

The Female Athlete

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An Imprint of Elsevier Science

The Curtis Center
Independence Square West
Philadelphia, Pennsylvania 19106

THE FEMALE ATHLETE

ISBN 0-7216-8029-1

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The Publisher

Library of Congress Cataloging in Publication Data

The female athlete / [edited by] Mary Lloyd Ireland and Aurelia Nattiv.

p. ; cm.

ISBN 0-7216-8029-1

1. Sports medicine. 2. Sports injuries. 3. Women-Health and hygiene. I. Ireland, Mary Lloyd II. Nattiv, Aurelia.

[DNLM: 1. Athletic Injuries. 2. Sports Medicine. 3. Women's Health. QT 261 F3291 2003]

RC1210 .F365 2003

617.1'027'082-dc21

2002075772

KI/MBY

Printed in the United States of America.

Last digit is the print number: 9 8 7 6 5 4 3 2 1

Chapter 39



Shoulder Injuries

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FUNCTIONAL ANATOMY AND BIOMECHANICS

The shoulder is a complex arrangement of joints and articulations with a greater range of motion than any other joint in the body. Synchronous motion among the various joints and articulations is required, otherwise instability or breakdown of the shoulder complex will occur. A basic understanding of functional anatomy of the shoulder is necessary for the accurate diagnosis of the various disorders that may occur.

The shoulder complex includes the glenohumeral, acromioclavicular, and sternoclavicular joints, as well as the scapulothoracic and sub-

acromial articulations. The bony architecture of the clavicle, acromioclavicular joint, and scapula is easily palpable and serves as landmarks for identification of soft-tissue structures. The ligaments that stabilize the clavicle are named for their bony attachments. These are the coracoclavicular ligament composed of the medial conoid and lateral trapezoid ligaments, the coracoacromial ligament, and the acromioclavicular ligament (Fig. 39-1).¹ The coracoacromial arch consists of these stabilizing ligaments and their connections to the acromion and clavicle.

The rotator cuff is composed of 4 muscles: the supraspinatus, infraspinatus, teres minor, and subscapularis (Fig. 39-2).⁴ The only internal rotator,

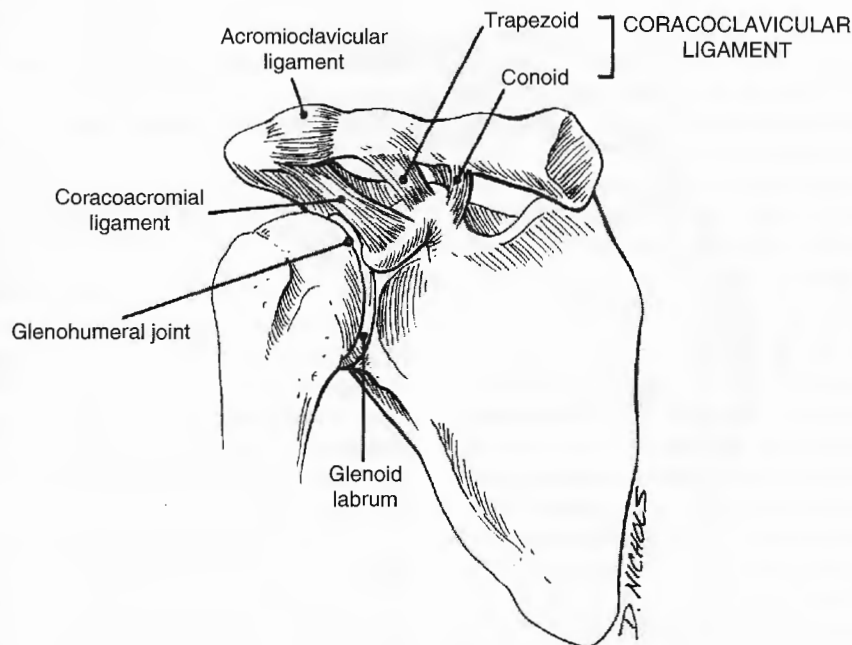


Figure 39-1. The 3 ligaments stabilizing the acromioclavicular and coracoid bones are named for their attachments. The coracoclavicular ligament has lateral trapezoid and medial conoid portions. (From Andrews JR, Zarins B, Wilk KE: *Injuries in Baseball*. Philadelphia, Lippincott-Raven, 1998, p 41, with permission.)

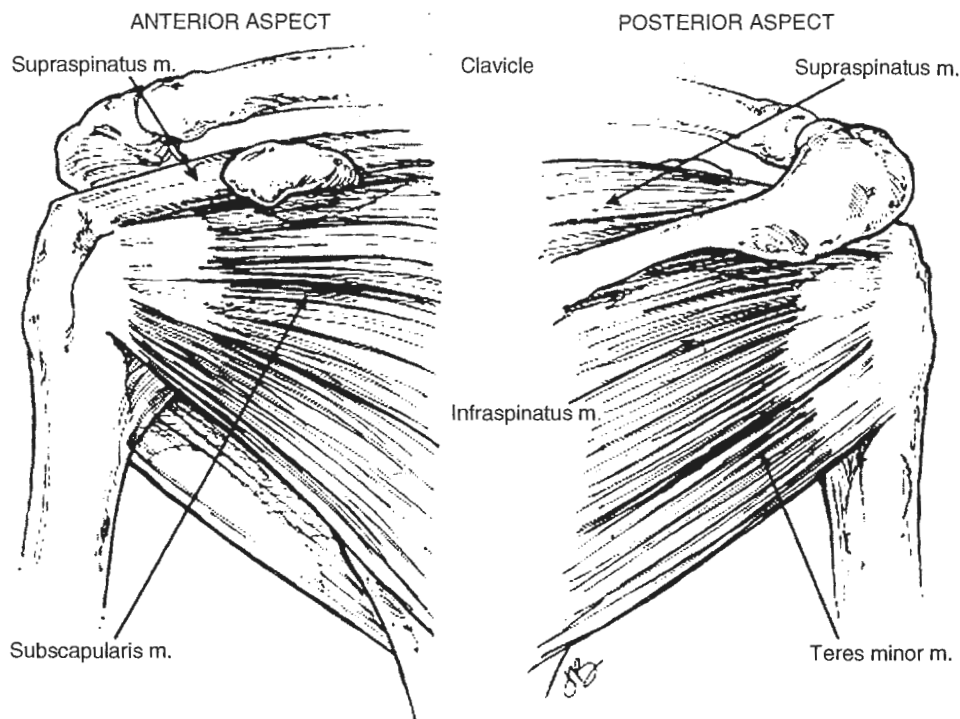


Figure 39-2. Anteriorly, the subscapularis is the only internal rotator of the rotator cuff, concerting onto the lesser tuberosity. The other 3 portions of the rotator cuff are external rotators (from superior to inferior): supraspinatus, infraspinatus, and teres minor, with insertions onto the greater tuberosity. (From Baker CL: *The Hughston Clinic Sports: Medicine Book*. Baltimore, 1995, Williams & Wilkins, p 230, with permission.)

the subscapularis, originates from the subscapular fossa on the anterior aspect of the scapula and inserts on the lesser tuberosity. The other 3 rotator cuff muscles are the external rotators, depressors, and stabilizers of the humeral head. They can be thought of as a "soft-tissue sandwich" passing underneath the compressive roof of the acromial arch and functioning to move and rotate the humeral head below (Fig. 39-3).²²

The supraspinatus originates superior to the scapular spine in the supraspinatus fossa and passes under the acromion on its way to insertion on the greater tuberosity. The supraspinatus counteracts the superior pull of the deltoid. The supraspinatus cannot initiate abduction. The posterior 2 rotator cuff muscles—infraspinatus and teres minor—are external rotators of the humeral head (Fig. 39-4).⁴² The infraspinatus originates inferior to the scapular spine in the infraspinatus fossa of the scapula and inserts on the greater tuberosity. The teres minor originates from the lateral border of the scapula and inserts on the lower facet of the greater tuberosity. The labrum surrounds the glenoid and provides static stability by deepening the socket, acting as a buttress, and serving as an attachment for the glenohumeral ligaments (Fig. 39-5).¹ The most important structure in anterior dislo-

cation is the anterior inferior glenohumeral ligament. The rotator interval involves the capsule between the superior glenohumeral ligament and the subscapularis. The normal interval prevents inferior subluxation of the humeral head. The middle glenohumeral ligament crosses the subscapularis tendon anteriorly.

The face of the glenoid can be thought of as a clock face. The side view of the right shoulder in Figure 39-6 shows the orientation during arthroscopy. The lesions of the labrum are named according to their relationship to the clock face (Fig. 39-6). A SLAP (superior labrum, anterior posterior tear) lesion is located in the 10:00 to 3:00 position. Instability can be associated with SLAP lesions. An anterior inferior glenohumeral dislocation results in an anterior inferior labrum detachment referred to as a *Bankart lesion*. Weight lifters are more susceptible to lesions in the posterior superior labrum. Posterior inferior labral lesions are rare.

Shoulder function results from a sequence of linking movements throughout the kinetic chain. Scapulothoracic musculature provides the stability of the scapula to the chest, with the thoracolumbar spine allowing the shoulder to be supported in space. The movements of the scapula are protraction, retraction, rotation

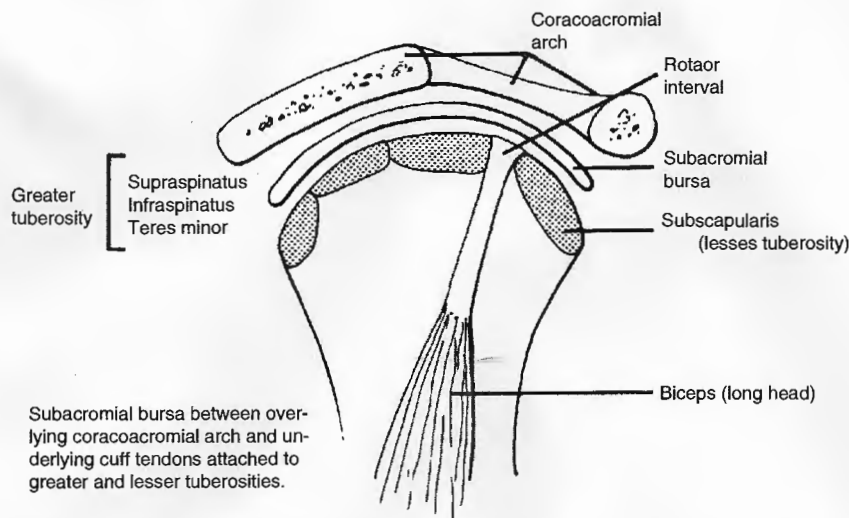


Figure 39-3. This side view of the coracoacromial arch and rotator cuff insertions shows the posterior position of the external rotators, supraspinatus, infraspinatus, and teres minor. The rotator interval is between the subscapularis and superior glenohumeral ligament. The bursa lies in the subacromial space and can be likened to a soft-tissue "sandwich" composed by the fixed coracoacromial arch, coracoacromial ligament superiorly and humeral head inferiorly. (From DeLee JC, Drez D: Orthopaedic Sports Medicine. Philadelphia, WB Saunders, 1994, p 624, with permission.)

(upward and downward), depression, and elevation. The largest and most easily seen muscle is the trapezius, which has its origin at the spinous processes of the thoracic vertebra and its insertion on the distal clavicle. The upper fibers elevate the scapula.^{44,59,64} Elevation of the scapula

is assisted by the levator scapulae, and the rhomboideus minor and major (Fig. 39-7).⁴¹ Opposing muscles that depress the scapula are the subclavius, which crosses the sternoclavicular joint, pectoralis minor, lower fibers of the pectoralis major, serratus anterior, latissimus

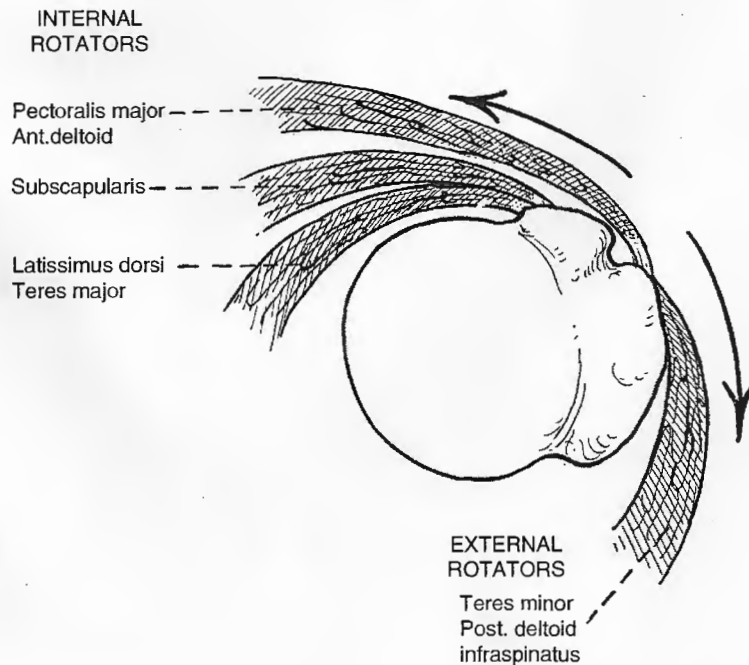
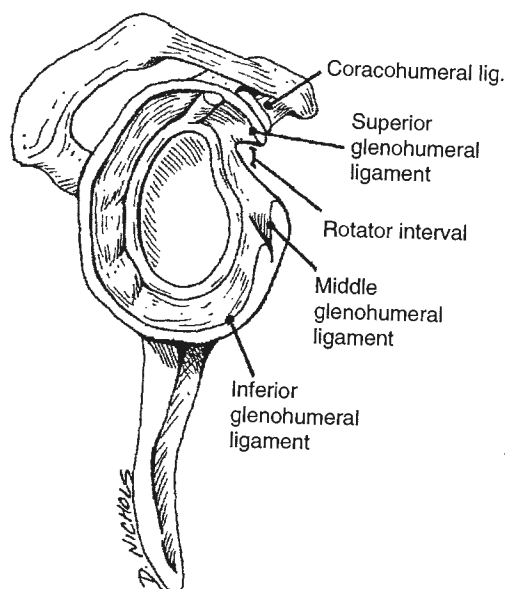


Figure 39-4. The important balance of the internal and external rotators is shown diagrammatically. The 4 muscles for the rotator cuff are external rotators of supraspinatus, infraspinatus, teres minor, and internal rotator of subscapularis. Other internal rotators of the shoulder are pectoralis major, anterior deltoid, subscapularis, latissimus dorsi, and teres major. (From Hollinshead WH, Jenkins DB: Functional Anatomy of the Limbs and Back. Philadelphia, WB Saunders, 1981, p 106 with permission.)



Orientation of glenohumeral ligament

Figure 39-5. With the humeral head removed, the glenoid concavity is deepened by the labrum and ligaments attach anteriorly onto the labrum in a superior, medial, and inferior fashion. (From Andrews JR, Zarins B, Wilk KE: *Injuries in Baseball*. Philadelphia, Lippincott-Raven, 1998, p 44, with permission.)

dorsi, and trapezius (Fig. 39-8).⁴¹ The upper part of the trapezius, lower part of the trapezius, and serratus anterior act as upward rotators (Fig. 39-9).⁴¹ The serratus anterior originates

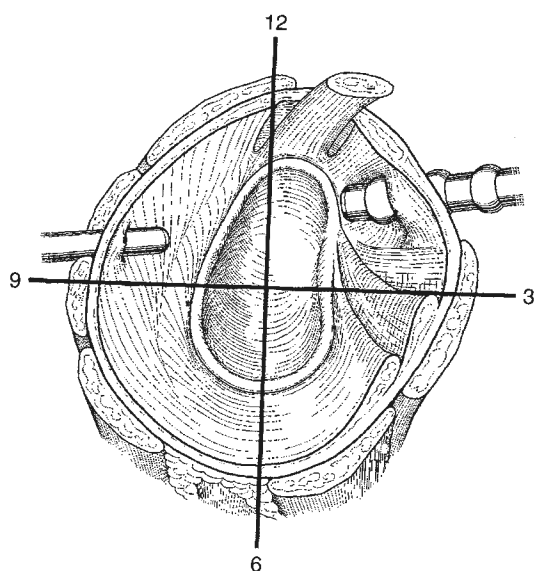


Figure 39-6. The orientation in this right glenoid visualized arthroscopically shows a clock schematic for classification of labral tears. Lesions in throwers typically are in the 12 to 3 o'clock position, and SLAP lesions in the 3 to 6 o'clock position anterior inferior. (Copyright 1998, ML Ireland, MD.)

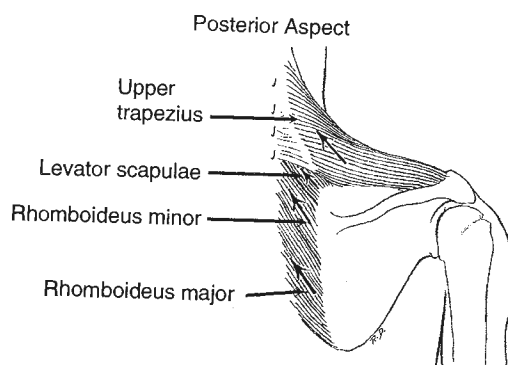


Figure 39-7. Scapular elevators and the direction of their forces. (From Hollinshead WH: *Anatomy for Surgeons*, Vol 3. New York, Harper & Row, 1969, p 327 with permission.)

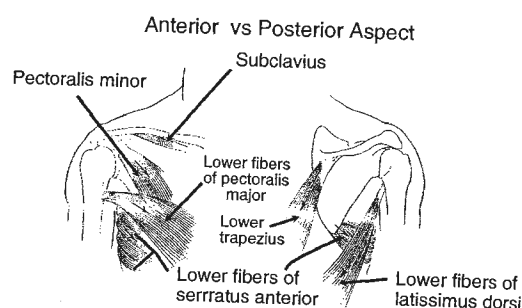


Figure 39-8. Scapular depressors and the direction of their forces. (From Hollinshead WH: *Anatomy for Surgeons*, Vol 3. New York, Harper & Row, 1969, p 328, with permission.)

from the ribs anteriorly and inserts on the inferior scapular angle. The serratus acts to protract and upwardly rotate the scapula.⁶⁷ Injury to the long thoracic nerve (C5-C7) causes winging of the scapula and significant disability. The downward rotators include the rhomboideus minor and major, levator scapulae, pectoralis minor, and lower pectoralis major (Fig. 39-10).⁴¹ The protractors of the shoulder are the pectoralis minor and major and serratus anterior muscles (Fig. 39-11).⁴¹ The opposing retractors of the scapula are the rhomboideus minor, middle

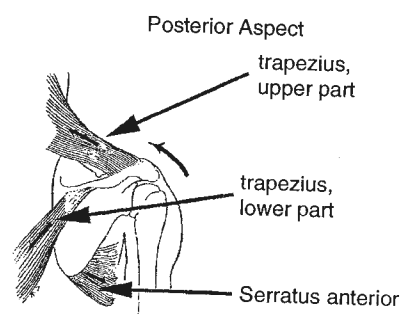


Figure 39-9. Upward rotators and the direction of their forces. (From Hollinshead WH: *Anatomy for Surgeons*, Vol 3. New York, Harper & Row, 1969, p 329 with permission.)

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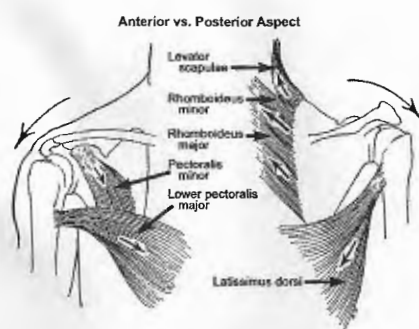


Figure 39-10. Downward rotators and the direction of their forces. (From Hollinshead WH: *Anatomy for Surgeons*, Vol 3. New York, Harper & Row, 1969, p 329, with permission.)

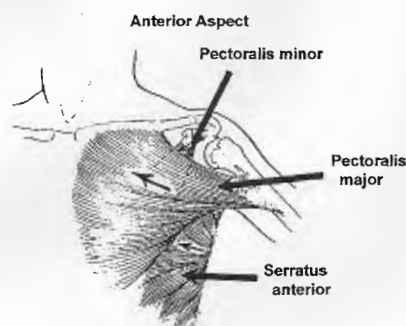


Figure 39-11. Scapular protractors. (From Hollinshead WH: *Anatomy for Surgeons*, Vol 3. New York, Harper & Row, 1969, p 330, with permission.)

trapezius, rhomboideus major, and upper latissimus dorsi (Fig. 39-12).⁴¹

The forces for shoulder function are generated mainly in the legs, hips, and trunk. The scapula helps to control the forces and motion at the shoulder joint and serves as a pivot point. Altered scapular motion and scapular dyskinesias may be seen in 67% to 100% of shoulder injuries. Efficient rotator cuff function requires a stable scapular base. Disorganized muscle activation patterns are observed early in shoulder injuries.

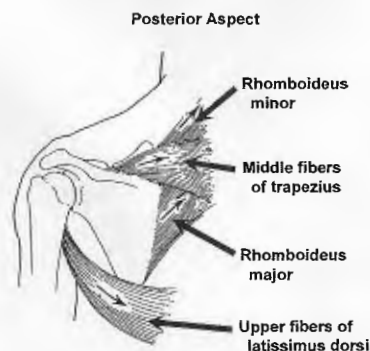


Figure 39-12. Scapular retractors. (From Hollinshead WH: *Anatomy for Surgeons*, Vol 3. New York, Harper & Row, 1969, p 331, with permission.)

Table 39-1 presents a summary of shoulder examination testing based on innervation, myotomes, and technique for testing.⁷⁰

PHYSIOLOGIC VARIATIONS AND GENDER DIFFERENCES

The female athlete, as a rule, has looser joints than the male athlete. There are familial and gender influences. In a study of 100 patients with musculoskeletal complaints, it was concluded that hypermobility syndrome occurs as an isolated condition and is genetically distinct from other connective tissue disorders.²⁸ An association of dominant inheritance in familial generalized articular hypermobility has been reported.⁹ There are reports of recurrent dislocation of the patella and shoulder associated with familial laxity.¹⁶ Increased generalized ligamentous laxity has been reported in patients with idiopathic scoliosis.⁸¹ In a study of normal shoulders and shoulders with instability and impingement, patterns of flexibility, laxity, and strength were evaluated.⁸² The study concluded that isokinetic testing may be helpful to screen for instability and impingement.

In a study comparing shoulder laxity and pain in competitive swimmers, 40 senior national elite swimmers completed a questionnaire and underwent clinical stability tests. The clinical score of glenohumeral laxity and presence of shoulder pain that interfered with practice or competition was statistically significant.⁵⁶ Therefore, shoulder laxity may be a common denominator in the cause of significant shoulder pain interfering with practice in the swimming athlete. The question remains, does underlying laxity predispose to the symptomatic instability?³ Thirty-six competitive swimmers with shoulder pain, the majority of whom were women, were evaluated for impingement and increased glenohumeral translation. The Hawkins test for impingement was more sensitive than other tests.^{39,61,62} The direction of shoulder laxity in swimmers in this series was predominantly anterior inferior and associated conditions existed (eg, shoulder pain from coracoacromial impingement with associated increased glenohumeral translation and apprehension). The goal is to determine the underlying or primary process. In the young athlete glenohumeral instability is usually the primary problem. A study of 150 asymptomatic shoulders in 75 school children revealed "instability in 57% of the shoulders in boys and in 48% of shoulders in girls." The mean age of the boys was 14.4 years and girls 16.6 years. A posterior drawer sign was found in 63 of the 300

Table 39-1. Shoulder Muscle Testing Chart

MUSCLE	INNERVATION	MYOTOMES	TECHNIQUE FOR TESTING
Trapezius	Spinal accessory	C2-C4	Patient shrugs shoulders against resistance.
Sternomastoid	Spinal accessory	C2-C4	Patient turns head to one side with resistance over opposite temporal area.
Serratus anterior	Long thoracic	C5-C7	Patient pushes against wall with outstretched arm. Scapular winging is observed.
Latissimus dorsi	Thoracodorsal	C7-C8	Downward backward pressure of arm against resistance. Muscle palpable at Inf. angle of scapula during cough.
Rhomboids	Dorsal	(C4) C5 ^a	Hands on hips pushing elbows backward against resistance.
Levator scapulae	Scapular		None
Subclavius	Nerve to subclavius	C5-C6	None
Teres major	Subscapular (lower)	C5-C6	Similar to lat. dorsi; muscle palpable at lower border of scapula.
Deltoid	Axillary	C5-C6 (C7)	With arm abducted 90°, downward pressure is applied. Anterior and posterior fibers may be tested in slight flexion and extension.
Subscapularis	Subscapular (upper)	C5	Arm at side with elbow flexed to 90°. Examiner resists internal rotation.
Supraspinatus	Suprascapular	C5 (C6)	Arm abducted against resistance (not isolated). With arm pronated and elevated 90° in plane of scapula, downward pressure is applied.
Infraspinatus	Suprascapular	C5 (C6)	Arm at side with elbow flexed 90°. Examiner resists external rotation.
Teres minor	Axillary	C5-C6 (C7)	Same as for infraspinatus
Pectoralis major	Medial and lateral pectoral	C5-T1	With arm flexed 30° in front of body, patient, adducts against resistance.
Pectoralis minor	Medial pectoral	C8, T1	None
Coracobrachialis	Musculocutaneous	(C4) C5-C6 (C7)	None
Biceps brachii	Musculocutaneous	(C4) C5-C6 (C7)	Flexion of the supinated forearm against resistance.
Triceps	Radial	(C5) C6-C8	Resistance to extension of elbow from varying position of flexion.

^aNumbers in parentheses indicate a variable but not rare contribution.

From Rockwood CA, Matsen FA III (eds): *The Shoulder*, Vol 1. Philadelphia, WB Saunders, 1990, with permission.

shoulders. Generalized joint laxity was not a feature of subjects whose shoulder had positive instability signs.²⁴

Females test weaker in upper body strength than males. Lower extremity gender differences are much less than those of the upper extremity and equalize more quickly with a strengthening program.

PHYSICAL EXAMINATION

In general, the physical examination is used to confirm the diagnosis suggested by the history.^{4,12,22,29,32,37} With a combination of careful history and physical examination, a diagnosis can be obtained. There are many excellent review articles about the physical examination of the shoulder. These articles all emphasize the importance of making the diagnosis. Oftentimes there are many abnormal physical examination tests, and from these results the examiner must decide the initial abnormality that started the

shoulder complex. Unfortunately, many of the physical examination tests do not isolate the primary or initial diagnosis. A detailed history and repeat examinations are required.

Access to the entire upper body, including both shoulders, is essential. Examination requires a table that will support both supine and prone testing. Systematic examination of the entire shoulder complex should be performed routinely. Examination comprises inspection, palpation, assessment of range of motion, strength testing, and finally, special provocative testing. Measurements should be taken the same way at each examination, recorded, and compared to the uninvolved side.

Inspection

Inspection requires complete access to the upper body. Female athletes are best evaluated in a gown or halter top that exposes both shoulders and scapulae. Systematic inspection may reveal asymmetry, atrophy, hypertrophy, prominences,

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depressions, or swelling, which should be noted. Scars suggest prior injury or surgery. Hypertrophy may be normal in the throwing and overhead athlete, however, atrophy in the supraspinatus and infraspinatus fossa may suggest rotator cuff pathology or suprascapular nerve entrapment. Deformity suggests an acute or chronic injury such as glenohumeral or acromioclavicular joint dislocation. Rupture of the long head of the biceps tendon would be demonstrated by asymmetrical distal biceps enlargement.

The lower extremity is often overlooked, and also requires careful observation. Trunk and core imbalances will result in abnormal shoulder biomechanics. The entire kinetic chain requires evaluation. Posture should be evaluated for trunk kyphosis or lordosis. Hip weakness may manifest as a Trendelenburg gait. The scapula may have a drooping or abnormally protracted attitude. All areas found to be abnormal on the physical examination must be addressed in the rehabilitation program.

Palpation

All joints and articulations require palpation, assessing for instability and pain with motion. The examination proceeds systematically from proximal to distal, starting with the sternoclavicular joint, progressing to the clavicle and acromioclavicular joint, and ending with the acromion and coracoid. Tenderness with deformity over a joint suggests dislocation or subluxation, while pain without deformity suggests arthritis. Posterior sternoclavicular dislocations require urgent medical attention as neurovascular compromise may occur. Tenderness surrounding the coracoid is nonspecific and can occur with anterior subluxation, acromioclavicular separations, and joint coracoid impingement. Joint line tenderness may suggest a labrum tear. The rotator cuff is assessed just lateral to the acromion. Discomfort suggests rotator cuff tendonitis or tear.

Range of Motion

Active and passive range of motion is assessed. Forward flexion, abduction, and internal and external rotation with the arm in 90° of abduction are recorded bilaterally. The scapula should be stabilized to assess true glenohumeral motion. Greater external rotation on the dominant side of an overhead or throwing athlete is common and is usually normal, however, if a significant internal rotation deficit exists, the posterior capsule may be contracted. Asymmetry and limitations are documented.

Palpation throughout range of motion may reveal crepitus emanating from the glenohumeral, acromioclavicular, or scapulothoracic joint or from the subacromial space. The quality of the scapulothoracic motion is assessed dynamically. The athlete is then asked to perform repetitive circular motions; dyskinesia suggests shoulder pathology or nerve injury. Flexibility of the hip and core should also be assessed.

Strength

Muscle strength is determined and recorded for the deltoid, supraspinatus, and involved external and internal rotators. The muscles work in patterns, and do not function in an isolated manner. Various grading systems have been described.^{70,71} The sides should be compared and determinations recorded.

The distant kinetic chain also should be evaluated. Hip strength is quickly assessed by having the patient perform a one-legged squat to 45° of knee flexion followed by extension. The proper position is one of hip over knee over ankle. Hip and leg rotation indicate weak hip abductors.

Order and Principles of Physical Examination

The most painful part of the examination should be done last. The goal of the examination is to determine the primary diagnosis. Is the involved joint glenohumeral, acromioclavicular, or sternoclavicular? Is the structure involved labrum or capsuloligamentous? Is the rotator cuff pathology articular or bursal? Is it inflammation or a tear, partial or complete? After a thorough history is taken, the patient is asked to actively move the shoulder while the examiner checks for ranges of motion of abduction, forward flexion, and internal and external rotation. Any asymmetry should be noted. Scapulothoracic motion is then assessed with several maneuvers. The patient should wear a halter or swim suit top to better assess scapulothoracic motion (Fig. 39-13). The patient is instructed to stand and to push backward against the examiner's hand. Scapular asymmetry and motion away from the spine is observed. While the patient performs a push-up against a wall, flexes forward, pushes her palms together, puts her hands on her waist, and pushes backward against the examiner's hand, the examiner assesses scapular movement and observes for symmetric protraction, retraction, upward and downward elevation, and rotation. The distance from the spinous processes to the scapula is measured. Scapular winging is observed. Trigger points are palpated. Next, the

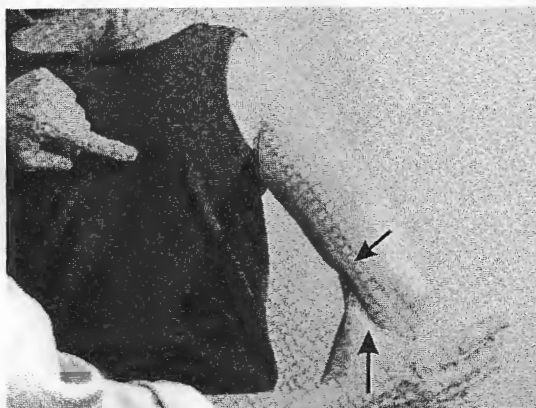


Figure 39-13. Observation for scapular motion is done as the patient is instructed to push against the examiner's hand. (Copyright 2002, ML Ireland, MD.)

patient is examined seated, supine, and prone while she goes through a series of range of motion and strength testing.

Correlation of the deficient anatomic structure as it relates to the physical examination allows the examiner to determine the diagnosis and better design the rehabilitation program and/or surgery. This helps to reveal what positions to avoid based on the apprehension positions obtained during the examination (Table 39-2).³³

The labrum is a fibrocartilaginous structure that attaches to the glenoid, improving stability by deepening the concavity of the glenoid. Variations of labral attachments at the biceps anchor and anterior superior and middle glenohumeral ligaments are frequently seen. SLAP tears are better understood as arthroscopic techniques have become more common and instrumentation and techniques have advanced.

Tears of the labrum are associated with instability in 50% of cases. Snyder classified labral tears into 4 types (Fig. 39-14)^{1,76}: type I, labral fraying with no detachment; type II, detachment of superior labrum and biceps anchor; type III, Bucket handle tear, intact biceps anchor; type IV, bucket handle tear extending into the biceps tendon.

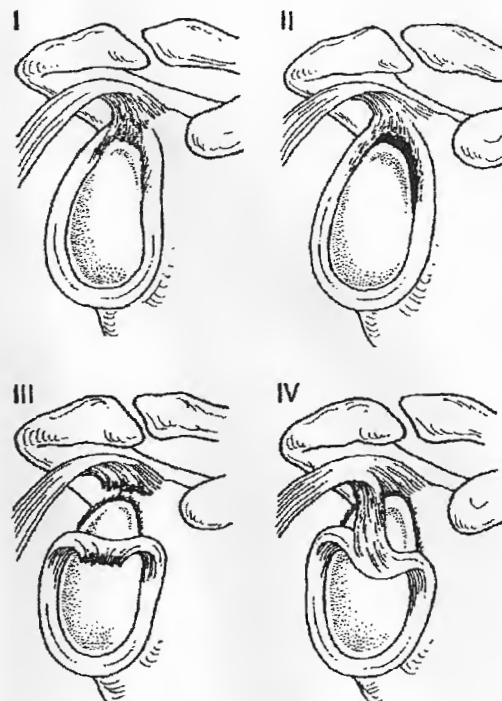


Figure 39-14. Snyder classification of labral tears. (From Snyder SJ, Karzel RP, Del Pizzo W, et al: SLAP lesions of the shoulder. *Arthroscopy* 6:274-9, 1990, with permission.)

PROVOCATIVE TESTS

Instability and Labral Injury

Numerous tests exist to help identify and quantify instability and labral pathology. The patient is sometimes able to voluntarily demonstrate posterior or multidirectional instability. Generalized ligamentous laxity may be present with instability and should be assessed. Elbow hyperextension greater than 10°, abduction of the thumb to touch the forearm, metacarpophalangeal joint hyperextension, and knee hyperextension greater than 10° are clues that generalized ligamentous laxity exists.

Table 39-2. Anatomic Considerations in Shoulder Stabilization

POSITION OF ABNORMAL TRANSLATION	DEFICIENT ANATOMIC STRUCTURE
Inferior subluxation (in adduction)	Rotator interval
Translation at 45°	Middle glenohumeral ligament
Translation at 90°	Anterior, inferior glenohumeral ligament
Inferior subluxation (in abduction)	Axillary recess
Posterior translation at 90°	Posterior, inferior glenohumeral ligament
Posterior translation at 45°	Mid-posterior capsule

From Guandre CA: Arthroscopic shoulder stabilization. *Operative Tech Sports Med* 10(1): 18-24, 2002, with permission.

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Stability Testing

Glenohumeral translation is evaluated. The patient is seated and a Lachman or drawer test of the shoulder is performed. The scapula is stabilized and anterior, posterior, and inferior forces are applied to the humeral head. Excursion is noted and compared to the uninjured side (Fig. 39-15). A grading system from 0 to III has been described. Grade 0 is normal. Grade I demonstrates up to 50% translation and is a normal excursion in anterior translation. In grade II the humeral head rides over the glenoid and spontaneously reduces; posteriorly, grade II is generally normal. In grade III, the humeral head dislocates and remains dislocated upon the release of force.²⁷ Grading the difference and direction from the involved side to the uninjured side is done and documented.

The sulcus sign is tested with the athlete's arm at the side. A longitudinal force is applied and the displacement between the humeral head and the lateral acromion is noted. Greater than 1 cm of excursion is pathologic and suggests inferior and multidirectional instability. Similar testing with the arm in 30° of external rotation will assess the rotator interval.³⁶

Anterior Apprehension Test. The patient is supine or sitting and the arm is in 90° of abduction and 90° of elbow flexion. The scapula is stabilized and while the shoulder is maximally externally rotated an anterior force is applied to the proximal humerus (Fig. 39-16). With anterior instability, the athlete becomes apprehensive

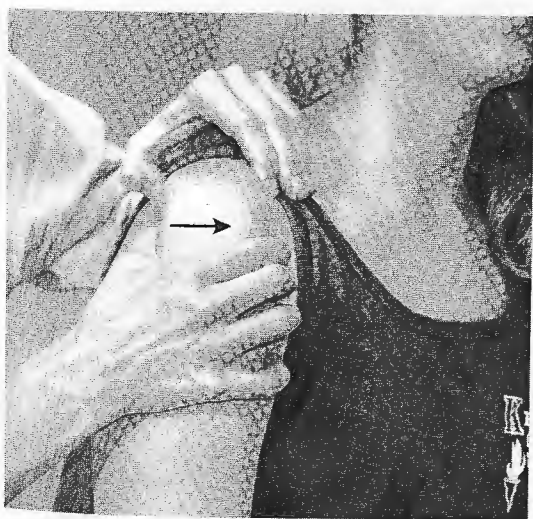


Figure 39-15. The stability of the shoulder is tested in the seated position by performing anterior humeral head translation with the right hand while stabilizing the acromion. (Copyright 2002, ML Ireland, MD.)

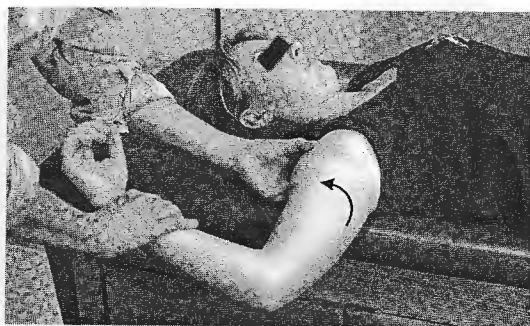


Figure 39-16. In a supine position, the arm is abducted and externally rotated and the humeral head is translated anterior to reproduce anterior instability or anterior labral symptoms. (Copyright 2002, ML Ireland, MD.)

and exhibits anxiety as it feels as if the shoulder will subluxate or dislocate. Speer and coworkers demonstrated that in patients who underwent anterior capsular reconstruction who had sustained a prior dislocation, true apprehension without pain was present in 96% of patients preoperatively. However, if pain is present, rotator cuff pathology needs to be considered as this shoulder position places stress on the rotator cuff and the anterior capsule. In subjects requiring anterior capsular reconstruction who have not had a complete dislocation, true apprehension without pain will be felt in only 42%, while pain will be present in 84%.⁷⁷

Posterior Apprehension Test. The athlete is supine or seated and the shoulder is placed in 90° of forward flexion and then internally rotated. A posterior force is applied at the elbow; the athlete may feel as if the shoulder is going to subluxate or dislocate. In some cases the patient can demonstrate posterior instability voluntarily moving her shoulder into horizontal adduction and internal rotation.

Palpating the humeral head and applying posterior force, the humeral head is pushed posteriorly and a "pop" is felt, indicating posterior instability and a posterior labral tear. If one is thinking about instability, attempts at distraction and reproducing the direction of instability posteriorly are made, going into horizontal adduction and internal rotation with posterior rotation. The anterior direction is external rotation, abduction, and anterior palpation for any humeral head luxation or labral "pop". With the patient in the prone position, posterior instability is checked. The posterior glenohumeral joint is palpated as force is directed posteriorly (Fig. 39-17).



Figure 39-17. In the supine position posteriorly directed forces are placed on the forearm while the glenohumeral joint is palpated with the left thumb. Reproduction of symptoms of humeral head luxation confirms posterior instability or labrum tear. (Copyright 2002, ML Ireland, MD.)

Labral Testing

To test for labral injuries, axial loading is performed and the arm is maximally horizontally abducted, internally rotated, and externally rotated. If there is pain in maximal internal rotation, this is more indicative of labral tear than in external rotation. Conditions of the rotator cuff may also cause pain with rotation maneuvers. No one test is specific for rotator cuff, labrum, or capsule. Many tests named after the examining physician have been reported. The principles of the test must be understood and the steps taken to reproduce symptoms described.

Oftentimes there are injuries to the labrum and articular side of the rotator cuff. The vicious cycle of injury in a younger person will usually start with instability, leading to rotator cuff weakness, then compression impingement, pain, and muscular imbalance. The labral injury can occur at the time of the initial instability episode.

The labral tests may be thought of as comparable to meniscal tests of the knee. Compression and rotation of the humeral head on the torn labrum produces pain, popping, and reproducible symptoms. Supine and prone tests are done similar to stabilization tests but axial loading and compression forces are applied instead of distraction.

With the patient supine, testing for stability is done again. While the examiner stabilizes the

scapula with his or her hand, the arm is externally rotated and abducted. Pain and apprehension or a labral "pop" indicate anterior instability.

Relocation Test. The relocation test is performed similar to the apprehension test. When symptoms begin to occur, a posterior force is applied to the proximal humerus and the symptoms of apprehension or pain diminish or resolve.⁴⁶ If apprehension complaints resolve, the likelihood of anterior labral pathology is high.⁷⁷

O'Brien's Test. The arm is placed in 90° of forward flexion, internally rotated with the thumb pointing downward, and then adducted 15° to 20° across the chest. The examiner applies a downward force at the hand. The thumbs-down position loads the biceps–glenoid–labrum complex, and places compressive loads on the acromioclavicular joint. Deep pain relieved with external rotation is suggestive of a SLAP lesion. Acromioclavicular joint pathology will cause more superficial pain. Pain must be relieved in the thumb-up position for the test to be positive.^{65,66}

SLAP Test. The arm is in 90° of abduction with the hand fully supinated. The examiner's hand is placed on the shoulder with the thumb in the axilla. The examiner applies a downward force to the supinated hand, while applying an upward force with the thumb. Pain is suggestive of a type II or IV SLAP lesion.

Anterior Glide Test. The seated athlete places her hand on the ipsilateral hip with her fingers anterior and her thumb posterior. While stabilizing the scapula, an upward and forward force is applied at the elbow by the examiner. The athlete may have pain or a "click" with anterior superior lesions, SLAP tears, and middle glenohumeral ligament avulsions. With a positive test, there is a high probability of a labral lesion. The reported specificity is 91% and sensitivity 79%.⁴⁷

Crank Test. An upright examination test has been reported by Liu.⁵² Sensitivity and specificity is very high in this test, which is performed with the patient in an upright position. The examiner performs the crank test by elevating the patient's arm 260° in the scapular plane and loading against the axis of the humerus with one hand, while externally and internally rotating the patient's other hand.

Load and Shift Test. This test allows the examination of any part of the labrum. The arm and elbow are abducted to 90°. The examiner places a thumb in the axilla and directs a force toward the area to be tested.

Rotator Cuff Injury

Supraspinatus Injury

Supraspinatus testing is done with the patient in the empty can position. (Fig. 39-18). With the palm parallel to the floor, the deltoid is tested. In the "empty can" position, there is lessening of the subacromial space and rotator cuff weakness is detectable. Neer, Welsh, and Hawkins popularized names for impingement signs in which the arm is placed into a hyperabducted forward elevated position, causing the supraspinatus to be "impinged" by the fixed bony acromion and coracoacromial ligament.^{37,89} In the standing position, the arm is horizontally adducted and internally rotated (Fig. 39-19). If this reproduces pain, this indicates subacromial bursal and rotator cuff involvement. Pain can often radiate into the upper arm.³⁸ In the supine position, the rotator cuff and subacromial space can be palpated for crepitus, popping, and reproducible pain in internal and external rotation (Fig. 39-20). Differences in location in glenohumeral labral popping and subacromial location can be felt by an experienced examiner. The examiner should pick several of the impingement tests and become proficient at these, describing what test is being done, rather than just giving the name of the tests.

Subscapularis Injury

Tests for subscapularis function include internal rotation testing with arms behind the back or the lift-off test. The subscapularis can be palpated anteriorly and there can be pain over the subscapularis tendon when there is inflammation or a tear. There is usually no palpable deformity. The lift-off test is performed by asking the



Figure 39-19. Impingement is tested by horizontally adducting the shoulder and internally rotating the humerus. Reproduction of pain in the upper arm indicates subacromial rotator cuff involvement. (Copyright 2002, ML Ireland, MD.)

patient to put the back of her hand behind the low back and lift her hand away from the spine while the examiner pushes on the palm.³⁰ The patient will have pain and be unable to push her arm back. Burkhart described the Napoleon sign, in which the patient is asked to put her hand on her abdomen and push toward the abdomen. The arm should stay in a straight line. If it does not, this indicates subscapularis involvement.



Figure 39-18. The rotator cuff is tested with the arm in slight horizontal adduction and a thumb-down position. Weakness and pain are consistent with rotator cuff dysfunction. (Copyright 2002, ML Ireland, MD.)

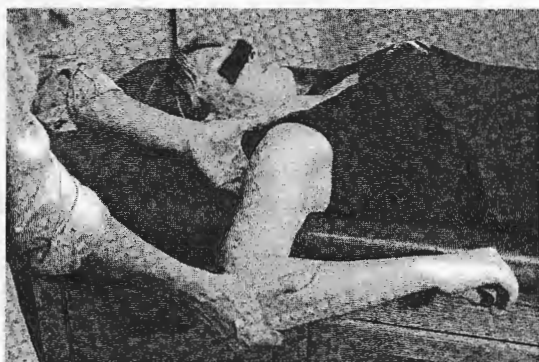


Figure 39-20. Palpating the subacromial space by internally rotating the humerus is done to distinguish primary rotator cuff involvement. Crepitus is often palpated in the subacromial space. (Copyright 2002, ML Ireland, MD.)

Biceps Tendon Injury

In the past, biceps tendinitis and instability were more often diagnosed. In overhead throwers, the biceps tendon is rarely involved by itself and is often associated with either an articular-sided supraspinatus disorder or a SLAP tear. In repetitive activities that involve elbow flexion, pronation, or supination, primary biceps problems can occur. Localized tenderness on palpation over the bicipital groove is seen. Feeling a "pop" and ecchymosis in an individual with an associated rotator cuff tear indicates a proximal biceps rupture.

In the Speed test, the patient resists forward elevation of the arm with the hand held in supination and the elbow extended.³¹ In the Yergason test, the patient flexes the elbow to 90° and is instructed to supinate the forearm against resistance.⁸⁷ Yergason and Speed tests are positive if pain is felt over the biceps tendon proximally in the bicipital groove.

IMAGING

Roentgenography

Plain roentgenography provides important information in assessment of the injured shoulder. Referral to a standard atlas helps the x-ray technician to position the patient for the view desired.⁵⁷ Views must be obtained in the anteroposterior and lateral directions. Failure to obtain adequate views in at least 2 planes may result in missed fractures or dislocations, partic-

ularly posterior lesions. Routine anteroposterior views are obtained in the plane of the thorax in internal rotation (Fig. 39-21).

The Stryker view (Fig. 39-22) was described by Hall and coworkers.³⁵ The axillary lateral view shows a notch in the posterolateral humeral head, known as a Hill-Sachs lesion (Figs. 39-23 and 39-24).

Standing outlet views also can be obtained (Fig. 39-25). The West Point view was described by Rokous and coworkers with the beam directed to view to anterior glenoid rim (Fig. 39-26 A,B).^{69,70} A modified axillary lateral view with the arm in external rotation will distinguish a Hill-Sachs lesion, a posterolateral humeral head fracture, from anterior instability (Fig. 39-27). The patient depicted in Figure 39-28 with anterior instability had a normal axillary view, but the modified axillary view in external rotation revealed flattening of the humeral head, consistent with a Hill-Sachs lesion. The axillary lateral view on the left shows no Bankart lesion and a normal humeral head; in the externally rotated position, however, a Hill-Sachs lesion is revealed. A West Point view can also be obtained to show humeral head lesions.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) gives the clinician another test to determine the correct diagnosis. Referral to an orthopaedic surgeon who treats many athletes with shoulder problems should be done prior to ordering an MRI scan. MRI performed at a facility where the

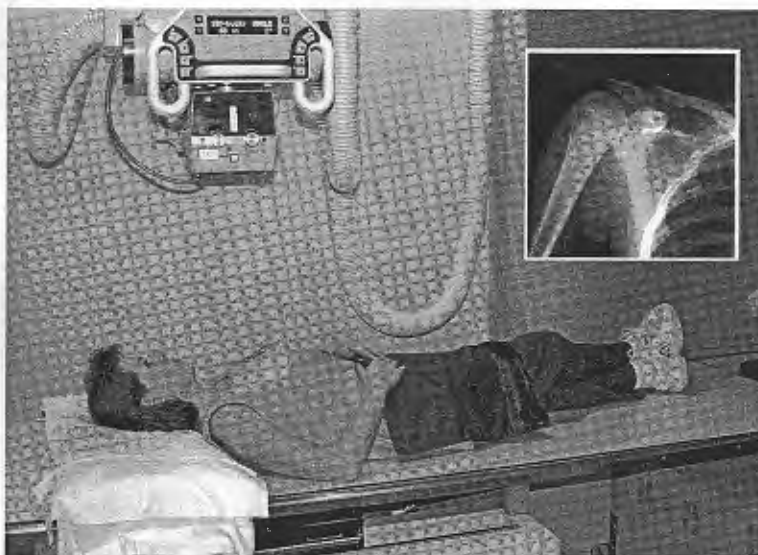


Figure 39-21. The position of the patient and normal roentgenographic findings are shown in the internal rotation anteroposterior view. (Copyright 2002, ML Ireland, MD.)

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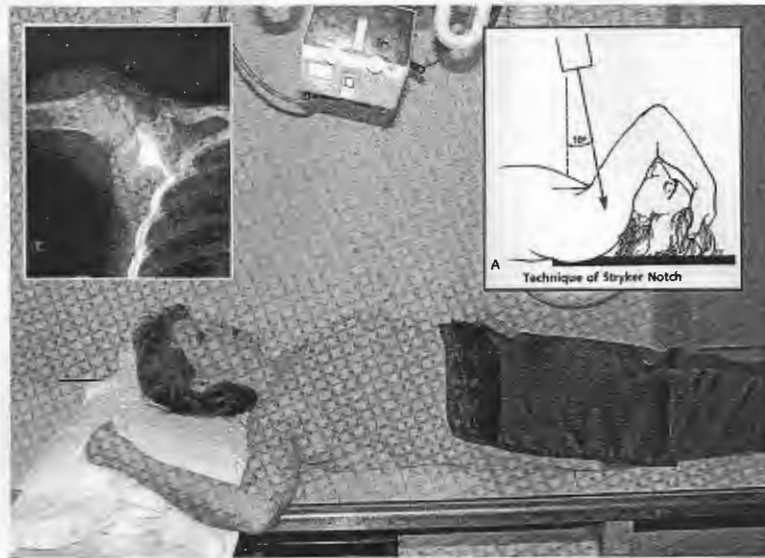


Figure 39-22. The Stryker view is described as 45° of abduction, as shown in the diagram. The modified Stryker view allows better roentgenographic imaging of the acromioclavicular joint and posterior glenoid. (Copyright 2002, ML Ireland, MD.)

quality is inferior and the reading radiologist cannot be contacted by the ordering physician is not of benefit. If the ordering physician cannot read the MRI scan, referral to a physician treating shoulder problems is appropriate. Intra-articular gadolinium-enhanced MRI gives more meaningful information if a labral tear is suspected.

A study comparing MRI and clinical examination found that physical examination is more accurate in predicting glenoid labrum tears than MRI.⁵³ The other conclusion was that in this era of cost containment, the diagnostic workup, without expensive ancillary services, allows the

patient's care to proceed in the most timely and economical fashion. However, a letter to the editor regarding questions on the Liu study reported that reanalysis of MRI interpretation revealed discrepancies. The MRI studies were not blinded in scoring and the study was retrospective.⁷⁴ Vigorous review of any published article must be done by all interested readers.

Several studies have been performed comparing intra-articular injection, arthrography, and MRI to non-intra-articular MRI. A study from the Hospital for Special Surgery concluded that with appropriate pulse sequences, unenhanced (non-intra-articular injected) MRI of

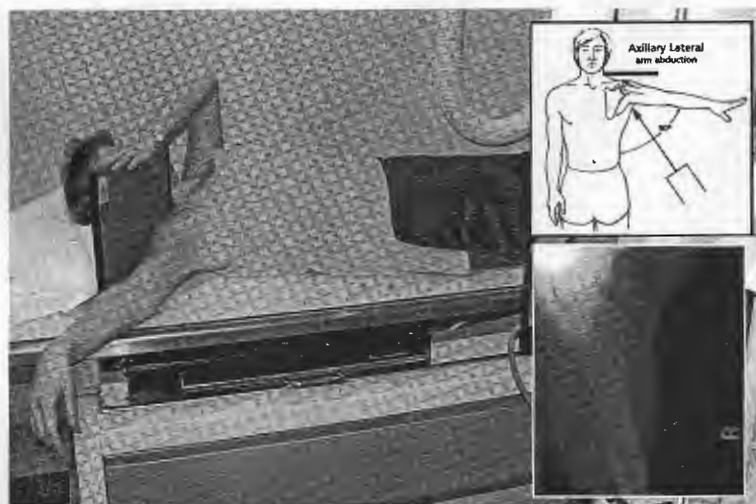


Figure 39-23. Supine position for axillary lateral view. The beam is angled from inferior to posterior and the arm is palm down, relatively internally rotated. (Copyright 2002, ML Ireland, MD.)



Figure 39-24. Supine outlet view position. The subacromial space and morphology of the acromion is well visualized. (Copyright 2002, ML Ireland.)

the shoulder is an accurate technique for detection and localization of labral injuries.³⁴

In another study from the Hospital of Special Surgery of non-contrast-enhanced superior labral lesions, MRI, and arthroscopy, the conclusion was that high-resolution non-contrast-enhanced MRI can accurately diagnose superior labral lesions and aid in surgical management. MRI had a specificity of 89.5% and an accuracy of 95.7% in this study of 102 patients.¹⁹

In another study of 57 subjects, routine MRI provided the best results in rotator cuff tears as opposed to labral injuries. Three injury groups were compared: labral tears, rotator cuff disease, and other pathologic conditions. In a study conducted at the University of Calgary MR Center, MRI did not appear to be an accurate, effective tool for assessing shoulder pathologic conditions in which the clinical picture is not clear.⁷⁹ Comparing MRI and arthroscopic evaluation in the 11 labral tears identified by MRI, accuracy

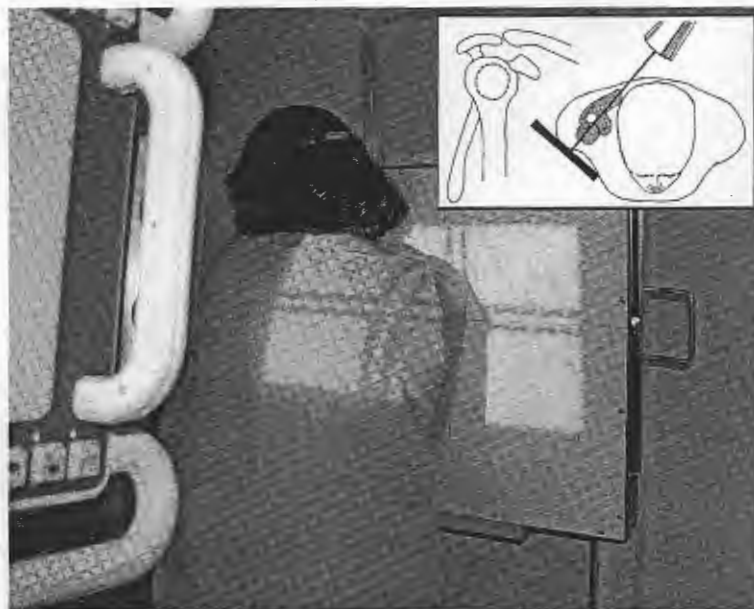


Figure 39-25. Standing outlet views can also be performed as shown by position and diagrammatically. (Copyright 2002, ML Ireland, MD.)

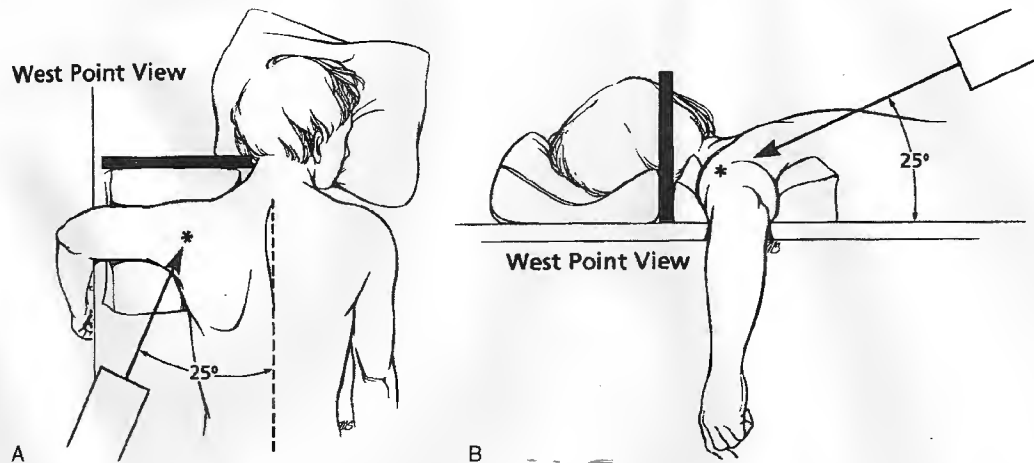


Figure 39-26. (A & B) The West Point view is obtained in the prone position, tangential, with the beam directed tangentially to the anterior inferior rim of the glenoid. Calcifications and Bankart lesions can best be seen in this view. (From Rokous FR, Feagin JA, Abbott HD: Modified axillary roentgenogram. Clin Orthop 82:84-6, 1972, with permission.)

was 62%, sensitivity 73%, and specificity 58%. In rotator cuff tears identified by MRI, accuracy was 68%, sensitivity 96%, and specificity 49%.

In another study correlating 88 patients, MRI, and arthroscopic surgery, MRI accurately predicted anterior labrum tears with a sensitivity of 96%, specificity of 86%, and accuracy of 92%. MRI was less predictive of tears of the superior labrum and was unreliable in the prediction of posterior or inferior labral tears.⁵¹

It is the authors' opinion that intra-articular gadolinium enhancement improves the accuracy and sensitivity of labral tears. In a study of 159 patients, 52 underwent arthroscopy after MRI

arthrography. Arthrography was found to be a useful and accurate technique in the diagnosis of SLAP lesions, giving information regarding the exact location of the tear and the greater involvement of the biceps tendon.¹¹

Computed Tomography

Computed tomography (CT) is still used by some to assess glenoid version and the labrum. However, the information obtained from MRI, which includes the rotator cuff, biceps, subscapularis, and capsule, makes the MRI superior to CT.



Figure 39-27. To reveal Hill-Sachs lesions, a modified axillary view is obtained with the arm in external rotation. Flattening of the posterior humeral head indicates anterior instability. (Copyright 2002, ML Ireland, MD.)



Figure 39-28. This football athlete with anterior instability had a normal axillary appearance on the left, but the external rotation view revealed humeral head flattening (arrow), consistent with a Hill-Sachs lesion. (Copyright 2002, ML Ireland, MD.)

EPIDEMIOLOGY

Injury rates are extremely difficult to calculate because of the many diagnoses recorded. For information that will assist in prevention, one must strive to make the primary diagnosis. The National Collegiate Athletic Association (NCAA) rates comparing genders for shoulder injury in 1999 to 2000 are shown in Table 39-3.⁶⁰ The categories are shoulder, clavicle, scapula, acromioclavicular joint separation, and other.

In sports that are comparable in competition, basketball and soccer, the rates for injuries to the clavicle, scapula, and acromioclavicular joint are extremely low but are greater in women than men. Classification of injuries is by body part: shoulder, clavicle, scapula, and acromioclavicular joint separation. The highest rate of shoulder injury is in men's football, 5.85, followed by wrestling, 5.51. However, in basketball, the injury rates are greater in the shoulder for women and men in practice and games. In soccer, the men and women's injury rates are the same in practice but greater in men and in games. Lacrosse has a greater injury rate of the shoulder in men compared to women.

Several series comparing gender and shoulder injury rates have been reported. In an epidemiologic survey of shoulder complaints in upper arm sports events, 372 athletes responded. In this survey, 35% (130) were female and 65% (242) were male.⁵⁴ Forty-four percent¹⁶³ in this survey had shoulder problems. The sport with the highest percentage of injury was volleyball, followed by swimming.

In a survey of recreational cyclists, the shoulder was more often injured in females compared to males. Neck injuries were also greater in females compared to males and occurred at the highest rate.⁸⁵

In a study of alpine skiing, gender comparisons were made. Males were injured more often than females. In falls, the top 3 diagnoses were rotator cuff contusion, 24%, anterior glenohumeral dislocation, 22%, and acromioclavicular joint separation, 20%. Of the anterior glenohumeral dislocations, 61 of 85 (72%) were primary dislocations. Males were affected in 83.5% of injuries and females in 16.5%. Similar percentages were seen in acromioclavicular joint separations.⁴⁹

DIFFERENTIAL DIAGNOSIS

The primary diagnosis in shoulder problems must be made. In the face of shoulder laxity in the female athlete, the incorrect diagnosis of subacromial impingement or rotator cuff dysfunction as the primary problem is often made. In the young athlete, repetitive movements that may cause humeral head subluxation and physiologic laxity predispose to a vicious cycle that results in rotator cuff dysfunction. Understanding the cascade of events that occur in swimming, gymnastics, cheerleading, and tennis is necessary in treating the athlete with shoulder problems (Fig. 39-29).

In a patient performing repetitive training activities, physiologic laxity can lead to micro-

Table 39-3. NCAA Injury Rates for Shoulders, 1999–2000

		SHOULDER		CLAVICLE		SCAPULA		AC SEPARATION		OTHER ^a	
		PRACTICES	GAMES	PRACTICES	GAMES	PRACTICES	GAMES	PRACTICES	GAMES	PRACTICES	GAMES
Gymnastics	Women	0.30	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00
	Men	1.82	0.85	0.10	0.00	0.00	0.00	0.20	0.00	0.00	0.00
Basketball	Women	0.14	0.41	0.00	0.03	0.00	0.00	0.00	0.07	0.08	0.07
	Men	0.09	0.33	0.01	0.00	0.01	0.00	0.00	0.03	0.06	0.09
Soccer	Women	0.09	0.40	0.01	0.11	0.00	0.00	0.00	0.07	0.15	0.26
	Men	0.09	0.66	0.04	0.12	0.00	0.00	0.01	0.20	0.09	0.00
Lacrosse	Women	0.16	0.47	0.00	0.00	0.00	0.00	0.03	0.00	0.03	0.00
	Men	0.23	2.22	0.01	0.08	0.00	0.00	0.08	0.82	0.05	0.00
Field Hockey	—Women	0.02	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.07	0.00
Volleyball	—Women	0.55	0.51	0.00	0.00	0.00	0.00	0.01	0.00	0.06	0.00
Softball	—Women	0.29	0.44	0.01	0.03	0.02	0.00	0.00	0.01	0.02	0.00
Spring Football	—Men	1.13	0.00	0.16	0.00	0.04	0.00	0.15	0.00	0.08	0.00
Wrestling	—Men	0.85	5.51	0.01	0.51	0.02	0.10	0.07	0.82	0.20	0.41
Football	—Men	0.50	5.85	0.04	0.56	0.00	0.04	0.09	1.42	0.18	0.30
Ice Hockey	—Men	0.22	2.28	0.05	0.75	0.00	0.14	0.04	1.40	0.06	0.14
Baseball	—Men	0.39	0.81	0.00	0.02	0.00	0.01	0.01	0.00	0.01	0.01

All data are shown as rate per 1000 athletic exposures for 1999–2000.

^aOther: Principal body part injured

From NCAA Injury Surveillance System, 1999–2000. Copyright 2002, ML Ireland, MD.

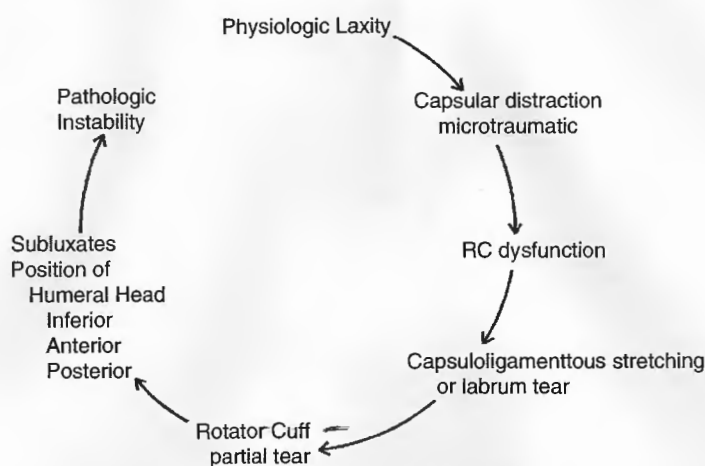


Figure 39-29. The vicious cycle in which physiologic laxity can lead to pathologic instability is shown schematically.

traumatic capsular distraction, as well as rotator cuff dysfunction and stretching of the capsule or labral tear. Because of these distraction forces and repetitive tensile forces on the rotator cuff, a partial articular-sided rotator cuff tear occurs. The humeral head can then become unstable in an anterior, posterior, or inferior direction, or in all 3 directions. As the activity continues, pathologic instability develops. The physician must decide the direction and degree of instability, and whether this instability is acute or chronic, and make a specific diagnosis. The TUBS pattern (*t*raumatic, *u*nidirectional, *B*ankart, *s*urgery) is the easiest instability pattern to treat, in that it is a one-event, one-direction problem that is treated with surgical repair of the injured structures. The AMBRI pattern (*a*traumatic, *m*ultidirectional, *b*ilateral *r*ehabilitation, *i*nferior capsule shift), seen commonly in the female athlete,³⁷ is a result of repetitive movements in a multidirectionally lax shoulder. Decisions for treatment and specific movements to avoid in rehabilitation are based on the severity and direction of the instability. To ensure all factors are included in the history and physical examination, the acronym MADAME (mechanism, acuteness, degree/directional, age, multiplicity, effort) should be kept in mind.

In the younger athlete, a capsuloligamentous or labral lesion is the most likely the primary diagnosis. Subsequently, rotator cuff involvement can occur. In middle-aged and older athletes, a rotator cuff injury is usually the primary problem. This injury can result from subacromial space compression from above with associated subacromial bursitis and impingement of the bony acromion, clavicle, and coracoacromial ligament. Impingement signs and a diagnostic injection into the sub-

acromial space will help confirm the diagnosis of subacromial impingement. In the past, subacromial decompressions have been done very frequently. Now, with better understanding of the shoulder and the higher incidence of glenohumeral instability and labral pathology, there are fewer diagnoses of subacromial impingement and subsequently subacromial decompression is less common. Impingement syndrome should not be used as a diagnosis much like anterior knee pain should not be used. A specific diagnosis should be made. If there is rotator cuff strain or tendinitis/tendinopathy, this should be listed as the diagnosis, not impingement syndrome.

In overhead throwing athletes, internal impingement has been reported.⁴⁵ Internal impingement is articular-sided rotator cuff involvement in an associated posterior superior glenoid labrum tear and is distinct from subacromial impingement²³ (Fig. 39-30). The cause of this lesion is thought to be excessive external rotation, but underlying instability has also been discussed.

INSTABILITY

The anatomic problem should be considered when performing a shoulder examination for instability (Table 39-4). If the humeral head translates at 90°, classic anterior inferior instability with involvement of the anterior inferior glenohumeral ligament is diagnosed. If there is inferior subluxation in adduction, the rotator cuff interval is the deficient structure. Translation at 45° involves the middle glenohumeral ligament. Posterior translation at 90° involves the posterior inferior glenohumeral lig-

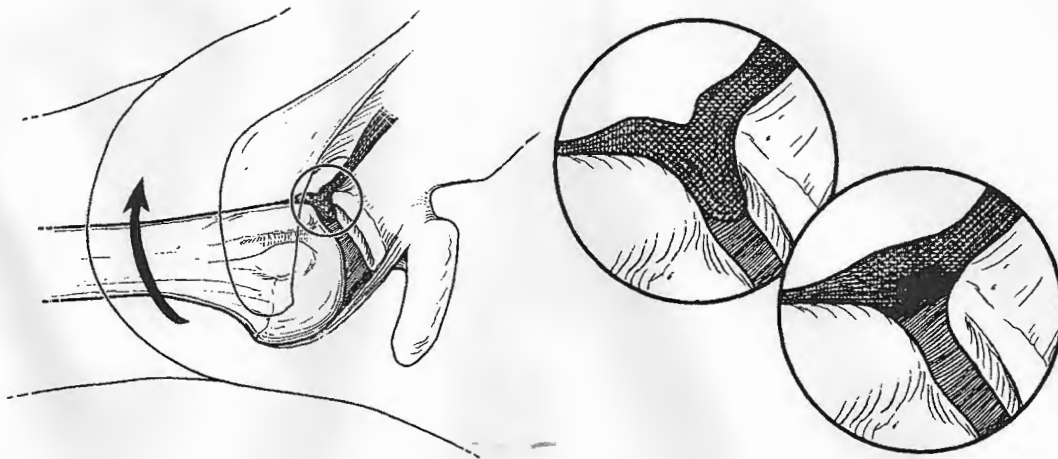


Figure 39-30. Internal impingement is defined as articular-sided infraspinatus and posterior superior labrum tear. The greater tuberosity impinges on the posterior superior aspect of the glenoid rim and labrum with the arm in abduction, external rotation, and extension. (From Edwards TB, Walch G: Posterosuperior glenoid impingement: Is microinstability really the problem? *Operative Tech Sports Med* 10(1):40-6, 2002, with permission.)

ament. Posterior translation at 45° involves the mid-posterior capsule.

LAXITY AND INSTABILITY

Laxity is the quality or condition of being lax or loose. *Instability* is defined as a lack of stability; it reflects the quality of unsteadiness, as in lack of firmness or steadiness.⁸⁴

Operative management should be considered only when nonoperative measures have been exhausted. Numerous procedures, both open and arthroscopic, have been described for treatment of instability. Open techniques have been considered the "gold standard" and include capsulolabral reconstruction, subscapularis transfer, and coracoid transfer. Although successful in treating the instability, open procedures have a variable success rate in terms of return to

Table 39-4. Abnormal Shoulder Exam: Differential Diagnosis — Make the Primary Diagnosis

INVOLVED JOINT	DIAGNOSIS	PATHOMECHANICS	MOST COMMON SPORTS
<i>Glenohumeral</i>	Instability		
	Direction	Contact	
	Unidirectional	Noncontact	Collision—Football, Gymnastics, cheerleading, swimming
	Multidirectional		
<i>Subacromial</i>	Labral tear	Distraction/compression	Throwing, weight lifting
	Articular side	Distraction	Throwing, baseball
	Rotator cuff tear		
	Bursal-sided rotator	Microtraumatic	Tennis, golf
<i>Subacromial</i>	Cuff involvement from bony impingement	Compression	
	Subacromial arch		Weight lifting
	AC Joint		Older age
	Arthrosis/osteolysis		
<i>Acromioclavicular</i>	Arthrosis	Macro and micro contact	Weight lifting
	Instability, sprain	Loading	
		Macro contact	Rugby, ice hockey, equestrian
<i>Scapulothoracic</i>	Neurologic	Serratus anterior weakness	Baseball, archery
	Long thoracic nerve involvement		
	Physiologic dysfunction	Underlying lack of strength	Swimming, tennis

previous level of sport participation in the throwing and overhead athlete. Many of the quoted studies on open procedures were performed decades ago and do not hold up to current peer review. Outcome shoulder measurement instruments continue to evolve. By today's standards, a surgical procedure is not considered successful if less than a perfectly functioning shoulder results. Arthroscopic procedures successfully repair the labrum and capsule. Advances in arthroscopy over the past 2 decades have allowed not only a better understanding of shoulder pathology, but also new and exciting treatment options. Appropriate patient selection (ie, making the correct diagnosis) and proper arthroscopic technique are crucial to achieve results equal or superior to those reported for open procedures.

The contraindications to arthroscopic reconstruction have decreased over the years as our understanding of anatomy and pathoanatomy has improved, through careful analysis of arthroscopically reconstructed failures. Structures that can be easily addressed arthroscopically include the anterior, posterior, and superior labrum, the capsule, the rotator interval, and the rotator cuff. Arthroscopic procedures allow for an anatomic reconstruction and have a lower morbidity, improved cosmesis, and increased postoperative range of motion. Current techniques can lead to success rates greater than 90%. The disadvantage is that arthroscopic reconstruction is technically demanding.

Open procedures are best able to address glenoid and humeral bone loss, version abnormalities, and the inability to achieve stability arthroscopically. Glenoid loss of greater than 20% to 25% has been described as having an inverted pear configuration by Burkhart.¹³ With this degree of glenoid bone deficiency, recurrence rates of 67% have been seen, with an 87% recurrence rate in contact athletes. Significant glenoid bone loss requires an open procedure such as a coracoid (Latarjet) transfer to the anterior inferior glenoid to restore the glenohumeral arc of motion. Burkhart has also shown that when an engaging Hill-Sachs lesion is present, higher failure rates will occur.¹³ The orientation of the Hill-Sachs lesion is viewed arthroscopically in 90° of abduction and external rotation. Lesions that are parallel to the anterior glenoid rim are defined as engaging. These lesions may be treated with a capsular shift procedure to restrict the humeral arc or by lengthening the glenoid arc by the Latarjet coracoid transfer. Typically more than 90% of open procedures are successful.

The goals of both open and arthroscopic procedure are uniform. Muscular injury is to be avoided during dissection and arthroscopic portal placement. The glenoid needs to be prepared down to a bleeding surface for labral repair. The labrum needs to be completely mobilized to allow for ligament tensioning. The labrum should be fixed to the rim of the glenoid. Capsular redundancy is eliminated. The rotator interval may require closing. Associated pathology is addressed. Appropriate rehabilitation is mandatory. An arthroscopic procedure is less painful and typically the patient feels ready to do more than the biology of healing will allow. The choice of an arthroscopic versus an open procedure is dependent on the skill of the surgeon and whether all pathology can be appropriately addressed.

BANKART LESIONS

Bankart lesions occur following an anterior shoulder dislocation.⁷ The labrum and anterior inferior glenohumeral ligaments are avulsed, sometimes with a piece of glenoid. Bankart lesions are shown diagrammatically in Figure 39-31. The classic Bankart lesion is a labrum tear with periosteal rupture. A bony Bankart lesion is a piece of anterior inferior glenoid with labrum still attached. A Perthes lesion is stripping of the soft tissue of the anterior inferior glenohumeral ligament with labrum stripped away from the glenoid.⁶⁸ The anterior inferior glenohumeral ligament, inferior capsule, and posterior inferior glenohumeral ligament all sustain injury with an anterior glenohumeral dislocation. This complex can be likened to a hammock that should tighten up in external rotation. If there is an avulsion of the labrum and anterior inferior glenohumeral ligament or glenoid bone, as well as stretching of the capsule, recurrent dislocations and increasing instability will occur. The inherent instability and mismatch of the humeral head in the glenoid eventually makes the shoulder the most unstable joint in the body.

Cadaveric ligament sectioning studies have shown that an injury to the posterior inferior ligaments must also occur to allow dislocation. Anterior dislocation in teenagers and young adults has a high recurrence rate. More than 80% of athletes younger than 20 and 30% of nonathletes younger than 20 had a recurrent dislocation.⁷⁵ Baker and colleagues demonstrated that intra-articular pathology is common following shoulder dislocation, with labral

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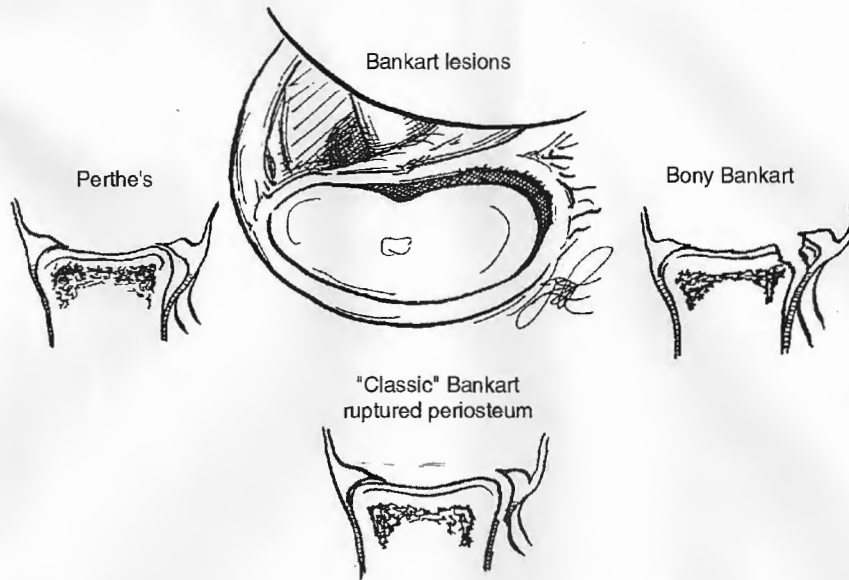


Figure 39-31. Glenoid lesions associated with anterior instability are shown and include Bankart lesion of ruptured periosteum, bony Bankart lesion, and Perthes lesion or soft-tissue stripping. (Courtesy of Stephen J. Snyder, MD.)

tears present in 39 of 45 first-time anterior dislocations.⁶ Traditional treatment following a first-time dislocation was conservative with strengthening and protective bracing.¹⁵ Because of the time lost from athletics and the high propensity of redislocation, a more aggressive approach has been observed.^{2,21,48,50}

Arthroscopic treatment allows for identification of all intra-articular pathologies. If no significant glenoid bone deficiency exists and an engaging Hill-Sachs lesion is not encountered, arthroscopic stabilization is performed. The labrum and capsule need to be mobilized until the subscapularis is visualized. The capsuloligamentous structures are then advanced to the anatomic position on the glenoid rim. These structures should not be attached in a medial position on the glenoid neck. Associated capsular laxity may be suture plicated or a thermal capsulorrhaphy may be performed. Evaluation of the rotator interval should also be performed. Chondral injuries may be mechanically débrided to prevent mechanical symptoms.

ANTERIOR INSTABILITY

Traumatic unidirectional anterior instability is often a result of injury from contact/collision sports. The individual depicted in Figure 39-32 has a history of 50 dislocations with her arm in a position of external rotation and abduction. She can easily reduce the dislocations. Her examination is consistent with anterior instabil-

ity with significant apprehension when her humerus is abducted, externally rotated, and backwardly flexed. The Stryker view (Fig. 39-32A) demonstrates radiolucency of the humeral head consistent with a Hill-Sachs lesion (posterolateral impaction fracture). The Axillary lateral view (Fig. 34-32B) shows a Bankart lesion with rounding off of the anterior glenoid. Arthroscopic findings confirm the roentgenographic findings. The Hill-Sachs lesion (Fig. 39-32C) indicates a compression fracture of the posterior lateral humeral head. The Bankart lesion of the anterior inferior glenoid labrum and the anterior inferior glenohumeral ligaments that were stripped off of the glenoid rim are shown in Figure 39-32D. Arthroscopic stabilization was performed using suture anchors to approximate the unstable soft tissues (Fig. 39-32E-G).

Open Bankart repair and capsular shift may be performed as well.⁷ Postoperative rehabilitation is essential. Return to activity is allowed after approximately 4 months.

SLAP (SUPERIOR LABRUM ANTERIOR POSTERIOR) LESIONS

SLAP lesions occur commonly in the throwing athlete and were first classified by Snyder and coworkers.⁷⁶ The SLAP lesions have been classified as types I to IV. Fifty percent of the time SLAP lesions are associated with instability.

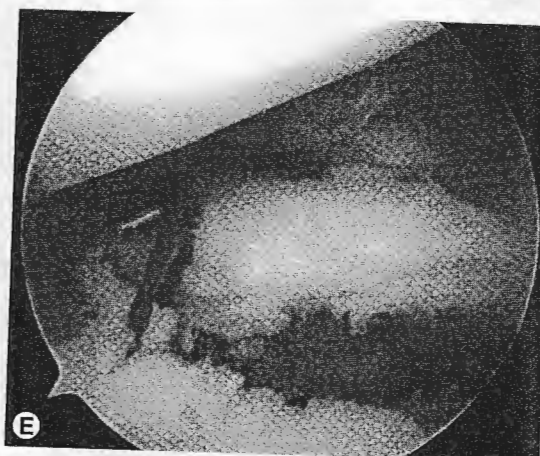
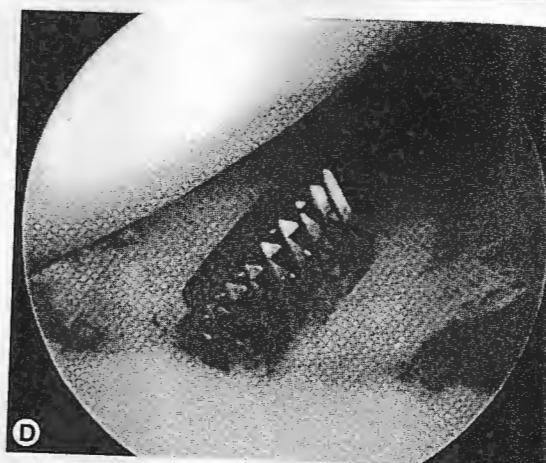


Figure 39-32. (A–G) The Stryker view suggests a Hill-Sachs lesion, with radiolucency of the lateral aspect of the humeral head. (A) Rounding-off of the glenoid anteriorly is consistent with recurrent anterior dislocation episodes and severe anterior instability. (B) Arthroscopic findings confirm the Hill-Sachs lesion (C) and Bankart lesion (D). (E) next page.

Classic labral tear signs exist. Early intervention for SLAP lesions may prevent progression to more serious types. These lesions are most common in overhead throwers.⁵⁴ Softball pitchers do not develop SLAP lesions because this position involves underhand throwing. In the over-

head/throwing athlete, SLAP lesions generally occur posteriorly (Snyder type II). The type II lesion has 3 subtypes: anterior, posterior, and anteroposterior.⁵⁸ Operative management needs to address the “peel-back” mechanism, which is caused by a torsional force transmitted through

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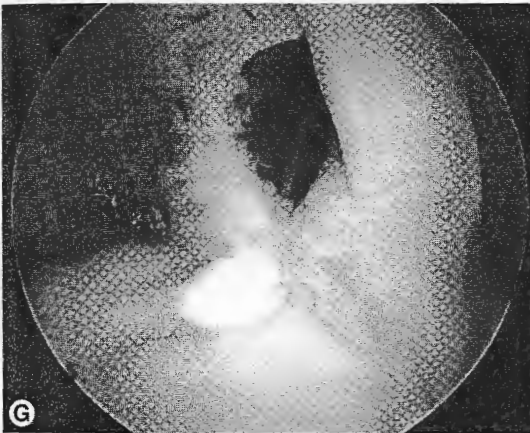
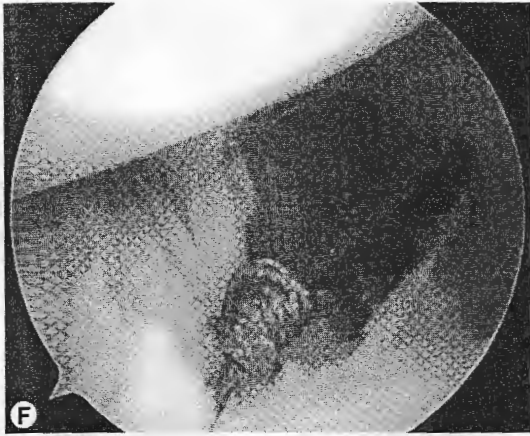


Figure 39-32. (Continued). (E-G) Arthroscopically aided stabilization was performed with suture anchors into the glenoid and passing them through the labrum. (Copyright 2002, ML Ireland, MD.)

the biceps tendon. This occurs as a result of an acquired tight posterior capsule increasing posterior superior forces of the humeral head on the glenoid labrum. The "peel-back" mechanism is dynamic and is visualized arthroscopically by abducting and externally rotating the arm. The labrum will be seen rotating medially over the glenoid. The criteria used in assessment of a posterior superior and combined SLAP lesion include (1) a positive "peel-back" sign; (2) a displaceable biceps root; (3) a positive "drive-through" sign; and (4) a superior sublabral sulcus greater than 5 mm. In an isolated anterior superior lesion, the only positive finding may be the "drive-through" sign.¹⁴

Different implants have been developed to manage labral lesions, including suture anchors and translabral tacks. The objective is reattachment of the labrum to the glenoid. Suture anchors, while more technically demanding, have a higher reported success rate than

translabral tacks. After preparing the superior glenoid down to bleeding bone with a motorized shaver, an anchor is placed directly inferior to the biceps root with a simple translabral suture loop placed directly posterior to the biceps root. Other suture anchors and suture loops are used as needed to repair the labrum and neutralize the "peel-back" mechanism and eliminate the "drive-through" sign.

Rehabilitation begins immediately with passive external rotation followed by progression to overhead motion and strengthening. Light throwing is begun 3 months post operatively and return to throwing at full speed from the mound is allowed at approximately 7 to 8 months.

POSTERIOR LABRAL TEARS

Posterior labral tears most often occur in football, hockey, and lacrosse athletes. Injury occurs with a posteriorly directed force to a shoulder prepared for collision and contact. The humeral head shears off the posterior central labrum and a posterior glenoid chondral lesion may occur. The lesion may also occur as a result of wear and tear of the posterior joint. Pain develops when the labrum detaches and is typically present with bench pressing, throwing, or posterior loading in sport participation. Conservative treatment can be successful and includes avoiding provocative activities. Physical therapy is usually not helpful. Surgery is considered with continued pain and difficulty with participation in the sport. The goals are the same as with other labral injuries. Repair of the torn posterior labrum to the glenoid can be addressed with either an open or an arthroscopic procedure. The advantages of arthroscopic repair are that a much bigger surgical dissection is avoided and the labrum is much better visualized arthroscopically. A postoperative rehabilitation program is initiated and return to contact athletics is possible at 4 months.

ACUTE POSTERIOR DISLOCATION

The high school junior depicted in Figure 39-33 dislocated her dominant shoulder throwing the discus. She released the discus as her arm went into adduction and internal rotation. Roentgenograms taken in the emergency department showed a posterior dislocation (Fig. 39-33A). The glenoid is shown by the arrows. Closed reduction was done. The patient was evaluated in the office and was found to

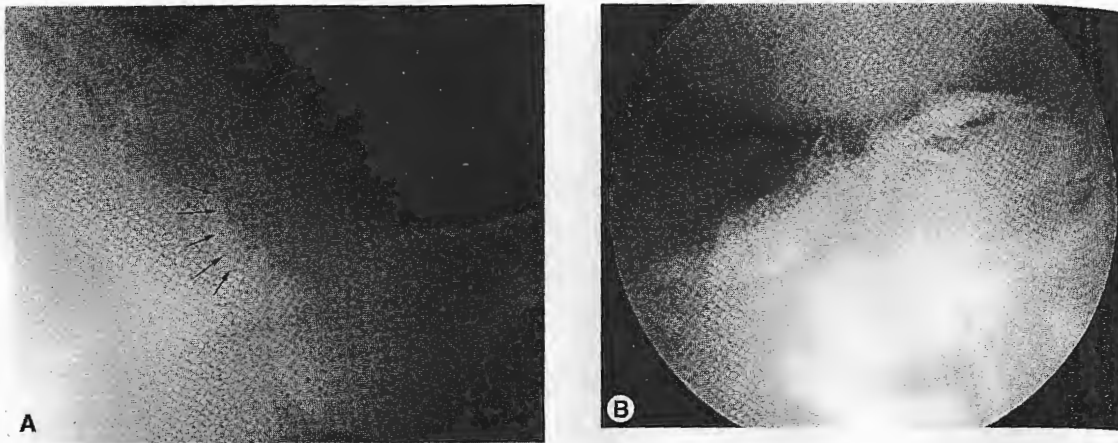


Figure 39-33. Posterior dislocation is shown radiographically. The arrows outline the glenoid and the humeral head is posteriorly dislocated. (A) Arthroscopic view of posterior labrum tear. (B) Patient underwent open anterior reconstruction.

have a greater posterior instability than the multidirectional laxity exhibited on the opposite side. Arthroscopy showed a posterior superior glenoid labrum tear, which was débrided (Fig. 39-33B). An open posterior capsular reconstruction was performed. She did not return to discus throwing but has had no subsequent posterior dislocations. Her main complaints now are of tightness and mild pain.

HABITUAL POSTERIOR INSTABILITY

The cheerleader and dance athlete depicted in Figure 39-34 is able to posteriorly dislocate her shoulder on command. When she puts her arm

in a horizontally adducted position and internally rotates, the humerus slips out posteriorly (Fig. 39-34A). Axillary lateral roentgenograms show a reverse (arrow) Hill-Sachs lesion with radiolucency of the anterior aspect of the humerus consistent with posterior instability (Fig. 39-34B). The patient was symptomatic on her right side and underwent arthroscopy and open posterior capsulorrhaphy. She has done well but has not had surgery on her opposite side.

The patient in Figure 39-35 dislocated her shoulder while playing volleyball at school. She underwent right open anterior reconstruction and was seen for problems of recurrent dislocation. Her examination was bilaterally symmetrical and revealed a multidirectional



Figure 39-34. This cheerleader and dance athlete is able to posteriorly dislocate her shoulder on command. She puts her arm in a horizontally adducted position and internally rotates, and the humerus slips out posteriorly. Axillary lateral roentgenograms (A)

Illustration continued on following page

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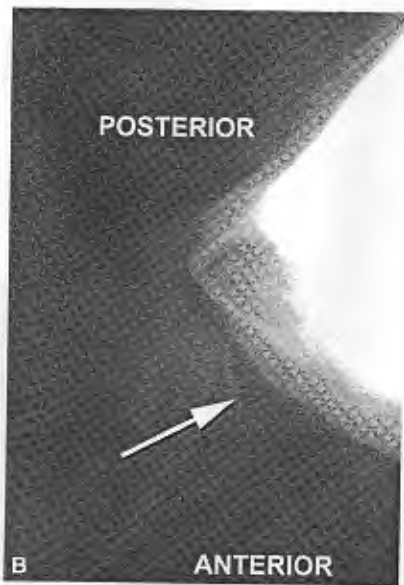


Figure 39-34 (Continued). show a reverse (arrow) with flattening and radiolucency of the humeral head (B).

component to her instability. The position she rested her shoulders in caused the humeral head to be in an anterior inferior luxated position (Fig. 39-35A). Instructing her to sit up straight and essentially move the scapula underneath the humeral head resulted in improved glenohumeral coaptation (Fig. 39-35B). Significant widening of her surgical scar consistent with capsular looseness and elastin insufficiency may be noted. A strengthening program and counseling on her posture was begun. She was placed in a figure-of-8-splint. No surgery was suggested.

MULTIDIRECTIONAL INSTABILITY

The pathoanatomy of multidirectional instability is believed to be increased capsular volume as a result of redundancy of the inferior glenohumeral ligament complex.⁸ Nonoperative treatment includes patient education, physical therapy for rotator cuff exercises, and more than 6 months of treatment prior to consideration of surgery. Nonoperative treatment has been shown to have an 80% satisfactory outcome. Surgery specifically addresses the tightening of loose ligaments through labral repair (if needed) and ligament plication. The rotator interval may require closing. If the surgeon chooses to address these patients with an open procedure, diagnostic arthroscopy is recommended to identify all pathology. Arthroscopic treatment of capsular redundancy and rotator interval defects

by laser shrinkage is as effective as open procedures.⁸⁸ The internal may require plication.

Multidirectional instability can also be addressed by an open inferior capsular shift. The rotator interval is closed and the capsule is then split in a T fashion from the glenoid or humeral side. The capsule is released both inferiorly and posteriorly and is then advanced and closed.



Figure 39-35. This patient dislocated her shoulder while playing volleyball at school. She underwent right open anterior reconstruction and was seen for problems of recurrent dislocation. Her examination was bilaterally symmetrical, showing a multidirectional component to her instability. The position she rested her shoulders in caused the humeral head to be in an anterior inferior luxated position. (A) The instructions to sit up straight and essentially move the scapula underneath the humeral head resulted in improved glenohumeral coaptation. (B) Note the significant widening of her surgical scar, which is consistent with capsular looseness and elastin insufficiency.

This procedure has been reported as 86% successful at 2 years.^{20, 63}

THERMAL CAPSULORRHAPHY

The use of heat to treat shoulder instabilities is an old concept. Hippocrates treated recurrent shoulder dislocations with a hot probe in the axilla.⁷² Heating of the capsular tissue of the shoulder has been performed with laser and radiofrequency probes. Radiofrequency probes are more commonly used today because of their lower cost, greater safety, and ability to provide temperature feedback. The pattern used in shrinkage is a grid, leaving a normal strip of tissue and a thermally modified strip of tissue.⁵⁵ Thermal energy applied to the shoulder capsule causes the highly ordered structure of collagen to break down and shrink, denaturing its type I collagen. Differences in the composition of collagen elastin fibers have been found in studies comparing stable and unstable shoulders.⁷³ In unidirectional and multidirectional instability, larger collagen fibril diameters and a greater proportion of cystine and elastin form a more stable collagen cross-link.

Histologic evaluation of the capsule after laser treatment shows collagen without its distinctive fiber structure and fusion of its bundles. There is cell death of the synoviocytes, fibroblasts, smooth muscle cells, and endothelial cells. Repair of these tissues becomes evident at 3 months.⁴⁰

Initial improved stability from thermal capsulorrhaphy is thought to be due to capsular thickening, scar formation, and reduction in afferent sensory stimulation to reduce painful stimuli. These factors contribute to improved stability, strength, and function.^{25,26,78,80}

There have been reports of adhesive capsulitis and arthrofibrosis and restricted range of motion following thermal modification. Other complications are injury to the axillary nerve by the transmission of heat.⁸⁰ Fortunately, this is usually temporary. Capsular necrosis may also occur. With the tissue necrosis that occurs after thermal modification prior to its remodeling, the timing of movement and return to sport is critical. Immobilization typically is done for 3 weeks, followed by a range of motion program to regain external rotation, with eventual return to full activities, at the earliest, after 4 months. An accelerated and basic rehabilitation program in overhead athletes has been reported by Wilk.⁸⁶ There is concern that return to sport too rapidly will result in initial cellular death and weakening of the capsule.

Use of thermal modification in the female athlete is of concern. The principles of stabilizing deficient structures anteriorly with arthroscopic or open repair are much more sound than those of thermal modification. In the authors' practice, use of thermal modification of the shoulder is rarely done. Many collegiate softball and volleyball athletes have had thermal modification. There are no long-term studies of the performance of these individuals. The significant potential complications of capsular necrosis, axillary nerve injury, and continued instability are of enough concern to cause reconsideration of thermal's use.

ROTATOR CUFF TEARS: CLASSIFICATION AND MANAGEMENT

The rotator cuff acts as a fine tuner of the shoulder to keep the humeral head seated in the glenoid throughout its multiple positions. The rotator cuff can be inflamed, partially torn, or completely torn. In the unstable shoulder, the rotator cuff is weak, but this is secondary to the instability. The rotator cuff can be involved on the subacromial side or the articular side. The diagnosis should describe the pathologic change in the involved structure. This allows better communication among the patient, therapist, and physician. The symptoms of the complete rotator cuff tear include night pain and weakness in external rotation and abduction. Oftentimes, there is a palpable defect in the rotator cuff or associated proximal biceps tendon rupture. The typical location of the tear is in the supraspinatus. The subscapularis—the only internal rotator of the rotator cuff—should be examined, whether involved with an isolated tear or biceps tendon instability.

Plain roentgenograms often show osteopenia and proximal migration of the humeral head. In chronic rotator cuff tears, there often is arthropathy with significant spurring and an abnormal shape to the humeral head. Further diagnostic imaging to document rotator cuff tear is indicated if the patient desires surgery. Arthrography is inexpensive and remains a good test to document a complete rotator cuff tear. MRI can be helpful to document the injury as partial versus complete, as well as to determine the size of the rotator cuff tear and the degree of its retraction. In some centers, ultrasonography is utilized to diagnose rotator cuff tear.

The primary indication for surgical intervention remains night pain, but with advances in

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Open repair by Codman in 1972 showed addition of arthroscopic cuff repairs does the deltoid function the timing

Studies have shown that early active range of motion is equal to passive range of motion following by the time must heal to provide the time 6 month maybe ne

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arthroscopic techniques, more rotator cuff surgeries are being performed. In rotator cuff tear patients who do not desire surgery, range of motion exercises should be performed in a functional arc of less than 90° to maintain scapulothoracic control and improve rotator cuff strength. Injection with steroid and anesthetic can help control night pain. Injection is done posteriorly into the subacromial space, but in a complete rotator cuff tear, this would also involve the glenohumeral articulation.

Open repair of the rotator cuff was reported by Codman in 1911.^{17,18} Neer's results reported in 1972 showed improvement of results with the addition of anterior acromioplasty.⁶¹ Advances in arthroscopic techniques have allowed rotator cuff repairs to be done entirely through the scope or in a mini-open fashion. These procedures do not require an approach that detaches the deltoid origin. This has greatly improved the functional outcome of this procedure, but not the timing of return to activity.

Studies comparing open versus arthroscopically aided rotator cuff repair have reported equal results.^{5,83} The return to full activities following rotator cuff surgery is not influenced by the choice of technique. The injured cuff must heal back to the greater tuberosity in order to provide adequate function. Postoperatively, the time to return to a sport like golf is 6 months and to throwing sports 9 months, maybe never.

Classification of rotator cuff tears is by the pattern of the tear: transverse, crescent,

L-shaped, linear in line with the fibers, and triangular (Fig. 39-36). The tear pattern is assessed and sutures are placed through the tendon. More than likely, anchors are placed in the greater tuberosity to bring the rotator cuff back down to its insertions. In explaining the rotator cuff tear to patients, one can describe the analogy of a window shade that should be all the way down to the sill but has now retracted, because the origin of the supraspinatus is still in place. This can be helpful in the process of discussing treatment options also. A massive rotator cuff tear (Fig. 39-37) with significant retraction of the supraspinatus, involvement of the biceps tendon with partial or complete rupture, and involvement of the subscapularis can be encountered. Primary repair may not be possible in these chronic situations. Tenderness over the acromioclavicular joint results from sprain, osteolysis, or arthrosis. In the chronically painful acromioclavicular joint, injection is diagnostic and therapeutic. Osteolysis (weightlifter's shoulder) is more common in males.

ADHESIVE CAPSULITIS

Adhesive capsulitis is seen more often in females than males. This diagnosis is most common in the perimenopausal female and can be associated with systemic conditions such as diabetes. The mainstay of treatment is aggressive physical therapy, emphasizing passive rotation and abduction. An early intra-articular injection with

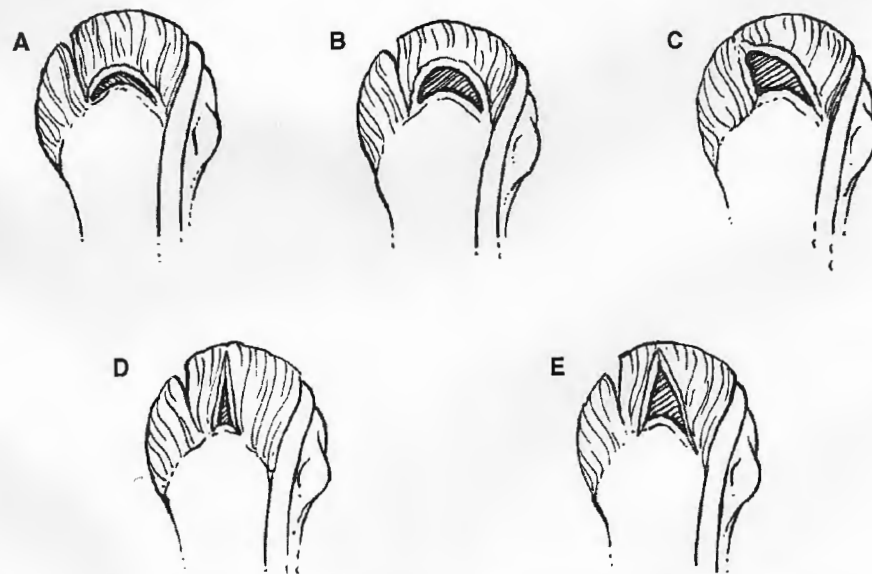


Figure 39-36. Diagram of the pattern variation of rotator cuff tears. (A) Transverse-shaped tear. (B) Crescent-shaped tear. (C) L-shaped tear. (D) Linear tear in line with the tendon fibers. (E) Triangular tear. (From Jobe FW: Operative Techniques in Upper Extremity Sports Injuries. St Louis, CV Mosby, 1996, p 225, with permission.)

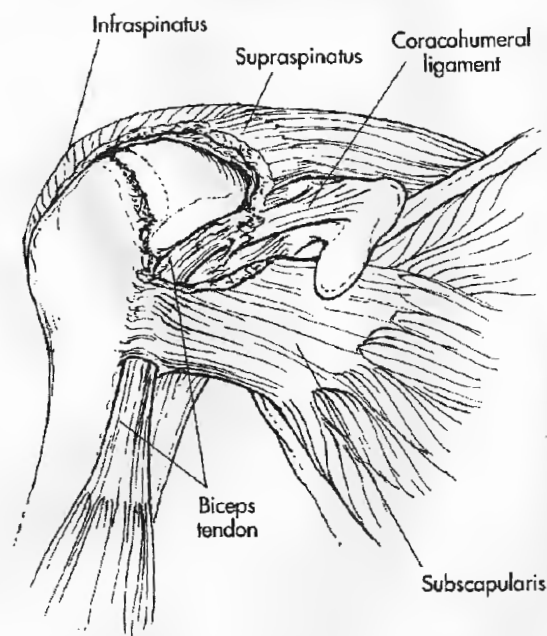


Figure 39-37. A massive rotator cuff tear involving the subscapularis, supraspinatus, and infraspinatus muscle tendons. There is retraction of the supraspinatus tendon, subluxation of the biceps tendon, and contraction of the coracohumeral ligament. (From Jobe FW: *Operative Techniques in Upper Extremity Sports Injuries*. St Louis, CV Mosby, 1996, p 228, with permission.)

anesthetic and steroids is diagnostic and therapeutic.

The adhesive capsulitis process may take a year to run its course. Typically patients respond to a therapy regimen and surgery is infrequently indicated.

FRACTURES

Gender comparisons are not usually made in fracture series. Regardless of gender, fracture management is similar.

The cheerleader depicted in Figure 39-38 was doing gymnastics in a parking lot and landed awkwardly on her left upper extremity. She was unable to move her shoulder. Roentgenograms revealed a displaced Salter II fracture of the proximal humerus (Fig. 39-38A). Closed reduction and percutaneous pinning was performed (Fig. 39-38B). The patient did well and pins were removed 6 weeks postoperatively. She was able to return to gymnastics and cheerleading. Remodeling of the proximal humeral epiphysis allows acceptance of a large amount of deformity. Because of the significant displacement and acute deformity in this situation, closed reduction was performed.

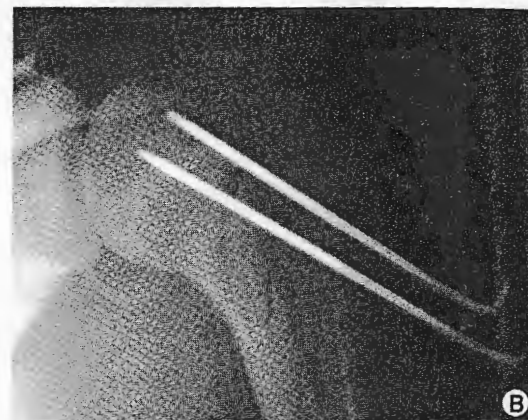


Figure 39-38. (A) Roentgenography revealed a displaced Salter II fracture of the proximal humerus. (B) Closed reduction and percutaneous pinning was performed. (Copyright 2002, ML Ireland, MD.)

The diver depicted in Figure 39-39 sustained a clavicle fracture when she was involved in a motor vehicle accident and struck the dashboard. This high-energy trauma resulted in a displaced mid-third clavicle fracture (Fig. 39-39A). After initial figure-of-8 splinting and use of a sling, there was no evidence of healing at 6 months following her injury (Fig. 39-39B). Her physical examination at the time of open reduction and internal fixation and iliac crest bone grafting showed gross movement at the fracture site (Fig. 39-39C). A plate was used and autogenous iliac crest bone grafting was performed (Fig. 39-39D). The plate was removed 18 months postoperatively. Follow-up roentgenograms revealed clavicular union and filling in of the screw holes (Fig. 39-39E).

Figure 39-39. board. (A) - and use of physical ex formed. (E) screw holes

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Figure 39-39. This diver sustained a clavicle fracture when she was involved in a motor vehicle accident and struck the dashboard. (A) This high-energy trauma resulted in a displaced mid-third clavicle fracture. (B) After initial figure-of-8 splinting and use of a sling, there was no evidence of healing (arrows) at 6 months following her injury. (C) At the time of surgery, physical exam showed gross motion at the nonunion site. (D) Plate was used and autogenous iliac crest bone grafting performed. (E) Plate was removed after 18 months and follow-up roentgenograms revealed clavicular union and filling in of the screw holes. (Copyright 2002, ML Ireland, MD.)

CONCLUDING REMARKS

Understanding the functional anatomy and biomechanics of the sport will allow the practitioner to make the correct primary diagnosis. (Is the diagnosis a primary instability or a labrum or rotator cuff tear?) Making every effort to determine the primary diagnosis will allow for implementation of the correct treatment and rehabilitation program with possible surgery. The advances in arthroscopy for diagnosis and

treatment of shoulder disorders are quite exciting. Earlier surgical intervention is occurring more frequently today. The arthroscopic treatment of anterior stabilization or rotator cuff repair does not allow for an earlier return to sports as compared to the open techniques. The principles of repairing injured structures based on arthroscopic findings has allowed improved function of the shoulder postoperatively. In treating athletes with shoulder problems, one

must be aware of the advances that have been made in rehabilitation after arthroscopic techniques. We should also be wary of newer and often unfounded basic science techniques such as thermal capsular modification. The health care provider must be aware of the advances that allow for predictable return to activity with a consideration of the demands placed on the patient's shoulder while performing sports.

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ANATOMY

The elbow jo only: flexion valgus deviat anterior and 1 The elbow humeroulnar,

Figure 40-1. Bo imal radial-ulna for bony contact radial head, and shown anteriorly Zarins B, Wilk K