A Guide to the Physical Examination of the Shoulder

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Introduction

The physical examination of the shoulder is a fundamental component of the assessment of patients with shoulder pathology. The accurate identification of specific pathologies, such as rotator cuff tears, labral injuries, and instability, necessitates a thorough physical examination and a knowledgeable examiner. Orthopedic surgeons, orthopedic surgery residents, students, physical therapists, and physician assistants are required to have a strong understanding of the physical examination and anatomy of the shoulder to be able to effectively diagnose and treat shoulder pathologies.

Anatomy of the Shoulder

The shoulder joint is one of the most complex and mobile joints in the human body. The **glenohumeral joint** connects the humeral head to the glenoid fossa of the scapula.[1] The humeral head is larger than the glenoid fossa, which provides the joint with a wide range of motion but also makes it inherently unstable. The glenohumeral joint is surrounded by a joint capsule that is reinforced by ligaments and tendons, including the rotator cuff. The **rotator cuff** is made up of four muscles, including the supraspinatus, infraspinatus, teres minor, and subscapularis, as well as their associated tendons, which help to stabilize the humeral head in the glenoid fossa during shoulder movement.[2] The **acromioclavicular joint** is formed by the articulation of the acromion process of the scapula and the lateral clavicle.[3] It is a gliding joint that allows for movement of the clavicle and scapula relative to one another. The acromioclavicular joint is stabilized by several ligaments, including the acromioclavicular ligament, coracoclavicular ligament, and coracoacromial ligament. In addition to these joints, the shoulder is also composed of various bursae and muscles, including the deltoid, pectoralis major, and latissimus dorsi. The bursae are fluid-filled sacs that help to reduce friction between structures in the shoulder, while the muscles provide the shoulder with strength and stability during movement.[1,4]

Shoulder Pathology

Shoulder pathology is a common presenting complaint in orthopedic surgery clinics. Rotator cuff tears, arthritis, labral injuries, and shoulder instability are among the most common shoulder pathologies patients present with. The prevalence of rotator cuff tears increases with age, with a reported incidence of 22 percent in individuals over sixty years old.[5] Shoulder-related injuries, such as superior labral anterior to posterior (SLAP) tears and instability, are commonly seen in athletes and can result in significant functional impairment.[6,7] Physical laborers and recreational athletes alike can suffer from rotator cuff tears and arthritis, among other injuries.

Mechanics of the Throwing Shoulder

Understanding normal throwing shoulder mechanics is crucial for identifying subtle variations from the norm that may predispose athletes to injury or limit performance. Normal throwing shoulder mechanics involve a series of complex movements that result in proper positioning and movement of the humerus and scapula. During the throwing motion, the scapula rotates and elevates while the humerus abducts and externally rotates, which creates a stable base for the arm to move.[8]

The stages of throwing can be broken down into wind-up, stride and early cocking, late arm cocking, acceleration, deceleration, and follow-through.[8] Notably, a wide variety of shoulder and trunk musculature facilitates the process of throwing. While the pectoralis major, serratus anterior, latissimus dorsi, and subscapularis have been shown to be most involved in the acceleration phase of throwing, the rotator cuff and trunk musculature are most involved during the deceleration phase.[8] Further, the position of the humerus and scapula at each stage of the throwing motion can affect the load and stress placed on the structures of the shoulder joint. For example, excessive external rotation during the late cocking phase has been associated with increased risk of shoulder injuries.[9] Proper throwing mechanics depend on a combination of strength, flexibility, and coordination of the shoulder musculature. Understanding the biomechanics of the throwing motion can help clinicians identify potential mechanical deficiencies that may contribute to shoulder pathologies. A comprehensive physical examination of the throwing shoulder should include an assessment of throwing mechanics, core stability, and leg stance to identify any areas of weakness or muscle imbalances that may need to be addressed in the management plan.

Overview of the Physical Examination of the Shoulder

The physical examination of the shoulder typically includes inspection, palpation, range of motion assessment, and various special tests that are unique to the pathology being examined.[4,10,11]

First, **inspection** of the shoulder involves visually assessing for any asymmetry, swelling, or deformity.[4,10,11] The examiner should look for any muscle atrophy, scars, or discoloration, which may indicate previous injuries or surgeries. Ideally both shoulders should be assessed for comparison. The clavicle and scapula should be compared on each side for any asymmetry or winging, which may indicate underlying pathologies such as nerve injuries or muscle weakness. It is important to closely compare the affected shoulder with the unaffected shoulder, as this may detect subtle differences and clues to narrow the differential diagnosis.

Palpation of the shoulder involves assessing for any tenderness, swelling, **crepitus**, or deformity with manual touch. The examiner should palpate the bony landmarks, joints, and soft tissue structures, including the rotator cuff muscles and their associated tendons. Tenderness over the rotator cuff tendons may indicate related pathology, while tenderness over the bicipital groove may indicate bicipital tendonitis.[4,10,11]

A **range of motion assessment** is used to evaluate the shoulder's mobility and to identify any restrictions or pain associated with movement.[4,10,11] The examiner should assess active and passive range of motion of the shoulder in all planes. **Active range of motion** refers to the patient using their own strength or ability to move the shoulder, while **passive range of motion** refers to the patient getting assistance from the examiner. Specific movements of the shoulder include **forward elevation**, **external rotation** at the side, **abduction**, external rotation in abduction, **internal rotation** in abduction, and internal rotation at the side to vertebral height. Clinically normal values are 180 degrees of forward elevation and abduction, 90 degrees of external rotation, internal rotation to T4, 70 degrees of internal rotation in abduction of 90 degrees, and 90 degrees of external rotation in abduction at 90 degrees.[12] Limited range of motion or pain with certain movements may indicate underlying pathologies such as frozen shoulder, arthritis, rotator cuff pathology, or glenohumeral instability (video 1).[4,10,11]

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Video 1: Range of Motion of the Shoulder. Active range of motion in the shoulder is assessed in the following order: forward elevation, abduction, external rotation at the side, external rotation in abduction, internal rotation in abduction, and internal rotation to vertebral height.

For these movements, corresponding strength testing should be performed as well. Strength is graded on a scale from 0 to 5, with 0 signifying a complete absence of muscle contraction and 5 indicating active movement against opposing resistance with full strength.[13] The examiner should ask the patient to perform forward elevation, abduction, external rotation, and internal rotation against resistance to accurately determine muscle strength. The full muscle grading scale is presented in table 1.

Table 1: Muscle Strength Grading

Grade	Strength Description
0	No muscle twitch seen
1	Muscle contraction observed
2	Active movement observed without gravity without full range of motion
3	Active movement against gravity, not against resistance, with full range of motion
4	Active movement against some resistance with full range of motion
5	Active movement against resistance with full range of motion

Physical Examination of the Cervical Spine

Additionally, it may be necessary to perform an examination of the cervical spine, as pain can be referred to the shoulder from a cervical spine condition. This includes palpating the cervical spinous processes for any tenderness, examining full range of motion of the neck, and performing a thorough neurological examination. Normal cervical spine flexion is to approximately 80 degrees, whereas extension is to 50 degrees and rotation is to 90 degrees bilaterally.[14] Spurling's test can also be performed as a screening test for cervical radiculopathy, a condition caused by compression of the cervical nerve roots, which results in radiating pain down the arm in the distribution of the corresponding compressed nerve root. To perform this maneuver, the examiner should gently, passively extend and tilt the patient's head to the shoulder of interest. An axial compressive force is applied to the head, and reproduction of radicular pain, or pain from the neck radiating to the shoulder and affected extremity, indicates a positive test (figure 1).

Figure 1*: *Spurling's Test. *The examiner performs Spurling's test to evaluate for cervical radiculopathy. While the patient's neck is slightly extended, tilted to the affected side, an axial compressive force is applied. Reproduction of radicular pain, or pain from the neck radiating to the shoulder and down the affected extremity, indicates a positive test.*

The test is considered positive when pain radiates from the neck down the ipsilateral upper extremity.[15] The assessment of the cervical spine should be completed with an examination of the C5–T1 cervical and thoracic nerve roots, which form the brachial plexus. For each cervical nerve root, its respective motor function, sensory function, and reflex should be tested, as listed in table 2 and shown in figure 2.

Table 2: Cervical Spine and Nerve Root Examination

Nerve Root	Motor Function	Muscles Tested	Sensation	Reflex
C5	Shoulder abduction	Deltoid, biceps	Lateral upper arm	Biceps
C6	Elbow flexion, wrist extension	Brachioradialis, ECRL	Thumb and radial hand	Brachioradialis
C7	Elbow extension, wrist flexion	Triceps	Digits 2, 3, 4	Triceps
C8	Finger flexion, thumb extension	FDS	5th digit	
T1	Finger abduction	Interossei	Medial forearm	

***Figure 2a: Cervical Spine and Nerve Root Examination**. The examiner asks the patient to abduct the bilateral shoulders past 15 degrees against resistance, examining the motor function of the C5 nerve root.*

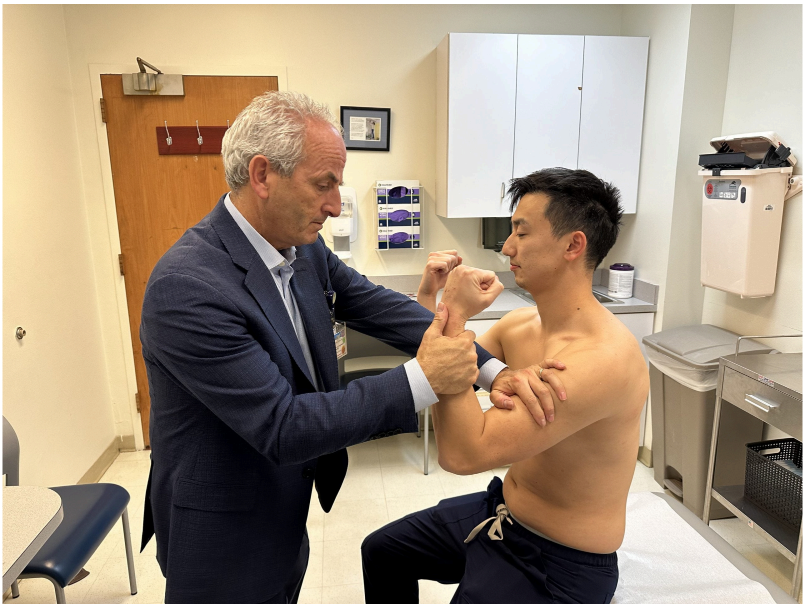

Figure 2b: *The examiner asks the patient to flex the elbow against resistance, examining the motor function of the C6 nerve root.*

Figure 2c: *The examiner asks the patient to extend the elbow against resistance, examining the motor function of the C7 nerve root.*

Figure 2d: *The examiner asks the patient to flex the fingers against resistance, examining the motor function of the C8 nerve root.*

Figure 2e: *The examiner asks the patient to abduct the fingers against resistance, examining the motor function of the T1 nerve root.*

Special Tests for the Shoulder Examination

Special tests are more targeted maneuvers that are used to further evaluate the shoulder and identify specific pathologies.[4,10,11] These tests are discussed in detail in later chapters and can include the Neer impingement test, the Hawkins impingement test, the Speed's test, the Yergason's test, and the apprehension, relocation, and release tests. The Neer and Hawkins impingement tests are used to evaluate for subacromial impingement, while Speed's test and Yergason's test are used to assess bicipital tendon pathology. Finally, the apprehension, relocation, and release tests are used to evaluate for shoulder instability.[4,10,11] When performing these special tests in practice, it is important to tailor the examination to the patient's history and presenting symptom. For example, if a patient presents with a primary symptom of pain at the acromioclavicular joint, palpation to elicit pain of the acromioclavicular joint should be deferred until the end of the examination so as to not prematurely elicit pain, which could potentially provide false positives with respect to the remainder of the shoulder examination.

In conclusion, the physical examination of the shoulder is a critical component of the assessment of patients with shoulder pathology. Orthopedic surgeons, orthopedic surgery residents, medical students, physician assistants, and physical therapists should have a thorough understanding of these concepts.

Key Terminology

Abduction

Motion of the glenohumeral joint upward and laterally. ↵

Acromioclavicular Joint

Articulation of the acromion process of the scapula and the lateral clavicle. ↵

Active Motion

Patient using their own strength and ability for range of motion. ↵

Crepitus

Crackling or grinding sound that occurs especially with motion. ↲

External Rotation

Motion of the glenohumeral joint, in the plane of the long axis of the humerus, away from the midline. ↲

Forward Elevation

Motion of the glenohumeral joint upward and anteriorly. ↲

Glenohumeral Joint

Highly mobile articulation between the humeral head and the glenoid fossa of the scapula. ↲

Inspection

Visually assessing for any asymmetry, swelling, or deformity. ↲

Internal Rotation

Motion of the glenohumeral joint, in the plane of the long axis of the humerus, toward the midline. ↲

Palpation

Assessing for any tenderness, swelling, or deformity with manual touch. ↲

Passive Motion

Patient getting assistance from another individual for range of motion. ↲

Range of Motion Assessment

Method of assessment of the shoulder's mobility and to identify any restrictions or pain associated with movement. ↲

Rotator Cuff

Group of four muscles and their associated tendons including the supraspinatus, infraspinatus, teres minor, and subscapularis, which help to stabilize the humeral head in the glenoid fossa and move the humerus in several planes. ↲

Special Tests

Targeted physical exam maneuvers to further evaluate specific structures in the shoulder and to identify specific pathologies. ↲

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1. Impingement Syndrome

Subacromial impingement syndrome, or symptomatic irritation of the rotator cuff tendons and subacromial bursa within the subacromial space, is the most common cause of shoulder pain, representing between 44 and 65 percent of shoulder disorders.[1,2] Impingement disorders are more common in individuals who participate in prolonged and repetitive overhead activities, including sports and manual labor.[3,4] Further, studies have shown that the incidence of shoulder impingement increases with age, and peak incidence is between ages sixty and sixty-nine.[3,5-7] Other factors that increase the likelihood of development of impingement syndrome include curved or hooked acromial morphology.

Anatomy

The **subacromial space** is an anatomic region of the shoulder defined as the space between the coracoacromial arch, consisting of the acromion, coracoacromial ligament, and coracoid process; the greater tuberosity; and the rotator cuff attachments.[3] Within the subacromial space, there is the presence of soft tissue structures, including the tendons of the rotator cuff, the coracoacromial ligament, the subacromial bursa, and the long head of the biceps tendon. On radiographs, the distance between the superior and inferior borders of the subacromial space has been measured between 0.8 and 1.2 centimeters.[3] The shape of the acromion has been classified, according to Bigliani et al., into three categories: type I (flat), type II (curved), and type III (hooked).[3] Bigliani et al. initially noted an association of the type II and III acromia with rotator cuff pathology, while other studies have found different associations with rotator cuff pathology.[3,8,9]

Pathophysiology

There are several proposed mechanisms that contribute to the development of subacromial impingement.[1,3,4] Extrinsic compression of the rotator cuff tendons occurs between the head of the humerus and the anterior acromion, the coracoacromial ligament, or the acromioclavicular joint. Processes that narrow the subacromial space and can lead to rotator cuff tendon compression include the development of subacromial spurs, osteophytes at the AC joint, and hypertrophy of the coracoacromial ligament, in addition to acromial morphology.[1,3,4] Factors contributing to subacromial impingement include:

- Anterior acromion morphology
- Subacromial spur
- Coracoacromial ligament
- Acromioclavicular joint

Further, repetitive motion and overuse of the shoulder may lead to bursitis and inflammation of the soft tissues within the subacromial space.

History

Initial evaluation of subacromial impingement begins with a thorough history. The most common presenting symptom is pain of the shoulder with overhead activity.[3] Classically, this pain occurs on forward elevation of the affected arm between 70 and 120 degrees.[3] Patients may additionally report pain upon overhead motion, pain when lying on the affected shoulder, and nighttime pain. Symptoms such as stiffness and weakness may be present but are more often secondary to pain.[3] The pain is often relieved by rest, ice, and non-steroidal anti-inflammatory drugs (NSAIDs), and exacerbated by motions including overhead motions, abduction, and internal rotation (i.e., reaching for a back pocket or hooking a bra). In addition to a thorough evaluation of the characteristics of pain, the duration of the symptoms should be determined. Subacromial impingement typically has an insidious course, with symptoms gradually worsening over a period of weeks to months.[2,3] Further, all previous interventions, including lifestyle changes, physical therapy, NSAIDs, corticosteroid injections, and surgical procedures, on the affected shoulder should be noted.

Physical Examination

A thorough physical examination, including inspection, palpation, range of motion, and specific physical examination maneuvers, are crucial for establishing a diagnosis of subacromial impingement. Inspection of the shoulder should be performed when standing in front of, on the side of, and behind the patient, and a comparison of the affected shoulder with the unaffected shoulder should be made. In subacromial impingement, palpation of the CA ligament and anterior acromion may elicit tenderness.[10] Additionally, it is important to perform a thorough examination of the cervical spine, as radiculopathy and degenerative processes can manifest similarly to impingement syndrome.[3] This includes palpating the cervical spinous processes for any tenderness, examining full range of motion of the neck, and performing a thorough neurological examination. Active and passive range of motion of the bilateral shoulders should be assessed in the following order: forward elevation, abduction, external rotation at the side, external rotation in abduction, internal rotation in abduction, and internal rotation to vertebral height (video 1.1). Strength of the affected shoulder should be compared to that of the unaffected shoulder. Weakness, although not always present, typically manifests as deficits of abduction and external rotation.

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Video 1.1: Range of Motion of the Shoulder. Active range of motion in the patient is assessed in the following order: forward elevation, abduction, external rotation at the side, external rotation in abduction, internal rotation in abduction, and internal rotation to vertebral height.

Special Tests

Several physical examination maneuvers have been described for impingement syndrome, including the Neer impingement sign, the Neer impingement test, and the Hawkins test. The Neer sign involves the examiner stabilizing the scapula of the affected shoulder with one hand and passively elevating the arm with the other hand (video 1.2; figure 1.1).[11] Pain that is elicited in the arc between 70 and 120 degrees of forward elevation indicates a positive test.[3] A variation of the **Neer impingement sign** is the **Neer impingement test**.[3] A sterile injection of ten milliliters of 1 percent lidocaine is made into the subacromial space, and the technique for the Neer impingement sign is repeated. A positive test is indicated by the relief of pain with the subacromial injection.

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Video 1.2: The Neer Impingement Sign. The examiner demonstrates the appropriate technique for the Neer sign for impingement on a patient's right shoulder. The patient is seated on the examiner's table. The examiner stabilizes the scapula of the right shoulder with one hand and passively elevates the arm in the scapular plane with the other hand. The test is considered positive if pain, which typically occurs in the arc between 70 and 120 degrees, is elicited by this maneuver.

Figure 1.1: The Neer Sign for Shoulder Impingement. *The examiner demonstrates the positioning for the Neer sign for impingement on a patient's right shoulder. The examiner's left hand is stabilizing the patient's scapula, while the examiner's right hand is passively elevating the patient's arm in the scapular plane.*

The next physical examination maneuver is the **Hawkins test**, or Hawkins-Kennedy test (video 1.3; figure 1.2).[11] The examiner places the patient's shoulder in 90 degrees of flexion and the patient's elbow in 90 degrees of flexion and maximally internally rotates the shoulder by applying a downward force to the wrist. A positive test is noted when pain is elicited by the maneuver (video 1.4).

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Video 1.3: The Hawkins Test. The examiner demonstrates the appropriate technique for the Hawkins test for impingement on a patient's right shoulder. The patient is seated on the examiner's table. The examiner stabilizes the posterior shoulder with one hand and places the patient's shoulder in 90 degrees of flexion and the patient's elbow in 90 degrees of flexion. Using the other hand, the examiner internally rotates the shoulder by applying a downward force to the wrist.

Figure 1.2: Internal Rotation of Shoulder at 90 Degrees of Flexion: *The examiner internally rotates the patient's shoulder at 90 degrees of flexion and the patient's elbow at 90 degrees of flexion by applying a downward force to the patient's wrist.*

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Video 1.4: Hawkins Test for Shoulder Impingement. The examiner performs the Hawkins test for impingement on the patient's right shoulder. The test is considered positive when pain is elicited by the maneuver. The patient here grimaces and nods in pain, indicating a positive test.

Lastly, the **Jobe test** is performed for the assessment of subacromial impingement and/or rotator cuff pathology (video 1.5; figure 1.3).[11] The patient's arms are placed in 90 degrees of abduction, angled forward 30 degrees, and internally rotated so that the thumbs face the floor. The examiner applies a downward force to the patient's arm, asking the patient to resist the force and keep their arm level. A test is considered positive if pain and/or weakness are elicited with the maneuver (video 1.6). It is critical to remember that a positive Jobe test does NOT necessarily indicate a rotator cuff tear—pain from the associated bursitis often causes inhibition of the muscles, and the patient simply cannot hold the arm against resistance.

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Video 1.5: The Jobe Test on Both Shoulders. The examiner demonstrates the appropriate technique for the Jobe test on the patient's right and left shoulders. The patient is seated on the examiner's table. Both arms are placed in 90 degrees of abduction, angled forward 30 degrees, and internally rotated so that the thumbs face the floor. The examiner first applies a downward force to the patient's left arm, asking the patient to resist the force and keep his arm level. The examiner then performs the same maneuver on the patient's right arm.

Figure 1.3: Patient Positioning for the Jobe Test. *The examiner demonstrates the appropriate patient positioning for the Jobe test. The patient's arms are placed in 90 degrees of abduction, angled forward 30 degrees, and internally rotated so that the thumbs face the floor.*

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Video 1.6: The Jobe Test on the Right Shoulder. The examiner performs the Jobe test on the patient's right shoulder. The test is considered positive if pain or weakness is elicited by the maneuver. This indicates weakness of the supraspinatus muscle and/or subacromial impingement. The patient here is unable to resist the examiner's downward applied force to his right shoulder, indicating weakness and a positive test.

A thorough and efficient examination for subacromial impingement involves all these tests for impingement performed in succession (video 1.7). Recent studies have examined the accuracy of these physical examination maneuvers in the diagnosis of subacromial impingement syndrome.[11,12] In an analysis of 1127 patients, Park et al. noted that the sensitivity, specificity, positive predictive value, and negative predictive value of these tests varied considerably and were influenced by the severity of the impingement syndrome.[11] In a systematic review and meta-analysis, Alqunaee et al. determined that these three tests of impingement were more useful in ruling out than ruling in subacromial impingement, as the pooled sensitivity (0.69–0.78) was greater than the pooled specificity (range, 0.57–0.62).[12] Regardless, these three physical examination maneuvers are critical in evaluating the patient for suspected subacromial impingement.

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Video 1.7: The Impingement Examination. The examiner performs the Neer sign, the Hawkins test, and the Jobe test in succession on the patient's right shoulder.

Sensitivities and specificities for all examinations described in chapter 1 are outlined in table 1.1.[12-14]

Table 1.1: Sensitivities and Specificities for Tests for Impingement

Test	Sensitivity	Specificity
Neer Impingement Sign[12]	89%	31%
Neer Impingement Test[13]	79%	53%
Hawkins Test[13]	74%	57%
Jobe Test[14]	88%	62%

Key Terminology

Hawkins Test

A test for subacromial impingement where the examiner places the patient's shoulder in 90 degrees of flexion and the patient's elbow in 90 degrees of flexion and maximally internally rotates the shoulder by applying a downward force to the wrist. A positive test is noted when pain is elicited by the maneuver. ↲

Jobe Test

A test for the assessment of subacromial impingement and/or rotator cuff (supraspinatus) pathology. The patient's arms are placed in 90 degrees of abduction, angled forward 30 degrees, and internally rotated so that the thumbs face the floor. The examiner applies a downward force to the patient's arm, asking the patient to resist the force and keep their arm level. A positive test is noted if pain and/or weakness is elicited by the maneuver. ↲

Neer Impingement Sign

A test for subacromial impingement where the examiner stabilizes the scapula of the affected shoulder with one hand and passively elevates the arm with the other hand. A positive test is indicated by pain in the arc between 70 degrees and 120 degrees of forward elevation. ↲

Neer Impingement Test

A variation of the Neer impingement sign, where a sterile injection of 1 percent lidocaine is made into the subacromial space, and the technique for the Neer impingement sign is repeated. A positive test result is indicated by the relief of pain with the subacromial injection. ↲

Subacromial Impingement Syndrome

Disorder characterized by the symptomatic irritation of the rotator cuff tendons and subacromial bursa within the subacromial space. ↲

Subacromial Space

Anatomic region of the shoulder defined as the space between the coracoacromial arch, consisting of the acromion, coracoacromial ligament, and coracoid process, and the greater tuberosity and the rotator cuff attachments. ↲

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2. Rotator Cuff Disease

Injuries to the rotator cuff are common orthopedic injuries and exist on a spectrum of disease that includes impingement, strains, partial or full thickness rotator cuff tears, massive rotator cuff tears (involvement of two or more tendons), and cuff tear arthropathy.[1] The prevalence of rotator cuff disorders greatly increases with age, with abnormalities present in 9.7 percent of patients younger than twenty years old, 13 percent of those thirty to thirty-nine years old, 30 percent of sixty- to sixty-nine-year-olds, and 62 percent of patients over age eighty.[2] Additional risk factors for sustaining a rotator cuff tear are hand dominance, smoking, hypercholesterolemia, manual or heavy labor, and a family history of rotator cuff tears.[2-7]

Anatomy

The **rotator cuff** consists of four muscles that contribute to the stability and motion of the shoulder joint: the supraspinatus, infraspinatus, teres minor, and subscapularis muscles. These muscles are innervated by nerves that arise from the brachial plexus, a network of nerves in the shoulder, from the contributions of the C5–T1 nerve roots, which provide sensory and motor innervation to the upper extremity (figure 2.1). First, the **supraspinatus** muscle originates from the supraspinous fossa of the superior aspect of the scapula and inserts on the greater tuberosity of the humerus. It functions in initiation of abduction of the shoulder from 0 to 15 degrees and then is accompanied by the deltoid to 90 degrees. Coactivation of the rotator cuff muscles and scapular rotation brings the shoulder motion up to 180 degrees of forward elevation. The **infraspinatus** muscle originates from the infraspinous fossa of the posterior aspect of the scapula and inserts on the greater tuberosity of the humerus, posterior and inferior to the insertion of the supraspinatus. It functions in external rotation of the shoulder. Both the supraspinatus and infraspinatus are innervated by the suprascapular nerve, which arises from the upper trunk of the brachial plexus and has contributions from the C5 and C6 nerve roots. The **teres minor** muscle originates from the lateral border of the scapula and inserts on the greater tuberosity of the humerus, below the insertion of the infraspinatus. It functions in external rotation of the shoulder when the arm is at 90 degrees of abduction and is innervated by the axillary nerve, which arises from the posterior cord of the brachial plexus. The **subscapularis** muscle originates from the subscapular fossa on the anterior aspect of the scapula and inserts on the lesser tuberosity of the humerus. It functions in internal rotation of the shoulder and is innervated by the upper and lower subscapular nerves, which also arise from the posterior cord of the brachial plexus.[8]

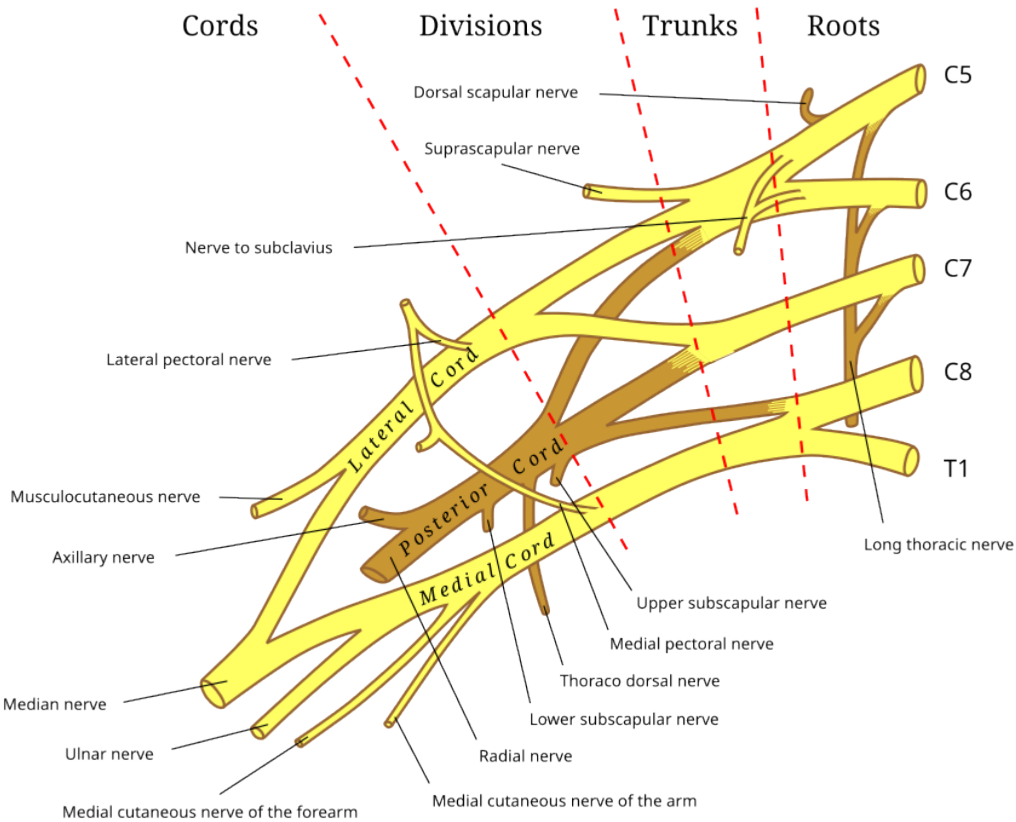

Figure 2.1: Diagram of the Brachial Plexus. *Brachial Plexus 2 by Captain-n00dle and MissMJ is in the public domain.*

The function of the rotator cuff in creating dynamic stability to the shoulder joint is made possible by force coupling of the rotator cuff in the coronal and transverse planes.[9,10] In the coronal plane, the superior moment from the deltoid muscle and supraspinatus is balanced by the inferior moment of the subscapularis, infraspinatus, and teres minor muscles. In the transverse plane, the anterior moment from the subscapularis muscle is balanced by the posterior moment of the infraspinatus and teres minor muscle. Rotator cuff tears alter this balance and equilibrium.

Pathophysiology

Broadly, injury to the rotator cuff can occur due to an acute, traumatic cause, or due to a chronic, degenerative cause.[11,12] In younger patients, traumatic rotator cuff tears generally occur after a high-energy event, such as a fall or traction injury, and are associated with injuries such as a shoulder dislocation.[12] In older patients, traumatic events remain a cause of rotator cuff tears, but degenerative mechanisms play a much larger role.[13] Degenerative causes of rotator cuff tears can be broadly characterized as being extrinsic or intrinsic.[13] The most notable extrinsic factor contributing to the development of degenerative rotator cuff pathology is acromial shape, as hooked, curved, and laterally sloped acromia are associated with the development of rotator cuff tears. While these extrinsic factors typically contribute to tears on the bursal of the rotator cuff, articular sided tears are more often due to intrinsic factors, such as those explored in the degeneration-microtrauma theory.[14] Aging, poor vascularity, and repetitive microtrauma lead to inflammatory changes and oxidative stress in the rotator cuff tendon, which alter gene expression and lead to apoptosis.[13,15] In an alternative neural theory of degeneration, overuse leads to overstimulation of the neurons of the rotator cuff, leading to pain, inflammation, and apoptosis in the tendon.[13,16]

History

Careful evaluation of a patient for a rotator cuff tear begins with the history.[17,18] Patients with a rotator cuff tear most commonly present with pain around the shoulder (secondary to associated bursitis) and weakness with overhead activity, although other patients may be asymptomatic (if they have no active bursitis). The pain will typically be worse with overhead activities, lifting or carrying objects, or lying on the affected side. Further, other key elements of history include occupation and activity level; hand dominance; smoking status; and previous intervention including lifestyle changes, physical therapy, NSAIDs, corticosteroid injections, and surgical procedures. Lastly, a family history of rotator cuff tears should be determined.

Physical Examination

Next, a diagnosis of rotator cuff pathology requires a thorough physical examination through observation, palpation, and physical examination maneuvers. Both shoulders should be carefully inspected for symmetry, posture, and muscle bulk. There may be visible atrophy of the supraspinatus or infraspinatus fossae in chronic rotator cuff disease.[17,19] Further, evidence of previous trauma or surgical scars on the skin should be noted. Patients with rotator cuff disease may present with tenderness to palpation along the insertion of the rotator cuff tendons on the greater and lesser tuberosities. Additionally, it is important to palpate adjacent structures, including the long head of the biceps tendon and the acromioclavicular joint. As the cervical spine is commonly a source of referred pain to the shoulder, a careful evaluation of the cervical spine with observation, palpation, active and passive range of motion, and provocative maneuvers, such as Spurling's test, should be performed.[20] Next, active and passive range of motion of the shoulder should be assessed. In the case of rotator cuff tears, active range of motion is typically diminished, while passive range of motion is maintained. Impingement signs may be present as well, as outlined in chapter 1.

Special Tests

Many physical examination maneuvers have been developed for further assessment of rotator cuff pathology. Certain tests are extremely sensitive and specific, while others may have less diagnostic accuracy. Advanced imaging is usually recommended to confirm the extent of rotator cuff pathology.[21,22] First, the **Jobe test** is commonly performed in the evaluation of rotator cuff pathology (video 2.1; figure 2.2).[17,18] The patient's arms are placed in 90 degrees of abduction, angled forward 30 degrees, and internally rotated so that the thumbs face the floor. The examiner applies a downward force on the patient's arm, and the patient is asked to resist this force. A positive test, which is indicated by pain or weakness during this maneuver, is suggestive of weakness of the supraspinatus muscle and/or concomitant subacromial impingement (video 2.2). Initiating the Jobe test is replicating part of the Neer sign maneuver, so there can be some crossover. Further, the drop arm test evaluates the integrity of the supraspinatus tendon. The examiner passively abducts the patient's shoulder to 90 degrees and asks the patient to maintain the position. An inability to hold this position, resulting in the sudden dropping of the arm, indicates a positive test and suggests tearing of the supraspinatus (video 2.3).

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Video 2.1: The Jobe Test. The examiner demonstrates the appropriate technique for the Jobe test on the patient's right and left shoulders. The patient is seated on the examiner's table. Both arms are placed in 90 degrees of abduction, angled forward 30 degrees, and internally rotated so that the thumbs face the floor. The examiner first applies a downward force to the patient's left arm, asking the patient to resist the force and keep his arm level. The examiner then performs the same maneuver on the patient's right arm.

Figure 2.2: Patient Positioning for the Jobe Test. *The examiner demonstrates the appropriate patient positioning for the Jobe test. The patient's arms are placed in 90 degrees of abduction, angled forward 30 degrees, and internally rotated so that the thumbs face the floor.*

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Video 2.2: Jobe Test on the Right Shoulder. The examiner performs the Jobe test on the patient's right shoulder. The test is considered positive if pain or weakness is elicited by the maneuver. A positive test indicates weakness of the supraspinatus muscle and/or subacromial impingement. The patient here is unable to resist the examiner's downward applied force to his right shoulder, indicating weakness and a positive test result.

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Video 2.3: Drop Arm Test. The examiner passively abducts the patient's affected shoulder to 90 degrees and asks him to maintain this position. The patient is unable to do so, and his arm drops to the floor, indicating a positive test and tear of the supraspinatus.

Furthermore, the strength of the rotator cuff musculature, including the supraspinatus, infraspinatus, subscapularis, and teres minor, should be evaluated. Further examination of the infraspinatus muscle can be performed with the **infraspinatus test** (video 2.4).[17,18] The patient's arm is placed at the side in full adduction, and the elbow is placed in 90 degrees of flexion. The examiner applies a medially directed force to the arm, while asking the patient to externally rotate the shoulder against this resistance. A positive test result is pain and/or weakness with resisted external rotation and suggests a deficit of the infraspinatus.

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Video 2.4: The Infraspinatus Test. The examiner performs the Infraspinatus Test on a patient with a rotator cuff tear. The patient is seated with the shoulders adducted and the elbow at 90 degrees of flexion. The examiner asks the patient to externally rotate their shoulder, while the examiner applies a medially directed force to the arm. A test is considered positive with pain or weakness with resisted external rotation. Here, the patient displays significant weakness of his left shoulder in external rotation, indicating a positive test result and deficit of the infraspinatus.

The **external rotation lag sign** is another physical examination maneuver performed to assess rotator cuff pathology, specifically to test the infraspinatus (video 2.5; figure 2.3).[17,18] Initially, the patient's shoulder is fully adducted, and the elbow is placed at 90 degrees of flexion. The examiner places the shoulder in maximal external rotation, and the patient is asked to hold this position. An inability to hold this position indicates weakness of the infraspinatus (video 2.6).

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Video 2.5: The External Rotation Lag Sign. The examiner demonstrates the appropriate technique for the external rotation lag sign on the patient's right shoulder. The patient is seated on the examiner's table with the right shoulder fully adducted and the elbow at 90 degrees of flexion. The examiner places the patient's right shoulder in maximal external rotation and asks them to maintain this position.

Figure 2.3: The External Rotation Lag Sign. *The examiner releases the patient's arm after having placed the patient's right shoulder in maximal external rotation and observes whether the patient is able to maintain this position.*

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Video 2.6: The External Rotation Lag Sign. The examiner demonstrates the external rotation lag sign on a patient with a rotator cuff tear. A test is considered positive if the patient is unable to maintain the position of maximal external rotation and if the arm falls into internal rotation. A positive test is specific for full-thickness tears of the infraspinatus. Here, the patient is unable to maintain the position of maximal external rotation and the arm drifts into internal rotation. The test is positive.

The **Hornblower's sign** is used to assess pathology of the teres minor (video 2.7; figure 2.4).[17,18] The patient's shoulder is placed in 90 degrees of abduction and 90 degrees of external rotation with the elbow also bent to 90 degrees, and the patient is asked to hold this position. The test is positive if the arm falls into internal rotation, assuming a position as if blowing a horn (video 2.8). A positive test result suggests tearing of the teres minor tendon.

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Video 2.7: The Hornblower's Sign. The examiner demonstrates the proper technique for the Hornblower's sign. The patient is seated on the examiner's table. The patient's right shoulder is placed in 90 degrees of abduction and 90 degrees of external rotation with the elbow also bent to 90 degrees. The examiner asks the patient to hold this position.

Figure 2.4*: *The Hornblower's Sign. *The examiner demonstrates the proper positioning for the Hornblower's sign. The patient's right shoulder is placed in 90 degrees of abduction and 90 degrees of external rotation with the elbow also flexed to 90 degrees.*

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Video 2.8: The Hornblower's Sign. The examiner demonstrates the Hornblower's sign on a patient with a rotator cuff tear. A test is considered positive if the patient is unable to maintain the shoulder in 90 degrees of abduction and 90 degrees of external rotation, and the arm falls into internal rotation. A positive test indicates a deficiency in the teres minor muscle. Here, the patient is unable to maintain the shoulder in 90 degrees of abduction and 90 degrees of external rotation when the examiner applies a downward directed force, indicating a positive test.

There are several tests to assess the integrity of the subscapularis, including the belly press test, lift off test, internal rotation lag sign, and bear hug test.[17,18] Increased passive external rotation in the affected shoulder compared to the contralateral shoulder is suggestive of a subscapularis tear as well (video 2.9). When all these tests are used in conjunction with one another, the best diagnostic accuracy is achieved.

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Video 2.9: Increased Passive External Rotation of the Shoulder. The examiner demonstrates the technique for examining passive external rotation of the shoulder. The patient is seated with his arm adducted and his elbow in 90 degrees of flexion. The examiner passively externally rotates both shoulders and compares the range of motion. An increase in passive external rotation in one shoulder compared to the contralateral shoulder is suggestive of a subscapularis tear. Here, the patient has increased passive external rotation in his right shoulder when compared to his normal left shoulder, which is suggestive of a right-sided subscapularis tear.

The **belly press test** is the most commonly used physical examination technique to assess the integrity of the subscapularis tendon (video 2.10; figure 2.5).[17,18] The patient is asked to press the hand into the belly and internally rotate the shoulder against resistance. If the patient's wrist flexes or they demonstrate weakness to resistance, then the test is deemed positive (video 2.11).

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Video 2.10: The Belly Press Test. The examiner demonstrates the appropriate patient positioning for the belly press test on the patient's right and left shoulders. The patient is seated on the examiner's table. The patient's shoulders are placed in internal rotation, his elbows are flexed to 90 degrees, and his palms are placed on his belly. The examiner asks the patient to press the hand into the belly and internally rotate the shoulder against resistance. The test is considered positive if the patient's wrist flexes or they demonstrate weakness to resistance.

Figure 2.5a: The Belly Press Test. *The examiner instructs the patient to assume the first position of the belly press test. The patient's shoulders are placed in internal rotation, his elbows are flexed to 90 degrees, and his palms are placed on his belly.*

Figure 2.5b. *The examiner instructs the patient to assume the second position of the belly press test. The patient's shoulders remain in internal rotation, his elbows are flexed to 90 degrees, and his palms are placed on his belly. From the first position, the examiner asks the patient to press the hand into the belly and internally rotate the shoulder against resistance. The test is considered positive if the patient's wrist flexes to compensate or they demonstrate weakness to resistance.*

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Video 2.11: The Belly Press Test. The examiner performs the belly press test on a patient with a rotator cuff tear. The test is considered positive if the patient's wrist flexes or they demonstrate weakness to resistance. A positive test indicates a tear of the subscapularis tendon. Here, the patient is unable to internally rotate his shoulder while keeping the wrist straight. Further, the patient is unable to resist a posteriorly directed force by the examiner. The patient has a positive right-sided belly press test, indicating a right-sided subscapularis tear.

Next, the **lift off test** is performed with the patient positioning their hand behind the back at the level of the lumbar spine with the palm facing outward (video 2.12; figure 2.6).[17,18] The patient is asked to lift their hand off their back. Weakness in response to resistance or inability to perform such a motion indicates a positive test, which is suggestive of deficiency of the subscapularis (video 2.13). This test may be difficult for a patient to perform with a stiff shoulder and internal rotation is limited due to glenohumeral arthritis, adhesive capsulitis, or severe pain from impingement. In addition, elbow extension from the triceps can give a false negative.

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Video 2.12: The Lift Off Test. The examiner demonstrates the appropriate technique for the lift off test on the patient's right shoulder. The patient positions his hand behind his back at the level of the lumbar spine with the palm facing outward. The patient is asked to internally rotate his shoulder to lift his hand off his lumbar spine. The test is negative if the patient is able to successfully lift his hand off his lumbar spine.

Figure 2.6a: The Lift Off Test. *Appropriate patient positioning is demonstrated for the lift off test. The patient's arms are placed behind his back at the level of the lumbar spine with the palms facing outward.*

Figure 2.6b. *The patient has successfully lifted his hand off the lumbar spine, indicating a negative test.*

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Video 2.13: The Lift Off Test. The examiner performs the lift off test on the patient's right and left shoulders. The test is considered positive if the patient is unable to internally rotate either shoulder and lift their hands off the back or if the patient cannot actively resist the gentle force applied by the examiner. A positive test indicates a deficit of the subscapularis. Here, the patient successfully lifts off her right hand but is unable to lift off her left hand. The patient has a positive left-sided lift off test.

The **internal rotation lag sign** (video 2.14) is performed by placing the patient's hand in maximal internal rotation with their hand elevated several centimeters off of the lumbar spine.[9,17,18] The patient is instructed to maintain this position. Failure to actively maintain this position (with the hand falling toward the patient's body) indicates a positive test, and deficit of the subscapularis.

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Video 2.14: The Internal Rotation Lag Sign. The examiner performs the internal rotation lag sign on a patient with a subscapularis tear. The patient's hand is placed behind his back at the level of the lumbar spine. The patient's shoulder is passively placed in maximal internal rotation by the examiner with the patient's hand several centimeters posterior to the lumbar spine, and the patient is asked to maintain this position away from the body. A positive test is indicated by failure to actively maintain this position and indicates a deficit of the subscapularis. Here, the patient has a positive right-sided internal rotation lag sign, but a negative left-sided internal rotation lag sign.

The last provocative maneuver discussed for subscapularis function is the **bear hug test** (figure 2.7; video 2.15). The hand of the affected shoulder is placed on the contralateral shoulder with the fingers extended and the elbow at 90 degrees. The patient is instructed to hold this position while the examiner applies an external rotation force to the patient's arm. A test is positive when the patient cannot maintain this position.

Figure 2.7: The Bear Hug Test. *The examiner demonstrates the bear hug test on a patient's right shoulder. The patient's elbow is bent to ninety degrees and the palm rests on his contralateral shoulder. The examiner applies an external rotation force to the patient's right arm. A test is positive if the patient can not maintain this position. Here, the test is negative, indicating an intact subscapularis.*

One or more interactive elements has been excluded from this version of the text. You can view them here: https://temple.manifoldapp.org/projects/a-guide-to-the-physical-examination-of-the-shoulder/resource/ch2-vid15

Video 2.15: The Bear Hug Test. The examiner demonstrates the bear hug test on a patient's right shoulder. The patient's elbow is bent to ninety degrees and the palm rests on his contralateral shoulder. The examiner applies an external rotation force to the patient's right arm. A test is positive if the patient can not maintain this position. Here, the test is negative, indicating an intact subscapularis.

Sensitivities and specificities for all examinations described in this chapter are outlined in table 2.1.[21,23-25]

Table 2.1: Sensitivities and Specificities for Rotator Cuff Examination Maneuvers

Test	Sensitivity	Specificity
Jobe Test[21]	88%	62%
Drop Arm Test[21]	21%	96%
Infraspinatus Test[21,25]	90%	74%
External Rotation Lag Sign[21,24]	97%	93%
Hornblower Sign[21]	17%	96%
Belly Press Test[23]	28%	87%
Lift Off Test[23]	22%	94%
Internal Rotation Lag Test[23.24]	32%	92%
Bear Hug Test[23]	55%	94%

Key Terminology

Bear Hug Test

Physical examination technique used to assess the integrity of the subscapularis tendon. The hand of the patient's affected shoulder is placed on the contralateral shoulder with the fingers extended and the elbow at 90 degrees. The patient is instructed to hold this position while the examiner applies an external rotation force to the patient's arm. A test is positive when the patient cannot maintain this position. ↲

Belly Press Test

Physical examination technique used to assess the integrity of the subscapularis tendon. The patient is asked to press the hand into the belly and internally rotate the shoulder against resistance. A test is positive if the patient's wrist flexes or they demonstrate weakness to resistance. ↵

External Rotation Lag Sign

Physical examination maneuver performed to assess rotator cuff pathology, specifically to test the infraspinatus. Initially, the patient's shoulder is fully adducted and the elbow is placed at 90 degrees of flexion. The examiner places the shoulder in maximal external rotation, and the patient is asked to hold this position. An inability to hold this position indicates a positive test result. ↵

Hornblower's Sign

Physical examination maneuver used to assess pathology of the teres minor of the rotator cuff. The patient's shoulder is placed in 90 degrees of abduction and 90 degrees of external rotation with the elbow also bent to 90 degrees, and the patient is asked to hold this position. The test is positive if the arm falls into internal rotation, assuming a position as if blowing a horn. ↵

Jobe Test

A test for the assessment of subacromial impingement and/or rotator cuff (supraspinatus) pathology. The patient's arms are placed in 90 degrees of abduction, angled forward 30 degrees, and internally rotated so that the thumbs face the floor. The examiner applies a downward force to the patient's arm, asking the patient to resist the force and keep their arm level. A positive test is noted if pain and/or weakness is elicited by the maneuver. ↵

Infraspinatus

Rotator cuff muscle that originates from the infraspinous fossa of the posterior aspect of the scapula and inserts on the greater tuberosity of the humerus, posterior and inferior to the insertion of the supraspinatus. It functions in the external rotation of the shoulder. ↵

Infraspinatus Test

An examination of the infraspinatus of the rotator cuff. The patient's arm is placed at the side in full adduction, and the elbow is placed in 90 degrees of flexion. The examiner applies a medially directed force to the arm, while asking the patient to externally rotate the shoulder against this resistance. A positive test is pain and/or weakness with resisted external rotation. ↵

Internal Rotation Lag Sign

Physical examination maneuver used to assess the subscapularis of the rotator cuff. The test is performed by placing the patient's hand in maximal internal rotation and elevated several centimeters off of the lumbar spine. The patient is instructed to maintain this position. A positive test result is indicated by failure to actively maintain this position (with the hand falling toward the patient's body). ↵

Lift Off Test

Physical examination maneuver used to assess the subscapularis of the rotator cuff. The test is performed with the patient positioning both hands behind their back at the level of the lumbar spine with the palms facing outward. The patient is asked to lift their hands off their back. A test is positive if there is weakness to resistance or inability to perform such a motion. ↵

Rotator Cuff

Group of four muscles and their associated tendons, including the supraspinatus, infraspinatus, teres minor, and subscapularis, which help to stabilize the humeral head in the glenoid fossa and move the humerus in several planes. ↵

Subscapularis

Rotator cuff muscle that originates from the subscapular fossa on the anterior aspect of the scapula and inserts on the lesser tuberosity of the humerus. Functions in internal rotation of the shoulder. ↵

Supraspinatus

Rotator cuff muscle that originates from the supraspinous fossa of the superior aspect of the scapula and inserts on the greater tuberosity of the humerus. It functions in the abduction of the shoulder. ↲

Teres Minor

Rotator cuff muscle that originates from the lateral border of the scapula and inserts on the greater tuberosity of the humerus, below the insertion of the infraspinatus. It functions in the external rotation of the shoulder when the arm is at 90 degrees of abduction. ↲

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3. Glenohumeral Instability

Glenohumeral instability is defined as pathological increased translation of the humeral head from the glenoid cavity.[1,2] Instability includes both **subluxation** (partial dislocation with spontaneous reduction) and **dislocation**, when the humeral head completely escapes the glenoid cavity, and special maneuvers are required to reduce the shoulder back into the socket. Additionally, instability can be classified by the direction of the translation of the humeral head: anterior, posterior, or multidirectional.[2-5] Instability is described as either traumatic or atraumatic.[2-5] **Traumatic instability** results from a forceful contact event that damages a previously structurally intact glenohumeral joint, while **atraumatic instability** occurs in the absence of trauma. Atraumatic instability may occur because the shoulder has already sustained extensive structural damage, or because of ligamentous laxity.

The glenohumeral joint allows significant degrees of motion in multiple directions and, therefore, is particularly susceptible to instability. Glenohumeral instability is a very common condition, as dislocations affect 1.7 percent of the global population.[6] Notably, dislocations predominantly affect younger patients, and the highest rate of dislocations occurs in individuals between twenty and thirty-nine years of age.[7] In addition to age, risk factors for the development of traumatic shoulder instability include male sex and participation in athletic activities or contact sports.[7,8] Anterior glenohumeral instability comprises over 95 percent of shoulder instability events.[9] In contrast, posterior instability makes up 2 to 5 percent of glenohumeral instability events, while the frequency of multidirectional instability is less common.[10,11] Patients who suffer an anterior dislocation have a high likelihood of recurrence. Notably, younger age, male sex, hyperlaxity, and participation in contact/collision sports greatly increase the risk of recurrence after anterior dislocation.[12,13]

Anatomy

The glenohumeral joint is composed of static and dynamic restraints that contribute to stability.[5,14] **Static restraints** to the glenohumeral joint include the bony anatomy of the humerus and glenoid, the joint capsule, ligamentous structures, the glenoid labrum, and the inherent negative intra-articular pressure of the glenohumeral joint.

The capsuloligamentous structures include the superior, middle, and inferior glenohumeral ligaments, all of which are important static stabilizers at various ranges of motion. The superior glenohumeral ligament specifically functions as an inferior stabilizer of the shoulder in adduction. The middle glenohumeral ligament confers anterior stability in 45 to 90 degrees of abduction, while the inferior ligament protects from excessive anterior and inferior translation of the humerus in the apprehensive position of 90 degrees abduction and 90 degrees external rotation.[15] **Dynamic restraints** to the glenohumeral joint include the rotator cuff, the long head of the biceps tendon, and the pericapsular muscles. Dynamic stabilizers are active when the shoulder is in motion, while static stabilizers are always in use even when the shoulder is at rest. Together, static and dynamic stabilizers allow the humeral head to translate just 1 millimeter during active range of motion in the normal shoulder.[16] Glenohumeral instability occurs when there is a violation of the static or dynamic stabilizers of the joint, which enables excessive translation of the humeral head on the glenoid.

Pathophysiology

Anterior shoulder instability occurs when a force is placed on the shoulder when the arm is in an abducted, externally rotated position.[5] Anterior dislocation commonly results in detachment of the anteroinferior labrum and the anterior band of the inferior glenohumeral ligament, resulting in a Bankart lesion. Horst et al. noted that 73 percent of anterior shoulder dislocations are associated with Bankart lesions.[17] Further, a Hill-Sachs lesion, or an osteochondral compression fracture in the posterolateral humeral head, is the other major pathology associated with anterior shoulder dislocations. The Hill-Sachs lesion occurs when the posterolateral humeral head engages with the glenoid rim and occurs in 84 percent of anterior shoulder dislocations.[17] **Posterior shoulder instability** occurs when a force is placed on the shoulder in a flexed, adducted, and internally rotated position.[10] Similar to anterior shoulder dislocations, posterior shoulder dislocations are associated with additional soft tissue and bony injuries. These include a reverse Bankart lesion, or detachment of the posterior labrum, and reverse Hill-Sachs lesion, or an osteochondral compression fracture in the anteromedial humeral head.[10] **Multidirectional shoulder instability**, which is defined as glenohumeral instability in two or more planes of motion (anterior, posterior, or inferior), occurs through two mechanisms.[11,18] First, repetitive activities and overuse result in microtrauma, which ultimately causes laxity in the capsular and ligamentous stabilizers of the glenohumeral joint. Alternatively, general ligamentous laxity, most often from connective tissue disorders such as Marfan syndrome, Ehlers-Danlos syndrome, or hypermobility joint syndrome, can result in multidirectional instability. Lastly, pan-labral injuries, which involve simultaneous injuries to the anterior, posterior, and superior labrum, are generally the result of trauma or contact sports.[19]

History

A detailed history is crucial in the evaluation and diagnosis of glenohumeral instability. It is important to inquire about the cause (major trauma, minor trauma, no trauma), direction (anterior, posterior, or multidirectional), degree (subluxation or dislocation), and chronology (acute, recurrent, or chronic) of instability. With regard to the direction of instability, some patients may accurately report the direction of their dislocation. For others, the position of the arm at the occurrence of injury or at maximal pain may help distinguish between anterior and posterior shoulder instability. The physical exam is critical in determining directionality of instability. For anterior shoulder instability, pain or the dislocation event typically occurs in an abducted, externally rotated arm.[5] For posterior instability, pain or the dislocation event typically occurs in a flexed, adducted, and internally rotated arm.[10] Further, it is important to gather information about functional limitations from instability and about nighttime symptoms, which may indicate more severe disease. Details of prior management, nonoperative or operative, should be gathered. Lastly, it is important to gather key elements of medical and social history, including the presence of seizure disorders, psychiatric illness, connective tissue disorders, occupation, and sport participation.

Physical Examination

The physical examination of glenohumeral instability begins with inspection of the shoulder and upper extremity.[2,3,5,9-11] The shoulders should be compared for asymmetry, and any evidence of obvious deformity, atrophy of the deltoid or rotator cuff musculature, and scapular winging should be noted. Next, palpation of both the unaffected and affected shoulder should be performed. In the case of an acute dislocation, it may be possible to palpate the humeral head anteriorly, posteriorly, or inferiorly based on the direction of dislocation. Furthermore, a soft tissue concavity may be both visible and palpable.[5] Range of motion and strength assessment with respect to forward elevation, abduction, external rotation at the side, external rotation in abduction, internal rotation in abduction, and internal rotation to vertebral height should then be performed in both the unaffected and affected shoulder. A thorough neurological exam is critical before and after reduction of any dislocation as there are often coexistent nerve injuries.[20] Atrophy or weakness of the deltoid and teres minor muscle and changes in sensation to the lateral shoulder may be suggestive of injury to the axillary nerve.[21]

Special Tests for Anterior Instability

Provocative maneuvers used in the assessment of anterior glenohumeral instability include the **apprehension, relocation, and anterior release tests**, which are typically performed in succession, and the anterior load and shift test.[22,23] For the apprehension, relocation, and anterior release tests, the patient is supine with the shoulder in 90-degrees abduction, the shoulder in full external rotation, and the elbow in 90 degrees of flexion (figure 3.1; video 3.1). The apprehension test is positive if the patient feels discomfort or a sense of instability in this position. Next, the relocation test is performed with the patient in the same position. The examiner applies a posterior force to the affected shoulder, and the test is positive if the patient no longer feels a sense of instability. Lastly, the anterior release test is performed with the examiner's hand starting on the humeral head, reducing the shoulder as it is placed into the apprehension position. The examiner's hand is then removed, and the test is positive if the patient has a sense of anterior apprehension.

Figure 3.1a: Apprehension, Relocation, and Anterior Release Tests. *The examiner demonstrates the proper technique of the apprehension test. The patient is supine with the shoulder in 90-degrees abduction, the shoulder in full external rotation, and the elbow in 90 degrees of flexion. A positive test is noted if the patient feels a sense of instability in this position.*

Figure 3.1b. *The examiner demonstrates the proper technique of the relocation test. The patient is supine with the shoulder in 90-degrees abduction, the shoulder in full external rotation, and the elbow in 90 degrees of flexion, as in the apprehension test. The examiner then provides a posteriorly directed force on the humeral head. A test is considered positive if the patient no longer feels a sense of instability in this position.*

Figure 3.1c. *The examiner demonstrates the proper technique of the anterior release test. The patient is supine with the shoulder in 90-degrees abduction, the shoulder in full external rotation, and the elbow in 90 degrees of flexion, as in the apprehension test. The examiner then provides a posteriorly directed force on the humeral head, as in the relocation test. The examiner finally removes the posteriorly directed force on the humeral head. A test is considered positive if the patient feels a sense of instability in this position.*

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Video 3.1: Apprehension, Relocation, and Anterior Release Tests. The examiner performs the apprehension, relocation, and anterior release tests for anterior shoulder instability in succession.

The anterior and posterior **load and shift test** is an important maneuver used in the assessment of anterior and posterior glenohumeral instability (video 3.2; figure 3.2).[23,24] The patient is placed supine to stabilize the scapula with the shoulder in 45 to 90 degrees of abduction, the shoulder in full external rotation, and the elbow in 90 degrees of flexion. Alternatively, the test can be performed with the patient upright if the scapula can be stabilized manually. The examiner holds and gently translates the humerus. For anterior instability, the examiner gently applies an axial force to the patient's humerus into the glenoid, while simultaneously applying an anterior translational force. For posterior instability, the examiner gently applies an axial force to the patient's humerus into the glenoid, while simultaneously applying a posterior translational force. The test is graded on a scale of 0 to 3, representing various degrees of humeral head shifting relative to the glenoid.[23] Table 3.1 outlines the grading scale for instability.

Table 3.1: Grading Scale for Instability

Grade	Description
0	Little to no movement of the humeral head
1+	Shift to the edge of the glenoid
2+	Head shifts past the edge of the glenoid with spontaneous relocation
3+	Head shifts past the edge of the glenoid without spontaneous relocation

A positive value indicates anterior direction, while a negative value indicates posterior direction.

Grade 0 denotes little or no movement of the humeral head. Grade 1+ represents a shift to the edge of the glenoid. Grade 2+ is when the head shifts past the edge of the glenoid with spontaneous relocation. Grade 3+ is the same as Grade 2+ but without spontaneous relocation. Notably, a patient's shoulder can be dislocated and then relocated with this maneuver in someone with a high grade of instability (figure 3.3). A positive value indicates anterior direction, while a negative value indicates posterior direction.

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Video 3.2: Anterior Load and Shift Test for Anterior Instability. The examiner demonstrates the appropriate technique for the anterior load and shift test with the patient in the lateral decubitus position in the operating room. The patient's scapula is stabilized by a bean bag. The examiner gently applies an axial load to the humerus into the glenoid fossa while also applying an anterior force. The grade of instability is determined by the amount of anterior translation of the humerus compared to the glenoid. Here, the anterior load and shift test displays Grade 2+ translation.

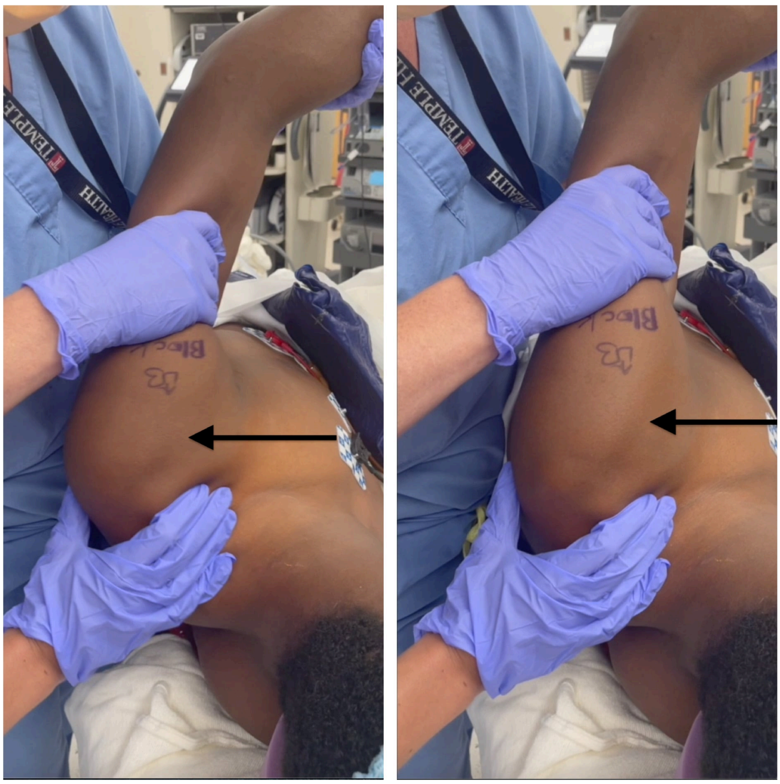

Figure 3.2: *Anterior Load and Shift Test.* *These images display Grade 2+ anterior instability with the anterior load and shift test. Note the position of the patient's humerus before and after applying an anterior load. There is clear, significant anterior translation of the humerus, as shown by the arrows.*

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Video 3.3: Anterior Load and Shift Test. In this patient with anterior instability of the shoulder, the examiner can dislocate the humeral head from the glenoid cavity with an anterior force. The examiner can also relocate the humeral head back into the glenoid cavity with a posterior force. This finding is consistent with a 3+ anterior load and shift test.

Alternatively, another physical examination maneuver to help diagnose instability of the shoulder is the **Gagey test**.[25,26] In this test, the examiner stabilizes the patient's shoulder girdle and then passively abducts the shoulder. Shoulder abduction greater than 105 degrees while the scapula is stabilized is considered a positive test and is indicative of laxity in the inferior glenohumeral ligament (figure 3.3).

Figure 3.3a: Gagey Hyperabduction Test. *The examiner stabilizes the patient's shoulder girdle with one hand and passively abducts the patient's unaffected shoulder to 90 degrees.*

Figure 3.3b. *The examiner stabilizes the patient's shoulder girdle with one hand and passively abducts the patient's affected shoulder to 105 degrees, signifying a positive test and laxity of the inferior glenohumeral ligament.*

Special Tests for Posterior Instability

The **posterior stress test** is a provocative maneuver used for the examination of posterior instability (video 3.4).[27] The patient is supine on the examiner's table to stabilize the scapula, with the shoulder flexed to 90 degrees, adducted, and internally rotated and the patient's elbow flexed to 90 degrees. A test result is positive if there is pain or a sense of instability when the examiner applies a posteriorly directed force in this position.

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Video 3.4: Posterior Stress Test. The examiner demonstrates the appropriate technique for the posterior stress test with the patient lying supine on the examination table to stabilize the scapula. The patient's shoulder is flexed to 90 degrees, adducted, and internally rotated with the patient's elbow flexed to 90 degrees. The examiner then applies a posteriorly directed force to the humeral head. A test is considered positive if there is pain or a sense of instability with the maneuver.

Further, the posterior load and shift test is used in the assessment of posterior instability as well (video 3.5).[23,27] The examiner applies an axial force to the patient's humerus into the glenoid, while simultaneously applying a posterior force. Notably, the posterior load and shift uses the same grading scale as anterior load and shift, with a minus sign to signify a posterior direction (video 3.6–3.7; figure 3.4).

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Video 3.5: Load and Shift Test for Anterior and Posterior Instability. The examiner demonstrates the appropriate technique for the anterior and posterior load and shift tests with the patient lying supine on the examination table in order to stabilize the scapula. The patient's shoulder is placed in approximately 45 degrees of abduction and external rotation. First, the examiner applies an axial load to the humerus into the glenoid fossa then applies an anterior force, performing the anterior load and shift. Next, the examiner applies an axial load to the humerus into the glenoid fossa while also applying a posterior force, performing the posterior load and shift. A test is graded, on a scale of 0 to 3, depending on the degree of increased anterior or posterior translation of the humerus compared to the glenoid. Here, the patient exhibits pain and increased translation upon the posterior load and shift maneuver.

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Video 3.6: Load and Shift Test for Posterior Instability. The examiner demonstrates the appropriate technique for the posterior load and shift test with the patient in the operating room. The examiner applies an axial load to the humerus into the glenoid fossa while also applying a posterior force. This test is graded on a scale of 0 to 3, with 3 indicating movement of the humeral head beyond the glenoid edge without spontaneous relocation. Here, the shoulder can be dislocated posteriorly, and there is no spontaneous relocation of the shoulder, indicating a test result of 3-.

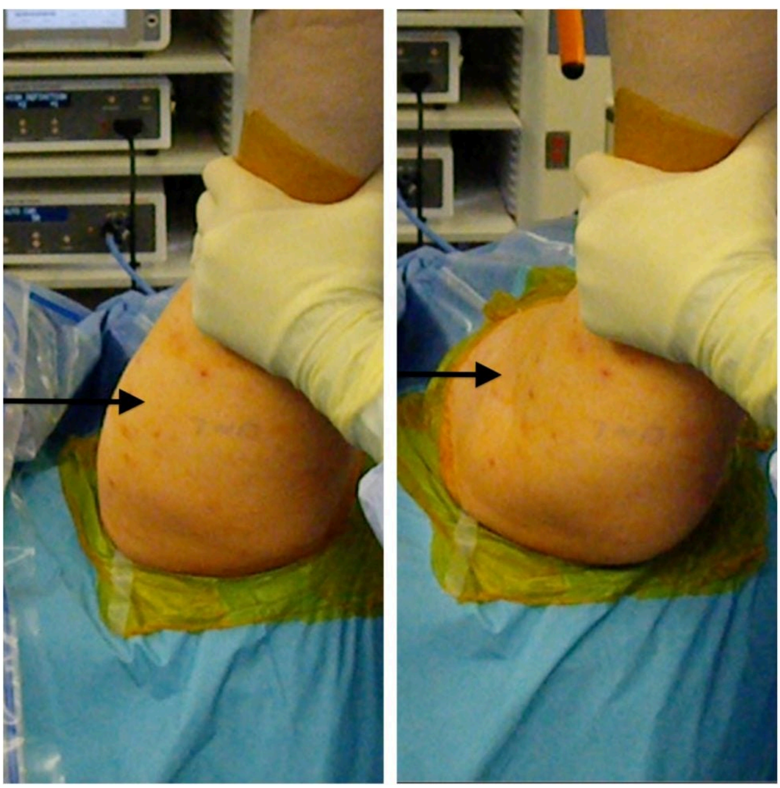

Figure 3.4: Posterior Translation of the Humerus. *These images denote the position of the patient's humerus before and after applying a posterior load. There is clear, significant posterior translation of the humerus, as shown by the arrows.*

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Video 3.7: Posterior Load and Shift Test. A patient suffering from recurrent posterior dislocations of the right shoulder is placed in the lateral decubitus position in the operating room and stabilized with a bean bag. The examiner performs the posterior load and shift test on the patient's right shoulder. With one hand, the examiner stabilizes the right forearm, and, with the other hand, the examiner provides a posterior force to the right upper arm. There is significant posterior translation of the humerus past the edge of the glenoid in this patient with spontaneous reduction, indicating a test result of 2-.

In some cases, dislocations may occur with proximal humerus fractures, resulting in fracture dislocations. The clinical examination and radiographs of a patient with bilateral posterior fracture dislocations are shown in video 3.8 and figure 3.5.

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Video 3.8: Examination of a Patient with Bilateral Posterior Fracture Dislocations.
The patient presents with posterior fracture dislocations of the bilateral proximal humerus. The patient can only forward elevate his right arm to 50 to 60 degrees and is then unable to externally rotate his right arm when it is at his side. Similarly, the patient can forward elevate his left arm to only 40 to 50 degrees and is also unable to externally rotate his left arm when it is at his side. The patient is attempting to compensate by moving his scapulothoracic articulation.

Figure 3.5a

Figure 3.5b

Figure 3.5c

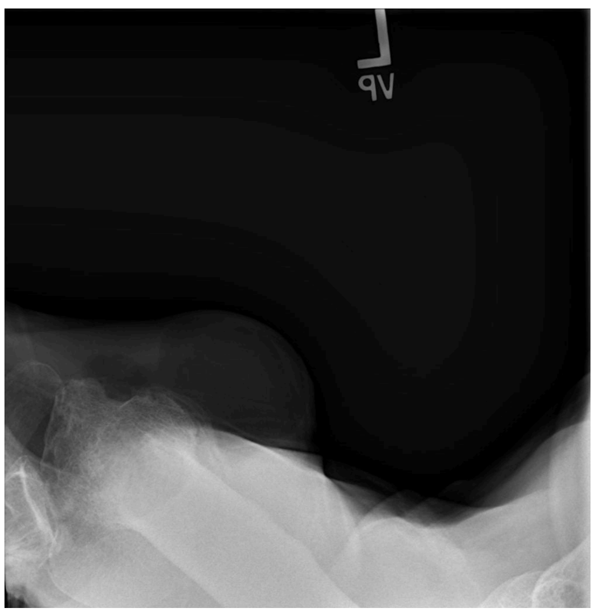

Figure 3.5d: AP and Axillary Shoulder X-Rays of Proximal Humerus Fracture Dislocation. *AP and axillary X-rays of the right and left shoulders in a skeletally mature individual. They reveal the presence of bilateral proximal humerus fractures and bilateral posterior dislocations of the humeral heads.*

Special Tests for Multidirectional Instability

Lastly, multidirectional glenohumeral instability denotes instability in two or more directions. It is important to first perform both the anterior and posterior maneuvers for instability when assessing for this pathology. In addition, the **sulcus sign** is a technique for the assessment of capsular laxity (video 3.9).[28] The examiner applies an inferiorly directed gentle traction force to the patient's arm starting in a neutral position. (video 3.10; figure 3.6). Next, the examiner externally rotates the arm to see if the sulcus disappears or remains. A persistent sulcus in external rotation indicates a positive test result and abnormal capsular laxity. Further, the sulcus sign can be classified, based on the acromiohumeral distance produced by inferior traction, into Grade I (<1.0 cm), Grade II (1.0 to 2.0 cm), and Grade III (>2.0 cm).[28] Higher grades are associated with MDI and capsular laxity.[28]

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Video 3.9: The Sulcus Sign. The examiner demonstrates the appropriate technique for the sulcus test. The patient is positioned with the arms resting at the sides. The examiner applies an inferiorly directed force to the patient's arm starting in a neutral position. The test result is negative if no sulcus or groove appears at the superior aspect of the humeral head.

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Video 3.10: Positive Sulcus Sign in the Shoulders. The examiner performs the sulcus test on a patient's bilateral shoulders. The test is considered positive if a sulcus or groove appears between the acromion and the superior aspect of the humeral head and does not diminish with external rotation. A positive test indicates insufficiency of the capsular restraints. Here, the patient displays a positive sulcus sign in both her left and her right shoulder.

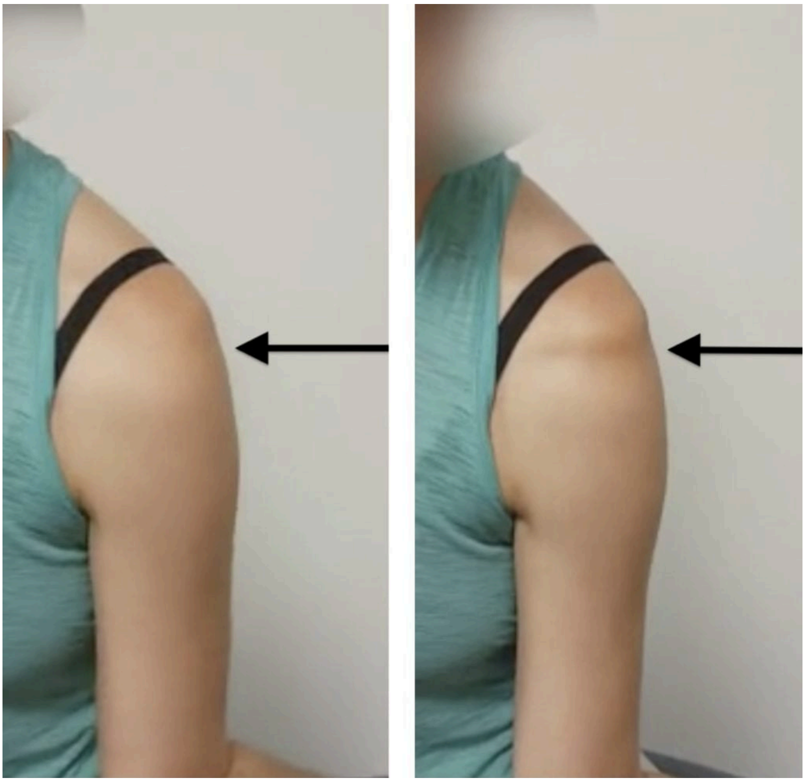

***Figure 3.6*: Sulcus Test on the Shoulder.** *These images denote the position of the patient's shoulder before and after applying an inferiorly directed force during the sulcus test, starting in a neutral position with the examiner then externally rotating the patient's arm. There is the clear appearance of a significant sulcus or groove at the superior aspect of the humeral head, as shown by the arrows.*

The Beighton score is used to assess the patient for generalized hypermobility and ligamentous laxity, which can be caused by connective tissue disorders (figure 3.7).[23] A score between 5 and 9 is considered positive for generalized joint laxity, while a score between 0 and 4 is considered negative for generalized joint laxity. The scoring system is depicted in table 3.2.

Table 3.2: Beighton Score Grading

Assessment Site for Joint Laxity	Right	Left
Hyperextension of the small finger >90°	1	1
Ability to oppose the thumb to the forearm	1	1
Knee hyperextension >10°	1	1
Elbow hyperextension >10°	1	1
Ability to place palms on the floor with the knees extended while standing	1 (both palms must touch)	

Notably, 80 percent of patients with hypermobile Ehlers-Danlos Syndrome and on the hypermobility disorder spectrum present with pain or instability of the shoulder. [29] Thus, it is important to perform a thorough assessment of joint hypermobility on these patients (video 3.11).

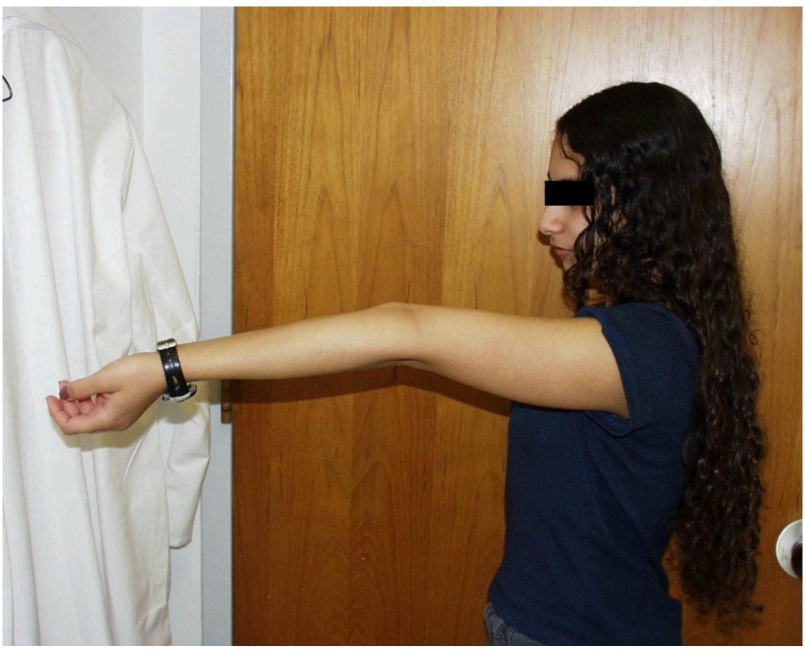

Figure 3.7a

Figure 3.7b

Figure 3.7c: The Beighton Score for Joint Hypermobility. *The Beighton Score measures joint hypermobility on a 9-point scale. A score between 5 and 9 is considered positive for generalized joint laxity, while a score between 0 and 4 is considered negative for generalized joint laxity. The scoring system is as follows: hyperextension of the small finger >90 degrees (1 point each), ability to oppose the thumb to the forearm (1 point each), knee hyperextension >10 degrees (1 point each), elbow hyperextension >10 degrees (1 point each), and ability to place the palms on the floor with the knees extended while standing (1 point). Here, the patient displays elbow recurvatum, finger metacarpophalangeal (MCP) joint hyperextension, and thumb to forearm apposition.*

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Video 3.11: General Examination for a Patient with Joint Hypermobility. The examiner demonstrates a general exam for a patient with joint hyperlaxity. In order, the examiner assesses MCP joint hyperextension, elbow extension, passive external rotation at the side, and passive external rotation at 90 degrees.

Sensitivities and specificities for all examinations described in chapter 3 are outlined in table 3.3.[26,30-33]

Table 3.3: Sensitivities and Specificities for Instability Examination Maneuvers

Test	Sensitivity	Specificity
Apprehension Test[31,33]	66%	95%
Relocation Test[26]	65%	90%
Anterior Release Test[32]	82%	86%
Anterior Load and Shift Test[32]	38%	89%
Gagey Test[26]	46%	38%
Posterior Stress Test[30]	19%	99%
Posterior Load and Shift Test[30]	94%	95%
Sulcus Sign[33]	28%	97%

Key Terminology

Anterior Shoulder Instability

Instability of the humeral head in the anterior, or frontward, direction. ↲

Apprehension, Relocation, and Anterior Release Tests

Physical examination maneuvers for anterior shoulder instability. The patient is supine with the shoulder in 90-degrees abduction, the shoulder in full external rotation, and the elbow in 90 degrees of flexion. The **apprehension test** is positive if the patient feels discomfort or a sense of instability in this position. The **relocation test** is performed with the patient in the same position. The examiner applies a posterior force to the affected shoulder with their hand, and the test result is positive if the patient no longer feels a sense of instability. The **anterior release test** is performed with the examiner's hand now removed from the shoulder. A positive test result occurs if the patient again has a sense of anterior apprehension. ↲

Atraumatic Instability

Instability that occurs in the absence of trauma, such as in a shoulder that has already sustained extensive structural damage, or because of ligamentous laxity. ↲

Dislocation

Humeral head has totally come out of the socket. ↲

Dynamic Restraints

Musculature, including the rotator cuff and the pericapsular muscles, that provide stability to the glenohumeral joint while it is in motion. ↲

Gagey Test

Physical examination maneuver for inferior laxity of the shoulder. The examiner stabilizes the patient's shoulder girdle and then passively abducts the shoulder. A positive test result is indicated by shoulder abduction greater than 105 degrees and is indicative of laxity in the inferior glenohumeral ligament. ↲

Glenohumeral Instability

Pathological increased translation of the humeral head from the glenoid cavity. ↲

Load and Shift Test

Physical examination maneuver used to assess anterior and posterior instability. The examiner applies an axial load to the humerus into the glenoid fossa while also applying either an anterior or posterior force. A test is graded on a scale of 0 to 3 based on whether there is increased anterior or posterior translation of the humerus compared to the contralateral side. ↲

Multidirectional Shoulder Instability

Instability in two or more planes of motion (anterior, posterior, or inferior). ↲

Posterior Shoulder Instability

Instability of the humeral head in the posterior, or backward, direction. ↲

Posterior Stress Test

Physical examination maneuver used for the examination of posterior instability. The patient is placed supine on the examiner's table to stabilize the scapula, with the shoulder flexed to 90 degrees, adducted, and internally rotated, and the patient's elbow flexed to 90 degrees. A test is positive if there is pain or a sense of instability when the examiner applies a posteriorly directed force in this position. ↲

Static Restraints

Bony, capsular, cartilaginous, and ligamentous structures that provide stability to the glenohumeral joint. ↲

Subluxation

Partial dislocation with spontaneous reduction. ↲

Sulcus Sign

Physical examination technique for the assessment of glenohumeral capsular laxity. The examiner applies a gentle, inferiorly directed traction force to the patient's arm, starting in a neutral position, then externally rotates the arm. A positive test result is indicated by the appearance of a sulcus, or groove, that does not diminish with external rotation. ↲

Traumatic Instability

Instability that arises from a forceful contact event that damages a previously structurally intact glenohumeral joint. ↲

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4. Superior Labrum Anterior to Posterior Tears (SLAP tears) and Biceps Tendon Pathology

The glenoid **labrum** is a circumferential ring of fibrocartilaginous tissue surrounding the glenoid fossa. A **superior labrum anterior to posterior (SLAP) tear** is an injury to the superior aspect of this labrum.[1-3] SLAP tears are commonly associated with biceps tendon pathology, as the long head of the biceps tendon attaches to the superior labrum.[4] These injuries are most commonly seen in overhead throwing athletes due to repetitive microtrauma.[5] Studies have shown that the presence of SLAP tears ranges from 6 to 26 percent on arthroscopy but can be present in up to 83 percent of throwing athletes.[6,7] In terms of the demographics of SLAP lesions, the highest incidence of SLAP tears was seen in males and in patients between twenty and twenty-nine and between forty and forty-nine years of age.[8]

Anatomy

Anatomically, the labrum serves as the attachment site of the glenohumeral ligaments and the long head of the biceps tendon. Half of the long head of the biceps tendon originates from the superior labrum, while the other half of the tendon originates from the supraglenoid tubercle of the scapula.[9] The blood supply to the labrum arises from the suprascapular, circumflex scapular, and posterior humeral circumflex arteries.[10] Functionally, the labrum deepens the glenoid by 50 percent and provides static stability to the glenohumeral joint by preventing humeral head subluxation.[11] Neer et al. and Andrews et al. suggested that the long head of the biceps plays a role in shoulder stability through depression and compression of the humeral head.[12,13] Later studies have clarified that the long head of the biceps plays a minor role in shoulder stability but can be a source of pain.[14] Snyder et al. developed a classification system for SLAP tears, categorizing these lesions into four types, which are outlined in table 4.1.

Table 4.1: SLAP Tear Classification System

Type	Description
I	Fraying of the superior labrum with an intact biceps anchor
II	Fraying of the superior labrum with a detached biceps anchor
III	Bucket handle tear of the superior labrum with an intact biceps anchor
IV	Bucket handle tear of the superior labrum with a detached biceps anchor

Pathophysiology

There are several proposed theories, which are based upon the mechanism of injury, that explain the development of SLAP tears and biceps tendon pathology.[3] For overhead throwing athletes, Andrews et al. postulated that tension on the long head of the biceps during the deceleration and follow-through phases of throwing effectively causes the tendon to pull off of the superior labrum.[12] Burkhart et al. further theorized that the position of the arm in maximal abduction and external rotation during throwing causes excessive torsional stress on the biceps tendon attachment, leading to the detachment of the posterosuperior labrum.[15] For more acute injuries caused by trauma, excessive traction on the biceps tendon is capable of causing type II SLAP tears.[16] They can also be degenerative in nature and are a common finding in patients over forty-five.

History

The evaluation of SLAP tears and biceps tendon pathology begins with taking a history.[1-3,7] Patients typically present with deep anterior shoulder pain that may be accompanied by mechanical symptoms such as clicking, catching, and popping. The pain is often exacerbated by overhead activities. Patients may also report a subjective sense of gross instability with these injuries. Furthermore, in throwers and overhead athletes, complaints about a decline in athletic performance, such as a loss in throwing velocity or distance, should raise clinical suspicion of a SLAP tear. Additionally, it is important to note any acute injuries, such as a fall on an outstretched arm or traction injury. Key additional elements of history to be gathered include a previous history of shoulder dislocation or other shoulder trauma, occupation, and level of sport participation.

Physical Examination

The physical examination in SLAP tears and biceps tendon pathologies involves inspection, palpation, range of motion, and diagnostic maneuvers.[1-3,7] Inspection of both shoulders should be performed with attention to scapular position, muscle atrophy, and skin changes, such as previous surgical scars. Next, palpation of the bicipital groove to assess tenderness in the long head of the biceps tendon should be performed. A proximal biceps tendon rupture is signified by the presence of the classic **Popeye's sign**, where the biceps loses its normal elliptical contour, balls up, and sags distally. Both active and passive range of motion should be assessed in the affected and unaffected shoulders. Overhead athletes may present with a **glenohumeral internal rotation deficit (GIRD)**, which is a deficit of greater than 20 degrees in internal rotation in the throwing shoulder compared to the non-throwing shoulder.[17] Lastly, assessment of scapular motion at rest and during range of motion should be performed due to the association between scapular dyskinesis and shoulder pathology in overhead athletes.[18]

Special Tests for SLAP Tears

There are several tests that have been developed for the assessment of superior labral pathology, including O'Brien's active compression test and the anterior slide test. As no one single physical examination maneuver used alone can definitively diagnose a SLAP tear, these tests should be used in conjunction with history and advanced imaging.[19] The first maneuver, the **O'Brien's active compression test**, requires the patient's shoulder to be placed in 90 degrees of forward elevation with the elbows fully extended and the arm adducted 10 to 15 degrees (video 4.1; figure 4.1).[20] In this first position, the patient's thumb is directed to the floor. The examiner applies an inferiorly directed force to the patient's arm, while the patient resists. In the second position, the patient's thumb is now directed toward the ceiling. Again, the examiner applies an inferiorly directed force to the patient's arm, while the patient resists. The patient is asked to report pain or the absence of pain with each maneuver. A positive test occurs if there is pain in the glenohumeral joint ("deep") in the first position with the thumb directed downward that is improved or alleviated with the second position. A positive O'Brien's test is suggestive of a SLAP tear. If the patient describes the pain from this maneuver as "superficial," it may suggest acromioclavicular joint (ACJ) pain.

One or more interactive elements has been excluded from this version of the text. You can view them here: https://temple.manifoldapp.org/projects/a-guide-to-the-physical-examination-of-the-shoulder/resource/ch4-vid01

Video 4.1: The O'Brien's Active Compression Test. The examiner performs the active compression test on a patient. The patient's shoulder is placed in 90 degrees of forward elevation with the elbow fully extended. The arm is then adducted 10 to 15 degrees. First, the shoulder is internally rotated and the forearm is pronated with the thumb pointing to the floor. In this position, the examiner then exerts an inferiorly directed force to the arm. Next, the shoulder is rotated to neutral external rotation and the forearm is supinated with the thumb pointing to the ceiling. In this position, the examiner again exerts an inferiorly directed force to the arm. A test is considered positive if there is pain in the glenohumeral joint when the forearm is pronated (first position) and the pain is diminished or absent when the arm is supinated (second position). A positive test is suggestive of a superior labrum anterior to posterior (SLAP) tear. Here, the patient has a positive O'Brien's active compression test. Notably, as with this patient, the pain experienced during the maneuver is located "deep" in the glenohumeral joint.

Figure 4.1a: The O'Brien's Active Compression Test. *The examiner demonstrates the first position of the active compression test on a patient.*

Figure 4.1b. *The examiner demonstrates the second position of the active compression test on a patient. The patient is asked to report the presence or absence of pain in each position.*

Next, the **anterior slide test** can also be performed in the assessment of a SLAP tear (figure 4.2).[21] The patient is standing upright or sitting on the examination table with their hands on their hips. The examiner places one hand under the patient's elbow and the other on the patient's shoulder and applies an axial compressive force to the patient's elbow simultaneously with an anterior directed force to the humerus. A test is positive if the patient experiences pain in the anterior shoulder with this maneuver. A positive test is suggestive of a SLAP tear.

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Video 4.2: The Anterior Slide Test. The examiner demonstrates the proper technique of the Anterior Slide Test on a patient. The patient is seated on the examiner's table with his hands on his hips. The examiner places one hand across the top of the shoulder. The examiner places the other hand under the elbow and directs an axial compressive force from the elbow to the glenohumeral joint, while simultaneously applying an anterior directed force to the humerus. A test is considered positive if the patient experiences pain in the anterior shoulder. A positive test is suggestive of a SLAP tear.

Figure 4.2: The Anterior Slide Test. *The examiner demonstrates proper positioning of the Anterior Slide Test on a patient. The patient is seated on the examiner's table with his hands on his hips. The examiner places one hand across the top of the patient's shoulder. The examiner places the other hand under the patient's elbow.*

Special Tests for Biceps Tendon Pathology

Several tests have been developed for the assessment of proximal biceps tendon pathology as well, but notably they have variable predictive values that are dependent on the examiner and patient population.[22] First, the **Speed's test** is performed with the patient's shoulder in 90 degrees of forward elevation, the elbow in full extension, and the forearm in full supination (figure 4.3).[22-24] The examiner palpates the patient's bicipital groove and asks the patient to forward elevate their arm against resistance. A test is considered positive if there is pain along the bicipital groove with this maneuver and is suggestive of proximal biceps tendon pathology. Notably, in a comparison with the diagnostic standard of arthroscopy, Holtby et al. noted that the Speed's test had a sensitivity of 32 percent and a specificity of 75 percent for biceps tendon pathology and SLAP tears.[22]

Figure 4.3: Speed's Test. *The examiner demonstrates the proper technique of the Speed's test on a patient. The patient is seated on the examiner's table with the shoulder in 90 degrees of forward elevation and the elbow in full extension. With one hand, the examiner holds the patient's hand, and with the other hand, the examiner palpates the patient's bicipital groove. The patient is asked to forward elevate the arm against resistance. A test is considered positive if the patient feels pain along the bicipital groove. A positive test indicates biceps tendon pathology.*

In addition, **Yergason's test** is also useful in the assessment of proximal long head of the biceps tendon pathology (video 4.3; figure 4.4).[22,24] The patient's elbow is placed in 90 degrees of flexion with the arm at the side. The examiner palpates the patient's bicipital groove with one hand and places the other hand on the patient's forearm, holding it in pronation. Then, the examiner asks the patient to supinate against resistance. Pain along the bicipital groove indicates a positive test result, which is suggestive of biceps tendon pathology. Similarly, Holtby et al. noted that, in comparison with the diagnostic standard of arthroscopy, the sensitivity and specificity of Yergason's test in detecting biceps tendon pathology and SLAP tears was 43 percent and 79 percent, respectively.[22]

One or more interactive elements has been excluded from this version of the text. You can view them here: https://temple.manifoldapp.org/projects/a-guide-to-the-physical-examination-of-the-shoulder/resource/ch4-vid03

Video 4.3: Yergason's Test. The examiner demonstrates the proper technique of Yergason's test on a patient. The patient is seated on the examiner's table with the elbow in 90 degrees of flexion. With one hand, the examiner holds the patient's forearm in pronation, and with the other hand, the examiner palpates the patient's bicipital groove. The patient is asked to supinate the forearm against the examiner's resistance. A test is considered positive if the patient feels pain along the bicipital groove. A positive test result indicates biceps tendon pathology.

***Figure 4.4*: Yergason's Test.** *The examiner demonstrates the proper positioning for Yergason's test on a patient. The patient is seated on the examiner's table with the elbow in 90 degrees of flexion. With one hand, the examiner holds the patient's forearm in pronation, and with the other hand, the examiner palpates the patient's bicipital groove.*

Sensitivities and specificities for all examinations described in Chapter 4 are outlined in table 4.2.[21–23,25]

Table 4.2: Sensitivities and Specificities for Physical Examination Maneuvers for SLAP Tears and Biceps Tendon Pathology

Test	Sensitivity	Specificity
O'Brien's Active Compression Test	83%	62%
Anterior Slide Test	78%	92%
Speed's Test	32%	75%
Yergason's Test	43%	79%

Key Terminology

Anterior Slide Test

Physical examination maneuver performed in the assessment of a SLAP tear. The patient is standing upright or sitting on the examination table with their hands on their hips. The examiner places one hand under the patient's elbow and the other on the patient's shoulder and applies an axial compressive force to the patient's elbow simultaneously with an anterior directed force to the humerus. A test is positive if the patient experiences pain in the anterior shoulder with this maneuver. ↲

Glenohumeral Internal Rotation Deficit (GIRD)

Deficit of greater than 20 degrees in internal rotation in the throwing shoulder compared to the non-throwing shoulder, commonly seen in the dominant arm of throwing athletes. ↲

Labrum

Circumferential ring of fibrocartilaginous tissue surrounding the glenoid fossa that deepens the glenoid articulation by 50 percent and provides static stability to the glenohumeral joint by preventing humeral head subluxation. ↲

O'Brien's Active Compression Test

Physical examination maneuver used in detecting SLAP tears and acromioclavicular joint pathology. The patient's arm should be placed in 90 degrees of forward elevation with the elbow fully extended, and the arm adducted 10 to 15 degrees. In the first position, the patient's thumb is directed to the floor, and the examiner applies an inferiorly directed force to the patient's arm. In the second position, the patient's thumb is now directed toward the ceiling and the examiner again applies an inferiorly directed force to the patient's arm. A positive test occurs if there is pain in the glenohumeral joint in the first position with the thumb directed downward that is improved or alleviated with the second position. A "deep" location of pain is suggestive of a SLAP tear, while a "superficial" location of pain is suggestive of acromioclavicular joint (ACJ) pathology. ↲

Popeye's Sign

Physical examination finding that indicates a biceps tendon rupture. The biceps loses its normal elliptical contour and in a proximal rupture, the muscle belly is seen more distally and appears rounded on physical examination with the patient's arm flexed to 90 degrees. ↵

Speed's Test

Physical examination maneuver for the assessment of long head of the biceps tendon pathology. The patient's arm is placed in 90 degrees of forward elevation, the elbow in full extension, and the forearm in full supination. The examiner palpates the patient's bicipital groove and asks the patient to forward elevate their arm against resistance. A positive test is indicated by pain along the bicipital groove with this maneuver. ↵

Superior Labrum Anterior to Posterior (SLAP) Tear

Injury to the superior aspect of the labrum, which is the attachment site of the long head of the biceps tendon. ↵

Yergason's Test

Physical examination maneuver for the assessment of long head of the biceps tendon pathology. The patient's elbow is placed in 90 degrees of flexion with the arm at the side. The examiner palpates the patient's bicipital groove with one hand and places the other hand on the patient's forearm, holding it in pronation. The examiner asks the patient to supinate against resistance. A positive test result is indicated by pain along the bicipital groove. ↵

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5. Adhesive Capsulitis

Adhesive capsulitis, or frozen shoulder, is an inflammatory condition that results in pain, stiffness, and loss of range of motion in the shoulder. It is a relatively common problem and affects approximately 3 to 5 percent of the general population.[1] The condition is more common in individuals with diabetes mellitus and thyroid disease.[2-4] Notably, adhesive capsulitis most commonly affects women and individuals between fifty and seventy years of age.[1]

The progression of adhesive capsulitis can be classified into three distinct stages: freezing (painful), frozen (stiff), and thawing.[1,5,6] In the **freezing** (painful) stage, there is the gradual onset of diffuse shoulder pain over the course of several weeks to several months. Next, in the **frozen** (stiff) stage, there is an improvement in shoulder pain, but a gradual loss of active and passive range of motion in all planes. This stage can last between four and twelve months. Lastly, in the **thawing** stage, which lasts between five and twenty-six months, there is a gradual improvement in active and passive range of motion.[1,5,6] While it was previously believed that the course of adhesive capsulitis was self-limiting and that patients would make a full functional recovery, recent evidence has disputed this claim.[7] Several studies that examined long-term follow-up in patients with adhesive capsulitis demonstrated that some patients had persistent pain and lasting restrictions in range of motion of the shoulder,[8,9] and surgical intervention or manipulation may be needed to minimize these deficits.

Pathophysiology

Adhesive capsulitis may be categorized as primary or secondary.[10] In primary idiopathic adhesive capsulitis, the pain and functional limitations of the shoulder have no underlying cause. In contrast, in secondary adhesive capsulitis, the symptoms result from previous trauma, previous surgery, or associated medical conditions, including diabetes and thyroid disease.[10] Regardless of etiology, the pathophysiology of adhesive capsulitis is not well understood. It is believed that an inflammatory process contributes to thickening, fibrosis, and contracture of the glenohumeral joint capsule, including the coracohumeral ligament.[6,11] Biopsies of the shoulder joint capsule in patients with adhesive capsulitis have identified both chronic inflammatory cells, including B cells, T cells, and mast cells, and dysregulated cytokines, including IL-1β, IL-6, and TNF-α. These cellular changes contribute to the hallmark histologic changes of fibroblast proliferation in Type I and Type III collagen. Notably, the fibroblasts change into smooth muscle fibroblasts (myofibroblasts), which causes the contraction of the joint capsule.[6,12] Altogether, these processes contribute to a mechanical restriction of motion, which results in the classical symptoms of adhesive capsulitis.

History

The diagnosis of adhesive capsulitis is made clinically, so it is essential to first obtain a thorough history of the present illness.[1,11,13] Patients typically present with an insidious onset of pain progressing over the course of several months. The pain often is deep and diffuse but also may localize to the anterior rotator interval.[14] Pain can be present at night, at rest, or with activity. Patients may report the loss of both active and passive range of motion of the shoulder. This deficit notably affects activities of daily living, including dressing, overhead activities, and reaching to the side or behind the back. In addition to gathering details about the presenting symptoms, it is important to gather information about hand dominance, occupation, recent shoulder injury or surgery, and comorbid medical conditions, such as diabetes, thyroid disease, or endocrine disorders. Notably, the presence of diabetes, in addition to increasing the likelihood of adhesive capsulitis, portends a worse prognosis in patients with this condition.[15,16]

Physical Examination

The next step in evaluation and diagnosis of adhesive capsulitis is a thorough examination involving inspection, palpation, and range of motion of the bilateral shoulders. The bilateral shoulders are examined with careful attention to signs of previous surgery. Further, palpation may elicit tenderness in the region of the bicipital groove, as the synovium of the long head of the biceps tendon is continuous with that of the glenohumeral joint.[11] Following inspection and palpation, it is important to assess and compare the range of motion in both shoulders. Specifically, forward elevation, abduction, external rotation at the side, and internal rotation to vertebral height should be documented. Careful examination is required as adhesive capsulitis is commonly mistaken for glenohumeral arthritis and vice versa. Importantly, OA of the glenohumeral joint has several distinguishing features such as a grinding sensation or crepitation. Additionally, radiographs will be normal in adhesive capsulitis, while the presence of osteophytes and joint space narrowing will confirm the presence of arthritis. With respect to timing, adhesive capsulitis typically progresses over a shorter period of time than glenohumeral arthritis, which progresses over a span of months to years.

In patients with adhesive capsulitis, a loss of both active and passive range of motion is observed in all planes. The distinguishing feature in this condition is the loss of passive range of motion, especially in external rotation at the side.[11,13] Video 5.1 illustrates the loss of passive range of motion in a patient with left-sided adhesive capsulitis, while video 5.2 illustrates the loss of active range of motion in a different patient with left-sided adhesive capsulitis. Notably, figure 5.1 demonstrates the deficit in forward elevation, external rotation, and internal rotation compared to the contralateral, unaffected side. In addition, there may be pain at the extremes of motion due to stretching of the joint capsule.[6] Strength of the rotator cuff should be normal in the absence of additional pathology.

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Video 5.1a: Examination of a Supine Patient with Adhesive Capsulitis. The examiner demonstrates a range of motion assessment on the left (affected) shoulder of a supine patient with adhesive capsulitis. In order, the patient demonstrates significant deficits in forward elevation, external rotation at the side, abduction at 90 degrees, external rotation at 90 degrees, and internal rotation at 90 degrees with passive range of motion.

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Video 5.1b: Examination of a Supine Patient with Adhesive Capsulitis. In the same patient, the examiner demonstrates a range-of-motion assessment on the right (unaffected) shoulder in the supine position. In order, the patient demonstrates normal passive range of motion with respect to forward elevation, external rotation at the side, abduction at 90 degrees, external rotation at 90 degrees, and internal rotation at 90 degrees.

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Video 5.2: Examination of a Standing Patient with Adhesive Capsulitis. In a different patient with left-sided adhesive capsulitis, the examiner asks the patient to perform active forward elevation, external rotation at the side, and internal rotation to vertebral height in the bilateral shoulders. The patient clearly has significant deficits in all three planes in the left (affected) shoulder compared to the right (unaffected) shoulder.

Figure 5.1a: Examination of a Standing Patient with Adhesive Capsulitis. *The patient demonstrates significant deficits in forward elevation in the left (affected) shoulder compared to the right (unaffected) shoulder.*

Figure 5.1b. *The patient demonstrates significant deficits in external rotation at the side in the left (affected) shoulder compared to the right (unaffected shoulder).*

Figure 5.1c. *The patient demonstrates significant deficits in internal rotation to vertebral height in the left (affected) shoulder compared to the right (unaffected) shoulder.*

Key Terminology

Adhesive Capsulitis

Inflammatory condition, also known as frozen shoulder, that results in pain, stiffness, and loss of both active and passive range of motion in the shoulder. ↲

Freezing

Initial stage in adhesive capsulitis, characterized by the gradual onset of diffuse shoulder pain over the course of several weeks to months. ↲

Frozen

Second stage in adhesive capsulitis, characterized by improvement in shoulder pain, but a gradual loss of active and passive range of motion in all planes. ↲

Thawing

Third and final stage in adhesive capsulitis, characterized by a gradual improvement in active and passive range of motion lasting between five and twenty-six months. ↲

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6. Glenohumeral Arthritis

Glenohumeral osteoarthritis is a degenerative joint disease characterized by wear of the articular cartilage on the humeral head and glenoid. For patients affected, it results in significant pain, loss of range of motion, and difficulties performing activities of daily living. In addition to these physical limitations, the presence of osteoarthritis can greatly affect emotional and psychological well-being, as it can lead to significant depression and anxiety.[1] Although less prevalent than osteoarthritis of the hip and the knee, osteoarthritis of the shoulder still is an extremely common musculoskeletal condition, affecting up to 17 percent of patients presenting with shoulder pain.[1,2] Notably, in 2017, there were 104,575 shoulder replacements, which is the end-stage treatment of shoulder arthritis performed in the United States.[3] The risk of developing glenohumeral osteoarthritis greatly increases with age, with the greatest risk in individuals over sixty years old.[4,5] In this age group it is estimated that over one-third of individuals are affected by glenohumeral osteoarthritis.[4] Other risk factors associated with the development of glenohumeral arthritis include female sex, obesity, family history, and a history of shoulder dislocation or fracture.[6-8]

Pathophysiology

Glenohumeral arthritis can be categorized as primary or secondary. **Primary glenohumeral osteoarthritis** is the more common etiology but has no known underlying cause. It is believed that the pathogenesis of arthritis results from a combination of biomechanical factors, which place abnormal stresses on the joint; genetic predisposition; and environmental factors.[9] A progressive loss of articular cartilage develops. Articular cartilage normally functions as a shock absorber and in facilitating motion of the joint by reducing friction. Over time, classic signs of glenohumeral arthritis on radiographs emerge, including subchondral sclerosis and cysts, joint space narrowing, osteophytes, and posterior glenoid wear.[10-12] In contrast, **secondary glenohumeral osteoarthritis** results from a specific cause or predisposing factor. One such cause is osteonecrosis, which results from a disruption of the subchondral blood supply to the humeral head, leading to collapse of the articular surface.[13,14] Common etiologies of osteonecrosis include corticosteroid use, sickle cell disease, and heavy alcohol use.[13,14] Degenerative joint changes, can occur as sequelae of trauma, such as dislocation and proximal humerus fracture.[15] Subluxation and dislocation may cause osteochondral fracture, subchondral bone injury, and damage to the glenohumeral articular cartilage. Similarly, initial fracture displacement or malunion (the healing of bone in an abnormal position) can result in accelerated joint degeneration.[6] Lastly, secondary glenohumeral arthritis can result from inflammatory causes, such as rheumatoid arthritis, or postsurgical changes.[6] Notably, intra-articular pain pumps, which were sometimes used following arthroscopic shoulder surgery, were a common cause of cartilage damage before this practice was stopped.[16]

History

Patients with osteoarthritis typically present with shoulder pain that localizes deep and posterior in the glenohumeral joint. The pain worsens with range of motion of the shoulder and may also be present at night. Some patients may report difficulty sleeping due to significant nighttime pain. Along with the pain, patients often report limited range of motion in all planes, and significant difficulties performing activities of daily living. Later in the course of the disease, mechanical symptoms, such as crepitus, catching, or locking, may be present. These mechanical symptoms may be suggestive of a bony fragment that is partially detached or in the glenohumeral joint,[17,18] or bone-on-bone contact as the cartilage wears out completely. In addition, it is important to note any previous intervention, including physical therapy, non-steroidal anti-inflammatory drugs (NSAIDs), or corticosteroid injections, as this knowledge can better inform current management. Lastly, relevant previous medical and social history should be obtained. This includes assessing for a history of shoulder subluxation, dislocation, or fracture; current medical conditions; and occupational or recreational activities.

Physical Examination

The physical examination for glenohumeral arthritis should include inspection, palpation, and range of motion assessment of the shoulder. Inspection involves examination of the bilateral shoulders for signs of previous surgery, fluid collection or muscle atrophy, which may be signs of a cuff tear arthropathy (glenohumeral arthritis with an associated rotator cuff tear).[19] Furthermore, palpation along the joint line may elicit tenderness in the affected shoulder. As always, a thorough examination of the neck and cervical spine should be performed to rule out other causes of pain.10 Next, both active and passive range of motion should be assessed in the following planes: forward elevation, abduction, external rotation at the side, external rotation in abduction, internal rotation in abduction, and internal rotation. Notably, there may be audible and palpable **crepitus**, or crackling, in the joint with range of motion (video 6.1).

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Video 6.1: Crepitus in a Patient with Glenohumeral Arthritis. The patient with glenohumeral arthritis displs audibayle crepitus, or crackling, with range of motion of the shoulder. Crepitus is a common physical examination finding in patients with glenohumeral arthritis.

Significant deficits in range of motion may be present in all planes including forward elevation and external rotation (video 6.2 and video 6.3).[18] In addition, patients may complain of pain during the midrange of the rotation arc. Lastly, the provocative maneuvers for rotator cuff pathology (chapter 2) should be performed to assess the integrity of the rotator cuff musculature. The usual maneuvers may not all be possible given the mechanical limitations of the arthritic shoulder. Following a comprehensive history and physical examination, radiographs of the shoulder should be obtained, which should confirm the diagnosis of glenohumeral arthritis.[10,17]

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Video 6.2: Forward Elevation in a Patient with Glenohumeral Arthritis.
Patients with glenohumeral arthritis may display deficits in all planes of motion in the affected shoulder. Here, the patient with left-sided glenohumeral arthritis is only able to passively elevate her left shoulder to 100 degrees with pain.

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Video 6.3: External Rotation and Internal Rotation in a Patient with Glenohumeral Arthritis.
This patient with left-sided glenohumeral arthritis displays pain on passive external rotation and a significant deficit in active internal rotation, as she is unable to reach her spine. This will make certain tests difficult to perform, such as the internal rotation lag sign used to assess integrity of the subscapularis.

Key Terminology

Crepitus

Crackling or grinding sound that occurs with motion of arthritic joints. ↲

Glenohumeral Osteoarthritis

Degenerative joint disease characterized by wear of the articular cartilage on the humeral head and glenoid. ↲

Primary Glenohumeral Osteoarthritis

Glenohumeral arthritis with no known underlying cause, believed to result from a combination of biomechanical factors, genetic predisposition, and environmental factors. ↲

Secondary Glenohumeral Osteoarthritis

Glenohumeral arthritis resulting from a specific cause or predisposing factor, such as an inflammatory condition, osteonecrosis, or a post-traumatic etiology. ↲

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7. Cuff Tear Arthropathy

While its clinical features were described more than a century ago, the term "cuff tear arthropathy" was first used by Dr. Charles Neer in 1977.[1,2] **Cuff tear arthropathy** consists of a triad of full thickness rotator cuff tearing with muscle atrophy, degenerative damage to the glenohumeral joint, and superior migration of the humeral head.[2-4] Additional features that may be seen include the concave erosion of the undersurface of the acromion, also known as acromion acetabularization.[1]

In terms of demographics, females are disproportionately affected by cuff tear arthropathy, especially those in their seventh decade of life.[5] In addition, cuff tear arthropathy more commonly affects the patient's dominant shoulder. The development of a massive rotator cuff tear that goes untreated leads to a progression toward cuff tear arthropathy,[6] via altered joint kinematics and abnormal joint reactive forces. Additionally, although rotator cuff disease is generally multifactorial in origin, multiple studies have pointed to a genetic component in the disease process.[7-9]

Pathophysiology

Mechanical and nutritional factors lead to the development of cuff tear arthropathy.[1,2] The mechanical factors include decentering of the humeral head, loss of concavity compression, and altered joint kinematics due to massive cuff tearing, which leads to superior migration of the humeral head up to the acromion. Instability from the loss of the dynamic shoulder stabilizers due to the torn rotator cuff musculature leads to accelerated cartilage wear and thus joint space narrowing. Additionally, massive tears of the rotator cuff allow joint fluid to escape the glenohumeral articulation. This disruption of the normal balance of the synovial joint fluid also contributes to cartilage degeneration as well as a decline in bone health.[1,2]

History

A thorough evaluation of cuff tear arthropathy begins with a history of the present illness. Patients with this condition will most often present with pain, which often occurs at night, as their predominant symptom. They will also report weakness as well as limited motion of the affected shoulder. Overhead movements and range of motion of the shoulder will be particularly difficult. The provider should also inquire about the onset of pain, prior procedures, and functional deficits of the affected shoulder. Notably, the course of the disease is typically progressive, with symptoms worsening over a span of several years.[2] Neer et al. noted that patients presenting with cuff tear arthropathy had pain for an average of 9.8 years.[2] Although there is frequently no inciting event, it is still important to inquire about one, as this may result in a rapid deterioration of symptoms.[6] Lastly, a patient may note the presence of a joint effusion in the shoulder.[10]

Physical Examination

With regard to the physical exam, the examiner should begin with inspection of the shoulder joint. There are several classic signs present in this condition, including atrophy and pseudoparalysis. There may be anterosuperior escape of the humeral head from the glenoid, which becomes especially prominent during arm elevation (video 7.1).[6]

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Video 7.1: Anterosuperior Escape. The examiner instructs the patient to elevate his right shoulder, which elicits anterosuperior migration of the humeral head. The humeral head is seen at a location anterior and superior to the glenoid. This finding is suggestive of rotator cuff tear arthropathy.

Another observation made on physical examination is the presence of shoulder swelling and a benign-appearing effusion, which is a sign of joint fluid in the subacromial bursa. A painless effusion can often be palpated on physical exam, and aspiration of this effusion typically yields light straw-colored fluid.[6] Lastly, atrophy may be present in the supraspinatus and infraspinatus fossa.

Next, the examiner can investigate active and passive range of motion of the shoulder. Specifically, the examiner should observe range of motion with respect to forward elevation, abduction, external rotation, and internal rotation. Notably, both active and passive range of motion demonstrate significant deficits in the presence of cuff tear arthropathy, and there may be crepitus, or crackling, on range of motion of the shoulder.[10] In some cases, patients may display **pseudoparalysis** of the affected shoulder, which is most commonly defined as active forward elevation of less than 90 degrees due to a massive cuff tear.[11]

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Video 7.2: Pseudoparalysis. This patient with a massive, irreparable rotator cuff tear demonstrates pseudoparalysis, as he is completely unable to actively forward elevate his affected shoulder.

In addition to inspection, palpation, and range of motion, strength testing for the rotator cuff muscles, including the supraspinatus, infraspinatus, subscapularis, and teres minor, should be performed, as previously discussed. It is also important to assess the integrity of the axillary nerve and the deltoid muscle, as reverse total shoulder arthroplasty, a common surgical treatment option for cuff tear arthropathy, requires both to be functioning. Notably, the axillary nerve supplies sensation to the inferior two thirds of the skin over the deltoid musculature, so deficits would manifest as sensory deficits in this region.[12] In addition, it controls motor function to both the deltoid muscle and the teres minor muscle. Deficits of the deltoid would manifest as inability to abduct the shoulder from 15 to 90 degrees, and deficits of the teres minor would manifest with a positive Hornblower's sign.

Special Tests

Further, there are also special tests that can be performed to investigate shoulder function in patients with cuff tear arthropathy. These include the drop arm test, external rotation lag sign, internal rotation lag sign, bear-hug test, and Hornblower's sign. The **drop arm test** evaluates the integrity of the supraspinatus tendon.[13,14] The examiner passively abducts the patient's shoulder to 90 degrees and asks the patient to maintain the position. An inability to hold this position, resulting in the sudden dropping of the arm, indicates a positive test and suggests tearing of the supraspinatus. This is demonstrated in video 7.3.

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Video 7.3: Drop Arm Test. The examiner passively abducts the patient's affected shoulder to 90 degrees and asks him to maintain this position. The patient is unable to do so, and his arm drops to the floor, indicating a positive test and tear of the supraspinatus.

The **external rotation lag sign** is another physical examination maneuver performed to assess rotator cuff pathology, specifically to test the infraspinatus (video 7.4; figure 7.1).[15,16] Initially, the patient's shoulder is fully adducted, and the elbow is placed at 90 degrees of flexion. The examiner places the shoulder in maximal external rotation, and the patient is asked to hold this position. An inability to hold this position indicates weakness of the infraspinatus (video 7.5).

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Video 7.4: The External Rotation Lag Sign. The examiner demonstrates the appropriate technique for the external rotation lag sign on the patient's right shoulder. The patient is seated on the examiner's table with the right shoulder adducted and the elbow at 90 degrees of flexion. The examiner places the patient's right shoulder in maximal external rotation and asks the patient to maintain maximal external rotation.

Figure 7.1: The External Rotation Lag Sign. *The examiner releases the patient's arm after having placed the patient's right shoulder in maximal external rotation and observes whether the patient is able to maintain this position.*

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Video 7.5: The External Rotation Lag Sign. The examiner demonstrates the external rotation lag sign on a patient with a rotator cuff tear. A test is considered positive if the patient is unable to maintain the position of maximal external rotation and if the arm falls into internal rotation. A positive test is specific for full-thickness tears of the infraspinatus. Here, the patient is unable to maintain the position of maximal external rotation, and the arm drifts into internal rotation. The test is positive bilaterally.

To assess the integrity of the subscapularis muscle, the **internal rotation lag sign** can be performed. In this maneuver the examiner has the patient maintain internal rotation of the affected shoulder behind the patient's back, with the dorsum of the hand facing the patient's back and the shoulder in approximately 20 degrees of extension (video 7.6; figure 7.2). The patient's shoulder is passively placed in maximal internal rotation by the examiner with the patient's hand several centimeters posterior to the lumbar spine, and the patient is asked to maintain this position away from the body. A positive test result is indicated by failure to actively maintain this position and indicates a deficit of the subscapularis (video 7.7).

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Video 7.6: Internal Rotation Lag Sign. The examiner holds the patient's arm in internal rotation behind the patient's back with the dorsum of the hand facing the back and the shoulder in about 20 degrees of extension. The examiner supports the patient's elbow as well as the wrist. Then the examiner releases the wrist, and the patient is able to maintain the position, indicating an absence of a subscapularis tear.

Figure 7.2: Internal Rotation Lag Sign. *The examiner demonstrates the appropriate positioning for the internal rotation lag sign. The examiner holds the patient's arm in internal rotation behind the patient's back, with the dorsum of the hand facing the back and the shoulder in about 20 degrees of extension.*

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Video 7.7: Internal Rotation Lag Sign. The examiner holds the patient's right arm in internal rotation behind the patient's back with the dorsum of the hand facing the back and the shoulder in about 20 degrees of extension. The examiner supports the patient's elbow as well as the wrist. Then, the examiner releases the wrist, and the patient is not able to maintain the position. The patient's hand falls against their own back. This positive sign can indicate a tear of the subscapularis tendon. The examiner tests the contralateral side, which is negative.

Another test to investigate the integrity of the subscapularis is the **belly press test**, which can be performed by instructing the patient to maintain their elbows in 90 degrees of flexion with the palms pressed against the abdomen (video 7.7). The examiner applies a posteriorly directed force against the patient's elbows while the patient is asked to resist the posteriorly directed force by internally rotating the affected shoulder to effectively press the palm into their abdomen. The test is considered positive if the patient cannot fully bring the elbows forward by internally rotating at the shoulders and if the wrist remains in flexion while pressing the palms against the belly. A positive test indicates a subscapularis tear.

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Video 7.8: Belly Press Test. The examiner performs the belly press test. The patient is instructed to maintain their elbows in 90 degrees of flexion with the palms pressed against their abdomen. The examiner applies a posteriorly directed force against the patient's elbows while the patient is asked to resist by internally rotating the affected shoulder to effectively press the palm into the abdomen. Here, the patient is unable to fully bring his left elbow forward while pressing his belly. Further, the patient is unable to resist a posteriorly directed force by the examiner. The patient has a positive left-sided belly press test, indicating a left-sided subscapularis tear. In contrast, the belly press test on the contralateral (right) shoulder is negative.

The **lift off test** can also assess for subscapularis deficits, by having the patient place the dorsum of the hand along their back with the elbow held in about 90 degrees of flexion (video 7.8). The test is considered positive if the patient is unable to lift the hand off the back. This test may be challenging to perform in cases of advanced arthropathy, where the patient will have limited motion of the shoulder.

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Video 7.9: Lift Off Test. The examiner performs the lift off test on the patient's right and left shoulders. The patient is instructed to place the dorsum of the hand on their back with the elbow held in about 90 degrees of flexion. The test result is considered positive if the patient is unable to internally rotate the shoulder and lift the hand off the back. A positive test indicates a deficit of the subscapularis. Here, the patient is successfully able to lift off her right hand but is unable to lift off her left hand. The patient has a positive left-sided lift off test.

The last provocative maneuver for subscapularis function discussed is the **bear hug test**. The hand of the affected shoulder is placed on the contralateral shoulder with the fingers extended and the elbow at 90 degrees. The patient is instructed to hold this position while the examiner applies an external rotation force to the patient's forearm. A test is positive when the patient cannot maintain this position, or if they display weakness compared to the opposite, unaffected, shoulder. Barth et al. determined that a positive test result indicates a tear of at least 30 percent of the subscapularis.[17]

To assess the function of the teres minor muscle, the **Hornblower's sign** can be assessed. For this maneuver, the patient's shoulder is positioned in 90 degrees of abduction with the elbow in 90 degrees of flexion (video 7.10). The examiner externally rotates the shoulder 90 degrees and then subsequently releases the arm with the patient attempting to hold the original position. The test is considered positive if the patient is unable to maintain the position and the patient's shoulder falls into internal rotation.

One or more interactive elements has been excluded from this version of the text. You can view them here: https://temple.manifoldapp.org/projects/a-guide-to-the-physical-examination-of-the-shoulder/resource/ch7-vid10

Video 7.10: Hornblower's Sign. The examiner has the patient seated with her right shoulder in approximately 90 degrees of abduction and the elbow in 90 degrees of flexion. The examiner passively externally rotates the shoulder to about 90 degrees. The examiner then releases the arm while having the patient attempt to hold the position. The patient is unable to hold the position, recoiling into internal rotation. Therefore, the test is positive, which suggests dysfunction of the teres minor muscle.

Sensitivities and specificities for all examinations described in chapter 7 are outlined in table 7.1.[13,18-20]

Table 7.1: Sensitivities and Specificities for Cuff Tear Arthropathy Examination Maneuvers

Test	Sensitivity	Specificity
Drop Arm Test[13]	21%	96%
External Rotation Lag Sign[16,18]	97%	93%
Internal Rotation Lag Sign[17,19]	32%	92%
Belly Press Test[19]	28%	87%
Lift Off Test[19]	22%	94%
Hornblower Test[16]	17%	96%

Key Terminology

Bear Hug Test

Physical examination technique used to assess the integrity of the subscapularis tendon. The hand of the patient's affected shoulder is placed on the contralateral shoulder with the fingers extended and the elbow at 90 degrees. The patient is instructed to hold this position while the examiner applies an external rotation force to the patient's arm. A test is positive when the patient cannot maintain this position. ↲

Belly Press Test

Physical examination technique used to assess the integrity of the subscapularis tendon. The patient is asked to press the hand into the belly and internally rotate the shoulder against resistance. A test is positive if the patient's wrist flexes or they demonstrate weakness to resistance. ↲

Cuff Tear Arthropathy

Disorder of the shoulder consisting of a triad of full thickness rotator cuff tearing with muscle atrophy, degenerative damage to the glenohumeral joint, and superior migration of the humeral head. ↲

Drop Arm Test

Physical examination maneuver performed to assess the integrity of the supraspinatus tendon. The examiner passively abducts the patient's shoulder to 90 degrees and asks the patient to maintain the position. An inability to hold this position, resulting in the sudden dropping of the arm, suggests tearing of the supraspinatus. ↲

External Rotation Lag Sign

Physical examination maneuver performed to test the infraspinatus. Initially, the patient's shoulder is fully adducted, and the elbow is placed at 90 degrees of flexion. The examiner places the shoulder in maximal external rotation, and the patient is asked to hold this position. An inability to hold this position indicates a positive test result. ↲

Hornblower's Sign

Physical examination maneuver used to assess pathology of the teres minor. The patient's shoulder is placed in 90 degrees of abduction and 90 degrees of external rotation with the elbow also bent to 90 degrees, and the patient is asked to hold this position. The test is positive if the arm falls into internal rotation, assuming a position as if blowing a horn. ↲

Internal Rotation Lag Sign

Physical examination maneuver used to assess the subscapularis. The test is performed by placing the patient's hand behind their back with the shoulder in maximal internal rotation and their hand elevated several centimeters off of the lumbar spine. The patient is instructed to maintain this position. A positive test is indicated by failure to actively maintain this position (with the hand falling toward the patient's body). ↵

Lift Off Test

Physical examination maneuver used to assess the subscapularis. The test is performed with the patient positioning their hand behind the back at the level of the lumbar spine with the palm facing outward. The patient is asked to lift their hand off their back. A test is positive if there is weakness to resistance or inability to perform the motion. ↵

Pseudoparalysis

Active forward elevation of less than 90 degrees due to a massive rotator cuff tear. The arm appears to be paralyzed but is, in fact, neurologically intact. ↵

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8. Examination of Shoulders After Joint Replacements

Total shoulder arthroplasty or replacement is the mainstay of treatment for advanced, disabling glenohumeral joint arthritis. Diseased parts of the glenohumeral joint are removed, and the articulation is replaced with plastic and metal components to recreate the normal anatomy of the shoulder joint. Historically, the first shoulder replacement was performed by the French surgeon Dr. Jules Emile Pean, using rubber and platinum implants in a patient with tuberculous arthritis of the shoulder in 1893.[1] Ultimately, the implant was removed after two years due to an infection.[1] The modern era of total shoulder replacement began in the 1950s when Dr. Charles Neer introduced and reported the results of a solid Vitallium arthroplasty implanted for a fracture.[2] In 1974, Dr. Neer reported the excellent results of a total shoulder replacement implanted for the management of glenohumeral arthritis.[3] Since then, there have been significant advancements in the design and technology of total shoulder replacements. Current options include **humeral head resurfacing**, **hemiarthroplasty**, anatomic total shoulder arthroplasty, and reverse total shoulder arthroplasty.[4]

Notably, the popularity of total shoulder replacements has grown substantially in recent years.[5,6] In the United States, there were 104,575 primary total shoulder replacements performed in 2017, a number that has increased by 103.7 percent since 2011.[6] This increase has largely been driven by the drastic increase in the number of reverse total shoulder replacements performed annually, which has grown by 191 percent in this time.[6] The volume of anatomic total shoulder replacements increased by 38.5 percent in the same period, while the volume of shoulder hemiarthroplasties has decreased by 60.9 percent.[6]

Types of Shoulder Replacements

Shoulder hemiarthroplasty, or a partial shoulder replacement, involves the replacement of the articular surface of the humerus with a metal humeral component.[7,8] Common indications for a hemiarthroplasty are severe glenohumeral arthritis that has failed nonoperative management and non-reconstructible comminuted proximal humerus fractures in younger patients. Specifically, hemiarthroplasty is considered in patients with inadequate glenoid bone stock for a total shoulder replacement and in patients with a diagnosis of avascular necrosis that does not involve the glenoid. Further, it is preferred in younger patients who frequently use the shoulder in high-demand activities and are unwilling to modify their lifestyles to accommodate a total shoulder replacement.[8] Lastly, in younger patients with severely comminuted fractures that are not re-constructible with open reduction internal fixation, shoulder hemiarthroplasty may be an option.[8,9]

Anatomic total shoulder arthroplasty (TSA) involves the replacement of the articular surface of the humerus with a metal humeral component and the resurfacing of the glenoid with a polyethylene component.[10,11] The humeral component may be a stemmed or stemless design. The primary indication for an anatomic TSA is disabling glenohumeral arthritis in a patient for whom nonoperative management has failed. Nonoperative management includes nonsteroidal anti-inflammatory medication (NSAIDs), physical therapy, activity modification, and corticosteroid injections. Possible etiologies of glenohumeral arthritis include osteoarthritis, inflammatory arthritis, and avascular necrosis with glenoid involvement. Contraindications to anatomic TSA include active infection, deltoid or rotator cuff dysfunction, and poor glenoid bone stock. Furthermore, patients younger than fifty years of age are typically cautioned against it, as TSA survival in this population is shown to be significantly worse than in patients over the age of fifty.[12] A recent review demonstrated that the ten-year survivorship of anatomic shoulder replacements, or implant longevity before revision surgery, was 96 percent. However, survivorship depends on the indication for shoulder replacement, as studies have shown that survivorship is worse in patients requiring shoulder arthroplasty for osteonecrosis and posttraumatic arthritis compared to primary glenohumeral arthritis.[13]

Reverse total shoulder arthroplasty is a type of joint replacement that involves switching the natural anatomy of the shoulder joint and includes a convex ball on the glenoid and a concave cup on the humerus with a stem down the medullary canal.[14] With this prosthesis, the center of rotation moves inferiorly and allows the deltoid to gain a mechanical advantage for forward elevation of the arm in the presence of a deficient rotator cuff. Reverse total shoulder arthroplasty is commonly used in patients with cuff tear arthropathy and in elderly patients with three- or four-part proximal humerus fractures. Although utilized in patients with massive rotator cuff tears, the procedure requires an intact deltoid muscle and axillary nerve.[15]

Surgical Techniques for Shoulder Replacements

The most common surgical approach for a shoulder replacement is the deltopectoral approach.[16] However, other surgical approaches, such as the anterosuperior approach, have been described and utilized with excellent results as well.[16] The **deltopectoral approach** uses the interval between the deltoid laterally and pectoralis major medially (video 8.1). An 8- to 10-centimeter linear incision is drawn just lateral to the coracoid process, down the deltopectoral groove, and toward the deltoid tuberosity of the humerus. Following superficial dissection, the interval between the deltoid, innervated by the axillary nerve; and the pectoralis major muscles, innervated by the medial and lateral pectoral nerve, is identified and dissected.[17]

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Video 8.1: Incision for the Deltopectoral Approach. In the deltopectoral approach, the surgeon makes a linear incision lateral to the coracoid process using the margin between the deltoid laterally and the pectoralis major medially. This surgical approach can be used for total shoulder replacements, proximal humerus fractures, and more.

It should be noted that the deltopectoral approach to shoulder arthroplasty requires mobilization of the subscapularis tendon in order to provide adequate exposure. Several techniques, including **subscapularis tenotomy**, **subscapularis peel**, and **lesser tuberosity osteotomy**, have been developed for management of the subscapularis.[18,19] While the subscapularis tenotomy is an intra-tendinous division of the subscapularis, and the subscapularis peel is a detachment of the subscapularis tendon from its insertion on the lesser tuberosity, the lesser tuberosity osteotomy was designed to decrease the risk of injury to the subscapularis by relying on bone-to-bone healing. While studies suggest similar clinical outcomes between these techniques, each technique requires the repair of the subscapularis. Therefore, careful attention to subscapularis function postoperatively should be noted.[19,20]

Postoperative Physical Examination

Thorough physical examinations during postoperative visits are essential in assessing the status of the total shoulder replacement. The examiner should assess wound healing and ensure that there is no erythema, edema, or other signs of inflammation that may indicate an underlying surgical site infection. Infection is a particularly devastating complication of shoulder replacements, with an occurrence of 2.9 percent after reverse shoulder replacements and 0.51 percent after anatomic total shoulder replacements.[21] This difference has been attributed to a variety of factors, such as the increased dead space in reverse total shoulder replacement due to the absent rotator cuff, older patient age, more comorbidities, and higher likelihood of prior shoulder surgery in patients undergoing reverse total shoulder replacements.[21] Additional signs of infection following shoulder replacements include a stiff and painful shoulder, and inflammatory markers should be obtained if clinical suspicion is high. However, it is important to note that inflammatory markers may not be elevated in the setting of *Cutibacterium acnes* (*C. acnes*) infection.[22] *C. acnes* has notably emerged as a common cause of infection following shoulder surgery.

It is important to carefully examine for signs of instability following anatomic and reverse total shoulder replacement. In a recent review article, Bohsali et al. noted that the overall rates of instability following anatomic and reverse total shoulder replacement were 1 percent and 5 percent, respectively.[21] However, instability rates vary based on patient-related factors, surgical technique, implant design, and surgical indication. Therefore, for example, studies have reported the instability rate following reverse total shoulder arthroplasty to be as high as 31 percent.[21] Signs of anterior shoulder instability on physical examination include anterior shoulder pain, weakness of subscapularis strength, and increased active or passive external rotation. Mechanical symptoms or a deformity may be present as well. On the other hand, signs of posterior shoulder instability on history and physical examination include the sudden onset of posterior glenohumeral joint pain and a loss or decrease of external rotation.[23]

In the immediate postoperative period, the focus should be on reducing pain and inflammation; maintaining range of motion in the wrist, hand, and elbow; and allowing only passive range of motion of the shoulder. After the patient meets surgeon-specific passive range-of-motion goals, the patient gradually begins active range of motion, with the goal of progressive improvement and strengthening.

Range-of-motion goals following shoulder replacement depend on both patient-specific and surgeon-specific factors. Kiet et al. reviewed and compared range of motion at minimum two-year follow-up following both anatomic and reverse total shoulder replacement in one hundred patients.[24] In their cohort of anatomic total shoulder replacements, they found an average forward elevation of 144 degrees, abduction of 136 degrees, external rotation of 53 degrees, and internal rotation to L2. In their cohort of reverse shoulder replacements, they found an average forward elevation of 136 degrees, abduction of 129 degrees, external rotation of 38 degrees, and internal rotation to L2. The only significant difference between the two groups was improved external rotation in the anatomic shoulder replacement cohort. Furthermore, deficits in internal rotation are often noted following a reverse total shoulder replacement, with patients reporting difficulty in performing activities of daily living, including washing their backs or closing their bras.[25] Overall, however, patients do achieve excellent pain relief and improvement in range-of-motion outcomes in terms of shoulder flexion, abduction, external rotation, and internal rotation following both anatomic and reverse total shoulder replacement (video 8.2; figure 8.1).

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Video 8.2a: Anatomic and Reverse Total Shoulder Replacement Postoperative Range of Motion.

This postoperative total shoulder replacement patient demonstrates full shoulder range of motion compared to the contralateral shoulder, including forward elevation of 180 degrees, external rotation at the side of 80 degrees, and internal rotation to the thoracic spine, at one-year follow-up.

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Video 8.2b: Anatomic and Reverse Total Shoulder Replacement Postoperative Range of Motion.

This postoperative reverse total shoulder replacement patient shows excellent range of motion at one-year follow-up. She demonstrates shoulder forward flexion of 180 degrees, external rotation at 90 degrees, abduction of 90 degrees, and internal rotation to the lumbar spine.

Figure 8.1a: Anatomic and Reverse Total Shoulder Replacement Postoperative Radiographs. *This radiograph shows an anteroposterior view of the right shoulder in a patient one year after a stemless anatomic total shoulder arthroplasty.*

Figure 8.1b. *This radiograph shows an axillary view of the right shoulder in a patient one year after a stemless anatomic total shoulder arthroplasty.*

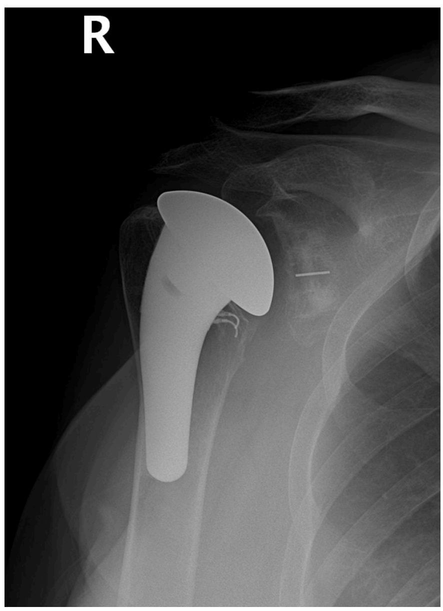

Figure 8.1c. *This radiograph shows an anteroposterior view of the right shoulder in a patient three years after a stemmed anatomic total shoulder arthroplasty.*

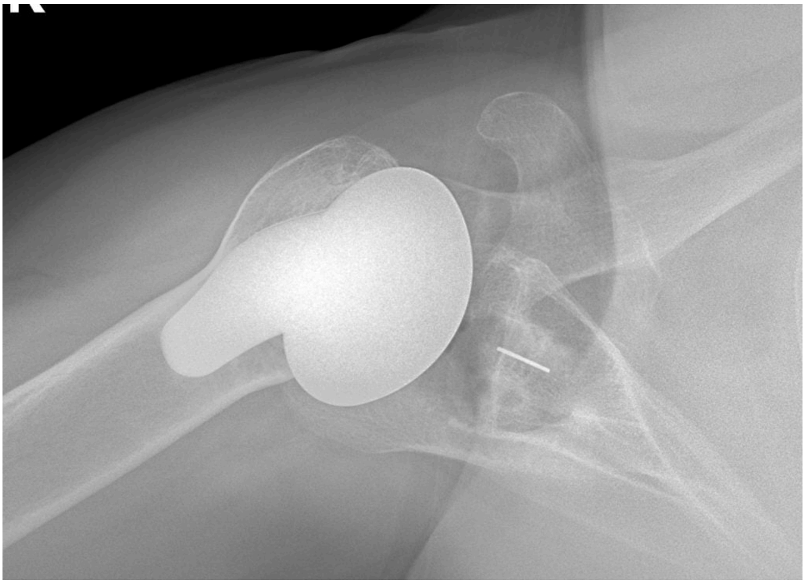

Figure 8.1d. *This radiograph shows an axillary view of the right shoulder in a patient three years after a stemmed anatomic total shoulder arthroplasty.*

Figure 8.1e. *This radiograph shows an anteroposterior view of the left shoulder in a patient one year after a reverse total shoulder replacement for a four-part proximal humerus fracture.*

Special Considerations

Subscapularis function should be assessed during postoperative physical examinations due to the mobilization of the subscapularis during the procedure. This is particularly important following anatomic total shoulder replacement. The subscapularis can be tested through the lift off test, belly press test, and passive external rotation at the side. Notably, shoulder pain, weakness of internal rotation, and increased passive external rotation at the side may be suggestive of a subscapularis rupture.[21]

The examiner should carefully palpate the acromion and scapular spine in a patient following a reverse total shoulder replacement. The origin of the deltoid includes the lateral third of the clavicle, acromion, and scapular spine. Due to the design of the reverse total shoulder replacement, which increases the deltoid abduction moment arm and increases deltoid tension, these altered kinematics may precipitate insufficiency fractures in the acromion and scapular spine.[26] The rate of these fractures has been estimated at 1 percent following reverse shoulder replacement.[21] These patients present with generally atraumatic point tenderness over the scapular spine, or wherever the insufficiency fracture is located.

Key Terminology

Anatomic Total Shoulder Arthroplasty

Replacement of the articular surface of the humeral head and glenoid with man-made components. Typically used in patients with debilitating glenohumeral arthritis after failure of conservative measures. Requires intact rotator cuff. ↲

Deltopectoral Approach

Common operative approach to the shoulder using the interval between the deltoid laterally and pectoralis major medially. Used in the exposure for shoulder replacements, proximal humerus fractures, and more. ↲

Hemiarthroplasty

Partial shoulder replacement involving the replacement of the proximal humerus with a man-made component. Commonly used for glenohumeral arthritis for which nonoperative management has failed and non-reconstructible comminuted proximal humerus fractures in younger patients. ↲

Humeral Head Resurfacing

Replacement of the articular surface of the humeral head with a non-stemmed implant. ↲

Lesser Tuberosity Osteotomy

Operative technique that involves cutting the lesser tuberosity of the humerus while maintaining the insertion of the subscapularis tendon in order to provide adequate exposure to the glenohumeral joint during the deltopectoral approach to shoulder replacement. ↲

Reverse Total Shoulder Arthroplasty

Type of shoulder replacement that switches the natural anatomy of the shoulder joint so that a half-sphere is affixed to the glenoid and the humerus receives a cup, typically with a stem down the medullary canal. Lengthens the deltoid to gain a mechanical advantage for forward elevation of the arm in the presence of a deficient rotator cuff. Commonly used in patients with cuff tear arthropathy and in elderly patients with three- or four-part proximal humerus fractures. ↲

Subscapularis Peel

Operative technique involving detachment of the subscapularis tendon from its insertion on the lesser tuberosity in order to provide adequate exposure to the glenohumeral joint during the deltopectoral approach to shoulder replacement. ↲

Subscapularis Tenotomy

Operative technique involving intra-tendinous division of the subscapularis in order to provide adequate exposure to the glenohumeral joint during the deltopectoral approach to shoulder replacement. ↲

Total Shoulder Arthroplasty or Replacement

Operative procedure involving the removal of diseased parts of the glenohumeral joint and replacing the articulation with manufactured components to restore mobility of the shoulder joint and reduce pain. ↲

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9. Disorders of the Acromioclavicular Joint

The acromioclavicular joint is composed of the articulation between the anteromedial acromion of the scapula and the lateral aspect of the clavicle.[1,2] Between these bony elements, there is a fibrocartilaginous disc, which functions to reduce the wear from stress applied across the joint during repetitive overhead lifting or even activities of daily living. The acromioclavicular ligament, which is composed of anterior, posterior, superior, and inferior components, serves as the primary stabilizer of the joint and controls horizontal motion.[3] Further, the coracoclavicular ligaments, the conoid and trapezoid, function to provide vertical stability of the joint. In addition to these structures, which provide static stability, the adjacent deltoid, trapezius, and serratus anterior musculature provide dynamic stability of the joint. Acromioclavicular joint disorders are a common source of shoulder pain and can result from either age-related degeneration or traumatic injury, which are discussed below.

Acromioclavicular Joint Degeneration

In some individuals, the degeneration of this disc begins as early as twenty years old and is a main determinant of the eventual osteoarthritis of this joint.[4] It has been shown that 54 to 57 percent of elderly patients show evidence of acromioclavicular joint degeneration on radiographs.[5] Etiologies of acromioclavicular (AC) joint degeneration include age-related degeneration of the intra-articular disc, post-traumatic changes, and inflammatory or septic arthritis. Distal clavicular osteolysis, commonly seen among athletes and weightlifters, is another overuse injury, which causes pain in the acromioclavicular joint. Distal clavicle osteolysis is the result of repetitive excess loading during adduction, internal rotation, and flexion of the shoulder, common movements in bench pressing or overhead lifting.[6] Patients with acromioclavicular joint degeneration will typically describe an insidious onset of anterior or superior pain of the affected shoulder.[1,7] Pain will be worse with cross-body movements or overhead activity.

Acromioclavicular Joint Separation

Although age-related degenerative changes constitute most acromioclavicular joint disorders, traumatic injury to the AC joint resulting in a separation is also a common shoulder injury. These injuries are notably more common in men, young adults in their twenties or thirties, and those who participate in contact sports. Filk et al. demonstrated that acromioclavicular joint injuries were the third most common injury in collegiate men's ice hockey players.[8]

Traumatic acromioclavicular joint injuries can occur through either a direct or an indirect mechanism.[7] The direct mechanism is a downward force on the lateral aspect of an adducted shoulder, which pushes the acromion inferiorly and medially. Most commonly, this occurs after a fall directly on the superolateral shoulder. In contrast, the indirect mechanism is a fall on an outstretched arm, which generates a superiorly directed force.[7] Regardless of etiology, the pain with traumatic acromioclavicular joint injuries is classically located in the anterior or superior shoulder and worsens with movement or exertion.

The Rockwood Classification is the most widely utilized classification system to describe and stratify the degree of acromioclavicular joint separations. It organizes AC joint separation—based on involvement of the acromioclavicular joint, the coracoclavicular ligaments, and the deltoid and trapezius muscles—into six degrees of injury.[9] Type I involves only a sprain of the acromioclavicular ligament with no significant changes on x-ray. Type II injuries involve a complete tear of the acromioclavicular ligament, a disruption of the corresponding joint, and a sprain of the coracoclavicular ligament. X-rays show an increase of the coracoclavicular distance of less than 25 percent compared to the contralateral. In Type III injuries, the acromioclavicular ligament and coracoclavicular ligaments are both torn, and the coracoclavicular distance is seen increased by 25 to 100 percent on x-rays of the affected shoulder compared to the unaffected shoulder. Type IV injuries involve tears of the acromioclavicular and coracoclavicular ligaments and a posterior dislocation of the lateral clavicle. A Type V injury includes tears of the acromioclavicular and coracoclavicular ligaments, a superior dislocation of the AC joint, and an increase of the coracoclavicular distance by 100 percent or greater in the affected compared to the unaffected shoulder on x-ray. Finally, Type VI injuries, which are rare, involve an inferior dislocation of the lateral clavicle.[9] Additionally, the acromioclavicular and coracoclavicular ligaments are torn.

Physical Examination

Physical examination of a patient with acromioclavicular joint pathology should begin with thorough observation of the affected shoulder for swelling, bruising, prominence, or asymmetry.[7,10,11] Comparison should be made to the contralateral side, and signs of obvious deformity should be noted (figure 9.1).

Figure 9.1a: Clinical Presentation of Acromioclavicular Joint Separations. *The patient presents with a Type III AC joint injury. In this type, the acromioclavicular joint capsule and both components of the coracoclavicular ligament, the conoid and trapezoid, are torn. There is a 25 to 100 percent increase in the coracoclavicular distance compared to the contralateral shoulder. Degree of displacement is determined by radiographs, but the deformity is also evident on physical examination.*

Figure 9.1b. *The patient presents with a Type V AC joint injury. In this type, the AC joint capsule and the CC ligaments are both torn, and the coracoclavicular distance is increased more than 100 percent compared to the distance in the contralateral shoulder.*

Next, the examiner should palpate the entire shoulder girdle. The areas palpated should include the sternoclavicular joint, the clavicle, and the acromioclavicular joint. The examiner should note any areas that elicit tenderness and be aware of any acromioclavicular joint prominence (figure 9.2; video 9.1). If there is asymmetry or superior displacement, the distal end of the clavicle should be further palpated to see if the deformity is partially or completely reducible. Furthermore, the overlying skin should be assessed for integrity and perfusion. Although rare, cases of acromioclavicular joint cysts have been reported in the literature, most commonly in elderly patients. This manifests radiologically as the Geyser sign and results secondary to a chronic rotator cuff tear that allows for the communication of synovial fluid from the glenohumeral joint into the acromioclavicular joint, which creates a palpable subcutaneous fluid collection (figure 9.3).

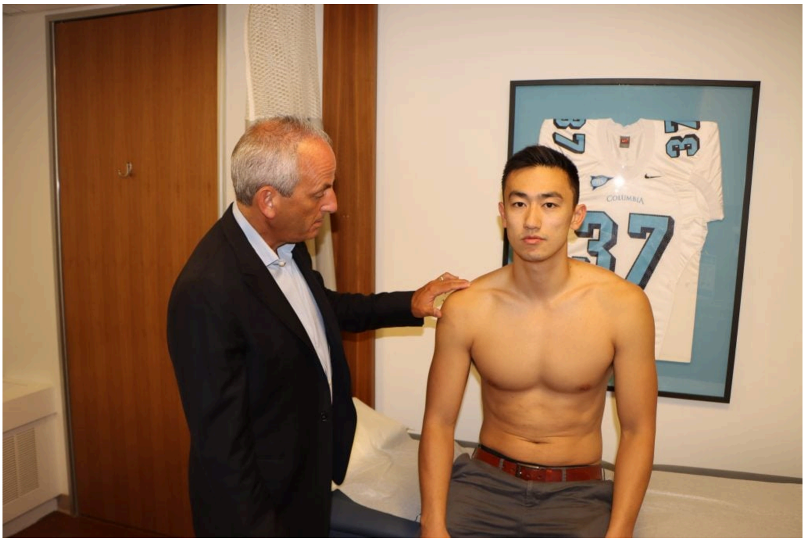

Figure 9.2: Acromioclavicular Joint Tenderness. *The examiner demonstrates the appropriate technique for palpating the right acromioclavicular joint of the patient, exerting mild downward pressure over the joint and observing whether the patient reports any discomfort.*

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Video 9.1: Acromioclavicular Joint Tenderness. The examiner uses two fingers to put downward pressure on the patient's right acromioclavicular joint. The test is considered positive if there is pain upon palpation. Here, the maneuver elicits pain in the patient, indicating a positive test.

Figure 9.3: Geyser Sign. *Clinical presentation of a patient's right shoulder demonstrating a subcutaneous fluid collection caused by extravasation of synovial fluid from the glenohumeral joint into the acromioclavicular joint, consistent with a Geyser Sign.*

Next, range of motion of the ipsilateral glenohumeral joint should be assessed, specifically with regard to any limitations in forward elevation, external rotation, and internal rotation. Active and passive range of motion measurements and strength testing should be performed on the affected shoulder and compared to the contralateral side. Patients with increasing severity of AC joint separation will experience more difficulty with forward elevation and shoulder strength.

Special Tests

In addition to point tenderness at the AC joint, several special tests can also be performed to assess the presence of acromioclavicular joint disorder. One of these tests is the **cross-body adduction test** (video 9.2; figure 9.4).[12] In this test, the affected arm is brought to 90 degrees of flexion. The examiner then helps the patient bring the affected shoulder to the contralateral side via horizontal adduction.

This test is considered positive if it elicits pain at the acromioclavicular joint upon adduction across the body (video 9.3).

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Video 9.2: Cross-body Adduction Test. The examiner performs the cross-body adduction test by passively raising the patient's shoulder to 90 degrees of forward flexion. The examiner palpates the patient's acromioclavicular joint with one hand. The examiner then horizontally adducts the patient's arm across the body, keeping the other hand at the patient's wrist for support. The test is considered positive if this maneuver elicits pain over the acromioclavicular joint.

Figure 9.4: Cross-body Adduction Test. *This picture shows the correct patient positioning for performing the cross-body adduction test. The patient has the affected shoulder in 90 degrees of forward flexion and adducted toward the contralateral shoulder. The examiner palpates the acromioclavicular joint of the patient with one hand and supports the patient's arm at the wrist with the other hand.*

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Video 9.3: Cross-body Adduction Test. The examiner palpates the affected shoulder with her left hand overlying the patient's acromioclavicular joint and the other hand supporting the patient's wrist. Then, the examiner horizontally adducts the affected arm across the body, with the shoulder passively held in 90 degrees of forward flexion. Here, the patient notes that this horizontal adduction elicits pain in the area overlying the acromioclavicular joint, indicating a positive cross-body adduction test result, and associated acromioclavicular joint pathology.

Lastly, the active compression test, also known as **O'Brien's active compression test**, is performed to assess for potential acromioclavicular pathology as well (video 9.4).[12]

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Video 9.4: O'Brien's Active Compression Test. The examiner performs the active compression test on a patient with acromioclavicular joint pathology. The patient's right shoulder is placed in 90 degrees of forward elevation with the elbow fully extended. The arm is then adducted 10 to15 degrees. First, the forearm is supinated with the thumb pointing to the ceiling. In this position, the examiner exerts an inferiorly directed force to the arm while the patient exerts resistance. Next, the forearm is pronated with the thumb pointing to the floor. In this position, the examiner again exerts an inferiorly directed force to the arm while the patient resists. A test result is considered positive if pain increases when the forearm is pronated (second position) and is relieved when the arm is supinated (first position). A positive test is suggestive of a superior labrum anterior to posterior (SLAP) tear if the pain is felt in the glenohumeral joint or acromioclavicular joint pathology if the location of pain is at the AC joint. Here, the patient has a positive right-sided active compression test.

To perform O'Brien's active compression test, the affected shoulder is put into 90 degrees of forward flexion with the elbow fully extended and the arm adducted 10 to 15 degrees. In the first position, the patient supinates the forearm with the thumb pointed to the ceiling. The patient is told to forward flex the shoulder against the examiner's resistance. In the second position, the patient pronates the forearm with the thumb pointed to the floor. Again, the patient is told to forward flex the shoulder against the examiner's resistance. A test result is considered positive when there is greater pain with the forearm pronated and the thumb to the floor than when the forearm is supinated with the thumb pointed to the ceiling. Pain deep in the shoulder is consistent with a SLAP tear, while pain at the AC joint superiorly is indicative of acromioclavicular joint pathology.

In addition to these physical examination maneuvers, evidence of acromioclavicular joint injury can also be assessed visually and radiographically (figure 9.5).

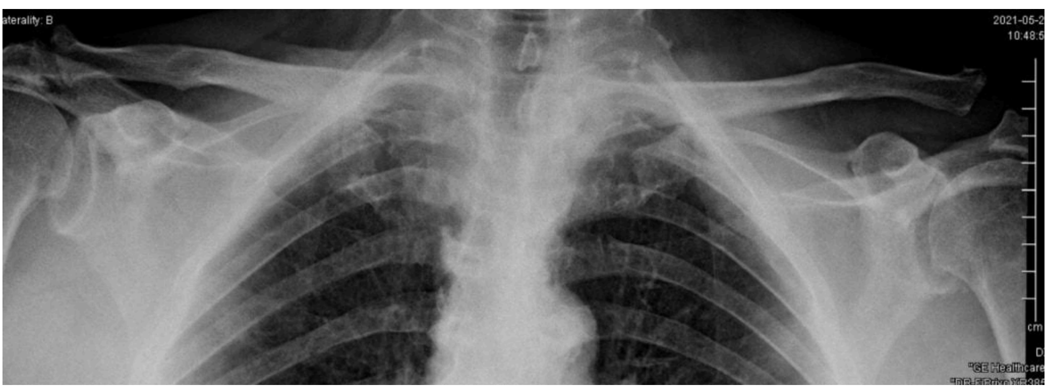

Figure 9.5: Bilateral AP Radiograph of Acromioclavicular Joint Asymmetry. *This radiograph illustrates left-sided acromioclavicular joint pathology. There is clear widening of the joint space between the acromion and clavicle on the patient's left side compared to the right side.*

Sensitivities and specificities for all examinations described in chapter 9 are outlined in table 9.1.[13,14]

Table 9.1: Sensitivities and Specificities for Physical Examination Maneuvers for Acromioclavicular Joint Disorders

Test	Sensitivity	Specificity
Cross-body Adduction Test[13]	77%	79%
O'Brien's Active Compression Test[13,14]	67%	37%

Key Terminology

Cross-body Adduction Test

Physical examination maneuver for the detection of acromioclavicular joint disorders. The affected arm is brought to 90 degrees of flexion. The examiner then helps the patient bring the affected shoulder to the contralateral side via horizontal adduction. A positive test is indicated by pain at the acromioclavicular joint upon adduction. ↲

O'Brien's Active Compression Test

Physical examination maneuver used in detecting SLAP tears and acromioclavicular joint pathology. The patient's shoulder is placed in 90 degrees of forward elevation with the elbow fully extended and the arm adducted 10 to 15 degrees. In the first position, the patient's thumb is directed to the floor, and the examiner applies an inferiorly directed force to the patient's arm. In the second position, the patient's thumb is now directed toward the ceiling, and the examiner again applies an inferiorly directed force to the patient's arm. A positive test occurs if there is pain in the first position with the thumb directed downward that is improved or alleviated with the second position. A "deep" location of pain is suggestive of a SLAP tear, while a "superficial" location of pain is suggestive of acromioclavicular joint (ACJ) pathology. ↲

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10. Scapular Winging and Scapular Dyskinesis

The scapula, located directly dorsal to the posterior thoracic ribs, provides important stabilizing forces to the upper limb and facilitates glenohumeral motion. [1] Notably, the scapula serves as the attachment point for numerous muscles of the chest, rotator cuff, and upper extremity. The anterior aspect of the scapula is the point of attachment for both the subscapularis and serratus anterior muscles.[2] The coracoid process is the anterior most portion of the scapula and serves as the point of attachment for the pectoralis minor, biceps brachii, and coracobrachialis.[2] The lateral aspect of the scapula is the glenoid surface, which articulates with the humeral head to form the glenohumeral joint. Further, the long head of the triceps originates from the infraglenoid tubercle of the scapula. The posterior aspect of the scapula includes the scapular spine, the acromion, and the supraspinous and infraspinous fossa. The scapular spine and acromion together form attachments for the trapezius and deltoid. On the other hand, the supraspinous and infraspinous fossa serve as attachments for the muscle bellies of the supraspinatus and infraspinatus, respectively. The medial aspect provides attachments for three muscles: levator scapulae, rhomboid minor, and rhomboid major.[2]

Anatomy

Scapular dysfunction can manifest as either medial or lateral scapular winging.[3-5] **Lateral winging of the scapula** is caused by damage to the trapezius or rhomboid muscles.[6] Similarly, injury to either the spinal accessory or the dorsal scapular nerves, which innervate the trapezius and rhomboid, respectively, can lead to lateral winging. The trapezius inserts on the clavicle, acromion, and scapular spine, while the rhomboid major and minor insert on the medial scapular border. The normal combined action of the trapezius and rhomboids is upward rotation of the scapula and scapular retraction. When the function of these muscles is compromised, lateral winging results from the unopposed pull of the serratus anterior.[3] On the other hand, **medial winging of the scapula** is typically caused by injury to the long thoracic nerve.[3,4] The long thoracic nerve innervates the serratus anterior muscle, which normally is responsible for anterior and lateral motion of the scapula. When this function of the long thoracic nerve or serratus anterior muscle is compromised, the unopposed pull of the rhomboids, trapezius, and levator scapula muscles creates medial scapular winging.[2,4]

Pathophysiology

Scapular dyskinesis, which refers to the abnormal movement of the scapula during shoulder motion, has been noted in 67 to 100 percent of athletes with shoulder injuries.[7] Notably, it occurs for three primary reasons: shoulder, neck, and posture-related abnormalities.[8] Most commonly, numerous shoulder-related pathologies, including acromioclavicular joint injury, shoulder impingement, and rotator cuff injuries, are associated with scapular dyskinesis. These shoulder-related pathologies cause alterations of the scapulohumeral rhythm, which is the coordinated movement of the scapula and humerus during motion.[8] Next, scapular dyskinesis can result from cervical spine–related abnormalities, including mechanical neck pain and nerve pathologies. Mechanical neck pain includes degenerative changes in the cervical spine, or fatigue and imbalance of the musculature in the neck. Nerve pathologies include injuries to the long thoracic or spinal accessory nerves, or cervical radiculopathy. Lastly, postural-related changes to scapular motion include excessive cervical lordosis or thoracic kyphosis, which change the position of the scapula at rest.[8]

History

Patients with scapular winging or scapular dyskinesis generally present with pain and weakness in overhead activities.[9] The pain may be diffuse over the shoulder blade, arm, and neck. Scapular winging may result from nerve injury or direct muscle damage. Common etiologies include trauma, athletics, iatrogenic injury from tumor resection or surgery, and infection.[3] Therefore, it is important to inquire about participation in strenuous labor or athletics, especially collision or overhead sports. Iatrogenic injury to the long thoracic can occur in breast cancer patients undergoing axillary lymph node dissection, as the reported incidence of long thoracic nerve injury has been estimated at 0.6 to 74.7 percent in breast cancer patients.[10] Similarly, iatrogenic injury to the spinal accessory nerve can occur with lymph node surgery or neck dissections in the posterior triangle. In addition, infectious causes, including Guillain-Barre syndrome, brachial neuritis, and Lyme disease, have been reported as causes of serratus anterior palsy and medial scapular winging.[4] Lastly, facioscapulohumeral dystrophy, a genetic disorder and the third most common type of muscular dystrophy, can cause scapular winging due to weakness of either the trapezius or serratus anterior muscles.[11]

It is important to note that some patients with scapular dyskinesis may not have a history of shoulder trauma and may not be symptomatic.[8] Lastly, associated shoulder pathology, including acromioclavicular joint separation, shoulder impingement, rotator cuff injury, labrum injury, and clavicular fractures, should be noted, as these conditions are associated with scapular dyskinesis.[8]

Physical Examination

Physical examination of a patient with suspected scapular disorder should begin with inspection. The patient's bilateral shoulder blades should be fully visible, and the examiner should stand behind the patient to evaluate the scapular mechanics. Any scars in the region should be noted, in addition to any atrophy in the periscapular musculature. The scapulothoracic articulation can be palpated for any crepitation. The examiner will then ask the patient to actively forward elevate as much as possible and observe scapular motion. The position of the scapula can also be noted with the shoulders at rest and then at 45 and 90 degrees of shoulder abduction. Forward elevation of the arm exacerbates scapular winging more than abduction and therefore is a more sensitive technique. In all positions, however, the examiner should still closely inspect the lateral and medial aspects of the scapula for signs of scapular winging (video 10.1; figure 10.1). Notably, lateral or medial winging can negatively affect a patient's active range of motion at the shoulder (video 10.2).[12] The scapular position should be compared to the contralateral side to assess for any asymmetry. The examiner should assess whether manual stabilization of the scapula improves pain associated with these movements.

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Video 10.1: Scapula Range of Motion Examination. The examiner demonstrates the appropriate technique for the scapula examination. The patient is asked to place his shoulders in 0, 45, and 90 degrees of abduction, and the examiner notes the position of the scapula at each of these positions.

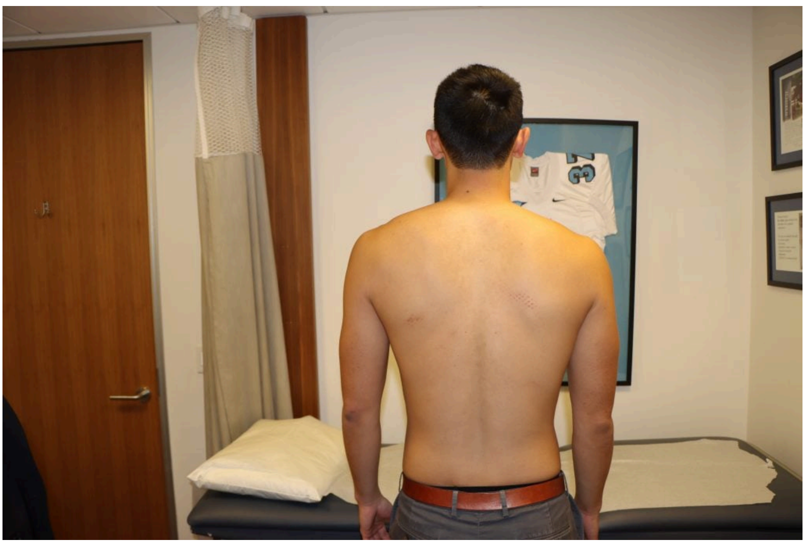

Figure 10.1a

Figure 10.1b

Figure 10.1c: Scapula Range of Motion Examination. *The patient's right and left scapula are observed when the shoulder is at 0, 45, and 90 degrees of abduction.*

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Video 10.2: Scapula Range of Motion Examination. The patient presents with a right-sided palsy of the trapezius muscle. The patient first attempts to abduct his right (affected) arm and can only abduct to about 60 degrees. The patient then abducts his left (unaffected) arm to about 150 degrees. Further, note the lateral winging of the scapula in the right (affected) side compared to the left (unaffected) side.

Patients suffering from lateral winging will present with winging exacerbated by ipsilateral upper extremity abduction and external rotation (video 10.3).[13] In these patients, the shoulder girdle appears to be depressed and inferior relative to the uninjured side.

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Video 10.3: Lateral Winging of the Scapula. This patient exhibits lateral winging of her right scapula. This is most prominent when she attempts to raise her arms. Notably, her right shoulder has decreased forward elevation compared to her left shoulder. In addition, the scapula is protracted with the lateral border inferior relative to the contralateral side.

In patients with medial winging, the inferomedial scapula elevates and retracts from the rib cage relative to the contralateral side. The deformity is exacerbated with forward flexion of the ipsilateral upper extremity (video 10.4; figure 10.2).[3]

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Video 10.4: Medial Winging of the Scapula. This patient exhibits medial winging of her right scapula, indicated by the superomedial retraction of the inferomedial aspect of the scapula. The medial winging is observed during rest and is worsened with shoulder abduction.

Figure 10.2: Medial Winging of the Scapula. *This patient suffered from a palsy of his long thoracic nerve, resulting in medial winging of his right scapula.*

Special Tests

Scapular winging can be provoked through the **wall test** (video 10.5; figure 10.3). In the wall test, the patient is asked to stand facing a wall and place their palms flat against the wall with the shoulders in 90 degrees of forward flexion. When the patient pushes against the wall, the examiner may notice the inferior border of the scapula migrating medially, which is a sign of medial winging and could be indicative of serratus anterior weakness or long thoracic nerve damage (video 10.6).[3] Conversely, if the superior aspect of the patient's scapula becomes inferiorly and laterally displaced, that is a characteristic of lateral winging and injury to the spinal accessory nerve and trapezius muscle.3 If the inferior aspect of the patient's scapula becomes laterally displaced, that is also a characteristic of lateral winging and injury to the dorsal scapular nerve and rhomboid muscles.[3]

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Video 10.5: Wall Test. This healthy patient demonstrates how to do the wall test to assess for winging of the scapula, by putting his shoulder into 90 degrees of forward flexion and pushing against the wall. There is normal scapular motion and an absence of scapular winging.

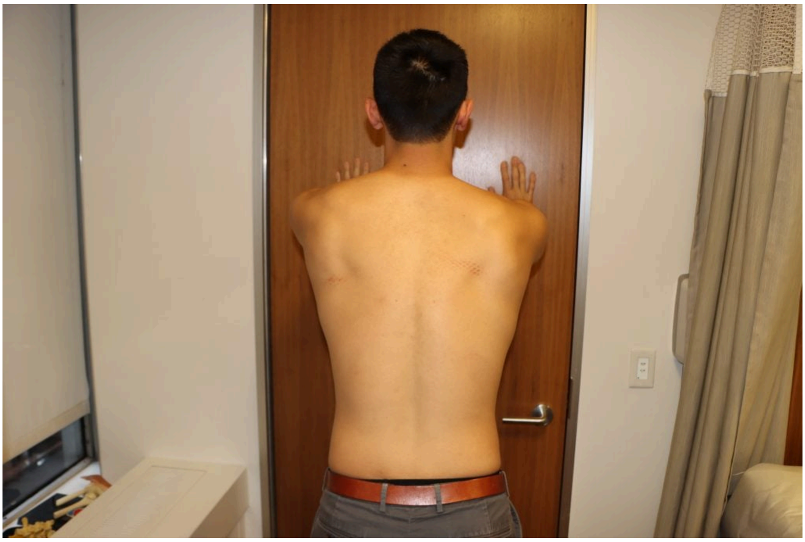

***Figure 10.3*: Wall Test.** *In this healthy patient performing the wall test, there is no evidence of medial or lateral scapular winging.*

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Video 10.6: Wall Test. This patient performs the wall test by putting his shoulders into 90 degrees of forward flexion and pushing against the wall. As he exerts pressure on the wall, his right scapula begins to wing medially, indicating that he may suffer from serratus anterior weakness or paralysis on that side.

In addition to the examination for scapular winging, there are several tests to assess for the presence or absence of scapular dyskinesis. The first of these is the yes/no test, which was first described by Kibler et al.[14,15] The patient is asked to raise their arms to maximal forward elevation 3 to 5 times. The examiner, standing behind the patient, observes for the presence of any prominence on the medial scapular border and categorizes this finding as "yes" (prominence detected) or "no" (no prominence detected").[14,15] The repetition is designed to assess for dysfunction as a result of muscle fatigue. An alternative physical examination maneuver for the assessment of scapular dyskinesis is the scapular assistance test. In this maneuver, the examiner stands behind the patient with one hand on the medial superior border of the scapula and the other hand positioned at the inferior angle of the scapula.[16] The patient is then instructed to actively elevate the affected arm, while the examiner guides the scapula to the normal elevation and rotation. If the examiner's manipulation improves the patient's range of motion or pain level, the test result is considered positive.

Key Terminology

Lateral Winging of the Scapula

Dysfunction in the trapezius or rhomboid muscles, or spinal accessory or dorsal scapular nerves, causes the scapula to be pulled more laterally. ↲

Medial Winging of the Scapula

Dysfunction in the serratus anterior muscle, or long thoracic nerve, causes the medial border of the scapula to be pulled medially. ↲

Scapular Dyskinesis

Abnormal or uncoordinated movement of the scapula during shoulder motion. ↲

Wall Test

Physical examination maneuver to detect winging of the scapula. The patient is asked to stand facing a wall, place their palms flat against the wall with the shoulders at 90 degrees forward elevation, and push against the wall. Movement of the medial border of the scapula medially or laterally demonstrates medial or lateral winging, respectively. ↲

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11. Examining the Throwing Shoulder

The throwing shoulder in overhead athletes presents a unique challenge to clinicians. An enormous amount of force is directed across the shoulder in the process of throwing, as the athlete must rapidly rotate their arm during a short time period.[1] Further, the athlete must achieve peak velocity, but also attain extreme precision with respect to the target.[2] Understandably, this action, especially when performed frequently, can result in injury to the shoulder.[1] In the quintessential throwing sport of baseball, the shoulder has been found to be the most frequently injured body part, comprising 31 percent of all injuries.[3,4] In addition to baseball, other throwing sports where shoulder injury may occur include softball, javelin, and football (especially quarterbacks). Common findings in the throwing athlete include impingement, rotator cuff tears, superior labrum anterior to posterior (SLAP) tears, instability, and a glenohumeral internal rotation deficit (GIRD).[2]

There are several aspects of a patient's background that are relevant when examining the throwing shoulder.[5,6] While the majority of patients will present with pain during throwing, other subtle symptoms may be present, such as a decrease in throwing velocity, changes in throwing accuracy, or feeling that the arm "went dead."[1] Further, a thorough history should be obtained with respect to the history of repetitive throwing. Non-adherence to pitch counts and year-round training, or early specialization, contribute to injuries in youth athletes in particular. It is especially important to note overuse of the throwing arm from inadequate rest, which can manifest in pitchers who play in back-to-back games.

History and Phases of Throwing

A thorough understanding of the phases of throwing is crucial in the evaluation of shoulder injuries in the throwing athlete.[1,4,5] Notably, there are six phases of the throwing motion, each of which poses a unique strain on the shoulder. It begins with the windup, progresses to stride, early and late arm cocking, then acceleration, followed by deceleration, and ultimately concludes with the follow-through (figure 11.1).[5,7]

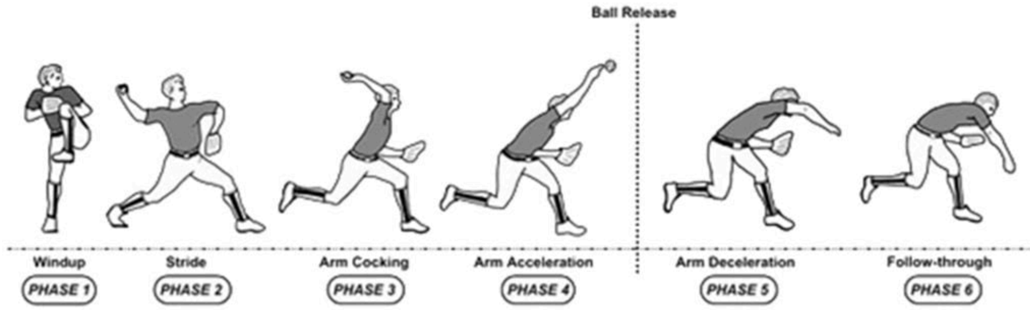

Figure 11.1: *Phases of Throwing*: *Phases of throwing include windup, stride, early and late arm cocking, arm acceleration, arm deceleration, and follow-through.*[7] *Saeed Ghorbani, Andreas Bund, Perceptual and Motor Skills (Vol. 124, Iss. 2) pp. 12. Copyright © 2017 by (Sage Publications). Reprinted by Permission of Sage Publications.*

Combined, all of these phases occur in less than two seconds.[2] The risk of injury to the shoulder is greatest in the transition between the late cocking and early acceleration phases of throwing.[4,8] In this position, the shoulder rapidly transitions from maximal external rotation to internal rotation, which results in the greatest forces and angular velocities on the shoulder.[8]

Careful attention should be directed to the phase of the throwing motion that is causing the patient pain or discomfort. For example, throwing athletes with anterior instability of the shoulder will report symptoms during the late cocking or early acceleration phase of throwing.[1] Conversely, throwing athletes with posterior instability of the shoulder will report symptoms during the follow-through phase of throwing.[1] Furthermore, the specific location of the pain or discomfort in the shoulder should be noted as well. Anterior pain is most often associated with subscapularis, biceps tendon, or joint capsule and anterior labral injury.[1] Anterolateral pain is associated with supraspinatus injury, and posterior pain is associated with infraspinatus or joint capsule and posterior labral injury.[1]

Physical Examination

Physical examination of the throwing shoulder should begin with observation of the affected and unaffected shoulder.[6] Examiners can often observe asymmetry of the shoulder musculature secondary to developmental changes occurring as a result of youth participation. All borders of the scapula should be inspected for potential signs of winging. Examiners should also look for signs of muscle atrophy, especially with respect to the supraspinatus and infraspinatus. Then, the examiner should palpate for any areas of tenderness or crepitation. It is specifically important to palpate at the acromioclavicular joint, biceps tendon, and posterior joint line of the shoulder, as these areas may be associated with throwing-related shoulder pathology.[6]

Further, passive and active range of motion and strength should be assessed. Notably, the throwing shoulder typically exhibits greater external rotation and less internal rotation compared to the contralateral, nonthrowing shoulder (video 11.1; figure 11.2).[6] Further, it is also important to assess for internal rotation of the glenohumeral joint while a patient is lying supine to stabilize the scapula (figure 11.3). [9]

One or more interactive elements has been excluded from this version of the text. You can view them here: https://temple.manifoldapp.org/projects/a-guide-to-the-physical-examination-of-the-shoulder/resource/ch11-vid01

Video 11.1: Range of Motion of the Throwing Shoulder. The throwing athlete often has loss of internal rotation in the throwing shoulder compared to the contralateral shoulder. Here, the patient, a recreational thrower in his twenties who participated in youth baseball, demonstrates a loss of internal rotation in his right (throwing) shoulder. The patient is asked to perform maximum internal rotation by placing his hands on the highest vertebral level behind his back.

Figure 11.2: Range of Motion of the Throwing Shoulder. *The same patient, a recreational thrower, has loss of internal rotation in his right (throwing) shoulder.*

Figure 11.3: Range of Motion of the Throwing Shoulder. *Examination of internal rotation of the glenohumeral joint with the patient supine.*[9]

These changes in range of motion in throwing athletes occur due to stretching of the anterior capsule, tightness of the posterior capsule, and increased humeral and glenoid retroversion due to repetitive throwing while the growth plates were open.[10] It has been shown that these adaptive changes occur in adolescence.[10] The increased external rotation is one of the things that allows the throwing athlete to generate more acceleration across the ball and throw at a higher velocity. Unfortunately, the cost of the added external rotation is less internal rotation. Specifically, this concept is known as **glenohumeral internal rotation deficit (GIRD)** . GIRD is defined as a deficit of greater than 20 degrees in internal rotation in the throwing shoulder compared to the non-throwing shoulder. This can be exacerbated by posterior capsular tightness and can be especially problematic when there is a loss of more than 25 degrees of internal rotation in the affected shoulder compared to the contralateral shoulder.[11]

Special Tests

In addition to GIRD, **superior labrum anterior to posterior (SLAP) tears** are also common in throwing athletes.[12] There are various special tests to evaluate the integrity of the superior labrum, including **O'Brien's active compression test** and the **anterior slide test** (video 11.2).[13]

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Video 11.2: Assessing Superior Labrum Anterior to Posterior (SLAP) Pathology in the Throwing Shoulder.

SLAP tears are common in the high-level throwing athlete. Here, the examiner performs O'Brien's active compression test on a collegiate baseball player for the assessment of a potential SLAP tear. The patient here has a positive active compression test, demonstrating pain with the thumb pointing downward but reduced pain with the thumb pointing upward.

In the O'Brien's test, the affected arm is held in 90 degrees of forward elevation and positioned in 10 to 15 degrees of adduction.[13] In the first position, the forearm is pronated with the thumb pointing downward, and the examiner places a downward force on the arm with the patient providing resistance upward. The patient is asked if any pain occurs with this maneuver. In the second position, the forearm is supinated until the thumb is pointing upward. The examiner repeats the downward force with the patient providing upward resistance. The patient is again asked if any pain occurs with this maneuver. A positive test occurs when there is pain in the first position that is alleviated in the second position, and a positive result is suggestive of a SLAP lesion.[13] The anterior slide test can also assess for SLAP lesions (video 11.3).[14]

One or more interactive elements has been excluded from this version of the text. You can view them here: https://temple.manifoldapp.org/projects/a-guide-to-the-physical-examination-of-the-shoulder/resource/ch11-vid03

Video 11.3: Anterior Slide Test for Assessment of SLAP Tears. As an additional assessment for a SLAP tear, the examiner demonstrates the proper technique for the anterior slide test on a patient, who is a recreational thrower in his twenties who participated in youth baseball. The examiner stabilizes the scapula and applies an anterosuperior force to the elbow, while the patient maintains his hands on his hips. A test is considered positive if the patient experiences pain in the anterior shoulder upon this maneuver. Here, the patient has a negative test as he does not experience pain with this maneuver.

As described in chapter 4, the patient is seated with the hand of the affected side placed on the hip with the fingers anterior and thumb posterior to the waist. The examiner stands behind the patient and, with one hand on the elbow and the other on the shoulder girdle, applies an anterosuperior force to the arm while simultaneously stabilizing the scapula from behind. This maneuver brings the humerus in contact with the superior labrum. The test is considered positive if pain is reproduced with the maneuver.[14]

Frequent overhead throwing can also predispose individuals to tearing and gradual laxity of the joint capsule and adjacent stabilizing structures.[1,6] A test to evaluate the shoulder for instability due to anterior or posterior labral tears is the anterior and posterior **load and shift test** (video 11.4).[15,16] The test can be performed with the patient supine. The examiner applies an axial load to the humerus into the glenoid fossa while also applying an anteriorly directed force followed by a posterior force. The test is considered positive when there is increased translation present. Translation is graded on a scale from 0 to 3 as outlined in chapter 3. Further, the **apprehension, relocation, and anterior release tests** can be performed to assess for anterior instability of the shoulder (video 11.5).[16] The examiner places the supine patient's shoulder in abduction with the elbow in 90 degrees of flexion. First, the examiner performs the apprehension test by externally rotating the shoulder in the abducted position, assessing for discomfort or a sense of instability in the patient. Next, the examiner places their hand on the anterior shoulder in the relocation test, assessing if the discomfort disappears with a gentle posteriorly directed force. Lastly, the examiner removes their hand from the anterior shoulder in the anterior release test, assessing if the discomfort reappears.[15,16]

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Video 11.4: Laxity and Instability of the Throwing Shoulder. Laxity, or looseness, of the shoulder may develop due to years of repetitive throwing, which may cause stretching and tearing of the anterior joint capsule, labrum, and stabilizing structures. The load and shift test examines anterior and posterior laxity of the shoulder. Here, the examiner demonstrates the proper technique for the load and shift examination on a supine patient. An axial load to the humerus is applied, while the examiner sequentially applies an anteriorly directed force followed by a posteriorly directed force. Degree of translation in each direction is noted.

One or more interactive elements has been excluded from this version of the text. You can view them here: https://temple.manifoldapp.org/projects/a-guide-to-the-physical-examination-of-the-shoulder/resource/ch11-vid05

Video 11.5: Instability of the Throwing Shoulder. The anterior capsule and labrum may also tear abruptly during the throwing motion, which results in acute traumatic instability. The apprehension, relocation, and anterior release tests examine for anterior instability of the shoulder. Here, the examiner performs these tests, which are negative, on a throwing athlete.

In throwing athletes, the rotator cuff can also be a source of pain or dysfunction, as throwing athletes may present with impingement and/or rotator cuff tears.[1,6] Uniquely, extreme abduction and external rotation can lead to contact between the humeral head and the undersurface of the rotator cuff, which can result in articular-sided cuff tearing. As described in chapter 1, there are many ways to assess for impingement (video 11.6), including the **Neer impingement sign** and the **Hawkins test**. Rotator cuff integrity can be assessed using several tests, including the **Jobe test**, external rotation strength test, external rotation lag sign, lift off test, internal rotation lag sign, belly press test, and Hornblower's sign.

One or more interactive elements has been excluded from this version of the text. You can view them here: https://temple.manifoldapp.org/projects/a-guide-to-the-physical-examination-of-the-shoulder/resource/ch11-vid06

Video 11.6: Subacromial Impingement and Rotator Cuff Pathology in the Throwing Shoulder.

It is important to assess for subacromial impingement and rotator cuff pathology in the throwing athlete. Here, the examiner is seen performing the Neer's sign, Hawkins test, and Jobe test in a recreational throwing athlete.

Finally, in throwing athletes, the latissimus dorsi and teres major are two muscles that can be injured.[17] These muscles serve as internal rotators of the humerus and are active during the cocking and acceleration phases of the throwing motion. A thrower with this injury typically presents with pain in the upper arm and affected axilla. Furthermore, one would expect tenderness along the teres major and latissimus dorsi upon palpation. The teres major muscle originates from the posterior surface of the inferior angle of the scapula and inserts on the medial humerus.[18] The latissimus dorsi is a broad muscle of the back and originates from the spinous process of thoracic vertebrae T7–T12, thoracolumbar fascia, iliac crest, inferior 3–4 ribs, and inferior angle of the scapula, and it inserts medial to the bicipital groove of the humerus, just lateral to the insertion of the teres major.[19]

Throwing athletes can be affected by a wide variety of shoulder pathology, including impingement, rotator cuff tears, instability, SLAP tears, and glenohumeral internal rotation deficits.[2] It becomes imperative to gather a detailed and in-depth history, as findings may be subtle and include seemingly vague complaints such as a decrease in throwing velocity or accuracy.[1] In addition, evaluation of the throwing athlete is complex and combines the physical examination for all these conditions and the full kinetic chain. Final diagnosis depends on a comprehensive history and physical examination, in combination with advanced imaging studies.[1]

Key Terminology

Anterior Slide Test

Physical examination maneuver performed in the assessment of a SLAP tear. The patient is standing upright or sitting on the examination table with their hands on their hips. The examiner stabilizes the scapula with one hand and places the other hand under the patient's elbow, then applies an axial compressive force to the patient's elbow simultaneously with an anterior-directed force to the humerus. A test is positive if the patient experiences pain in the anterior shoulder with this maneuver. ↵

Apprehension, Relocation, and Anterior Release Tests

Physical examination maneuvers for anterior shoulder instability. The patient is supine with the shoulder in 90 degrees of abduction, the shoulder in full external rotation, and the elbow in 90 degrees of flexion. The **apprehension**

test is positive if the patient feels discomfort, or a sense of instability in this position. The **relocation test** is performed with the patient in the same position. The examiner applies a posterior force to the affected shoulder with their hand, and the test is positive if the patient no longer feels a sense of instability. The **anterior release test** is performed with the examiner's hand now removed from the shoulder. A positive test result occurs if the patient again has a sense of anterior apprehension. ↲

Glenohumeral Internal Rotation Deficit (GIRD)

Deficit of greater than 20 degrees in internal rotation in the throwing shoulder compared to the non-throwing shoulder, commonly seen in throwing athletes. ↲

Hawkins Test

A test for subacromial impingement where the examiner places the patient's shoulder in 90 degrees of flexion and the patient's elbow in 90 degrees of flexion, and maximally internally rotates the shoulder by applying a downward force to the wrist. A positive test result is noted when pain is elicited with the maneuver. ↲

Jobe Test

A test for the assessment of rotator cuff (supraspinatus) pathology. The patient's arms are placed in 90 degrees of abduction, angled forward 30 degrees, and internally rotated so that the thumbs face the floor. The examiner applies a downward force to the patient's arm, asking the patient to resist the force and keep their arm level. A positive test is noted if pain and/or weakness is elicited by the maneuver. ↲

Load and Shift Test

Physical examination maneuver used to assess anterior and posterior instability. The examiner applies an axial load to the humerus into the glenoid fossa while also applying either an anterior or posterior force. A test is graded on a scale of 0 to 3 depending on the degree of anterior translation (anterior instability) or posterior translation (posterior instability) of the humerus relative to the glenoid. ↲

Neer Impingement Sign

A test for subacromial impingement where the examiner stabilizes the scapula of the affected shoulder with one hand and passively elevates the arm with the other hand. A positive test result is indicated by pain in the arc between 70 and 120 degrees of forward elevation. ↲

O'Brien's Active Compression Test

Physical examination maneuver used in detecting SLAP tears and acromioclavicular joint pathology. The patient's arm should be placed in 90 degrees of forward elevation with the elbow fully extended, and the arm adducted 10 to 15 degrees. In the first position, the patient's thumb is directed to the floor and the examiner applies an inferiorly directed force to the patient's arm, while the patient resists. In the second position, the patient's thumb is now directed toward the ceiling, and the examiner again applies an inferiorly directed force to the patient's arm while the patient resists. A positive test occurs if there is pain in the glenohumeral joint in the first position with the thumb directed downward that is alleviated in the second position. A "deep" location of pain is suggestive of a SLAP tear, while a "superficial" location of pain is suggestive of acromioclavicular joint (ACJ) pathology. ↲

Superior Labrum Anterior to Posterior (SLAP) Tears

Injury to the superior aspect of the labrum, which is also the attachment site of the long head of the biceps tendon. ↲

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