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Shoulder Impingement in the Overhand Athlete: A Chiropractic Approach

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In today's health care environment more and more primary care physicians are being asked to assess and manage athletes of varying ages and abilities with sports related injuries of all types. Shoulder pain is one of the most common chief complaints of an athlete. It is also one of the most unique joints of the body. Consequently, its assessment, diagnosis, and management must be equally unique.[1]

The shoulder is the most complex joint in the body. The excessive range of motion is accompanied by inherent instability. The structure of the glenohumeral joint has been characterized as a golf tee (the glenoid) with an oversized ball (the humeral head) sitting on it. Jobe and Iannotti[2] have calculated that at any given time, approximately 28% of the humeral head is in contact with the bony glenoid cavity. This arrangement places the demand of stabilization on the soft tissue restraints of the shoulder girdle. These are the glenohumeral capsule and ligaments as well as the four rotator cuff, or SITS muscles, (supraspinatus, infraspinatus, teres minor, and subscapularis). As a result of the demands placed on the soft tissue structures, various impingement injuries can occur.[3]

Impingement is the most common cause of shoulder pain in the overhand athlete.[4,5] Neer and Welsh[6] originally described three stages of impingement based on observation and age. Impingement was considered stage one if the patient was <25 years of age. They classified this as tendonitis and stated that this stage was reversible with conservative management. Stage two was considered if the patient was between the ages of 25–40 years, and fibrosis of the subacromial bursa and rotator cuff had taken place. They recommended acromioplasty if the patient failed conservative management. In stage three, patients were considered to have full or partial thickness rotator cuff tears, and to be >40 years of age. Unfortunately, their impingement continuum did not take into account the special attributes found in the athletic population.

Although the work of Neers and Welsh[6] is helpful in the nonathletic population, Jobe and Pink's[1] instability continuum better illustrates the process that leads to a symptomatic athletic shoulder. The instability continuum begins with rotator cuff weakness and moves to instability, subluxation, impingement, and eventual rotator cuff tearing.

Functional Anatomy

The shoulder consists of four articulations. The sternoclavicular joint (SCJ), acromioclavicular joint (ACJ), glenohumeral joint (GHJ), and scapulothoracic articulation (STA). Of the four, the SCJ is the only true osseous articulation. The remaining three joints are primarily suspended by muscular, capsular, or ligamentous restraints.

Restraints to static motion are the glenohumeral ligaments (GHL). The GHLs are merely thickened bands of the capsule that provide reinforcement. These include the superior, middle, and inferior GHLs. The inferior glenohumeral ligament

complex (GHLC) consists of an anterior and posterior band. The inferior GHLC is also the most commonly injured of the GHLs as they provide support at extremes of range of motion. The GHLs reinforce the capsule. In the overhand athlete, it is common for the inferior GHLC to display some redundancy creating an anterior or anterior inferior type laxity and for the posterior aspect of the capsule to tighten in response to the anterior laxity.[3]

The rotator cuff muscles provide dynamic stability of the GHJ during range of motion. Their primary task is to provide compression and depression of the humeral head during abduction and external rotation. This force couple mechanism keeps the humeral head centered in relation to the glenoid fossa. Proper function of the muscular force couple is necessary to prevent impingement. In the overhand athlete this task becomes more challenging due to the high demands resulting in overuse and repetitive strain injury.[7,8]

Just as important to glenohumeral stability are the muscles responsible for scapular stability. It is critical that the STA is well maintained to create a firm base for GHJ function.[9]

The overhand athlete will commonly present with weakness of the middle and lower trapezius, rhomboids, and the serratus anterior muscle. Together these muscles provide retraction and elevation during abduction and external rotation. During adduction internal rotation, they provide controlled protraction through eccentric muscle contraction.

Impingement Syndrome

There are three general subtypes of impingement syndrome. Primary impingement refers to an external source of impingement against the rotator cuff as it courses through the subacromial space. This usually has a degenerative etiology, such as subacromial spurring, ACJ arthrosis, spurring of the anterior acromion, and/or a type three acromion (Figure). The patient with primary impingement is usually >35 years of age. They will commonly experience anterior or anterolateral shoulder pain during over-hand movements. A painful arc is usually present between 70°–130° of combined abduction external rotation. This patient may experience pain during the night if they roll onto the affected shoulder. If there is ACJ involvement they will also experience pain with crossed body adduction. Causes of primary impingement in the <35 age population include a type three acromion or an os acromiale.[10]

Secondary impingement refers to external impingement of the rotator cuff under the coracoacromial arch. This is in response to either occult or subtle instability of the GHJ. In the overhand athlete it may present if the athlete also has hyperlaxity with rotator cuff weakness. Secondary impingement usually occurs in patients <35 years. However, it may be present in competitive recreational athletes >35 years. The patient will complain of anterior or anterolateral shoulder pain during the overhand activity. The onset is usually specific to the overhand athletic activities. Typically, symptoms are not associated with activities of daily living (ADL) or at rest unless it has been present for a substantial period of time.[11–13] Patients with more severe levels of laxity/instability may complain of transient subluxation episodes with or without the sensation of a "dead arm." The "dead arm" phenomenon results when the humeral head tractions the brachial plexus during anterior-inferior subluxation.[5,14] The physician should also be suspicious of underlying instability when the overhand athlete presents with hand symptoms consistent with an ulnar nerve distribution and anterior or anterolateral shoulder pain. The shoulder pain may be worse during athletic activity, while the ulnar nerve symptoms may exacerbate after the activity.

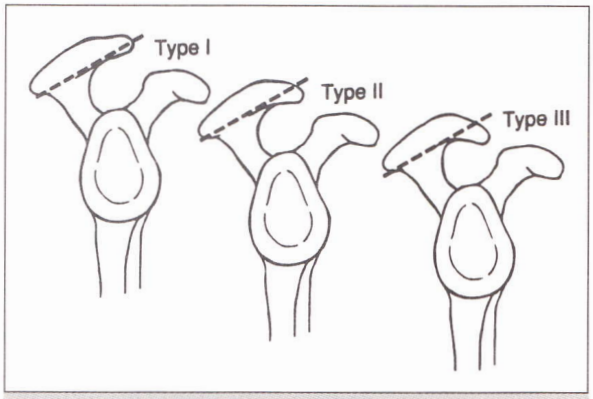

Figure. Variations of acromial morphology. Type I, flat; Type II, curved; Type III, hooked or "beaked."[34]

The third type of impingement is internal glenoid impingement. This has also been referred to as posterior-superior glenoid impingement or in the throwing athlete "over rotation syndrome." The excessive external rotation that is common in the overhand athlete results in impingement of the articular or undersurface of the rotator cuff against the posterior-superior aspect of the glenoid labrum and/or glenoid rim. Chronic abrasion of the cuff against the glenoid may eventually lead to partial thickness tears on the articular side of the rotator cuff. This is probably the most common type of impingement in the overhand athlete. The athlete is generally <35 years and involved in a competitive overhand sport. If they are >35 years and not involved in athletics their occupation may involve repetitive use of the shoulder in an abducted externally rotated position, such as in maneuvering a forklift through a warehouse. They will present with posterior shoulder pain. Their posterior shoulder symptoms are related to a specific overhand activity involving abduction between 80°–120°, maximal external rotation, and horizontal extension of the GHJ. This may include throwing a baseball, striking a volleyball, serving a tennis ball, swimming, or even golf. As with secondary impingement it is specific to the overhand activity unless it has been present for an excessive period of time. In a long standing problem it is common for the patient to experience night pain and pain with ADLs.[15–18]

Examination Findings

In addition to the history, the physical examination is the most important aspect in accurately diagnosing the underlying cause of shoulder impingement syndrome in the overhand athlete.

Examination of the shoulder should always begin with a neurovascular assessment of the cervical spine and upper extremities. Cervical spine range of motion should be assessed in all ranges. Palpation of the cervical spine for paravertebral or spinous process tenderness is performed. Cervical compression and distraction tests are performed to rule out a herniated disc as a potential etiology of the athlete's shoulder pain. Shoulder depression with the patient's head rotated 45° to the contralateral side will help assess brachial plexus injury as a cause of the shoulder pain. Motor strengths, muscle stretch reflexes, and pinwheel examination of the nerve roots C5 through T1 are tested. Additionally, wrist and ankle clonus should be assessed especially in the young adult to help rule out multiple sclerosis (MS). Vascular examination should include a check of the upper extremity peripheral pulses, auscultation of the head and neck vessels, and Roo's test as a screen for thoracic outlet syndrome (TOS).[5,13]

INSPECTION. The examination begins with a visual screening check for deformity of the clavicle, ACJ hypertrophy, a step off deformity of the GHJ, scapular winging, atrophy of the deltoid, supraspinatus, and/or infraspinatus muscles or dermatological lesions, such as herpes zoster.[5]

RANGE OF MOTION. Active and passive shoulder range of motion is assessed according to the guidelines of the American Shoulder and Elbow Surgeons.[19] It is easiest to check external rotation in a neutral position with the palms up first as this is the least provocative position. Overhand athletes commonly display increased external rotation on the dominant side relative to the nondominant side.[20] Next, forward flexion with the thumbs pointed to the sky and elbows fully extended should be performed. Pain at the end range felt on the superior aspect of the shoulder during the passive phase may be the first examination finding of impingement. External rotation is then assessed with the humerus at 90° of abduction. Posterior superior pain may indicate internal glenoid impingement. Anterior shoulder pain may indicate subtle instability, where anterior apprehension may indicate occult instability. The last range is internal rotation. Have the patient reach behind their back as though they are attempting to touch the contralateral scapula. Record the highest spinal level they can reach with their thumb. The overhand athlete will commonly display less internal rotation on the dominant arm. The authors also advocate measuring the difference be-

tween the two extremities by marking the level with a pen. The difference should be measured in centimeters. Table I provides a synopsis of the cardinal ranges of motion in the shoulder with diagnostic clues.

Rotator Cuff Assessment

Several maneuvers have been validated for testing the integrity of the rotator cuff based on electromyographic and arthroscopic findings.[21] This reduces the number of maneuvers necessary to assess the rotator cuff and increases the examination accuracy.[22] Athletes may display adequate yet painful range of motion of the shoulder. In these cases the supraspinatus should be tested in the scapular plane with 90° of elevation and the thumb up, or in the "full can" position.[21] This is performed first as this is a less provocative position than the traditional thumbs down, or the "empty can" position. The "full can" position is less provocative and therefore, may give a more accurate strength assessment. This is then followed by the more provocative "empty can" test (humerus positioned in the scapular plane with 90° of elevation and the thumb pointed to the floor). An increase in symptoms during the "empty can" test relative to the "full can" test is another indication of impingement.[23] The infraspinatus and teres minor are tested with the humerus in neutral or 0° of abduction with the humerus in -45° of rotation (internally rotated 45°).[21]

The subscapularis is assessed using the lift off test (LOT). The patient should position their arm with the elbow flexed to 90°. It is then placed in the "small" of the back or approximately the L3–L4 spinal segment. If internal rotation is severely limited the physician may have to passively position the patient's arm. The patient is then asked to lift the hand and forearm off of their back. Excessive forward body lean, dropping the hand so that the elbow angle is >90°, or an inability to perform the test are indications of subscapularis involvement.[24,25] The serratus anterior should also be assessed during the rotator cuff assessment. The patient is asked to face the wall with the arms neutral, the palms facing the wall, and the elbows fully extended. They are then asked to push the palms into the wall while the examiner inspects for scapular winging. Subtle winging on the symptomatic side should be considered significant in the overhand athlete. Weakness of the serratus anterior is a validated finding in overhand athletes with instability and secondary impingement. This may be a subtle examination finding of secondary impingement.[26]

Provocative Testing for Impingement

Neers impingement sign (NIS) has been considered the hallmark test for impingement.[6,27] The maneuver is performed with the examiner behind the patient. One hand contacts the acromion for the purpose of preventing scapular rotation.

TABLE I. CARDINAL FIELDS OF MOTION FOR THE SHOULDER WITH COMMON SYMPTOMS AND THEIR POSSIBLE DIAGNOSTIC SIGNIFICANCE

Range of Motion and Associated Diagnostic Clues		
Range of Motion	Other Significant Findings	Diagnosis
Forward elevation	Inability to perform pain at end range	Rotator cuff tear Impingement
Neutral external rotation	Posterior pain PSGI Anterior pain	
External rotation at 90° abduction	Posterior pain Anterior pain	Anterior instability PSGI Secondary impingement/instability
Internal rotation	Posterior pain Posterior apprehension	Rotator cuff tendonitis Posterior capsulitis Posterior instability

PSGI=Posterior superior glenard impingement.

TABLE II. GRADING OF SULCUS SIGN[36]

Grade I	<1 cm
Grade II	1–2 cm
Grade III	>2 cm

The other hand grasps the elbow. The examiner then performs passive forward flexion with internal rotation while stabilizing the scapula. The sign is present if the patient experiences anterior or anterolateral shoulder pain. NIS is commonly negative in the young athletic population with secondary impingement or internal glenoid impingement. It is more commonly positive in the older population presenting with primary impingement. Occasionally, during the performance of NIS a palpable "clunk," or subluxation of the joint may occur. This is indicative of posterior shoulder instability and should not be quickly dismissed as insignificant in the symptomatic shoulder.[28]

Hawkins impingement sign (HIS)[29] has also been considered an examination essential in the diagnosis of impingement syndrome. The examiner should be facing the patient. The patient's humerus is abducted to 90° in the plane of the scapula with elbow bent to 90°. The examiner performs passive internal rotation by supporting the elbow with one hand and lowering the hand. This is performed three times. The first time is with the humerus in the scapular plane. The second is with the humerus in 45° of forward flexion and the last is with the humerus in 90° of forward flexion. This creates a gradual progression of adduction and eventual compromise of the coracoacromial arch. The maneuver is positive if the patient experiences anterior or anterolateral shoulder pain consistent with their chief complaint. Because of this mechanism, the HIS sign is a better maneuver for the diagnosis of secondary impingement. This maneuver requires internal rotation of the humerus and, therefore, may produce posterior shoulder pain in a patient with a tight posterior capsule, capsulitis, or even posterior instability.

The dynamic impingement test (DIT)[15] is a recent test that assists in the diagnosis of internal glenoid impingement. This maneuver has been shown to correlate well arthroscopically. The patient should be supine. The arm is started in the neutral position. The examiner then externally rotates the humerus. Once full external rotation in the neutral position is achieved, the examiner begins to abduct and extend the GHJ while maintaining external rotation. The patient with internal impingement will experience posterior-superior shoulder pain between 70°–150° of abduction. Pain localized to this region and within this arc is considered positive for internal glenoid impingement.

The sulcus sign[30] is used to assess the patient for inferior instability. The patient should be seated and relaxed. The examiner stabilizes the scapula with one hand while providing long axis traction to the humerus. If a step off is observed at the acromion, this is indicative of inferior capsular laxity. Table II lists the grading criteria for a sulcus sign. It is common for normal asymptomatic shoulders to display excessive translation. It is essential to perform a bilateral comparison to differentiate between hyperlaxity and instability. Findings on the sulcus sign have to be correlated carefully to other historical and examination findings.

The apprehension[1] and relocation[31] tests when combined are the most sensitive for microinstability in the overhand athlete. The apprehension test is performed with the patient supine. The shoulder is abducted and externally rotated to 90° with the elbow also positioned in 90° of flexion. The examiner then induces maximal external rotation and extension of the GHJ while using the other hand to apply a posterior to anterior (P-A) force on the humeral head. If symptoms are produced or reproduced, the examiner places the most medial hand on the anterior surface of the proximal humerus and applies an anterior to posterior (A-P) force, while maintaining maximal external rotation and extension. Resolution of the symptoms during the relocation maneuver indicates subtle anterior instability. If there is an excessive unilateral sulcus sign on the involved arm the two may indicate multidirectional instability (MDI) of an anterior-inferior type. This is a common finding in the overhand athlete. Posterior shoulder pain during this maneuver relieved by the relocation test may indicate internal glenoid impingement.

O'Brien et al's[32] maneuver, or the active compression test, is a useful screening maneuver because it will assist the examiner in the detection of several types

of lesions. O'Brien et al[32] originally described the maneuver for the detection of superior labral lesions, or SLAP (superior labrum, anterior to posterior) tears and ACJ pathology. The authors have used the maneuver successfully in the diagnosis of posterior instability (Buchberger DJ and Hartwell-Ford's unpublished data, 1999). The patient can be seated or standing. The GHJ is forward flexed to 90°. The humerus is internally rotated fully so that the thumb points to the floor. The humerus is then adducted approximately 15°. The examiner then applies a downward force distal to the elbow. Pain localized to the ACJ is indicative of ACJ pathology. Internal pain to the anterior aspect or referring down the biceps muscle is indicative of a SLAP lesion. Posterior shoulder pain or apprehension is indicative of posterior instability. The maneuver is not considered positive for the respective lesion unless there is resolution of respective provocation, when the test is performed with the palm up (humerus externally rotated).

Radiographic Assessment

Proper assessment of the shoulder in the overhand athlete should include a minimal impingement series (Table III). Plain film radiographic assessment is useful in detecting osseous pathology in the young adult as well as growth plate abnormality in the immature athlete. The impingement series will establish the presence or absence of an os acromiale, or type three acromion, as a cause of primary impingement in the young individual. In the older patient, degenerative processes, such as anterior acromial spurring, ACJ spurring, and impact lesions of the humeral head, may be evident.[33]

Diagnostic Imaging

Imaging, such as MRI, in the young overhand athlete is reserved for those cases that present with dramaticexamination findings indicating rotator cuff tear or internal derangement, such as labral pathology. Athletes who fail a conservative management approach of at least 8–12 weeks are also candidates for MRI examination.

It is currently accepted that when an MRI is ordered for the overhand athlete that it be ordered with gadolinium contrast material. This raises the diagnostic capability especially in the case of capsulolabral disruption. The contrast material will help delineate confusing normal variants in the capsulolabral complex from actual pathology.[34]

The authors also recommend obtaining MRI results prior to consideration of cortisone injection in the young overhand athlete. MRI results correlated with the physical examination will allow the treating practitioner to make a better clinical decision regarding the use of therapeutic injection.

Management

Chiropractic management focuses on the underlying etiology of the impingement as well as rebuilding the kinetic chain. In the case of primary impingement range of motion, scapulohumeral dynamics and posture are usually of

TABLE III. RECOMMENDED RADIOGRAPHIC SERIES FOR IMPINGEMENT SYNDROME

View	Lesions
A-P GHJ	GH degenerative changes Calcific tendonitis
ACJ spot (15° cephalad tilt)	ACJ degenerative changes AC separation Distal clavicular osteolysis
Axillary lateral	GHJ dislocation Bony Bankart lesion (glenoid rim) Os acromiale Hill Sachs (post humeral head)
Supraspinatus outlet (Y view)	Acromial morphology Degenerative changes anterior acromion

A-P=anterior to posterior; GH=glenohumeral; ACJ=acromioclavicular joint; AC=acromioclavicular; GHJ=glenohumeral joint.

concern when attempting a conservative program. If conservative measures fail, then subacromial decompression is usually recommended with appropriate postoperative rehabilitation.[1,7,35]

Identifying and correcting the instability is the key regarding patients with secondary impingement and internal glenoid impingement. All facets of the dysfunction must be addressed to return this athlete to their overhand athletic activities.

The first goal of treatment is to reduce symptoms while restoring range of motion. This is accomplished through a comprehensive manual approach. The authors use the following plan in the treatment of secondary and internal impingements with modification for individual variance.

Active Release Techniques Soft Tissue Management System (ART®) is applied to the rotator cuff muscles to loosen and reduce fibrotic lesions within or between the muscle planes. Areas of concern in the overhand athlete are the teres minor at the quadrilateral space, the supraspinatus, and the subscapularis. The subscapularis is particularly important due to its intimate relationship to the serratus anterior at the scapulothoracic articulation.[6,7,36,37]

It has recently been demonstrated that the subscapularis is an issue in the athlete with secondary impingement and microinstability. ART® has also been shown to improve function of the rotator cuff muscles, allowing for a better response to rehabilitative strengthening.[35]

Rhythmic stabilization is utilized to stimulate co-contraction of the rotator cuff and scapular stabilizers. This is very effective in restoring proprioception and normal firing patterns to the rotator cuff muscles. Contract relax technique is used to stretch and restore flexibility to the posterior capsule. It is performed with the patient supine while stabilizing the scapula to isolate the posterior capsule. The GHJ is then taken progressively into horizontal adduction post contraction. Chiropractic manipulation is performed to the cervical and thoracic spinal articulations to provide adequate motion in the base of the upper extremity kinetic chain. Young et al[38] have found that restricted cervical spine motion significantly affected the velocity and accuracy of a group of pitchers.

High velocity low amplitude manipulation is not performed to the GHJ in cases of underlying instability. The other manual techniques outlined in this paper address the capsular tightness with a better risk to benefit ratio.

Manual therapy is followed with the application of pulsed ultrasound to reduce any post treatment inflammation and assist in the healing process.

The patient is instructed on a series of isometric strengthening and flexibility exercises to preserve muscle strength and volume while restoring flexibility to the posterior capsule.[7]

Rehabilitation

When pain-free range of motion is established, a rotator cuff strengthening program can be started. The patient continues with the previous prescribed flexibility program. The authors advocate the use of the following program based on electromyographic findings and clinical experience for patient variation.

The standing four way exercise provides a simple method of strengthening the rotator cuff with minimal risk of symptom exacerbation or injury. The patient stands holding a light handweight between 1–5 lbs, depending on their current status. Rotator cuff strengthening exercises should never be performed with >5 lbs. When resistance >5 lbs is used, the tendency is for the patient to recruit the larger muscles and alter technique. This is counter-productive to the rehabilitation goal. The patient may need to start with something as light as a soup can. Four maneuvers are performed. The first is to forward flex to 90° with the thumbs pointed to the ceiling and the elbows fully extended. The patient then slowly lowers to neutral. Secondly, the patient lifts their arm with the thumbs up to the ceiling in the scapular plane to 90°. The patient should then return to a neutral position. Third, abduct the shoulder with the thumbs pointed up to the 90° level. The last maneuver is a two arm row (flexing the elbows and extending the shoulders), pulling the weights up along the body. All four of these maneuvers are considered one repetition. The patient should start with a light weight and perform three sets of 10–12 repetitions 1–2 times per day.[7,39]

The prone three way exercise will appear more difficult for your patient because there is less deltoid activity in this position compared to the standing position. They may need to use a lighter weight for this exercise relative to the standing four way. The first maneuver involves extension of the shoulder with the elbow fully extended and the palm facing the floor. This can be accomplished by lying on the side of the bed. The second maneuver involves horizontal shoulder extension from the prone position. The elbow is fully extended with the thumb pointed to the ceiling. The third is similar to maneuver two, only the shoulder is abducted to approximately 100°. As in maneuver two, the thumb points to the ceiling.[7,39]

The next maneuver utilizes a concentric (muscle shortening) contraction followed by an eccentric (muscle lengthening) contraction in external rotation and horizontal adduction. This is helpful in training the overhand athlete for the deceleration phase common to most overhand athletic activities. The patient lies in a side lying posture with the affected arm upward. The elbow is bent to 90°. The patient brings the arm into external rotation while maintaining 90° of elbow flexion and supinating the hand. Then, the patient should press the weight to the ceiling extending the elbow. When full elbow extension is achieved, they should slowly lower the weight across their body while pronating the hand or turning the thumb down to the floor.

The final exercise combines scapulothoracic movement with glenohumeral movement in a coupled pattern. The patient can perform this seated or prone. However, they must start with their arms hanging down. The first maneuver is to retract the scapula fully. While holding this position the arms are extended with the elbows flexed to 90°. At this stage, the patient externally rotates the humerus, pointing the thumbs up to the ceiling. They reverse each motion individually, releasing scapular retraction last. This will be the most difficult exercise for them to perform and it can be anticipated to take several weeks to accomplish.[7,40]

Conclusion

The overhand athlete places unusual and extreme stresses on the GHJ. Participation in overhand athletics requires the GHJ to undertake extreme range of motion. The excessive external rotation predisposes the shoulder to instability, usually in the anterior direction. It is the excess range of motion that also predisposes the overhand shoulder to secondary or internal impingement. Because instability is the underlying cause, this must be the entity that is addressed. Conditions, such as biceps tendonitis and rotator cuff tendonitis, are not the primary diagnosis, but merely the sequlae of underlying instability. If the sequlae is the focus of the treatment, the condition will not resolve.■

Note: Author or related institution has received financial benefit from research in this study.

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