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**Title Page**

An evidence based approach to shoulder injuries.

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## **Abstract**

**Objective:** Shoulder injuries are common complaints seen by primary care physicians, with up to 66.7% of people experiencing shoulder pain at some point in their life.

**Method:** This manuscript takes an evidence based look at the anatomy of the shoulder, shoulder injuries seen in sports and the more common shoulder complaints faced by primary care physicians in practice.

**Conclusion:** It is prudent that primary care physicians have a solid evidence based grounding in the more common types of shoulder injuries seen in practice, to better investigate, diagnose and treat these injuries, to enhance patient outcomes.

## **Introduction**

Shoulder pain is a complex and prevalent complaint for primary care physicians with up to 66.7% of the population experiencing shoulder pain at some point in their lifetime [1]. It is therefore important that primary care physicians have a thorough understanding into the anatomical and kinematic make up of the shoulder joint.

The glenohumeral joint is formed by the humeral head and the glenoid fossa of the scapula [2]. This creates a ball and socket joint, which results in a joint with a remarkable range of motion, but the trade off is a joint which has a loss of biomechanical stability [2]. This is due to a humeral head with a large spherical shape articulating with a small fossa, similar to a golf ball and tee [2]. The stability of the joint comes from the surrounding soft tissue structures which includes the articular cartilage (labrum), the joint capsule and ligaments (coracohumeral ligament, superior, middle and inferior glenohumeral ligaments), the rotator cuff muscles (supraspinatus, infraspinatus, subscapularis, teres minor) which supply the concave joint compression [2].

Movement at the glenohumeral joint is dependent on three other joints, the scapulothoracic, acromioclavicular and sternoclavicular joints. Together the movement that occurs between these 4 joints is called “scapulohumeral rhythm” [3]. During normal movement of the shoulder the scapula will upwardly and posteriorly tilt on the thorax during elevation of the arm in flexion, abduction, scapular plane abduction or unrestricted overhead reaching [4]. Scapulothoracic internal and external rotation are more inconsistent and are determined by the plane in which the arm is being elevated in and on what portion of elevation range of motion is considered. The motion of the scapula is dependent on scapular rotating muscular balance, with excessive internal rotation, or protraction, the result of muscle weakness. The scapular must adjust in the transverse plane for the intended plane of elevation [5].

The complexity of the joint complex, coupled with the lack of biomechanical stability of the glenohumeral joint exposes the joint to injury [6]. The more common mechanism of injuries to the shoulder include direct and indirect trauma to the shoulder (FOOSH injury, direct blow to the shoulder, high force impact to the shoulder, lifting a heavy object), repetitive overuse and disruption to the scapulohumeral rhythm [3,5-8]. From here injuries can be classified as acute, chronic, stable, unstable, strains, tears (partial thickness, full thickness, degenerative). It is also important to consider the cervical and thoracic spine when evaluating a suspected shoulder injury as there can be concomitant injury to both [9].

Exercise also plays an important role in determining what type of shoulder injury has been sustained, with different injuries associated with different sports. Table 1 provides a list of sports, the common types of shoulder injuries seen in that sport, and the more common mechanism of injuries.

There is an exhaustive list of potential injuries that can occur with the shoulder. This manuscript will provide an evidence based overview on the more common shoulder injuries seen in clinical practice, how they should be evaluated, and what treatment options are available to primary care physicians.

## **Impingement**

Shoulder impingement is a very common shoulder complaint which is believed to be associated with rotator cuff disease [23]. It can be broken down into different categories. There is external impingement, internal impingement, which can then be further divided into anterior, posterior and coracoid impingement [5].

## External Impingement

External shoulder impingement is usually confined to the subacromial space and is associated with overhead overuse. The pain is commonly anterior with overhead activities, and is due to the compression or abrasion of the cuff tendons or long head of the biceps tendon beneath any aspect of the coracoacromial arch [24]. Common causes are structural and degenerative, such as acromion spurs, shape of the acromion, degenerated cuff tendon [25]. In patients under 40 years of age where external impingement is suspected, further investigation is required, as often there will be other factors involved such as instability, scapular dyskinesia. A protracted scapula will lessen the acromial humeral distance and potentiate impingement. Many patients can be successfully treated with scapula rehabilitation instead of acromioplasty.

## Internal Impingement and Posterior Capsular Tightness

Internal shoulder impingement usually occurs in younger athletes involved with overhead sports such as baseball, swimming, tennis. The pain is usually posterior and occurs in the late cocking phase of throwing. It is due to the humeral head loss of centricity in the glenoid fossa, either as a result of laxity in the anterior capsule, tightness in the posterior capsule, a type II labral injury, or scapular dyskinesia [25]. Internal impingement occurs when the posterior edge of the supraspinatus and the anterior edge of the infraspinatus impinge against the posterior superior glenoid and labrum in the late cocking position [26].

Another source of shoulder pain is due to microtrauma of the posterior shoulder capsule and cuff, leading to scarring and contracture causing a reduction in internal shoulder rotation i.e. glenohumeral internal rotation deficit (GIRD) [25]. This then causes the humeral head to rotate posterior superiorly, impinging the rotator cuff between the humeral head and glenoid [25].

## Assessment

Assessment should always consist of a thorough history and physical exam. The physical exam should look to confirm the impingement syndrome as well as the potential cause of the impingement including tendon pathology, scapular dyskinesia, capsule laxity or instability. Physical exam tests to assess for impingement include active and passive range of motion, Neer impingement sign, Hawkins test, horizontal adduction, resisted abduction, scapular assistance test and scapular retraction test [27]. Throwers should undergo a full kinetic chain evaluation, with particular attention paid to abduction weakness, lead and stance leg hip rotation deficits and quadriceps tightness.

If warranted, further imaging will be driven by the diagnosis and should include plain films [29]. Ultrasound and MRI are equally as good at picking up tendon pathology [29]. MRI and MRA (gold standard) are best for identifying labral tears [30].

## Treatment

Scapular motion is a key factor when assessing and treating impingement with scapular motion abnormalities identified in subjects with impingement and rotator cuff disease [31]. Without correction of the dysfunctional shoulder kinematics the impingement mechanism will remain. Therefore a targeted stretching and strengthening program is important to assist in reducing pain and improving function [32]. It is important though to combine the exercise therapy with other treatments, as exercise alone is not as effective as combined treatments with exercise [33]. With combined therapies and treatments yielding better results than single interventions alone [33].

Acute patients tend to respond well to ultrasound guided cortisone injection, followed by a structured rehabilitation program, whereas those who have injections alone tended to fare worse [33,34]. Exercise therapy with specific exercises combined with kinesio tape and acupuncture are ideal for patients with early shoulder impingement. While low level light therapy and localised NSAID injections are not recommended [33]. Nitroglycerine patches may help cuff pain. PRP injections are currently inconclusive. Correction of kinetic chain abnormalities may require abductor strengthening, quadriceps and hip stretching as well as scapular repositioning exercises.

Surgical treatment options such as arthroscopic acromioplasty, bursectomy, subacromial decompressive surgery, labral and cuff repairs should be considered to aid in restoring normal function to an impinged shoulder where the impingement is due to acromion spurring or glenohumeral joint instability or in long standing cases [33].

## **Labral Tears**

The labrum is a dense fibrous tissue that is attached to the periphery of the glenoid fossa, increasing the depth and width of the glenoid fossa [35]. This results in greater stability of the shoulder while still allowing for increased range of motion. The labrum also serves as the attachment site for the long head of the biceps with 40 to 60% of the fibres inserting into the supraglenoid tubercle and the remaining into the labrum [36]. Other structures serving as attachment sites for the labrum include the long head of the triceps and glenohumeral ligaments.

Labral tears can occur at any point around the labrum, but the more common labral tears include SLAP tears (Superior Labral Anterior Posterior) and Bankart lesions [35].

### **SLAP Tears**

The most common mechanisms of injury for a SLAP tear are forced traction on the shoulder such as a external rotation and hyperextension force, and direct compression (acute traumatic or chronic-overhead throwing athlete) [35]. There are four classes of SLAP tears [36]:

Type I: degenerative tear of the undersurface of the superior labrum with the biceps anchor intact.

Type II: tear of the superior labrum as well as of the biceps anchor.

Type III: bucket-handle tear of the superior labrum with biceps anchor intact.

Type IV: bucket-handle tear of the superior labrum with extension into biceps tendon

SLAP tears tend to present with deep pain in the shoulder which can be sharp or dull [35]. The pain can be aggravated by overhead activity, pushing or lifting a heavy object. There maybe catching, popping or clicking and often there will be other associated shoulder conditions present [35]. Throwing athletes may present with pain in the late cocking phase or early acceleration phase of throwing, which may also be accompanied by weakness or decreased velocity [25,35].

### **Bankart Lesions**

Bankart lesions occur when the humeral head shifts anterior and inferior out of the glenoid fossa. In doing so it damages the anterior inferior labrum, glenohumeral ligaments, joint capsule and rotator cuff [35]. They are seen in 85-97% of anterior shoulder dislocations [37,38]. The end result is anterior instability as a result of the damaged structures, as well as the loss of negative pressure the labrum creates to hold the humeral head in the socket [35]. The main symptom of a Bankart lesion therefore will be instability and subsequent pain which is usually associated with a dislocation event or recurrent episodes of instability.

The key physical examination tests to evaluate for a labral tear or Bankart lesion include, Shift and Load, Andrews "pitcher" provocation test, Kim 1 and Kim 2, Sulcus sign, abduction with inferior distraction, O'Brien's, Apprehension test, Crank test [28,35,39]. Kuhn's Test comprises of Sulcus sign, abduction and inferior distraction and Yergason's test. If all three are negative there is a 6% of a SLAP tear, if one is positive there is a 14-20% chance of a SLAP tear and if 2 or more are positive there is a 34-66% of a SLAP tear, which warrants an MRA [40]. MRI and MRA (gold standard) are best for identifying labral tears [30].

## Treatment

The treatment of first time dislocated shoulders remains very controversial, however in the absence of significant glenoid or humeral bone loss, rehabilitation may be a viable option. The presence of a bony bankart lesion or large Hill Sachs lesion will likely be best treated with surgical repair.

Most surgical cases can be successfully managed with an arthroscopic approach. However, if glenoid bone loss exceeds 25%, then a coracoid transfer procedure (Latarjet) may be the best recourse.

The initial treatment of SLAP labral tears should involve a period of conservative treatment for 6-12 weeks, which should include, rest, physical therapy and nonsteroidal anti inflammatory, with the goal of reducing pain and improving shoulder function [28]. Those failing conservative treatment and overhead throwing athlete's, should consider arthroscopic repair which has shown predictably good functional results with an acceptable rate of return to play [36].

## Rotator Cuff Tears

Rotator cuff pathology is associated with 30-70% of cases of shoulder pain with anywhere between 5-40% involving tears [41]. The rotator cuff muscles are comprised of the infraspinatus, supraspinatus, subscapularis and teres minor muscles. The cuff muscles together act to stabilize the humeral head in the glenoid fossa and to facilitate movement of the arm [42]. Injuries to the rotator cuff include strains, tendonitis (impingement syndrome) and tears.

There are two categories of tears, acute traumatic and chronic degenerative. Acute tears usually occur in younger athletes and often involve a FOOSH injury, high energy trauma, heavy lifting, shoulder dislocation [42]. Chronic degenerative tears occur in older individuals, with the incidents of rotator cuff tears increasing with age [43]. Many chronic tears tend to be asymptomatic and often involve chronic overuse, mechanical impingement, normal age degeneration of the tendon, and lack of blood supply to the tendon [42]. Additional risk factors include smoking, hypercholesterolemia and genetics [43].

## Assessment

On examination there is usually pain on palpation, weakness with or without pain on manual muscle testing, pain when elevating the arm overhead and difficulty sleeping on the affected shoulder. There is no relationship between the severities of pain to the size of the tear [44]. But increased pain or worsening pain indicates tear progression. Orthopaedic assessment should include the Hawkins-Kennedy test, infraspinatus muscle test, and painful arc, as well as internal rotation lag sign, external rotation lag sign, lift off test, dropping sign as well as empty can and bear hug test [45].

## Imaging

Imaging work up is useful in patients who present with 6 weeks or more of rotator cuff tear symptoms. Plain film x ray and ultrasound together are recommended as the most valid imaging method to exclude tendon rupture in those unresponsive to conservative management [41]. MRI is excellent at identifying full thickness tears. The evidence for the use of MRI to identify partial tears is conflicting [41,46]. MR arthrograms only have limited usefulness when compared with MRI [41]. There is no consensus statement yet as to which imaging method is more precise at identifying full and partial thickness tears.

## Treatment

Conservative management over surgical repair for rotator cuff tears has been proven to be beneficial in some studies over the short and long term, while others have shown early surgical intervention provides better outcomes [46]. Conservative management needs to involve an individualised rehabilitation program that focuses on range of motion optimization, scapular stabilization and core abdominal strengthening. NSAIDs can be used in the first 3-4 weeks to manage pain levels, but in the long term they provide no benefit in restoring function to the shoulder [41]. In general, patients with two tendon tears are likely best served with surgical repair.

There is inconclusive evidence regarding the benefit of PRP injections in the treatment of rotator cuff pathology, although one recent study has shown PRP in association with surgical repair of medium to large tears improved the quality of the tendon, but not the healing rate [47].

## Surgical management of rotator cuff tears

There is no obvious long term difference in open vs arthroscopic cuff repair. However repairs performed with the arthroscopy do realize less pain. Furthermore, larger retracted tears are better visualized with arthroscopy so that mobilization and side to side repairs can be afforded.

Subscapularis tears may be present in up to 35% of rotator cuff lesions and must be addressed in order to attain optimal results.

## Clavicular Fracture

Clavicular fractures account for 35-45% of all shoulder girdle fractures. Middle  $\frac{1}{3}$  fractures account for 81% of all fractures, with 17% lateral  $\frac{1}{3}$  and 2% medial  $\frac{1}{3}$  [48]. The most common mechanism of injury involves a fall on the lateral shoulder which commonly occurs in cyclists and motorcycle pilots, less common causes include a direct blow or FOOSH injury [6].

It is uncommon to have secondary complications associated with the fracture, but pneumothorax, hemothorax and injuries to the brachial plexus and subclavian arteries have been reported [49]. Examination should therefore include a neurovascular and lung exam.

Plain film x ray is sufficient to identify the fracture with the Zanca, or cephalic view essential to assess displacement. Non displaced fractures in any region of the clavicle can be treated conservatively with a sling, ice and analgesics [6]. With elbow range of motion exercises started when tolerable. Shoulder range of motion and strengthening exercises should begin once the fracture has healed.

There is a slight increase in risk of delayed non-union in displaced fractures treated conservatively compared to surgical repair. Surgical repair is also associated with better function and less disability in the short term since clavicle strut shortening is associated with scapular protraction [48]. Displaced fractures may require surgical intervention if more than 2 cm shortening is seen and scapula dyskinesia is present.

## **Conclusion**

Shoulder pain is a complex, common complaint seen by primary care physicians. It is pertinent that primary care physicians have a sound understanding of the anatomy and kinematics of the shoulder, and understand the potential impact sports have on the shoulder. This knowledge coupled with an evidenced based approach to examination and management should enable primary care physicians to more accurately diagnose and more appropriately management common shoulder injuries.



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<b>Activity</b>	<b>Shoulder Injury</b>	<b>Mechanism of Injury</b>
Collision sports (ie. NFL, Rugby, AFL, Lacrosse)	AC joint injuries, fractures, dislocations, labral tears	Direct or indirect trauma
Weight lifting	Osteolysis of the distal clavicle, impingement, rotator cuff strains/tears	Repetitive overuse
Swimming	Rotator cuff tendonosis/tears, impingement	Repetitive overuse
Racquet sports (ie. tennis, squash, badminton)	Rotator cuff tendonosis/tears, labral tears	Repetitive overuse
Throwing sports (baseball, softball)	Rotator cuff tendonosis/tears, impingement, labral tears	Repetitive overuse
Combat sports (judo, mixed martial arts)	AC joint, dislocations, labral tears	Direct or indirect trauma
Golf	AC joint, instability, impingement	Repetitive overuse
Cycling	AC joint, fracture, dislocation	Direct trauma
Volleyball	Impingement, labral tears, rotator cuff tendonosis/tears, suprascapular neuropathy	Repetitive overuse

Table 1. Common sports specific shoulder injuries [10-22].