

5 Points on Shoulder Examination of the Overhead Athlete

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The overhead athlete's shoulder is exposed to extremes of stress and range of motion (ROM), predisposing this joint to unique injury patterns. Prompt diagnosis and management begin with a comprehensive history and a physical examination, supplemented by imaging studies as needed. Furthermore, the throwing shoulder undergoes adaptive changes, such as partial undersurface rotator cuff tears and capsular laxity. Imaging studies typically demonstrate abnormalities in asymptomatic throwers. Therefore, clinicians must be skilled in history taking and physical examination in throwing athletes to accurately determine the cause of symptoms and provide optimal treatment. This primer provides orthopedic surgeons with the key points in performing a thorough physical examination of the shoulder in overhead athletes.

When working with overhead athletes, surgeons must elicit the precise nature of symptoms. For example, it is important to distinguish pain from fatigue, as well as complaints related purely to decline in performance. Often, collaboration with the player's parent or coach may help clarify the chief complaint. In addition, surgeons must have an intricate knowledge of the

various stages of the overhead motion, as symptoms in specific stages (late cocking/early acceleration) may raise suspicion for distinctive pathology (labral/biceps complex). Last, it is imperative to understand that the shoulder represents only one part of the kinetic chain in overhead athletes. Successful throwing relies on integrity of the entire kinetic chain, starting with the lower extremity and trunk, extending through the spine, scapula, and shoulder, and terminating with the hand and fingers. Pathology anywhere in the chain must be evaluated and addressed.

When examining the shoulder in overhead athletes, surgeons must address several anatomical structures, both bony and soft tissue. Proper examination begins with comprehensive assessment of the ROM and strength of the various muscles around the shoulder, along with visual inspection to identify any asymmetry of these structures. In addition, the scapulothoracic structures must be examined in detail to rule out underlying dyskinesia. The capsular and ligamentous components of the shoulder joint must be further assessed to note any capsular contracture causing glenohumeral internal rotation deficit (GIRD) or any pathology with the rotator cuff or labral/biceps complex. Last, a comprehensive neurovascular examination should be performed to rule out any compression or neuropathy affecting the shoulder and overhead motion. Findings from the physical examination may then require further imaging to correlate the history and physical examination findings.



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1 Inspection, palpation, strength testing

Every examination of the shoulder must begin with visual inspection, along with assessment of basic ROM and strength. The patient must be positioned and exposed adequately to promote visualization of the entire shoulder and scapular girdle, from both anterior and posterior. Visual inspection focuses on identifying any areas of asymmetry, such as position of the bony prominences or bulk of the muscular fossae. Asymmetry of the bony architecture may indicate prior trauma, and atrophy of the muscular fossae may indicate nerve compression. For example, atrophy of the infraspinatus fossa may be caused by compression of the suprascapular nerve at the spinoglenoid notch (likely by a cyst, often associated with labral pathology, but infraspinatus atrophy can result even without the presence of a compressive cyst¹). Alternatively,

atrophy of both the supraspinatus and infraspinatus fossae may indicate underlying compression of the suprascapular nerve at the suprascapular notch (either by a cyst or by the transverse scapular ligament). Static and dynamic observation of the posterior aspect of the shoulder may help identify gross pathology with scapular positioning or retraction, indicating underlying dyskinesia (discussed later). Deformity of the acromioclavicular joint may indicate prior trauma or separation. Last, all prior surgical scars should be noted.

Selective palpation may help identify pathology in the shoulder of the throwing athlete. Tenderness at the acromioclavicular joint may be especially common in patients who have had prior sprains of this joint or who have degenerative changes. Tenderness along the biceps tendon may be present in those with biceps tendinitis or partial tear. In addition, tenderness at the coracoid may be present in those with scapular dyskinesia. Posteriorly, palpation at the inferomedial aspect of the scapula (Figure 1), as with palpation along the medial border of the scapula, may elicit tenderness in those with scapulothoracic bursitis.

Strength testing in the shoulder is performed to elicit any deficiencies of the rotator cuff/musculature or surrounding structures. Weakness in forward elevation may indicate pathology in the supraspinatus, whereas weakness in external rotation may reflect deficiency in the infraspinatus or teres minor. Teres minor deficiency may be more isolated with weakness in a position of shoulder abduction to 90°. Last, weakness in internal rotation may indicate subscapularis deficiency. Lag signs and other provocative maneuvers are similarly elicited but typically are positive only in the event of large tears of the rotator cuff. These signs and maneuvers include the internal rotation lag sign or belly press test for subscapularis integrity, the drop-arm sign for supraspinatus function, the external rotation lag sign for infraspinatus function, and the hornblower sign for teres minor integrity. Supporting muscles of the shoulder may also be tested. Latissimus strength may be tested with resisted downward rotation of the arm with the shoulder in abduction and the elbow flexed to 90°.



Figure 1. Palpation along inferior and medial aspects of scapula may elicit symptoms associated with scapulothoracic bursitis.

2 ROM and GIRD assessment

After inspection and palpation, the shoulder should be ranged in all relevant planes of motion. Our standard examination includes forward elevation in the frontal and scapular planes, along with external rotation at the side and at 90° of abduction, as well as internal rotation behind the back with documentation of the highest spinal level that the patient can reach. This examination may be performed with the patient upright, but supine positioning can help stabilize the scapula and provide more accurate views of motion. Deficits of internal rotation may be a common finding in overhead athletes, and the degree of this deficit should be quantitatively noted.

Bony and soft-tissue remodeling of the shoulder (and associated structures) in the overhead athlete can lead to contracture of the posterior capsule. This contracture can cause excessive external rotation and subsequent decrease in internal rotation, leading to pain and anterior instability in the throwing shoulder.² For precise measurements of the internal and external rotation arc, the scapula must be stabilized. This can be done with the patient supine on the examining table or seated upright with manual stabilization of the scapula by the examiner. Once the scapula is stabilized, the arc of internal and external rotation (with the arm in about 90° of abduction) can be measured with a goniometer, with maximum values obtained as the scapula begins to move along the posterior chest wall.² The difference in internal rotation between the dominant and nondominant arms defines the extent of the athlete's GIRD. Internal rotation can also be qualitatively assessed by having the athlete internally rotate each arm and reach up the spine while the examiner notes the difference in level achieved. However, this does not provide a quantitative assessment of the patient's GIRD.

In general, the sum of the internal and external rotation arcs on the 2 sides should be symmetric. Consequently, in GIRD, excessive external rotation is balanced by decreased internal rotation. Symptomatic GIRD may be present when there is more than 25° of discrepancy in internal rotation between the athlete's dominant and nondominant arms.² The goal is to reduce this discrepancy to less than 20°.

3 Internal impingement: rotator cuff and labrum

In overhead athletes, an intricate relationship involving rotator cuff, labrum, and biceps tendon allows for efficient, pain-free force delivery at the shoulder. However, because of the significant external rotation and abduction required in the overhead motion, there may be internal impingement of the posterosuperior rotator cuff (infraspinatus and posterior aspect of supraspinatus) between the posterior labrum and the greater tuberosity. Detailed examination of these structures must be performed in any assessment of an overhead athlete. Symptomatic patients may complain of pain during the throwing cycle, particularly in late cocking and early acceleration.

The modified relocation examination is a common maneu-

ver to detect internal impingement.³ In this examination, the patient's arm is brought into a position of maximal external rotation and abduction mimicking that found in late cocking or early acceleration. In this position, a patient with internal impingement complains of pain in the posterior shoulder. A posteriorly directed force on the humerus relieves this pain.

There are also many examinations for detecting labral pathology, specifically a SLAP (superior labrum, anterior to posterior) lesion, which is commonly found in patients with internal impingement. One commonly tested maneuver is the O'Brien active compression test (Figures 2A, 2B), which has excellent sensitivity and specificity in detecting type II SLAP lesions.⁴ In this examination, the patient holds the arm in about 15° of adduction and 90° of forward elevation. A downward force is applied with the forearm pronated and subsequently supinated. If pain is noted on the force applied to the pronated arm, and if this pain decreases in the supinated examination, the test is positive for labral pathology.

Anterior instability is routinely found in these patients. Translation is measured with the anterior load and shift test. Anterior translation is tested with the patient supine, with the arm in abduction and external rotation, and with the examiner placing an anteriorly directed force on the humeral head. Translation is compared with the contralateral side and graded on a 3-point scale (1+ is translation to glenoid rim, 2+ is translation over glenoid rim but reduces, 3+ is translation over glenoid and locking). We also use the anterior release test, in which the patient is supine, the arm is brought into abduction and external rotation, and the examiner places a posteriorly directed force on the humeral head. When the examiner removes this force, the patient notices symptoms of instability caused by subluxation (Figures 3A, 3B).

Biceps tendon testing should also be performed to help elicit signs of labral pathology. The Speed test is performed by placing a downward force on the patient's arm, which is held in 90° forward elevation, and with elbows in extension



Figure 2. Positive O'Brien active compression test is denoted by discomfort or pain deep in shoulder joint on (A) resisted elevation in pronation that is relieved or decreased with (B) resisted elevation in supination.



Figure 3. (A) In anterior release test, posterior force is directed on abducted, externally rotated arm. (B) When force is released, apprehension denotes positive finding.

and forearm in supination. Pain in the long head of the biceps tendon is considered a positive sign and suggestive of SLAP lesion. Although not commonly found in these athletes, external impingement should also be elicited through both the Neer test and the Hawkins test. In the Neer test, the patient's arm is brought to maximal forward elevation with the forearm supinated and elbow extended, while the scapula is stabilized by the examiner. Pain in the shoulder indicates a positive examination. In the Hawkins test, the patient's arm is brought into a position of forward elevation, internal rotation, and elbow flexion. The arm is then further internally rotated, and shoulder pain defines a positive examination.

Any of these findings can be concomitant with scapular dyskinesis. Moreover, symptoms related to internal impingement may be exacerbated by concomitant scapular pathology, and therefore proper assessment of scapulothoracic motion must also be performed.

4 Scapulothoracic examination

Motion coupled between the scapula and the rest of the arm (scapular rhythm) allows for efficient use of the shoulder girdle. The scapula helps transfer the force generated by the core so that the hand can efficiently deliver it. Therefore, scapular pathology (or dyskinesis) results in inefficient functioning of the arm, which can be especially debilitating in an overhead athlete.

Scapular assessment begins with visual inspection of the patient, typically from the posterior view, which allows for assessment of the resting position of the scapula. Evidence of prominence of the medial or inferomedial border, coracoid malposition (or pain on palpation), or general scapular malposition should be noted. On active ROM, as the patient forward-elevates the arm, any asymmetric prominence of the inferomedial border of the scapula should be noted. Such asymmetry may indicate underlying scapular dyskinesis. In another important test, the lateral scapular slide test (described by Kibler⁵), the distance from the inferomedial angle of the

scapula to the thoracic spine should be measured for both sides and in 3 different positions, noting any asymmetry between the affected and nonaffected sides. These 3 positions (Figures 4A–4C) are with arms at side, with hands on hips (internal rotation of humerus in 45° abduction), and in 90° of shoulder abduction. Last, medial and lateral scapular winging—caused by long thoracic nerve and spinal accessory nerve pathology, respectively—can be detected by asking the patient to do a “push-up” against the wall while the examiner views from posterior.

After assessment of scapular position at rest and through motion, a series of provocative maneuvers⁶ may aid in the diagnosis of scapular dyskinesis. The first maneuver is the scapular assistance test, in which the examiner provides a gentle force at the inferomedial angle of the scapula, promoting upward rotation and posterior tilt as the patient elevates the arm (Figures 5A, 5B). If the patient experiences a decrease or absence of symptoms through this arc, the test is considered positive. The second maneuver is the scapular retraction test, in which strength testing of the supraspinatus is performed before and after retraction stabilization of the scapula. In the baseline state, the strength of the supraspinatus is tested in standard fashion, with resisted elevation of the internally rotated and abducted arm. The strength is then tested with the scapula stabilized in retraction (the examiner medially stabilizes the scapula). With scapular stabilization, an increase in strength or a decrease in symptoms is considered a positive test.

5 Neurovascular examination

It is essential to perform a comprehensive neurovascular examination in all overhead athletes. This includes basic cervical spine testing for any motor or sensory deficits, along with assessment of scapular winging to detect long thoracic or spinal accessory nerve palsy for medial and lateral winging, respectively. Although neurovascular injury may be a rare finding in the overhead athlete, a detailed examination must still be performed to rule it out.

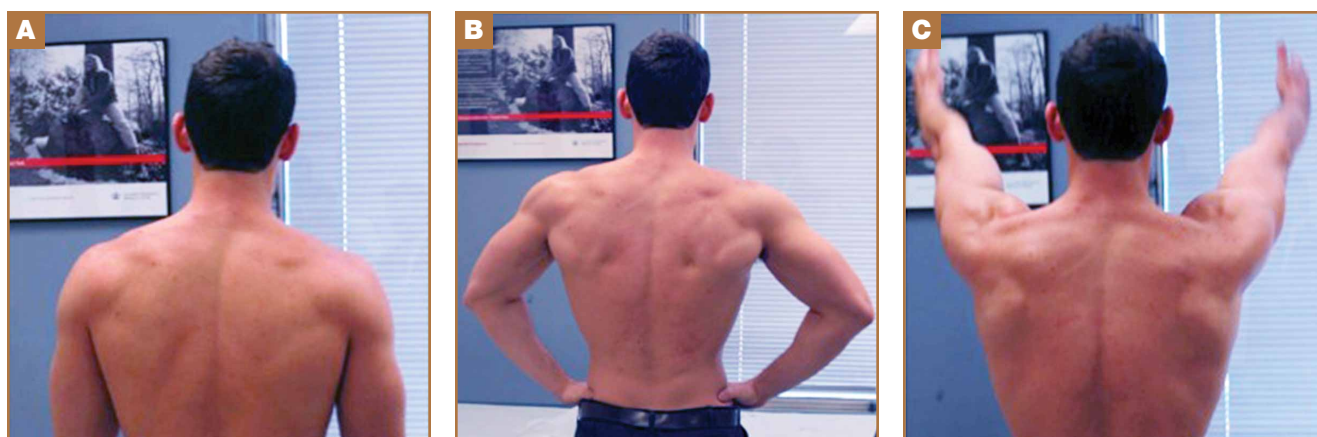


Figure 4. Lateral scapular slide test is performed by measuring distance between inferior angle of scapula and thoracic spine (A) with arms at side, (B) with hands on hips (internal rotation of humerus in 45° abduction), and (C) in 90° of shoulder abduction. Asymmetry between affected and nonaffected sides denotes positive finding indicative of scapular dyskinesis.

Thoracic outlet syndrome

Thoracic syndrome is a compressive neuropathy of nerves and vasculature exiting the thorax and entering the upper extremity. Common symptoms include pain and tingling (sometimes vague) in the neck and upper extremity. These symptoms may be positional as well.

Diagnosis of thoracic outlet syndrome begins with visual inspection of the involved upper extremity, noting atrophy or asymmetry. Weakness may also be present. Additional provocative maneuvers can be used to detect decrease or loss of pulses, along with reproduction of symptoms, during a provocative maneuver with subsequent return of pulses and resolution of symptoms after the maneuver is completed.

One examination that can be used to detect thoracic outlet syndrome is the Adson test.⁷ During this maneuver, the radial pulse is palpated with the arm at rest on the patient's side.

The patient then turns to the symptomatic side, hyperextends the arm, and holds inspiration. A positive test coincides with both decreased pulse and reproduction of symptoms, indicating compression within the scalene triangle. In the Wright test,⁷ the pulse is again palpated at rest with the arm at the side. The patient then holds inspiration and places the arm in a position of abduction and external rotation. If the pulses decrease with this maneuver, the test is considered positive, indicating compression in the sub-pectoralis minor region deep to the coracoid. In a third test, the costoclavicular test, again pulses are measured before and during the provocative maneuver, which is with the shoulders thrust backward and depressed downward. A positive test indicates compression between the clavicle and the first rib. In our practice, we use a modified Wright test in which the arm is held in abduction and external rotation while radial pulses are palpated. The fist

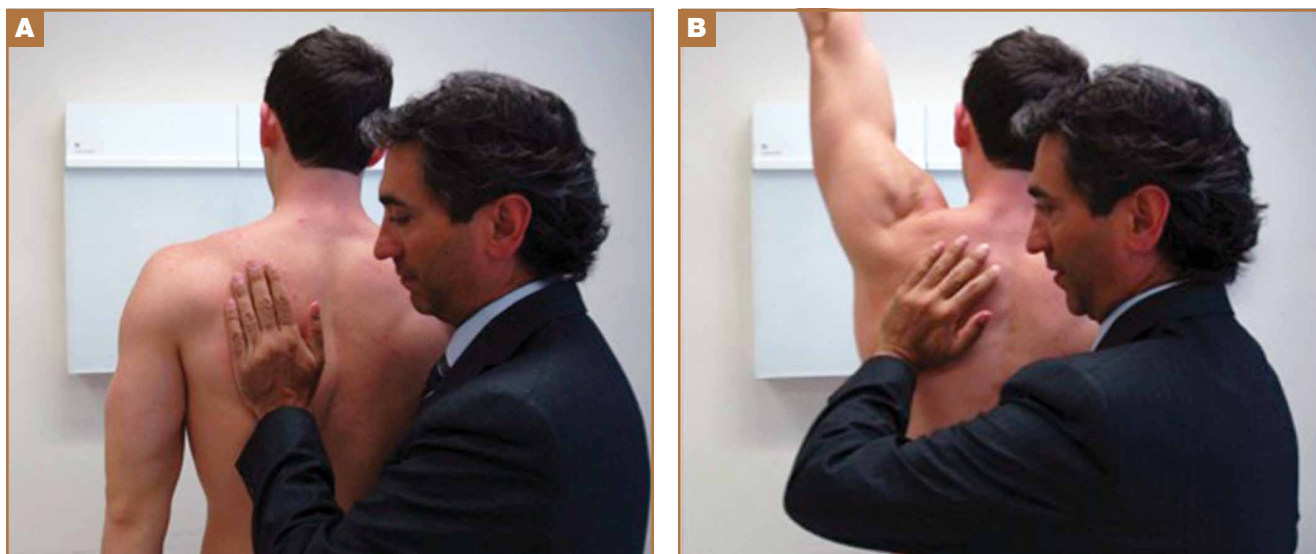


Figure 5. In scapular assistance test, examiner provides (A) gentle force at inferomedial angle of scapula, (B) promoting upward rotation and posterior tilt as patient elevates arm. If patient experiences decrease or absence of symptoms through this arc, test is considered positive.

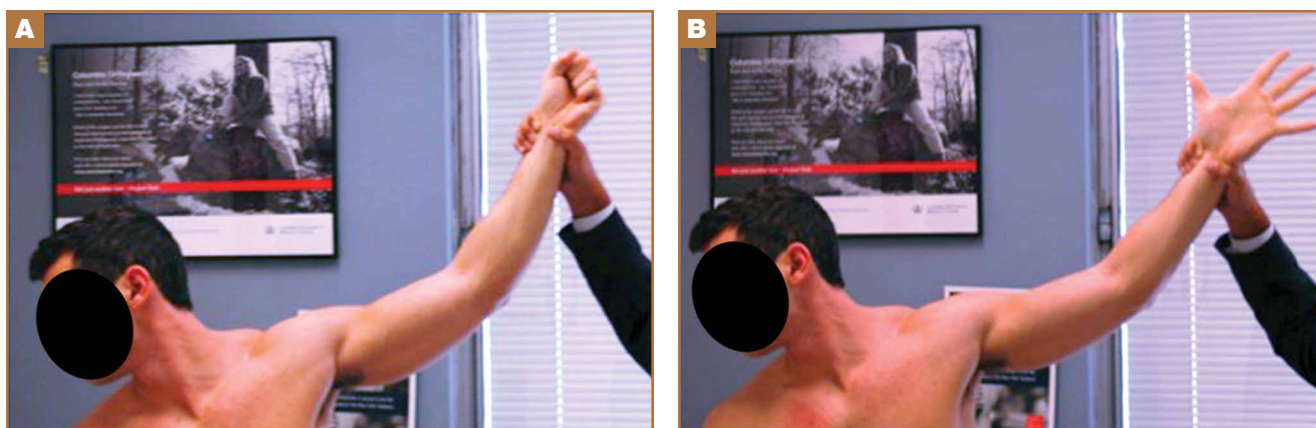


Figure 6. In modified Wright test, radial pulse is palpated while hand is rapidly (A) closed and (B) opened with arm in abduction and external rotation. Diminution of pulse signifies positive finding for thoracic outlet syndrome.



Figure 7. Patients with proximal arterial aneurysm may develop splinter hemorrhages under fingernails of affected extremity.

is then opened and clenched rapidly, and diminution of radial pulses is considered a positive examination (Figures 6A, 6B).

Effort thrombosis

Overhead athletes are at increased risk for developing effort thrombosis⁸ (Paget-Schroetter syndrome). This thrombosis, which results from repetitive motion involving the upper extremity, is not limited to overhead sports; it may be caused by underlying compression of or microtrauma to the venous infrastructure. On physical examination, there may be swelling of the affected limb, along with diffuse pain and fatigue, as well as dermatologic changes. Positive findings warrant further testing, such as coagulation profile testing and advanced imaging or venography.

Arterial aneurysm

Although rare, arterial aneurysms, especially of the axillary artery, must be ruled out in the overhead athlete with vague upper extremity pain (especially distally) and without clear diagnosis.⁹ Aneurysm of the axillary artery can result from repetitive microtrauma related to repetitive overhead motion of the up-

per extremity. This condition may cause showering of emboli distally to the vasculature of the hand and fingers (Figure 7). Patients may complain of pain in the fingers, difficulty with grip, cyanosis, or cold sensation. On examination, the sufficiency of the radial and ulnar arteries should be assessed, as with detailed sensorimotor examination of the fingers. The fingernails should be examined for splinter hemorrhages.

Conclusion

Overhead athletes place extreme stress on the shoulder during the throwing motion and are at high risk for injury because of repetitive stress on the shoulder girdle. When examining overhead athletes with shoulder pain, surgeons must consider the entire kinetic chain, as inefficiencies anywhere along the chain can lead to altered mechanics and pathology in the shoulder.

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