoms suggestive of rotator cuff pathology. Improvement of abduction strength when performed while the scapula is stabilized by the examiner suggests weakness of the scapula stabilizers. Less commonly, nerve injury can cause winging of the scapula. (See 'Scapulothoracic motion and strength' below and "Nerve entrapment syndromes of the shoulder".)

Scapulothoracic bursitis — Scapulothoracic (subscapular) bursitis may result from mechanical pressure and friction, most often between the superior-medial angle of the scapula and the adjacent second and third ribs. Poor muscular development in thin patients, kyphotic posture, repetitive to-and-fro motion of the scapula (ironing, assembly work, throwing sports), and direct pressure are common causes.

Affected patients complain of localized pain over the upper back or a popping sound whenever the shoulder is shrugged. A typical patient has poor muscular development, an asthenic physique, and poor posture.

Referred pain — Referred pain to the shoulder may be seen in a variety of clinical settings:

- Neural impingement at the level of the cervical spine due to disc herniation (generally at the C5 or C6 levels) or spinal stenosis. (See "Evaluation of the patient with neck pain and cervical spine disorders".)
- Peripheral nerve entrapment distal to the spinal column, with involvement of either the long thoracic or suprascapular nerves. (See "Nerve entrapment syndromes of the shoulder".)
- Diaphragmatic irritation (eg, from splenic laceration, perforated viscus, or ruptured ectopic pregnancy), intrathoracic tumors, and distension of the hepatic capsule can produce ipsilateral shoulder pain. (See "Overview of cancer pain syndromes" and "Pancoast's syndrome and superior (pulmonary) sulcus tumors".)
- Myocardial ischemia with associated left shoulder pain.

A distinguishing characteristic of referred pain, in contrast to intrinsic shoulder problems, is that **shoulder movement is normal** and does not alter the character of the pain. A careful history can often distinguish among the causes of referred shoulder pain.

EXAMINATION — Examination of the shoulder is guided by the history. Although some components of the examination, such as inspection and a basic neurovascular evaluation are universal, other components are performed selectively based upon the diagnoses being entertained. What follows is

an overview of the physical examination of the shoulder, which includes both preliminary screening tools and tests designed to evaluate for specific diagnoses. A framework for determining when to perform specific maneuvers is provided in the shoulder pain algorithm and the section on clinical evaluation below. (See 'Stepwise clinical approach' below.)

The sensitivity and specificity of the various diagnostic maneuvers are given when well-performed studies are available, but data are limited. Studies have found relatively poor interobserver agreement in the interpretation of clinical examinations of the shoulder, even by highly experienced clinician and non clinician examiners (table 3) [17,18].

Inspection — The clinician should inspect the shoulder looking for any obvious deformity or asymmetry, muscle atrophy, or abnormal motion. A clavicle fracture, anterior glenohumeral dislocation, or high-grade acromioclavicular (AC) sprain is often immediately recognizable on the basis of the deformity present. As an example, the patient with an anterior glenohumeral dislocation typically holds the arm in slight abduction with external rotation, and a concavity below the acromion is visible. Atrophy can develop with chronic rotator cuff tears or nerve injury, such as subscapular nerve entrapment.

If possible, the clinician can observe shoulder motion by watching the patient take off a coat or don an examining gown. Unilateral abnormalities in motion, such as an inability to lower the arm smoothly (possible supraspinatus tear) or the use of accessory muscles to raise the arm (possible impingement syndrome), may provide diagnostic clues.

Neurovascular assessment — A screening neurovascular examination should be performed on every patient to confirm peripheral nerve function and adequate perfusion. If the clinician suspects neurologic injury on the basis of history or preliminary examination findings, then a thorough examination is needed. (See "The detailed neurologic examination in adults".)

Palpation — As with the shoulder examination generally, palpation is often performed selectively and is guided by the history and inspection of the shoulder. Involvement of the acromioclavicular (AC) or sternoclavicular (SC) joints, or the subscapular bursa, is determined by direct palpation. If referred pain from an intraabdominal source is suspected, the abdomen should be carefully examined.

In patients with trauma, gentle palpation may reveal focal tenderness or a step-off in the clavicle or AC joint, consistent with a fracture or ligament rupture. Glenohumeral dislocation can manifest as a palpable concavity in the subacromial space along with a bony prominence anteriorly (displaced humeral head).

For patients with nontraumatic intrinsic shoulder problems, at a minimum, systematic palpation of high-yield sites is needed. These sites include:

- The clavicle including SC and AC joints
- The acromion and the subacromial space
- The bicipital groove, and greater and lesser tubercles
- The scapular spine and adjacent musculature
- The cervical spine

Because the glenohumeral joint lies deep within the soft tissues, small or moderate sized effusions are usually not detectable. Warmth or redness may not be observed even with acute inflammation. Therefore, ultrasound imaging may be required to establish the presence of an effusion. However, demonstrating excessive synovial fluid by joint aspiration remains the definitive test.

- Joint tenderness - Tenderness of the acromioclavicular (AC) and sternoclavicular (SC) joints is assessed as follows. The anterior, lateral, and posterior edges of the acromion are demarcated. The AC joint is palpated at the juncture of the acromion and distal clavicle, approximately 4 cm

proximally from the lateral edge of the acromion (picture 1). The SC joint is palpated at the juncture of the proximal end of the clavicle and the lateral edge of the sternum, approximately one inch from the midline of the body.

- Subacromial space tenderness - The acromial process of the scapula is covered by the deltoid muscle. The supraspinatus tendon attaches to the greater tubercle, located just under the anterior third of the acromion. The subacromial structures may be indirectly examined by palpating directly below the acromion (picture 2). Alternatively, these structures can be moved anteriorly and better palpated by extending the shoulder [19]. This is accomplished by gently lifting the elbow of the adducted arm posteriorly (picture 3). Tenderness is consistent with impingement syndrome, rotator cuff tendinopathy, rotator cuff tear, subacromial bursitis, muscle contusion, or a humeral lesion.

If subscapular pathology is suspected, the subscapular bursa can be palpated at the junction of the superior-medial angle of the scapula and the closest underlying rib; exposure of this bursa requires full adduction of the ipsilateral arm by asking the patient to hold his or her opposite shoulder (picture 4).

Range of motion — Motion testing is performed to help determine the site and nature of intrinsic shoulder pain. If the patient is able to perform the "NFL touchdown sign" test without difficulty, there is no need for further range of motion testing. Any problems with the test indicate a need for further evaluation. Generally, active motion is assessed before passive. Symptom reproduction with active motion testing suggests a contractile structure (ie, muscle, tendon) is injured. Symptom reproduction with passive motion testing suggests a noncontractile structure (ie, bone, cartilage) is causing pain.

Preliminary screen — The "NFL touchdown sign" (raising both arms from the sides to straight overhead) is a simple active maneuver used to assess range of motion of the shoulder joint and the basic strength of abduction (picture 5). Full abduction requires a normal glenohumeral joint, intact rotator cuff tendons, a functional AC joint, and reasonably well developed deltoid and rotator cuff muscles. The following findings may be noted during this test:

- Full painless motion excludes glenohumeral pathology and suggests an extrinsic source of pain.
- Severe pain is consistent with acute rotator cuff tendinopathy and inflammatory or septic arthritis.
- True weakness is associated with rotator cuff tendon tear, but it can also be caused by severe atrophy of the rotator cuff and deltoid muscles, severe C5 radiculopathy, or suprascapular nerve palsy. Adhesive capsulitis will limit motion and may cause pain.
- Patients who have had trauma resulting in dislocation, AC joint separation, or fracture will rarely even attempt the maneuver.

Joint rotation — The Apley scratch tests are used to assess motion of the shoulder joint. Full rotation requires a normal glenohumeral joint, intact rotator cuff tendons, and reasonably well-developed rotator cuff muscles. Thus, rotation is limited with:

- Acute inflammation of rotator cuff tendinopathy
- Adhesive capsulitis (ie, frozen shoulder)
- Arthritis of the glenohumeral joint (osteoarthritis or inflammatory arthritis)

The impairment of rotation correlates well with the severity of these conditions. Side-to-side comparison provides the most practical and objective measurement of rotation.

The Apley scratch tests are simple to perform (picture 6).

- To assess adduction more thoroughly, the patient is asked to reach across his or her chest and touch the opposite shoulder (picture 6). A patient with acromioclavicular pathology will have difficulty with this maneuver.
- To assess external rotation and abduction, the patient is asked to reach behind his or her head and touch the superior medial tip of the opposite scapula (picture 6). A patient with normal function can reach approximately the level of the T4 spinous process.
- To assess internal rotation and adduction, the patient is asked to reach behind his or her back and touch the inferior tip of the opposite scapula (picture 6). A patient with normal function can reach approximately the level of the T8 spinous process [19].

In addition to assessment, the Apley scratch maneuvers are used to follow objectively the response to treatment. As an example, effective conservative therapy might enable a patient who could reach only the level of the L1 spinous process to reach the T10 level.

Active range of motion can also be assessed by having the patient perform each shoulder motion (flexion, extension, abduction, adduction, internal and external rotation) in isolation and comparing sides (table 4). The examiner can brace the superior trapezius with one hand to prevent the use of accessory muscles in abduction.

Scapulothoracic motion and strength — Coordination of motion at the glenohumeral joint and the scapulothoracic articulation is important for normal shoulder function. (See 'Anatomy and biomechanics' above.) Normally, once the shoulder is abducted more than 20 degrees, further abduction occurs at these articulations in a 2:1 ratio: for every two degrees of abduction at the glenohumeral joint, the scapulothoracic articulation moves one degree. Normal motion is smooth and symmetric.

Clinicians can assess scapulothoracic motion and abduction by observing the undressed patient from behind while simultaneous shoulder abduction is performed. Another technique is to place a thumb on or to hold the inferior tip of each scapula and have the patient abduct the arm.

Patients can compensate for decreased glenohumeral motion by using scapulothoracic motion, which is capable of up to 90 degrees of abduction. Such compensation is manifest as shoulder shrugging. Abnormal motion most often occurs either to compensate for an injury that limits glenohumeral movement or because the stabilizing muscles of the scapula are weak, in which case there may be no asymmetry.

Scapular instability, whether from nerve damage or muscle weakness alone, can be evaluated by either the push-off or stabilization tests. In the former, the patient pushes against a wall, as if performing an upright push-up. Instability manifests as scapular winging. In the scapular stabilization test, the patient flexes his or her shoulder, while the examiner manually compresses the patient's scapula against the ribcage [20]. Elimination of pain and improved shoulder motion (shoulder flexion ≥150 degrees) and strength suggests scapular instability is causing the patient's symptoms. Evaluation of supraspinatus strength can also be performed with and without scapular stabilization [21]. Pain relief and improved strength with stabilization suggest that scapular instability is contributing to the patient's symptoms. (See 'Assessment of abduction and the supraspinatus' below.)

Passive range of motion — If active motion is limited, passive range of motion should be assessed for each major movement of the shoulder. Such testing helps the clinician to distinguish between motion limitations caused by pain and those caused by a structural constraint (eg, adhesive capsulitis or glenohumeral arthritis).

Strength and tendon integrity — Strength testing is used both to assess neurologic integrity and to identify injury. Significant focal weakness, in the setting of lancinating pain radiating from the neck along the posterior shoulder and back or into the arm, is consistent with cervical nerve root impingement or peripheral nerve entrapment. (See "Evaluation of the patient with neck pain and cervical spine disorders".) Weakness associated with nonradiating, dull or achy pain is more consistent with a rotator cuff or other muscle tear.

With intrinsic pain, the essential distinction to be made by strength tests is between pain without weakness (tendinopathy) and pain with weakness (tendon tear). Several tests exist to evaluate the strength of specific muscle groups [19,22].

Assessment of abduction and the supraspinatus — Of the three abductors of the shoulder (deltoid, supraspinatus, and trapezius muscles), the supraspinatus is responsible for abduction in the mid arc (approximately 30 to 90 degrees). Thus, isometric testing of the supraspinatus tendon in midarc assesses the strength, integrity, and degree of inflammation of the supraspinatus tendon:

- Pain with normal strength is seen in patients with rotator cuff tendinopathy (affecting the supraspinatus).
- Pain and weakness are seen in patients with rotator cuff tendinopathy or rotator cuff tendon tear. It may also occur with radiculopathy.
- Weakness alone may be seen in patients with rotator cuff tear, muscular atrophy, weakness of muscles stabilizing the scapula, C5 radiculopathy, or suprascapular nerve palsy.

Supraspinatus isometric strength is assessed by having the patient abduct the arm about 45 degrees with about 30 degrees of forward flexion, and then having the patient resist, while the examiner attempts to adduct the arm (picture 7).

This isometric test of supraspinatus strength is highly sensitive but nonspecific for the diagnosis of supraspinatus tendon injury [23]. The severity of functional impairment during testing does not correlate well with the size of the tear.

The integrity of the supraspinatus tendon can also be assessed with the "drop arm" test and the active painful arc test. The drop arm test assesses the ability of the patient to lower his or her arms from a fully abducted position. A positive test occurs when the patient is unable to lower the affected arm with the same smooth coordinated motion as the unaffected arm. It is highly specific but insensitive for the diagnosis of rotator cuff tear [24].

The active painful arc test (not to be confused with the Neer test, an impingement test performed passively) is used to assess rotator cuff tendinopathy (picture 8). Pain with active abduction beyond 90 degrees marks a positive test.

The "empty can" (or Jobe's) test is another means of evaluating supraspinatus function (picture 9). It is performed by having the patient place a straight arm in about 90 degrees of abduction and 30 degrees of forward flexion, and then internally rotating the shoulder completely. The patient then resists the clinician's attempts to adduct the arm. Pain without weakness is consistent with tendinopathy; pain with weakness is consistent with tendon tear.

When pain limits the ability to evaluate strength in abduction, the clinician can assess the integrity of the axillary nerve by having the patient fully adduct the shoulder and then abduct against some resistance [25].

Assessment of external rotation and the infraspinatus — The infraspinatus muscle is responsible for external rotation with the teres minor muscle contributing to a minor degree.

Isometric testing of the infraspinatus tendon in neutral position is used to assess the strength and integrity of the infraspinatus tendon, as well as pain indicative of injury (picture 10). Testing with resistance bands can be used to further evaluate the functional strength of external shoulder rotation (picture 11). The following findings may be noted:

- Pain and normal strength are consistent with rotator cuff tendinopathy.
- Pain and unilateral weakness are consistent with rotator cuff tendon tear, C5 radiculopathy, or suprascapular nerve palsy.
- Weakness alone is consistent with rotator cuff tear, muscular atrophy, C5 radiculopathy, or suprascapular nerve palsy.
- Bilateral weakness is consistent with poor muscular development, bilateral rotator cuff tears, bilateral glenohumeral arthritis, or other chronic conditions.

Assessment of internal rotation and the subscapularis — The subscapularis is the rotator cuff muscle primarily responsible for internal rotation. Its strength can be assessed using the push-off (or Gerber's lift-off) test. This test is performed by having the patient place one hand behind his or her back and push posteriorly against resistance (picture 12). As with other strength tests, the essential distinction is between pain with weakness (tendon tear) and pain without weakness (tendinopathy).

Assessment of biceps tendon — Injury or inflammation of the long head of the biceps tendon can cause anterior shoulder pain. In addition to direct palpation, two simple tests allow for evaluation of this tendon. To perform the "Speed's" test, the patient forward flexes the shoulder about 30 degrees against the clinician's resistance, while keeping the elbow fully extended and the arm fully supinated (picture 13). To perform the "Yergason's" test, the patient holds his or her arm adducted with elbow flexed to 90 degrees and the arm fully pronated. The patient holds the examiner's hand and attempts to supinate it while the examiner resists (picture 13). Either test is considered positive for bicipital tendinopathy, if it elicits pain in the bicipital groove.

Impingement — The rotator cuff tendons and subacromial bursa are located in the narrow space between the acromial process of the scapula and the top of the humeral head making them susceptible to injury. (See 'Anatomy and biomechanics' above.) Testing for impingement is an important part of the shoulder examination for any patient in whom the diagnosis of rotator cuff injury is being considered [22]. If impingement is present clinically, isometric strength testing of individual rotator cuff tendons follows to determine which tendons are inflamed (most commonly affected is the supraspinatus; the infraspinatus can also be involved). (See 'Strength and tendon integrity' above.)

Two straightforward tests for impingement are described below.

- Passive painful arc (Neer) test - The "passive painful arc maneuver" (passively flexing the glenohumeral joint while simultaneously preventing shoulder shrugging) is used to assess the degree of impingement (picture 14). The clinician should note whether the patient is guarding by shrugging as the maneuver is performed. The severity of impingement and rotator cuff tendinopathy is determined by the angle at which the arc becomes painful.

  Pain at 90 degrees is consistent with mild impingement.

  Pain at 60 to 70 degrees is consistent with moderate impingement.

  Pain at 45 degrees or below is consistent with severe impingement.

One study of 125 patients with painful shoulders found this test to be specific but not sensitive; a negative test does not rule out rotator cuff pathology [26].

- Flexion with internal rotation (Hawkins) test - In this test, the clinician stabilizes the shoulder with one hand and, with the patient's elbow flexed 90 degrees, internally rotates the shoulder using the other hand (picture 15). Shoulder pain elicited by internal rotation represents a positive test.

- Yocum's test - This test of impingement involves placing the hand of the affected side on the patient's unaffected shoulder and then raising the elbow, without elevating the shoulder (picture 16). Shoulder pain elicited by raising the elbow represents a positive test.

Instability — General glenohumeral instability or looseness may be the cause of shoulder discomfort in young throwing athletes, people with weak shoulder musculature, and patients who have sustained a rotator cuff tear. Instability may be multi or unidirectional; anterior and inferior laxity is most common. Several tests are used to assess this problem [27].

- Sulcus sign - Downward movement of the humeral head is influenced by the tone and bulk of the deltoid, the tone and thickness of the supraspinatus tendon, and the redundancy of the glenohumeral capsule.

  The sulcus sign maneuver evaluates the looseness of the shoulder (especially the subacromial space) and is used to assess the patient's tolerance of the Codman pendulum stretch exercise (picture 17). The following findings may be noted:

  No movement can be seen in patients with extreme guarding or tension, fibromyalgia, or an overly developed deltoid muscle.

  6.5 mm of movement is normal.

  One-half inch or greater movement is consistent with hypermobility (subluxation).

- Apprehension, relocation, and release tests - These tests work in combination and are most easily performed with the patient supine. (picture 18). To perform the apprehension test, the patient is asked to place the symptomatic arm in the throwing position (shoulder abducted and externally rotated). Next, the clinician braces the posterior shoulder with one hand while using the other hand to push back on the wrist with steady pressure, thereby increasing the abduction and external rotation of the shoulder (as if he or she were attempting to dislocate the shoulder anteriorly). Any sensation of impending dislocation at any time on the part of the patient constitutes a positive test.

  The relocation test is begun at the end of the apprehension test and is performed by simply reversing the forces being exerted by the examiner. Forced abduction and external rotation are stopped, and the clinician moves the hand that was bracing the posterior shoulder to the anterior shoulder. The examiner then pushes the humerus posteriorly (as if he or she were attempting to relocate the shoulder). Relief of pain or of the sensation of impending dislocation on the part of the patient represents a positive test.

  The release test is performed at the end of the relocation test when the clinician abruptly stops pushing the humerus posteriorly. Again, any sensation of impending dislocation on the part of the patient constitutes a positive test.

  One meta-analysis of these tests found both the relocation and release tests to have reasonable

sensitivity (85 percent) and specificity (87 percent) for the detection of glenohumeral instability [27]. The authors warn, however, that most of the studies reviewed involved patients in orthopedic clinics, and it remains uncertain whether their findings apply to more general populations.

STEPWISE CLINICAL APPROACH — For many primary care clinicians, determining how best to evaluate patients with shoulder pain can be difficult. The anatomy of the shoulder is complex and the differential diagnosis broad. Fortunately, patients with shoulder pathology most often present in stereotypical fashion. By following the basic approach outlined here (algorithm 1), clinicians should be able to diagnose and either manage or refer appropriately the great majority of patients with shoulder complaints.

Step one: Traumatic versus nontraumatic — The first step is to determine whether a traumatic injury is present. Most often this determination is straightforward based on the patient's history, although delayed presentations do occur, for example, with mild acromioclavicular (AC) separations. Examination may reveal deformity, and the patient is nearly always able to localize the pain. Plain x-rays make or confirm the diagnosis.

The most common shoulder injuries from minor blunt trauma include: fractures of the clavicle and proximal humerus, dislocations of the glenohumeral joint, and sprains of the AC joint.

Should x-rays fail to reveal an injury but the patient's symptoms persist, a soft tissue injury (eg, rotator cuff tear) is likely and the clinician should perform an appropriate assessment (step three below).

Step two: Extrinsic versus intrinsic — Once traumatic injury has been excluded, the second step is to determine whether the patient's shoulder pain is a referred symptom caused by pathology extrinsic to the shoulder (table 1), or intrinsic. A careful history and preliminary examination should enable the clinician to make this distinction. Often, if the cause is extrinsic, the patient has difficulty localizing the pain. The pain itself is often vague, if it is referred from a thoracic or abdominal source, or sharp with radiation if it is from a neurologic source.

The history may reveal details or associated symptoms of concern:

- Cervical nerve root impingement may be present in the patient with sharp pain radiating from the neck into the posterior shoulder area or arm.
- Splenic injury may be present in the patient with shoulder pain recently involved in an automobile accident in which the shoulder was not initially injured.
- Myocardial ischemia may be present in the patient who experiences diaphoresis or dyspnea with each episode of shoulder pain.

Examination of patients with an extrinsic cause of shoulder pain most often reveals painless range of motion and no asymmetry in appearance, motion, or strength when compared with the opposite shoulder.

Step three: Glenohumeral versus extraglenohumeral — If an intrinsic problem is present, the clinician must next determine whether its focus is the glenohumeral joint or not. Generally the patient is able to localize the pain from extra-glenohumeral pathology to a specific site, such as the bicipital groove for biceps tendinopathy, or the acromioclavicular (AC) joint for AC osteoarthritis. Weakness of the stabilizing muscles of the scapula is a notable exception, and this diagnosis can be difficult to make. A careful assessment of scapulothoracic motion and observation for any scapular winging can aid diagnosis.

In all cases of extra-glenohumeral pathology, passive range of motion of the glenohumeral joint should be normal, although assessment may be limited by pain or guarding. With problems related directly to the glenohumeral joint and its surrounding structures, examination should reveal some abnormality, be it pain, weakness, or abnormal motion.

Step four: Differentiating glenohumeral pathology — Once extra-glenohumeral pathology has been ruled out, the clinician must try to determine which of several glenohumeral abnormalities is causing the patient's symptoms. Assessment of shoulder range of motion, strength, and signs of impingement will help to distinguish among such diagnoses as rotator cuff tendinopathy, rotator cuff tear, and adhesive capsulitis. A summary of the key examination findings for each common diagnosis is found immediately below. Further detail is found in the text (table 3). (See 'Examination' above.)

- Impingement and rotator cuff tendinopathy - Anterolateral shoulder pain that increases with overhead reaching; pain with supraspinatus testing and/or external rotation; positive impingement tests
- Rotator cuff tendon tear - Older patient (age >40); pain and weakness with supraspinatus testing and/or external rotation; positive impingement tests
- Adhesive capsulitis - History of diabetes or immobilizing disability (eg, stroke, injury requiring sling); diminished active and passive range of motion
- Glenohumeral osteoarthritis - History of shoulder trauma; pain; diminished active and passive range of motion; x-ray shows sclerosis and diminished joint space
- Multidirectional shoulder instability - Younger patient (age <40); positive sulcus sign; positive instability test

INJECTION TESTS — When the examination suggests the presence of a specific disorder, certain tests can be performed to confirm the diagnosis.

Lidocaine injection test — The lidocaine injection test is used to (picture 19):

- Exclude glenohumeral joint involvement
- Confirm rotator cuff tendinopathy
- Exclude rotator cuff tear
- Determine the degree of frozen shoulder

Patients with a rotator cuff tear will have persistent weakness despite pain relief with injection, while those with rotator cuff tendinopathy will have normal strength in association with pain relief. Patients with a frozen shoulder will have persistent loss of range of motion. Dramatic reduction in pain and improvement in overall shoulder function after injection of the subacromial bursa effectively rules out a significant glenohumeral joint process.

The lidocaine injection test in the subacromial bursa is indicated when the history and physical examination cannot effectively exclude an underlying rotator cuff tendon tear, a developing frozen shoulder, or concurrent involvement of the acromioclavicular (AC) joint.

Local anesthetic block at the bicipital groove — Bicipital tendinopathy can be confirmed by local anesthetic block (picture 20). This is most often indicated in the patient presenting with anterior shoulder pain with an equivocal physical examination demonstrating signs of bicipital tendinopathy and rotator cuff tendinopathy, especially involving the subscapularis tendon (an internal rotator and adductor of the shoulder).

RADIOGRAPHIC STUDIES — Diagnostic imaging of the shoulder may be valuable when directed by the history and physical examination. A variety of modalities may be employed. A complete

discussion of these studies is found elsewhere. (See "Radiologic evaluation of the painful shoulder".)

Plain radiographs — Plain radiographs of the shoulder generally have limited benefit in the evaluation of nontraumatic shoulder pain. This was illustrated in a study of 312 patients seen in an emergency department setting for shoulder pain: only 37 of the 185 shoulder films (20 percent) were therapeutically informative, ie, identified conditions requiring specific therapy such as a fracture or dislocation [28]. No patient without a shoulder deformity or a precipitating fall had an informative radiograph.

A subsequent study of 206 patients used the presence or absence of the following features: history of falling, swelling, rest pain, abnormalities in range of motion, and obvious deformities of the shoulder, to help identify those in whom a shoulder radiograph was unlikely to be informative [29]. Among those without obvious shoulder deformities and swelling, the following three groups had relatively insignificant radiographs:

- Patients without rest pain who had fallen. No significant radiographic findings were found among 18 patients with these features.
- Patients who had fallen, had rest pain, and had normal range of motion. No therapeutically informative radiographs were reported in 10 such patients.
- Patients who had not fallen. Only 1 of 107 such patients had a lytic lesion discovered on radiograph; this individual was already known to have multiple myeloma.

While there are no specific guidelines for when radiography is indicated, we generally recommend obtaining plain films in patients who have lost range of motion, particularly when there is severe pain, and after trauma. Plain films can identify the following:

- Fractures of the proximal humerus, clavicle, and scapula
- Glenohumeral dislocations
- Glenohumeral osteoarthritis (picture 21)
- Acromioclavicular (AC) joint arthritis or injury (picture 22)
- Sternoclavicular (SC) joint arthritis (apical lordotic views of the chest)

In addition, indirect evidence of rotator cuff thinning, tear, or both may be evident on plain x-ray of the shoulder (picture 23). A subacromial space measurement less than 1 cm suggests thinning with or without tear, which can be confirmed by MRI.

When plain films are obtained in a patient with a history of trauma, both AP and axillary views are warranted since some conditions can be missed on the former alone.

Magnetic resonance imaging — MRI is the preferred imaging study for patients with suspected impingement and rotator cuff injury. A normal MRI suggests that the likelihood of a rotator cuff tear is less than 10 percent [30-32]. On the other hand, MRI findings for rotator cuff tears are not highly specific, particularly in older patients [33]. The sensitivity and specificity of MRI for the diagnosis of impingement are approximately 93 and 87 percent, respectively [34]. MRI is also useful in the evaluation of avascular necrosis, biceps tendinopathy and rupture, inflammatory processes, and tumors [35].

Ultrasonography — In the hands of skilled operators, the diagnostic accuracy of ultrasound has been found to be the equivalent of MRI in identifying rotator cuff tears, labral tears, and biceps tendon tears and dislocations [36-42]. Ultrasound is less expensive than MRI and preferred by

patients [42,43].

Arthrography — Arthrography has largely been replaced by MRI for the diagnosis of rotator cuff disorders. It is specific for rotator cuff tears, but it has a low sensitivity since it cannot detect partial-thickness tears nor associated soft tissue injuries [44]. Arthrography still may be useful for evaluating frozen shoulder and may even be therapeutic. (See "Frozen shoulder (adhesive capsulitis)".)

INFORMATION FOR PATIENTS — UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient information: Biceps tendinopathy (The Basics)" and "Patient information: Rotator cuff injury (The Basics)" and "Patient information: Bursitis (The Basics)" and "Patient information: Frozen shoulder (The Basics)" and "Patient information: Shoulder impingement (The Basics)")
- Beyond the Basics topics (see "Patient information: Rotator cuff tendinitis and tear" and "Patient information: Biceps tendinitis or tendinopathy" and "Patient information: Bursitis" and "Patient information: Frozen shoulder" and "Patient information: Shoulder impingement syndrome")

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