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Comprehensive Shoulder Evaluation Strategies

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Introduction

Shoulder pathology and dysfunction represent some of the most commonly diagnosed and treated conditions by primary care, sports medicine, and orthopedic providers.[1] This comprehensive review article discusses the clinical pearls as well as tips and tricks for delineating complex shoulder pathologies.

Anatomy

Osseous elements[2][3][4]

The shoulder girdle itself consists of the scapula and clavicle which articulate with the chest wall, and the proximal humerus which articulates with the scapula (the glenoid). The humeral head and the glenoid vault of the scapula form the osseous components of the glenohumeral joint of the shoulder.

The glenohumeral joint is a complex, mobile, multiaxial, ball-and-socket articulation that allows coordinated motion in the frontal, transverse, and sagittal planes. The latter allows for 360 degrees of circumduction. The relatively shallow glenoid fossa articulates with the much larger humeral head to allow for a wide range of physiologic motion. In addition, the joint capsule is relatively lax. Shoulder movements occur secondary to the dynamic and coordinated articulations at four distinct joints:

- Sternoclavicular
- Acromioclavicular
- Glenohumeral
- Scapulothoracic

Static and dynamic stabilizers

The static stabilizers include the glenohumeral articulation, the labrum, the glenohumeral ligaments, rotator cuff interval structures, and the negative intraarticular pressure. The dynamic stabilizers consist of the rotator cuff muscles, the deltoid, and the scapular and periscapular stabilizers.

The rotator cuff muscles[5][6]

Supraspinatus

- Arises from the medial two-thirds of supraspinatus fossa of the scapula, passes across the superior aspect of the glenohumeral joint and inserts into the superior and middle facet of the greater tuberosity of the humerus
- Initiates shoulder abduction primarily

  - Important for the initial 0 to 15 degrees of shoulder abduction motion when the arm is adducted against the side of the trunk
  - Beyond 15 degrees of abduction, the deltoid moment arm acts synergistically to assist in shoulder/arm abduction
- Along with the other rotator cuff muscles provides dynamic stabilization of the shoulder
- Innervation: Suprascapular nerve (C4,C5,C6)
- Blood supply: Suprascapular artery

Infraspinatus

- Occupies the majority of the infraspinatus fossa, coursing posterior to the supraspinatus before inserting on the posterior impression and middle facet of the greater tuberosity of the humerus; the tendinous insertion becomes confluent with fibers from the supraspinatus to create a seamless anatomic blend at the rotator cuff footprint
- External rotator of the shoulder
- Along with the other rotator cuff muscles provides dynamic stabilization of the shoulder
- Innervation: Suprascapular nerve (C5, C6)
- Blood supply: Suprascapular and circumflex scapular arteries

Subscapularis

- Broad muscle arising from the subscapular fossa of the scapula and inserts into the lesser tuberosity of the humerus; anteriorly, the fibers coalesce and blend with the anterior shoulder joint capsule
- Internal rotator of the shoulder
- Important dynamic anterior shoulder stabilizer
- Innervation: Upper and lower subscapular nerves (C5, C6, C7)
- Blood supply: Subscapular artery

Teres minor

- Narrow and long muscle, which takes origin from the dorsal surface of the lateral border of the scapula and insert on the inferior facet of the greater tuberosity of the humerus
- External rotator of the shoulder
- Along with the other rotator cuff muscles provides dynamic stabilization of the shoulder
- Innervation: Axillary nerve (C5, C6)
- Blood supply: Subscapular and circumflex scapular arteries

Proximal biceps[7][8][9]

The long head of the biceps brachii tendon (LHBT) originates at the supraglenoid tubercle and superior glenoid labrum. The labral origin is predominantly posterior in more than half of cases. Inside the joint, the tendon is extrasynovial, passing obliquely heading toward the bicipital groove. The long head tendon distally joins the short head of the biceps tendon (SHBT) as both transition to their respective muscle bellies in the central third of the brachium, and after crossing the volar aspect of the elbow, forms a common tendon and inserts on the radial tuberosity and medial forearm fascia. The latter occurs via the bicipital aponeurosis.

The short head of biceps originates from the coracoid process, and the long head originates from the supraglenoid tubercle, passing through the intertubercular groove of the proximal humerus. The biceps brachii is not a shoulder muscle but does originate from the shoulder.

The bicipital groove is an anatomic landmark located between the greater and lesser tuberosities of the humerus and serves as a critical location for proximal biceps stability. The soft tissue components of the groove create a tendoligamentous sling to support the LHB tendon and include portions of the rotator cuff muscles (subscapularis and supraspinatus), coracohumeral ligament (CHL), and the superior glenohumeral ligament (SGHL).

Biomechanically, the LHBT has a controversial role in the dynamic stability of the shoulder joint. It has been demonstrated, mostly in biomechanical cadaveric-based studies and animal models, that the tendon at least plays a passive stabilizing role in the shoulder. Neer proposed in the 1970s that the LHBTs stabilizing role varied depending on the position of the elbow.[3] Several subsequent studies refuted the theory that the LHBT played any active shoulder stabilizing effect. Jobe and Perry evaluated the activation of the biceps during the throwing motion in athletes. The authors reported the peak muscle stimulation occurred in relation to elbow flexion and forearm deceleration, with very little proximal biceps activity during the earlier phases of throwing.

Thus, in most healthy patient populations, the LHBT plays a negligible role in the dynamic stability of the shoulder. The main function of the biceps muscle is forearm supination and elbow flexion. The biceps also contributes 10% of the total power in shoulder abduction when the arm is in external rotation.

Bicipital groove soft tissue pulley

The bicipital groove is an anatomic landmark that sits between the greater and lesser tuberosities, and its osseous and soft tissue components contribute to the inherent stability of the LHBT. The depth, width, and medial wall angle have been studied in relation to overall bicipital groove stability, with significant variability recognized in its components. Many authors attribute these parameters as predisposing factors to pain and instability in both primary and secondary LHBT pathologies.

The LHBT takes a 30-degree turn as it heads toward the supraglenoid tubercle, relying on the integrity of the enveloping soft tissue sling/pulley system. The most important elements in maintaining stability at this critical turn angle are the most medial structures at the proximal-most aspect of the groove's exit point. The soft tissue components of the biceps pulley system include the following:

- Subscapularis
- Supraspinatus
- The coracohumeral ligament (CHL)
- The superior glenohumeral ligament (SGHL)

The subscapularis has superficial and deep fibers that envelope the groove, creating the "roof" and "floor," respectively. These fibers also coalesce with those from the supraspinatus and SGHL/CHL complex. These structures attach intimately at the lesser tuberosity to create the proximal and medial aspect of the pulley system, with soft tissue extensions serving to further envelope the LHBT in the bicipital groove.

The CHL is a dense fibrous structure connecting the base of the coracoid process to the greater and lesser tuberosities. At its origin, the ligament is thin and broad, measuring about 2 cm in diameter at the base of the coracoid. Laterally, the CHL separates into 2 distinct bands that envelope the LHBT at the proximal extent of the bicipital groove. Once the LHBT exits the groove, it takes a 30- to 40-degree turn as it heads toward the supraglenoid tubercle and glenoid labrum. Thus, the proximal soft tissue elements of the groove are especially critical for the overall stability of the entire complex. In addition to the CHL, the SGHL reinforces the complex at this proximal exit point. The SGHL travels from the superior labrum to the lesser tuberosity, becoming confluent with the soft tissue pulley as it takes on a

U-shaped configuration. Warner and colleagues previously demonstrated that the cross-sectional area of the CHL is, on average, 5 times larger than that of the SGHL.

Historically, the transverse humeral ligament (THL) was thought to play a primary role in bicipital groove stability. However, more recently, its role in stability has been refuted with many authors questioning its existence as a distinct anatomic structure. The latter remains fairly controversial, with most studies now reporting the THL is, at most, a continuation of fibers from the subscapularis, supraspinatus, and CHL. A histologic study in 2013 identified a distinct fibrous fascial covering in the "roof" of the groove. Neurohistology staining showed the presence of free nerve endings but no mechanoreceptors. Despite the controversial evidence with respect to its definitive existence as an anatomic structure, its location at the distal extent of the bicipital groove inherently refutes the previous dogma of its potential role in LHBT stability. Furthermore, the presence of free nerve endings in the recent histological studies suggests its possible role as a potential pain generator in the anterior shoulder.

Periscapular stabilizers[10]

The scapula provides attachment for several groups of muscles. The intrinsic muscles of the scapula include the rotator cuff muscles and teres major. These muscles attach to the scapular surface and assist with abduction and external and internal rotation of the glenohumeral joint.

The extrinsic muscles include the triceps, biceps, and deltoid. The third group of muscles includes the periscapular stabilizers. These muscles play a pivotal role in a wide range of scapular-based pathologies, including shoulder instability, scapular dyskinesia, and scapulothoracic pathology. These muscles include the rhomboids, trapezius, levator scapulae, and serratus anterior.

Rhomboid minor

The rhomboid minor originates from the nuchal ligament and spinous processes of C7-T1. The rhomboid major originates from the spinous processes of T2-T5. The rhomboid muscles insert on the medial border of the scapula and work in combination with the levator scapulae muscles to elevate the medial border of the scapula. The only muscle which acts to depress the shoulder is the lower trapezius, which is assisted by gravity in the upright position.

Trapezius

The trapezius is a large triangular-shaped muscle that overlies the shoulder posteriorly. The trapezius originates from the superior aspect of the nuchal line in the occipital, cervical, and upper thoracic region and inserts at the lateral aspect of the clavicle, the acromion, and spine of the scapula. The function of the trapezius muscle is both elevation and depression of the shoulder depending on whether the upper or lower muscle fibers are activated. When the entire trapezius muscle contracts the fibers are geometrically opposed, and the forces are balanced resulting in no movement of the shoulder.

Deltoid

The deltoid muscle overlies the shoulder superficially and functions to abduct the humerus. The deltoid muscle has three origins; the body of the clavicle, the spine of the scapula, and the acromion. The deltoid muscle has its insertion on the deltoid tuberosity of the humerus. The function of the deltoid muscle is variable depending on which muscle fibers are activated. The anterior deltoid flexes and medially rotations the humerus, the middle deltoid abducts the humerus, and the posterior deltoid performs the actions of extension and external rotatation of the humerus.

Serratus

Originates on the superolateral surfaces of the upper 8 ribs at the side of the thoracic cavity. The serratus anterior inserts on the vertebral border of the scapula and acts to draw the scapula forward and upward. The serratus abducts and rotates the scapula while also dynamically stabilizing its vertebral border.

Levator scapulae

The levator muscle originates from the posterior tubercles of transverse processes C1 through C4 in the cervical spine. The muscle inserts on the superior and medial border of the scapula and it acts to elevate the scapula and thereby tilting the glenoid vault inferiorly.

Indications

In general, the indications for a comprehensive evaluation of the shoulder includes any patient presenting with any degree of shoulder, periscapular, neck, and nonspecific upper extremity pathology[11].

Technique

History taking pearls[1][12][8][9]

A comprehensive history should be acquired by clinicians evaluating patients presenting with acute or chronic shoulder dysfunction. Even in the acute traumatic setting, patients may present with an ipsilateral upper extremity injury or fracture and this should not preclude an examination of the shoulder in order to mitigate the risk of a missed diagnosis. Furthermore, one should be aware that there are many "spooks" in the shoulder, and this phrase can aid the provider in painting a relatable picture to the patient regarding the multitude of potential pain generators and sources of pain in and around the shoulder.

When assessing patients presenting with history/symptoms concerning for LHBT instability, it is important to evaluate for co-existing shoulder injuries or pathology clinically. Often, a thorough history taking of the mechanism of injury can aid the clinician in the preliminary differentiation between various shoulder pathologies. For example, AC joint pathology often presents secondary to acute trauma, with the patient reporting either trauma directly to the shoulder during a contact sport, or the patient may report a history of a fall directly onto the shoulder.

The following is a summary of some of the most high-yield patient history elements that can facilitate in identifying some common underlying shoulder pathologies.

LHBT tendinopathy

- Atraumatic, insidious onset of anterior shoulder pain; often acute or acute-on-chronic exacerbations
- Symptom exacerbation with overhead activities
- Pain at rest, pain at night
- History or current overhead sport participation
- History or current manual/physical laborer occupations

LHBT instability:

- Patients often report painful “clicking” or audible “popping” noted with shoulder abduction, extension, and rotational movement of the shoulder. The patient often can reproduce this during the actual office visit.
- LHBT instability (or tendinopathy) often manifests as pain at the anterior aspect of the shoulder, with or without radiation down the anterior arm over the biceps brachii muscle belly

Rotator cuff syndrome

Rotator cuff syndrome (RCS) can encompass any number of shoulder impingement etiologies. Typical history elements include:

- Atraumatic, insidious onset of pain
- symptom exacerbation with overhead activity

- Pain at night

Characteristics of a history of potential rotator cuff (RC) injury include:

- Acute RC tendonitis: history of trauma and/or acute on chronic exacerbation
- Chronic RC tendinopathy: either acute on chronic history/mechanism or an atraumatic, insidious onset presentation
- symptom exacerbation with overhead activity
- pain at night

Superior labrum anterior-posterior (SLAP) lesions

SLAP tears may present in a relatively nonspecific fashion and in association with other shoulder pathologies. Clinicians should inquire regarding certain elements in history taking that may help differentiate SLAP tears from other shoulder injuries.

Pertinent elements in history taking to best elucidate the nature of a potential SLAP tear (or other associated shoulder injuries) include:

- Acute onset of “deep” shoulder pain
- Mechanical symptoms: popping, locking, catching with various movements and activity
- History of any sudden, jerking force to the shoulder with associated onset of pain
- History of or current episodes of shoulder instability
- History or current sport-specific participation
    - Including level of competition (e.g. professional, collegiate, recreational)
    - Common SLAP-provoking sports include but are not limited to:
        - Overhead sports (volleyball, baseball pitchers, javelin, swimming)
    - History or current manual/physical laborer occupations

Shoulder instability

Clinicians evaluating patients with acute or chronic shoulder instability should obtain a comprehensive history. Providers should document any detailed elements regarding the index injury for both first time versus chronic presentation dislocators. In addition, other elements often include the following:

- First time dislocators
-
    - Patients presenting after a single acute event typically report a recent history of high-energy trauma or collision impact causing the dislocation
    - Clinicians should inquire regarding:
    -
        - Degree of trauma (high- or low-energy impact mechanisms)
        - Sport activity and position(s)
        - Discern a true dislocation from a subluxation event
        -
            - Elicit the requirement for on-field or on-site manual reduction; presentation to the emergency department +/- sedation requirements

- Chronic cases
    - Patients typically present in delayed fashion once range of motion limitations begin to significant impact daily activities
    - Clinicians should gather a detailed history for any inciting instability events
        - The initial injury may be overlooked, and the patient subsequently develops chronic instability/recurrence
        - Heightened clinical suspicion is warranted in the setting of:
            - History of seizures or electrical shocks
            - Polytraumas in which the shoulder instabilty was overlooked or missed
        - Low-energy, recurrent subluxation cases
            - Shoulder instability episodes during sleep may be indicative of more complex instability that may involves significant bone loss
            - Clinicians should elicit for any medical comorbidities or family history of underlying connective tissue disorders or generalized hyperlaxity on exam

A thorough history also include sport participation and position(s) (if applicable occupational history and current status of employment, hand dominance, any history of injury/trauma to the shoulder(s) and/or neck, and any relevant surgical history.

Physical examination pearls

Cervical Spine/Neck Exam

Co-existing cervical pathology, especially radiculopathy, should be ruled out in any situation where shoulder pathology is possible. Observation of neck posturing, muscular symmetry, palpable tenderness, and active/passive ROM should be evaluated. Special tests that are helpful in this regard include Spurling's maneuver, myelopathic testing, reflex testing, and a comprehensive neurovascular exam.[13][14][15][16]

A detailed sensory examination should be performed in all patients presenting with possible underlying shoulder or neck pathologies. A bilateral exam is imperative in many of these cases in order to obtain an accurate working differential diagnosis.

Motor function of the elbow, wrist, and hand should be assessed to rule out the possibility of a brachial plexus injuries and distal pulses should be assessed at the wrist as well.[17][18][19][20]

Shoulder Exam

Clinicians should observe the overall shoulder girdle to assess symmetry, shoulder posturing, and overall muscle bulk and symmetry. Scapular winging should also be ruled out. The skin should be checked for the presence of any previous surgical incisions, lacerations, scars, erythema, or induration. In the setting of proximal biceps pathology, especially in traumatic or spontaneous LHBT ruptures, patients will typically exhibit significant ecchymosis in the upper arm over the area of the biceps brachii muscle itself, and an associated “Popeye” deformity is characteristic for a complete rupture. The latter is more readily appreciated in fit or thin patients and can be a rather subtle finding in patients with a large body habitus. Comparison to the contralateral extremity is helpful.

After the observations mentioned above, the active and passive ROM is documented. In the setting of both primary and secondary proximal biceps tendinitis cases, full ROM should be observed. In the absence of advanced glenohumeral arthritic changes affecting, limited passive ROM is considered diagnostic for adhesive capsulitis.

Provocative Testing[11][9]

Proximal Biceps Provocative Testing

There are many different focused physical examination maneuvers reported in the literature. Specific testing targets either LHBT pathology localized to the bicipital groove, or more proximally near its origin at the supraglenoid tubercle.

Bicipital groove palpation: Direct palpation over the patient's bicipital groove elicits a painful response in the setting of pathology.

Speed's test: A positive test consists of pain elicited in the bicipital groove when the patient attempts to forward elevate the shoulder against examiner resistance; the elbow is slightly flexed, and the forearm is supinated.

Uppercut test: The involved shoulder is positioned at neutral, the elbow is flexed to 90 degrees, the forearm is supinated, and the patient makes a fist. The examiner instructs the patient to perform a boxing "uppercut" punch while placing his or her hand over the patient's fist to resist the upward motion. A positive test is pain or a painful pop over the anterior shoulder near the bicipital groove region.

Yergason's test: The arm is stabilized against the patient's trunk, and the elbow is flexed to 90 degrees with the forearm pronated. The examiner manually resists supination while the patient also externally rotated the arm against resistance. A positive test is noted if the patient reports pain over the bicipital groove and/or subluxation of the LHB tendon.

Dynamic tests for bicipital groove symptoms:

- The examiner brings the patients shoulder to 90 degrees of abduction and 90 degrees of external rotation. The examiner passively rotates the shoulder at this position in an attempt to elicit the patient-reported audible "popping" or "clicking" sensations. Sometimes passively maneuvering the shoulder from the extension to cross-body plan is helpful in eliciting instability symptoms.
- At the 90/90 shoulder abduction/external rotation position, the patient is asked to "throw forward" while the examiner resists this forward motion. A positive test for groove pain must be localized to the anterior aspect of the shoulder to enhance diagnostic sensitivity and specificity.

Proximal biceps pathology is often associated with concomitant shoulder pathologies. Thus, it is important to differentiate the primary sources of patient-reported pain and symptoms clinically. Other important, provocative testing categories include the AC joint, the glenohumeral labrum, and rotator cuff muscles. The latter includes special consideration for subscapularis given the common pathological associations.

AC Joint Provocative Testing

Observation and direct palpation: Patients presenting with chronic AC joint pain and/or arthritic pathology often will have clinically obvious AC joint hypertrophy that can be appreciated solely with observation and/or direct palpation over the joint.

Cross-body adduction: The examiner may find it helpful to directly localize the AC joint with direct palpation before initiating any shoulder movement. Subsequently, the examiner brings the shoulder into about 90 degrees of flexion in front of the plane of the scapula, and a positive test includes patient-reported symptom reproduction as the arm is brought into cross-body adduction positions. The physician should be able to discern the exact location of pain reproduction with the cross-body adduction maneuvers.

Superior Labrum Anterior-Posterior (SLAP) Lesions

O'Brien's test/Active compression test: The patient is standing, and the arm of interest is positioned at 90 degrees of forward flexion, 10 degrees of adduction, and internally rotated so the thumb points toward the floor. The examiner places his or her hand over the patient's elbow while instructing the patient to resist the examiner's downward force applied to the arm. This maneuver is repeated with the patient's arm now rotated, so the palm faces the ceiling. A positive test is denoted by pain located at the joint line during the initial maneuver (thumb down/internal rotation) in conjunction with reported improvement or elimination of the pain during the subsequent maneuver (palm up/external rotation).

Anterior slide test: The patient stands with his or her hand of the involved arm placed on the ipsilateral hip with the thumb pointing posteriorly. The examiner places one hand on the joint line of the shoulder and the other hand on the elbow. The examiner then applies an axial load in an anterosuperior direction from the elbow to the shoulder. A positive test includes pain or a painful click on the anterior or posterior joint line.

Modified O'Driscoll test/Modified dynamic labral shear test: The patient stands with his or her involved arm flexed 90 degrees at the elbow and the shoulder is abducted in the scapular plane to above 120 degrees. The examiner then applies terminal external rotation until resistance is appreciated. Next, the examiner applies a shear force through the shoulder joint by maintaining external rotation and horizontal abduction and lowering the arm from 120 to 60 degrees abduction. A positive test includes a reproduction of the pain and/or a painful click or catch in the joint line along the posterior joint line between 120 and 90 degrees of abduction.

Rotator Cuff Muscle Testing

Supraspinatus (SS)

- Jobe's test: Positive test is pain/weakness with resisted downward pressure while the patient's shoulder is at 90 degrees of forward flexion and abduction in the scapular plane with the thumb pointing toward the floor.
- Drop arm test: The patient's shoulder is brought into a position of 90 degrees of shoulder abduction in the scapular plane. The examiner initially supports the limb and then instructs the patient to adduct the arm to the side of the body slowly. A positive test includes the patient's inability to maintain the abducted position of the shoulder and/or an inability to adduct the arm to the side of the trunk in a controlled manner.

Infraspinatus (IS)

- Strength testing is performed while the shoulder is positioned against the side of the trunk, the elbow is flexed to 90 degrees, and the patient is asked to externally rotate the arm while the examiner resists this movement.
- External rotation lag sign: The examiner positions the patient's shoulder in the same position, and while holding the wrist, the arm is brought into maximum external rotaions (ER). The test is positive if the patient's shoulder drifts into internal rotation (IR) once the examiner removes the supportive ER force at the wrist.

Teres Minor

- Strength testing is performed while the shoulder positioned at 90 degrees of abduction and the elbow is also flexed to 90 degrees. Teres minor (TM) is best isolated for strength testing in this position while the examiner resists ER.
- Hornblower's sign: The examiner positions the shoulder in the same position and maximally ERs the shoulder under support. A positive test occurs when the patient is unable to hold this position, and the arm drifts into IR once the examiner removes the supportive ER force.

Subscapularis

The high rate of associated pathologies with the LHBT and the subscapularis (SubSc) makes the subscapularis evaluation component significantly important in this clinical setting. The diagnosis of injuries to the subscapularis remains a challenge in any setting of shoulder pathology. Multiple provocative maneuvers and special exams exist in the literature, with the bear-hug test being the most sensitive exam modality although it only boasts a 60% sensitivity rate:

- Bear-hug test: The patient places his or her hand on the contralateral (normal) shoulder in a “self-hug” position. The palm is on the anterior aspect of the contralateral shoulder with the elbow flexed to 90 degrees. The examiner applies a perpendicular external rotational force to try and lift the patient’s hand off of the shoulder. A positive test results when the patient cannot hold the hand against the shoulder as the examiner applies an external rotation force.
- IR lag sign: The examiner passively brings the patient’s shoulder behind the trunk (about 20 degrees of extension) with the elbow flexed to 90 degrees. The examiner passively IRs the shoulder by lifting the dorsum of the hand off of the patient’s back while supporting the elbow and wrist. A positive test occurs when the patient is unable to maintain this position once the examiner releases support at the wrist (i.e., the arm is not maintained in IR, and the dorsum of the hand drifts toward the back)
- Passive ER ROM: A partial or complete tear of the SubSc can manifest as an increase in passive ER compared to the contralateral shoulder.
- Lift off test: More sensitive/specific for lower SubSc pathology. In the same position as the IR lag sign position, the examiner places the patient’s dorsum of the hand against the lower back and then resists the patient’s ability to lift the dorsum of the hand away from the lower back.
- Belly press: More sensitive/specific for upper subscapularis pathology. The examiner has the patient’s arm at 90 degrees of elbow flexion, and IR testing is performed by the patient pressing the palm of his/her hand against the belly, bringing the elbow in front of the plane of the trunk. The examiner initially supports the elbow, and a positive test occurs if the elbow is not maintained in this position upon the examiner removing the supportive force.

External Impingement/SIS

- *Neer impingement sign:*Positive if the patient reports pain with passive shoulder forward flexion beyond 90 degrees.
- *Neer impingement test:*Positive test occurs after a subacromial injection is given by the examiner and the patient reports improved symptoms upon repeating the forced passive forward flexion beyond 90 degrees.
- *Hawkins test:*Positive test occurs with the examiner passively positioning the shoulder and elbow at 90 degrees of flexion in front of the body; the patient will report pain when the examiner passively internally rotates the shoulder.

Internal Impingement

- *Internal impingement test:* The patient is placed in a supine position, and the shoulder is brought into terminal abduction and external rotation; a positive test consists of a reproduction of the patient’s pain.

Shoulder instability considerations

Global tissue laxity should be assessed by examining glenohumeral translation and hypermobility at the shoulder joints and other joints in the body if applicable. Hyperlaxity at other joints (e.g. elbow and knee hyperextension) may aid in the clinical diagnosis of underlying MDI-related diagnoses or connective tissue disorders.

Anterior apprehension test:

The anterior apprehension test is performed by lying the patient supine on the examination table. The examiner positions the shoulder to 90 degrees of abduction and 90 degrees of external rotation. while an anteriorly directed force is applied to the proximal humerus. The test is positive if symptoms of anterior instability are reproduced.

Apprehension at lower degrees of abduction may suggest glenoid bone loss. Patients may be guarded during the examination, but in most circumstances the provider is able to elicit if the apprehensive position is reproducible the patient's feelings of anterior shoulder instability.

Jobe relocation test:

The Jobe relocation test is utilized with the previous apprehensive testing maneuver. Once the patient reports a subjective feeling of reproduction of the shoulder instability symptoms, the examiner applies a posteriorly directed force while keeping the shoulder in the same apprehensive position. Resolution or improvement of symptoms indicates a positive test result.

Load-and-shift test:

The examiner uses one hand to apply an axial load through the elbow to center the humeral head within the glenoid. An anterior and posterior directed force is then applied at 0-, 45-, and 90-degrees of shoulder abduction. Increased translation at increasing degrees of shoulder abduction implies compromise of the IGHL.

Magnitude of humeral head translation is graded:

- Grade 1:
- - Increased translation compared with the normal shoulder
- Grade 2
- - Indicates humeral head translation to, but not over, the glenoid rim
- Grade 3
- - indicates translation of the humeral head over the glenoid rim

The load-and-shift test has been found to be up to 98% specific, but it has poor sensitivity for detection of unidirectional and multidirectional instability.

IMAGING

Radiographs

Clinicians should obtain a true anteroposterior image of the glenohumeral joint also known as the "Grashey" view. The true anteroposterior image is taken with the patient rotated between 30 and 45 degrees offset the cassette in the coronal plane. The beam can otherwise be rotated while the patient is neutral in the coronal plane. The distance between the acromion and the humeral head, in other words, the acromiohumeral interval can be computed. A normal interval is between 7 and 14 mm. This interval decreases in cases of advanced degenerative arthritis and RCA. Other standard views include the lateral, or "scapular Y," view and an axillary view.

Ultrasound (US)

Ultrasound (US) is highly operator-dependent but is touted as a fast, cost-effective tool for diagnosing LHBT pathology. Characteristic findings include tendon thickening, tenosynovitis, and synovial sheath hypertrophy, and fluid surrounding the tendon in the bicipital groove. The ability to perform a dynamic examination increases the sensitivity and specificity for detecting subtle instability. The diagnostic accuracy of US in detecting LHB pathology ranges from 50% to 96% (sensitivity) and 98% to 100% (specificity) when compared to Magnetic resonance arthrography (MRA).

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is useful in evaluating the LHBT, bicipital groove, and any fluid or edema that may be indicative of pathology. MRI helps define other associated shoulder pathologies, and in the setting of LHBT instability, particular attention should be given to evaluating for concomitant subscapularis injury. Most of the previous studies that have investigated the accuracy of preoperative MRI scans have used open surgical approaches to correlate MRI with surgical findings.

Over 90% of subscapularis tendon injuries begin on the articular side. Therefore, it is important to correlate suspected MRI pathology with direct visualization during shoulder arthroscopy. A 2010 study demonstrated that preoperative MRI interpretations (by radiologists) did not correlate with arthroscopic findings in the setting of suspected injury.

MRI is useful in identifying the LHBTs position with respect to the bicipital groove. The absence of the tendon within the groove would suggest subluxation and/or dislocation. Given the relatively poor reliability of MRI capabilities in diagnosing subscapularis injuries, the presence of LHBT subluxation/dislocation has been advocated for diagnostic capability improved accuracy by association. A 2015 study by Warner and colleagues investigated 100 patients with shoulder pathologies, of which 26 were diagnosed with LHBT subluxation based on preoperative MRI. Results indicated that the presence of LHBT subluxation was a predictor for full-thickness subscapularis tears, with a sensitivity of 82%, specificity of 80%, the positive predictive value of 35%, and the negative predictive value of 97%. LHBT subluxation was directly correlated with the severity of the subscapularis tendon tear.

Other associated shoulder pathologies and rotator cuff integrity can also be evaluated with MRI. Other common sources of acute or chronic shoulder pain can be evaluated on MRI, including subdeltoid and/or subacromial bursitis, acromioclavicular (AC) joint pathology and morphology. A systematic approach to review shoulder MRIs is essential, especially when tying the MRI findings with patient-reported symptoms and clinical examination.

MR Arthrography

Many studies have suggested MR arthrography (MRA) as the best imaging modality for the detection of biceps soft tissue pulley lesions. Walch previously described the “pulley sign” on MRA, suggesting a lesion to the soft tissue pulley structures. The “pulley sign” is an extra-articular collection of contrast material anterior to the upper subscapularis muscle. A 2012 study established MRA criteria for diagnosing biceps pulley lesions. The findings on MRA included:

- LHBT displacement relative to subscapularis tendon on oblique sagittal series; Up to 86% sensitive, 98% specific
- LHBT tendinopathy on oblique sagittal image series; Up to 93% sensitive, 96% specific
- Medial LHBT subluxation on axial image series; Up to 64% sensitive, 100% specific
- Discontinuity of the SGHL; Up to 89% sensitive, 83% specific

Other pertinent MRA findings include contrast material extending to the coracoid, indicative of a potential lesion of the rotator interval. Recent studies have highlighted the importance of advanced imaging as well as diagnostic arthroscopy for evaluating for the presence, and extent of biceps soft tissue pulley injuries. Advancements in imaging and arthroscopic techniques have become increasingly important as the clinical examination is prone to equivocal results.

Clinical Significance

Rotator Cuff Syndrome

Rotator cuff syndrome (RCS) describes a spectrum of clinical pathology ranging from minor injuries such as acute rotator cuff tendinitis, to advanced/chronic rotator cuff tendinopathy and degenerative conditions.

Rotator cuff injuries represent a common cause of shoulder pain. The rotator cuff tendons, particularly the supraspinatus tendon, are uniquely susceptible to the compressive forces of subacromial impingement. Improper athletic technique, poor posture, poor conditioning, and failure of the subacromial bursa to protect the supporting tendons results in a progressive injury from acute inflammation, to calcification, to degenerative thinning, and finally to a tendon tear.

Rotator cuff (RC) tendonitis/tendinosis

Acute or chronic tendinopathic conditions that result from a vulnerable environment for the RC secondary to repetitive eccentric forces and predisposing anatomical/mechanical risk factors.

Shoulder impingement

A clinical term often used nonspecifically to describe patients experiencing pain/symptoms with overhead activities. Shoulder impingement is best subdivided into internal and external conditions:

- **Internal impingement**: common in overhead-throwing athletes such as baseball pitchers and javelin throwers. Impingement occurs at the posterior/lateral articular side of the cuff as it abuts the posterior/superior glenoid rim and labrum when the shoulder is in maximum abduction and external rotation (i.e., the “late cocking” phase of throwing)
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    - The term, "thrower's shoulder" refers to a common set of anatomic adaptive changes that occur over time in this subset of athletes.
    - These adaptive changes include but are not limited to increased humeral retroversion and posterior capsular tightness.
    - Glenohumeral internal rotation deficit (GIRD) is a condition resulting from these anatomic adaptations, and GIRD is known to predispose the thrower's shoulder to internal impingement.
- **External impingement**: a term used synonymously with SIS. External impingement (EI) encompasses etiologies of external compressive sources (i.e. the acromion) leading to subacromial bursitis and bursal-sided injuries to the RC.

Swimmers shoulder

Swimmers have a significant potential for shoulder injuries due to the unique nature of the different strokes involved in swimming as well as the high volume of repetitions needed during training. Swimmer’s shoulder is a term that can represent numerous shoulder pathologies. These include impingement syndrome, rotator cuff tendinitis, labral injuries, instability secondary to ligamentous laxity or muscle imbalance/dysfunction, neuropathy from nerve entrapment, and anatomic variants. In order for the athlete to return to the sport in an appropriate and timely manner, the clinician must be able to differentiate between these different etiologies

Inflammatory Conditions/Tendinitis/Tendinopathy

Biceps tendonitis describes a clinical condition of inflammatory tenosynovitis most commonly affecting the LHBT as it travels within the bicipital groove in the proximal humerus. Chronic pathology results in tendinosis and eventually, severe tendinopathy.

Inflammatory pathologies are often secondary in nature due to the high prevalence of associated or preceding shoulder pathologies. In the 1970s, Neer demonstrated that the proximal biceps tendon is subjected to the same mechanical compressive forces under the coracoacromial arch as the rotator cuff. Thus, he noted their high degree of pathological association. In 1982, Neviaser demonstrated the relationship between increasing LHBT inflammatory changes with severity of rotator cuff (RC) injury and tendinopathy. Other associated shoulder pathologies include shoulder impingement (external or internal) and glenohumeral arthritis.

Primary bicipital tendinitis is much less common compared to secondary cases. The etiologies for primary bicipital tendinitis are not well understood compared to the more common secondary presentations. A particular subset of patients with primary, isolated biceps tendinitis is recognized in the younger, athletic population. Provocative sports include baseball, softball, and volleyball. Various medical conditions can cause intrinsic degeneration of the tendon, potentially leading to spontaneous rupture. End-stage degenerative LHB tendinopathy can result in spontaneous rupture and resulting "Popeye" deformity in the upper arm.

Traumatic Pathologies and tendon ruptures

Traumatic pathologies can overlap with instability spectrum. Conditions include superior labrum anterior to posterior (SLAP) lesions, partial versus complete ruptures, and injury secondary to direct or indirect trauma. The latter injuries would include partial or complete lacerations from a penetrating object or weapon, and indirect damage can occur to the tendon in various fracture patterns at the proximal humerus.

Rupture of the tendon usually occurs at either the musculotendinous junction or the LHBT origin near the supraglenoid tubercle. Just as in cases of LHB tendinitis, most ruptures occur in association with other shoulder pathologies. The most common cause of secondary LHBT rupture is rotator cuff injuries. The pathophysiology of secondary rupture is appreciated due to the loss of the protective role of the rotator cuff in protecting the LHBT from the coracoacromial arch. Primary LHBT rupture occurs at a similar rate to its primary LHB tendinitis counterpart pathology, about 5% of all total cases in each group.

Biceps Instability

Medial subluxation/dislocation of the LHBT can occur with repetitive mechanical wear, overuse, or acute trauma. While the osseous dimensions of the bicipital groove contribute to the stability of the LHBT, the most important stabilizers are the SGHL, CHL, and the interwoven fibers of the subscapularis and supraspinatus. The SGHL/CHL complex and the subscapularis fibers are intimately coalesced at the lesser tuberosity, serving an integral role as the medial and proximal portion of the soft tissue sling as part of the bicipital groove pulley system. Injury to one, a combination, or all of these components can lead to LHBT instability. Frequently, these structures can avulse from the tuberosity and remain attached to one another in the setting of varying degrees of instability.

Shoulder Instability

Glenohumeral instability encompasses both dislocation and subluxation events, and instability events commonly affect the general population. Approximately 1% to 2% of the general population will experience a glenohumeral dislocation in their lifetime. The young, active, athletic population is particularly susceptible to shoulder instability events. Over 95% of shoulder instability events occur in the anterior direction.

Enhancing Healthcare Team Outcomes

A comprehensive evaluation of the shoulder and neck is imperative in patients presenting with upper limb, nonspecific symptomatic presentations. Shoulder pathology and dysfunction represent some of the most commonly diagnosed and treated conditions by primary care, sports medicine, and orthopedic providers. Everyone on the healthcare team must work in a coordinated fashion to help delineate an appropriate clinical diagnosis in order to ensure all patients are managed with optimal medical and/or surgical care. Level of evidence: II-III

Questions

To access free multiple choice questions on this topic, click here.

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