Rotator cuff impingement

by

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s.v.u.

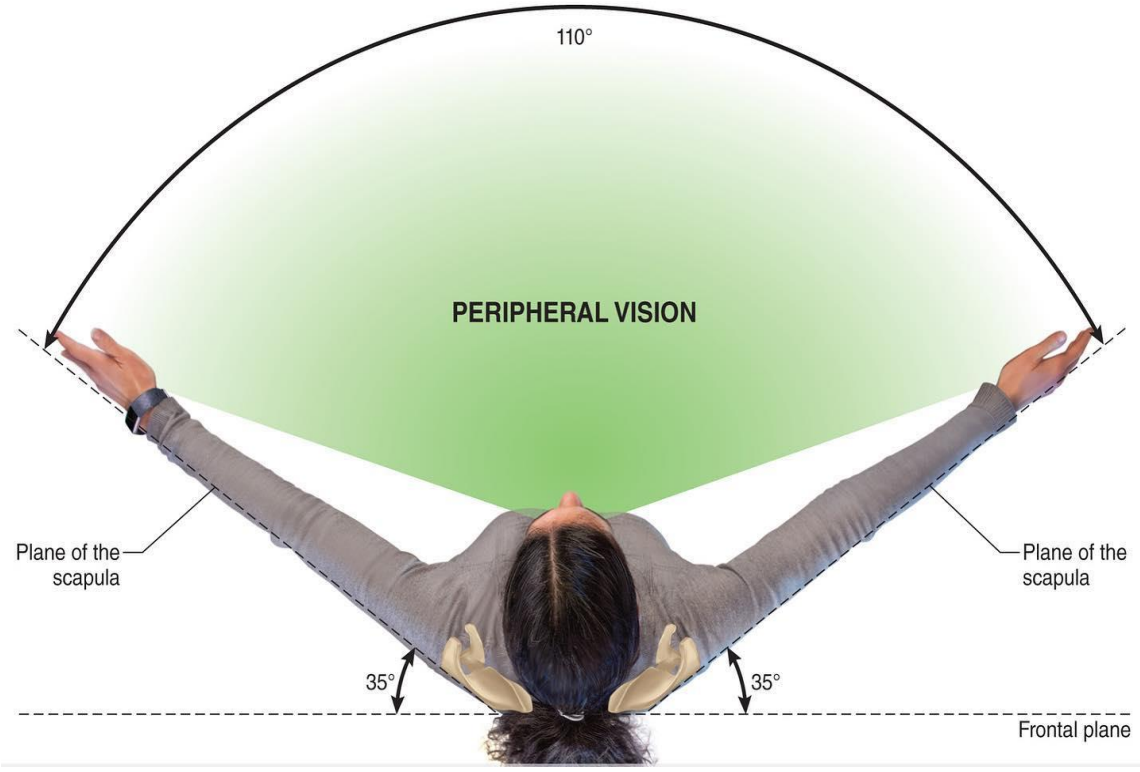
Scapular Plane Concept

the **scapular plane** is defined as being 30° anterior to the coronal or frontal plane of the body. This plane is formed by the retroversion of the humeral head, which averages 30° relative to the shaft of the humerus coupled with the native anteversion of the glenoid, which is also 30°

the scapular plane is widely recommended as an optimal position for the performance of various evaluation techniques, as well as during many rehabilitation exercises recommended throughout this book (Ellenbecker 2006, Saha 1983).

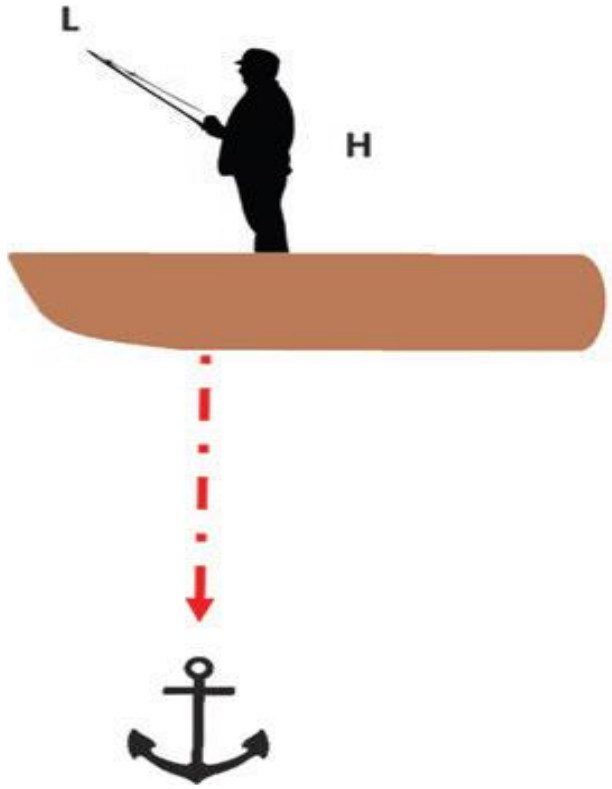
advantages of the scapular plane position

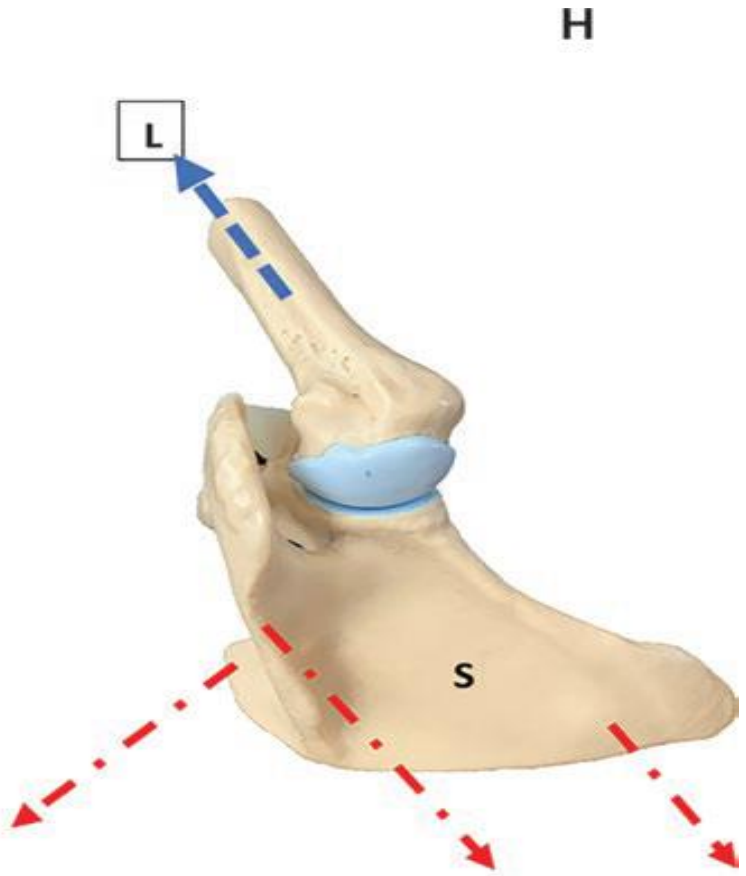
- With the glenohumeral joint placed in the scapular plane, bony impingement of the greater tuberosity against the acromion does not occur
- optimizes the osseous congruity between the humeral head and the glenoid decreases stress on the anterior capsular components of the glenohumeral joint
- enhances activation of the posterior rotator cuff due to a length– tension enhancement compared to function in the coronal plane (Neumann 2002, Saha 1983).



Periscapular stability is essential for arm motion
Why?

Glenohumeral movement uses the glenoid surface as a fulcrum point for the humerus to move. Thus, the glenoid must be stable when glenohumeral movement occurs. So the scapula acting as a stable "platform" for the rotator cuff muscles to produce optimal glenohumeral motion.



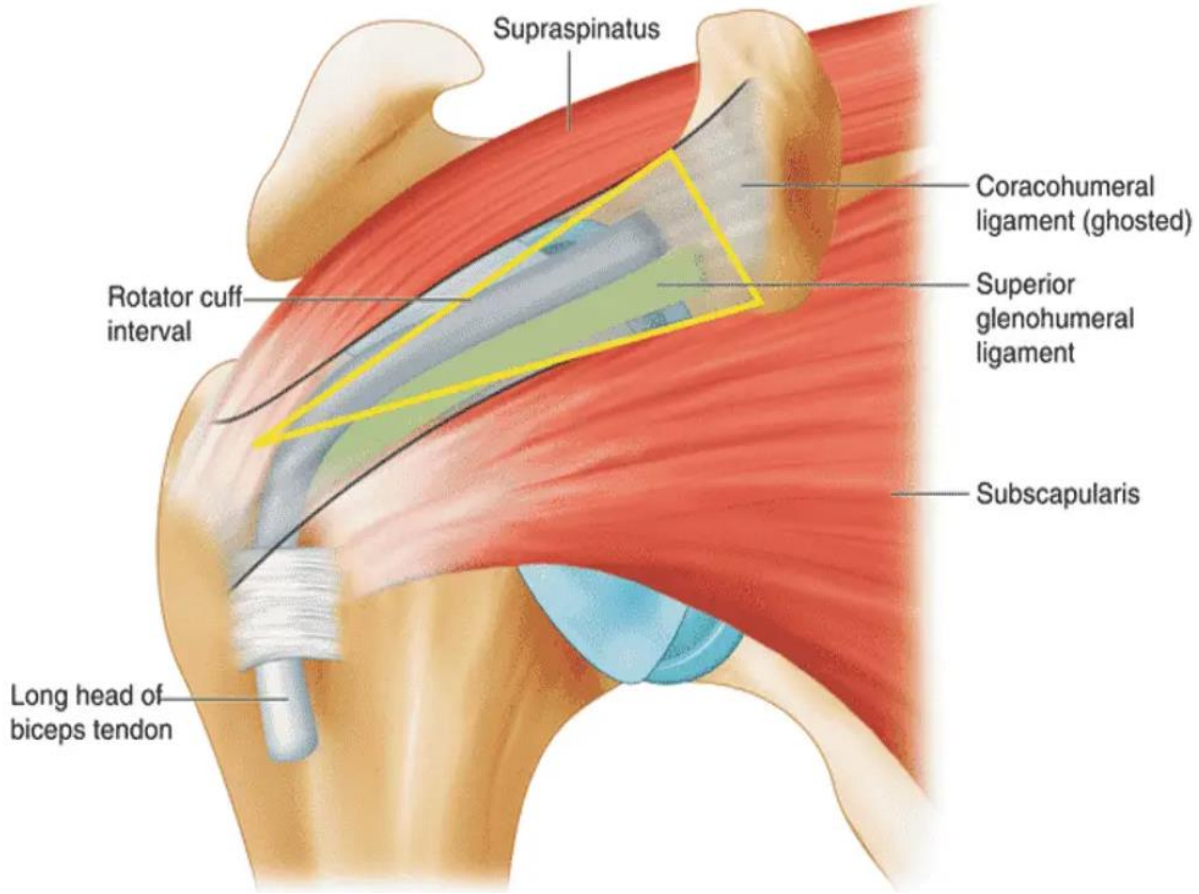


Scapular stability contributes to efficient motion of the upper limb. The fisherman (humerus) standing on the boat (scapula) tries to move the rod (rest of upper limb) but has to expend energy to keep standing due to lack of stability of the boat on the water. If the boat is anchored (coordinated co-contraction of periscapular muscles, M), the fisherman (humerus and glenohumeral muscles) will expend less energy to remain standing (glenohumeral stability) and the rod (upper limb) will be moved more efficiently

rotator interval

The space between the supraspinatus and superior border of subscapularis. This space is triangular, with its base located medially at the coracoid process.

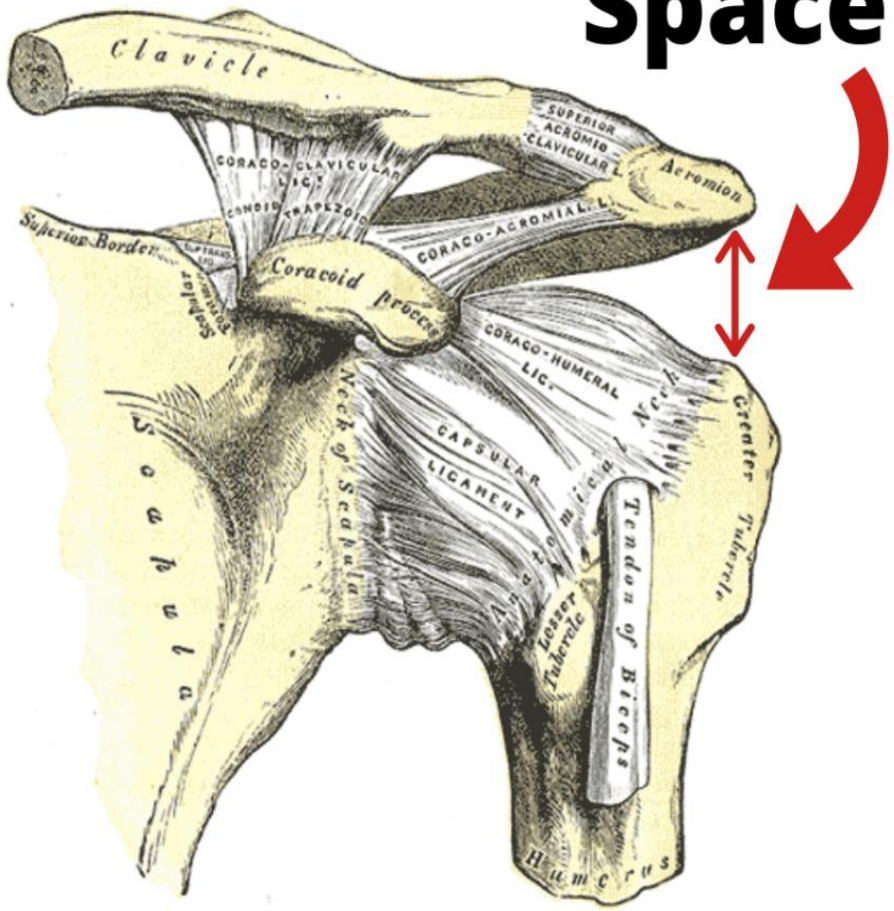
The rotator interval contains the coracohumeral ligament, superior glenohumeral ligament, glenohumeral capsule, and biceps tendon



The clinical diagnosis of “impingement syndrome” was introduced in 1972 by Dr. Charles Neer II and comprised a spectrum of disease ranging from chronic bursitis and partial tears of the supraspinatus tendon to complete tears

It was hypothesized that the rotator cuff underwent progressive pathologic change due to compression against a rough undersurface of the coracoacromial arch made up of the anterior third of the acromion, the coracoacromial ligament, and the AC joint

Subacromial Space



Static 9-10 mm (range 8-12 mm)
dynamic about 6 mm: normal

- Coracoacromial Arch, composed of the Acromion, Coracoid Process and Coracoacromial Ligament
- Humeral Head
- Subacromial Bursa
- Tendons of the Rotator Cuff; Supraspinatus, Infraspinatus, Teres Minor and Subscapularis
- Tendon of the Long Head of Biceps Brachii
- G-H Joint Capsule

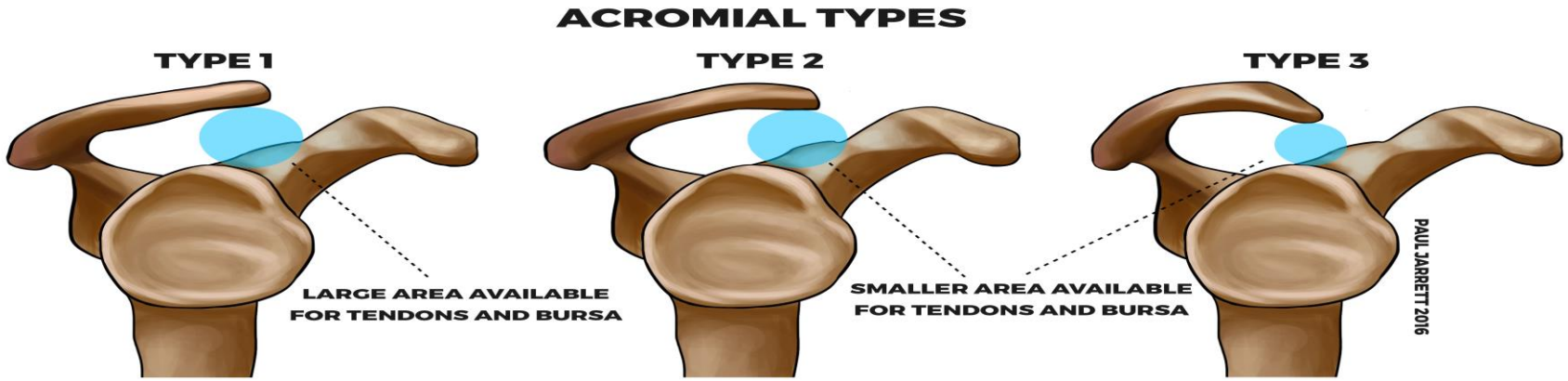
Types of Rotator Cuff Impingement

External Impingement

Primary Impingement

- also known as *compressive disease* or *outlet impingement*
- Primary subacromial impingement is the result of an abnormal mechanical relationship between the rotator cuff and the coracoacromial arch (acromion, coracoacromial ligament, and/or coracoid process)
- related to structural changes, either congenital or acquired, that mechanically narrow the subacromial space such as; bony narrowing or osteophyte formation, bony malposition after a fracture, or an increase in the volume of the subacromial soft tissues.
- bony abnormality contributing to narrowing of the subacromial space from acromial morphology, spurring, or hypertrophy of the AC joint

Flat, curved and hooked acromion

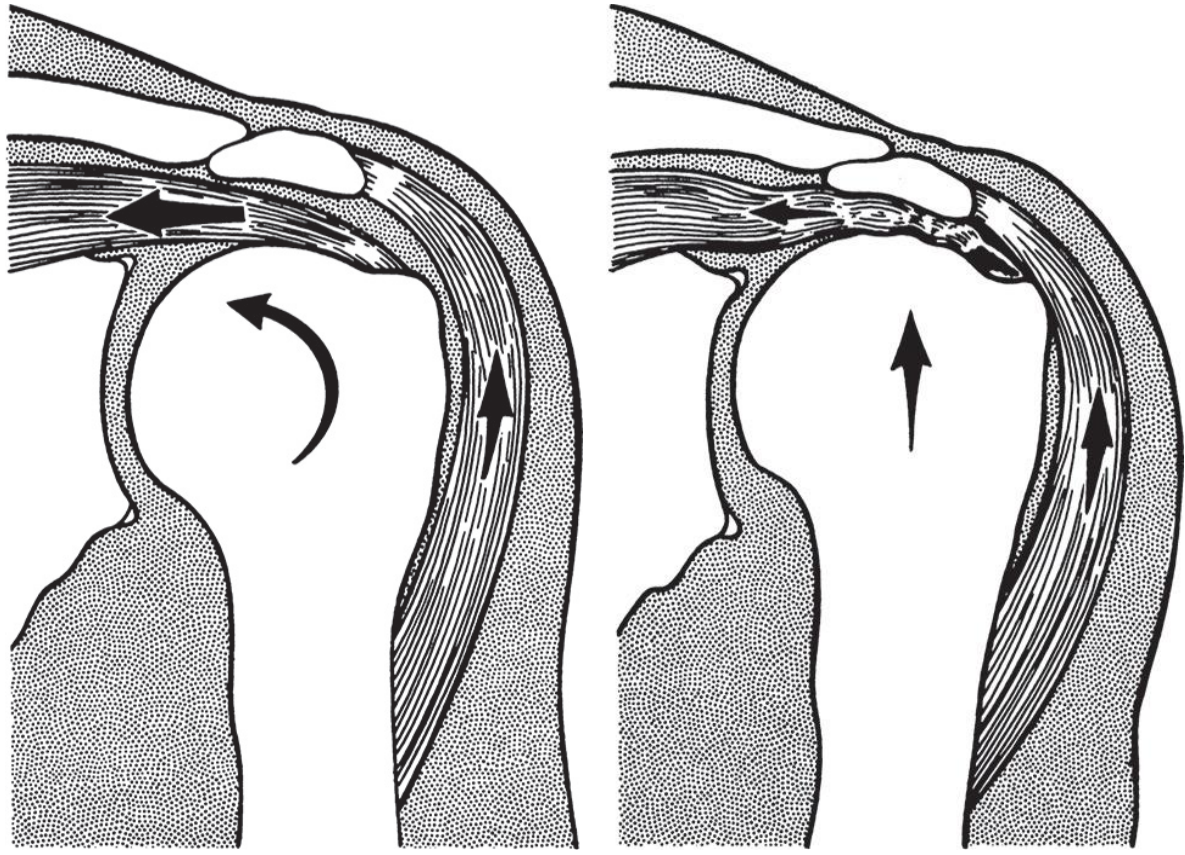


Secondary External Impingement

- is a clinical phenomenon that results in a “relative narrowing” of the subacromial space.
- related to abnormal scapulothoracic kinematics
- This often results from excessive GH joint mobility or scapular dyskinesis (Kibler 1998, Kibler 2013)

GH joint hypermobility

In those patients who have underlying GH hypermobility, with or without instability, the symptoms of secondary rotator cuff impingement are caused by excessive demands placed on the rotator cuff to dynamically stabilize the shoulder. While the rotator cuff may effectively stabilize the hypermobile GH joint, when this requirement is coupled with repetitive overhead movement (i.e., swimming or throwing) muscular fatigue is often produced. Rotator cuff fatigue leads to the loss of the stabilizing function and allows superior migration of the humeral head (decreased depression of the humeral head during throwing and less “clearance”) and is thought to result in mechanical compression of the rotator cuff on the coracoacromial arch (Chen 1999, Michener 2003, Royer 2009)



scapular dyskinesis

In patients with scapular dyskinesis (limited or excessive scapular mobility), impingement results from **improper positioning of the scapula with relation to the humerus.** This loss of neuromuscular scapular control produces insufficient retraction along with inadequate upward rotation and posterior tilting of the scapula resulting in earlier abutment of the acromion and coracoacromial arch on the underlying rotator cuff (Kibler 1998, Kibler 2013, Ludewig 2009, Michener 2003).

SO

The scapular retraction and scapular assistance tests can effectively demonstrate the impact of altered scapular neuromuscular control as a source of the patient's symptoms and indicate the potential for improved shoulder function by correcting this deficiency (Burkhart 2003, Tate 2008).

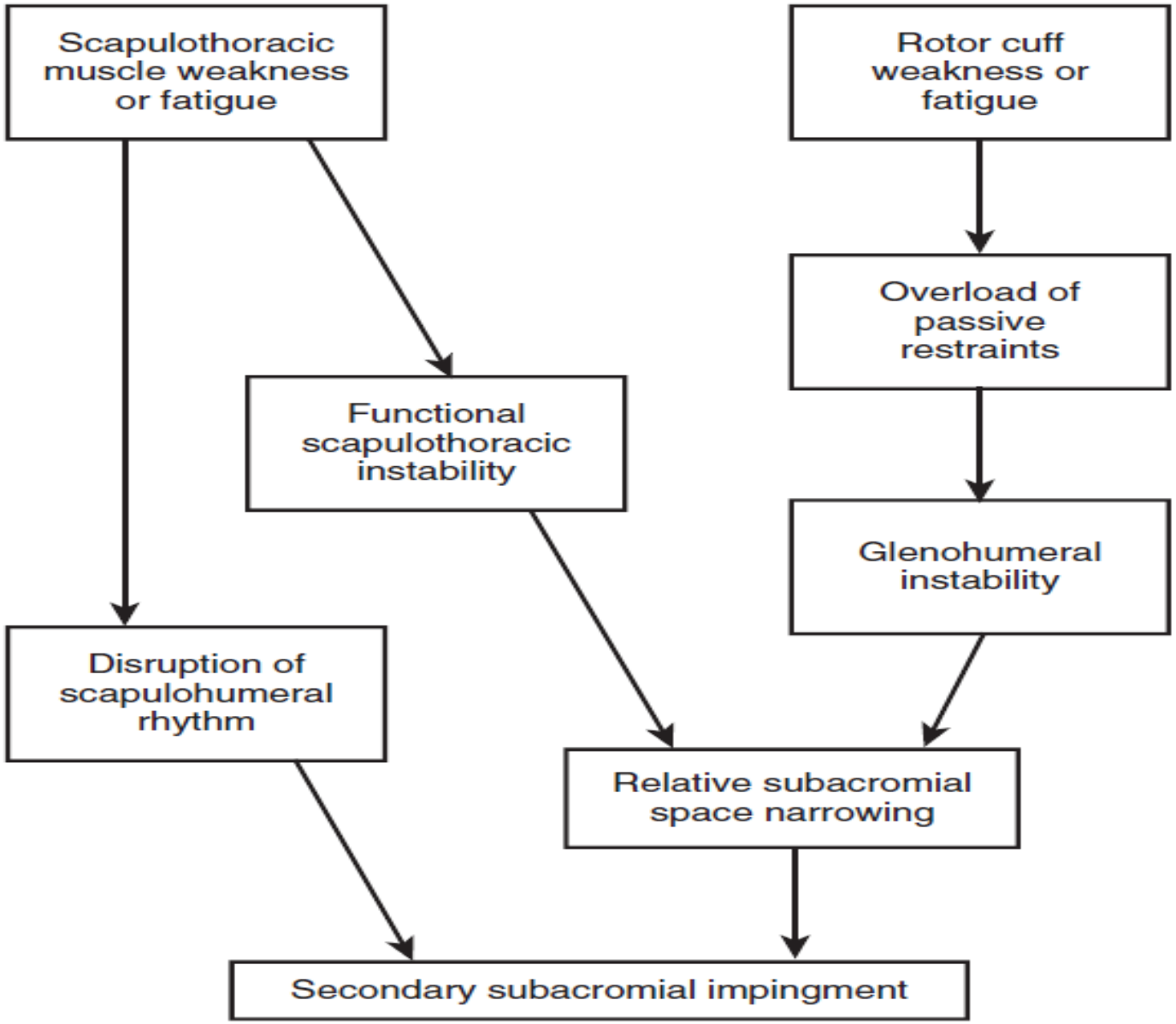


Fig. 33.3 Development of secondary impingement.

In patients with secondary impingement, treatment of the underlying problem should result in resolution of the "secondary impingement" symptoms. Clinicians should be aware of the potential for proximal kinetic chain deficits (i.e., lumbo-pelvichip complex) to contribute to secondary impingement (Kibler 1998, McMullen 2000)

Often, recognition of the underlying GH joint laxity or scapular instability is missed, and the "secondary impingement" is incorrectly treated as a "primary" impingement. A subacromial decompression may worsen the symptoms because the shoulder is rendered even more "unstable" and does not address the primary mechanical problem.

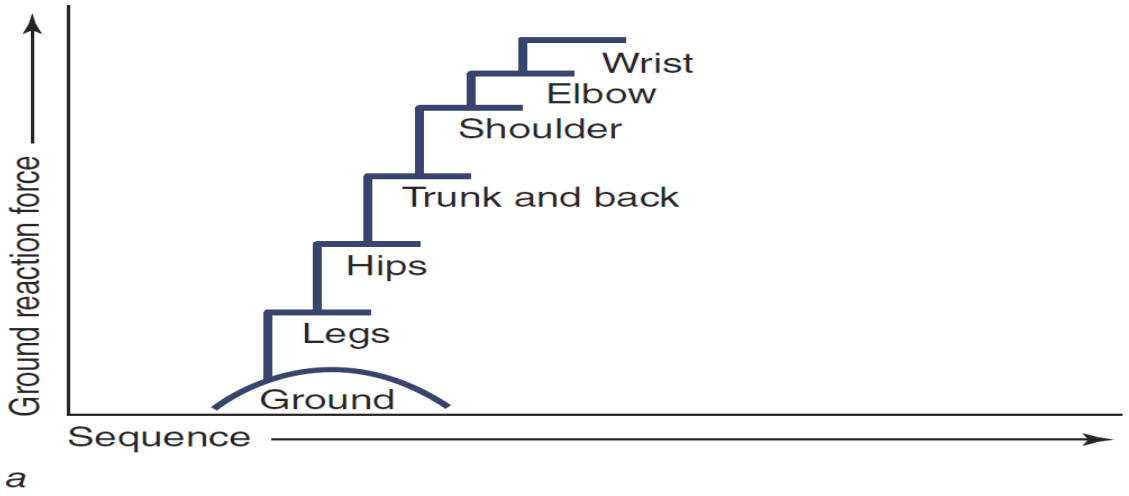
Kinetic Chain

The term **kinetic chain** refers to energy being created by the larger segments and muscles and the transfer of that energy up through the legs and trunk and out to the throwing arm, wrist, and ultimately the ball

The motion of each of the segments in the chain helps not only to maintain the energy transferred but also to build on it

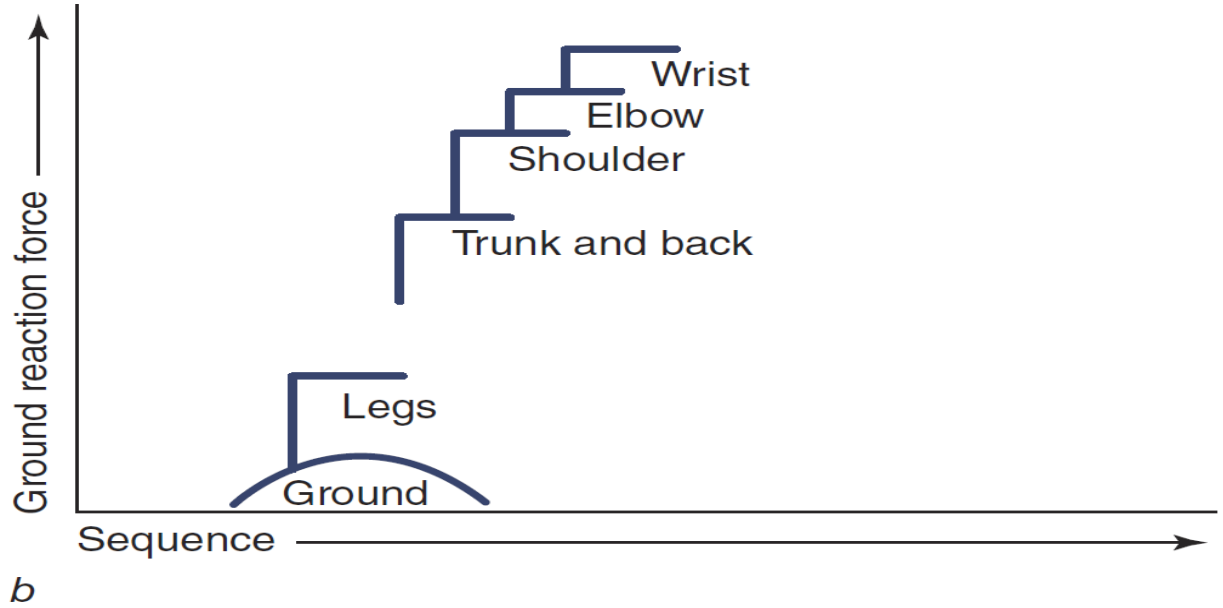
The more body segments that sequentially contribute to the total force output, the greater the potential velocity at the distal end where the object is released.

During the throwing motion, movements are initiated from the larger muscles of the base segments and are transferred to the core of the body, then terminating with the smaller distal segments. There appear to be primarily seven segments that have movements during the overhead throwing motion: (1) lower extremity, (2) pelvis, (3) spine, (4) shoulder girdle, (5) upper arm, (6) forearm, and (7) hand (Atwater 1979, Dillman 1990, Dillman et al. 1993, Feltner & Dapena 1989a, 1989b)



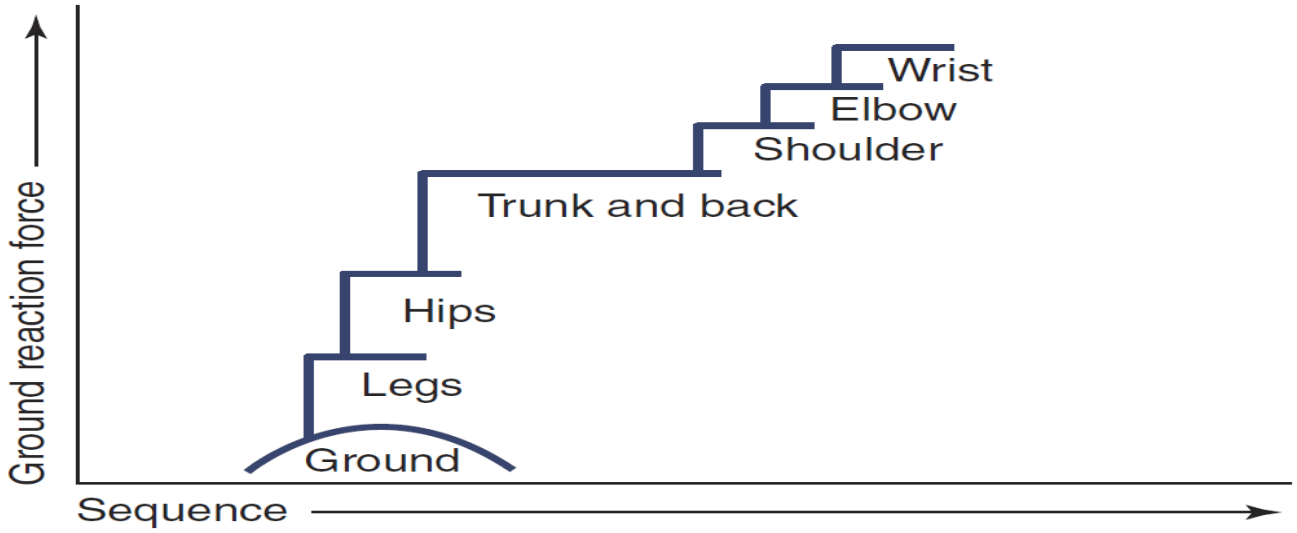
a

nonoptimal use of the kinetic chain system because of a missing link (as in hip injury)



b

nonoptimal use of the kinetic link system due to improper timing



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Section III – Sports Training

DE GRUYTER OPEN

Effect of Core Training on Male Handball Players' Throwing Velocity

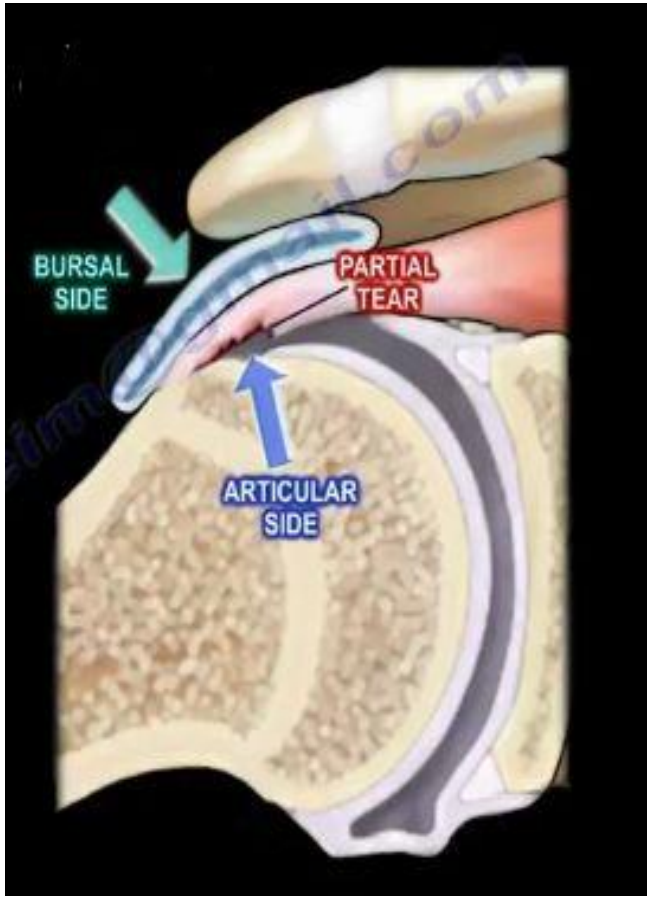
by
Carmen Manchado[1], José García-Ruiz[1], Juan Manuel Cortell-Tormo[1], Juan Tortosa-Martínez[1]

The results seem to indicate that an increase in the strength and stability of the lumbo-pelvic region can contribute to an improvement in the kinetic chain of the specific movement of throwing in handball, thus, increasing throwing velocity.

Internal Impingement (Undersurface)

Posterior Internal Impingement

- This phenomenon was originally identified by Walch et al upon performing shoulder arthroscopy with the shoulder placed in the 90 degrees of abduction and 90 degrees of external rotation (ER) (90/90) position.
- Placement of the shoulder in the 90/90 position causes the supraspinatus and infraspinatus tendons to rotate posteriorly. This more-posterior orientation of the tendons aligns them such that the undersurface of the tendons rubs on the posterior superior glenoid lip and becomes pinched or compressed between the humeral head and the posterosuperior glenoid rim



- While this “internal impingement” is present in normal physiologic motion it may become pathologic with repetitive overhead activities.
- The pathology consists of undersurface tears of the posterior supraspinatus and/or anterior aspect of the infraspinatus tendon and often includes superior labrum anterior to posterior (SLAP) tears (Heyworth 2009)

External impingement (bursal Surface) produces anterior and anterolateral pain distributions. Conversely, internal impingement (undersurface, aricular surface) produce posterior shoulder pain

The presence of anterior translation of the humeral head with maximal ER and 90 degrees of abduction, which has been confirmed arthroscopically during the subluxation- relocation test, can produce mechanical rubbing and fraying on the undersurface of the rotator cuff tendons.

Anterior GH instability: Jobe et al. hypothesized that anterior instability/laxity of the shoulder complex caused by repetitive stretching of the anterior GH capsule led to this type of impingement in throwing athletes. This laxity allows for increased anterior humeral head translation. This type of acquired instability is often referred to as acquired instability overuse syndrome (AIOS).

Tight posterior GH capsule: The posterior-inferior GH joint capsule is hypothesized to become hypertrophied in the follow-through tensile motion of throwing. The tightness of the posterior capsule and the muscle tendon unit of the posterior rotator cuff is believed to limit internal joint rotation. Posterior capsule tightness leads to GIRD (glenohumeral internal rotation deficit). Burkhart et al. defined GIRD as a loss of internal rotation of >20° compared with the contralateral side.

Anterior Internal Impingement

It is the compression of the rotator cuff on the anterior glenoid and should be not confused with sub-coracoid, external impingement, due to rubbing between the coracoid process and the humerus (usually the lesser tuberosity)

classification system for ASI

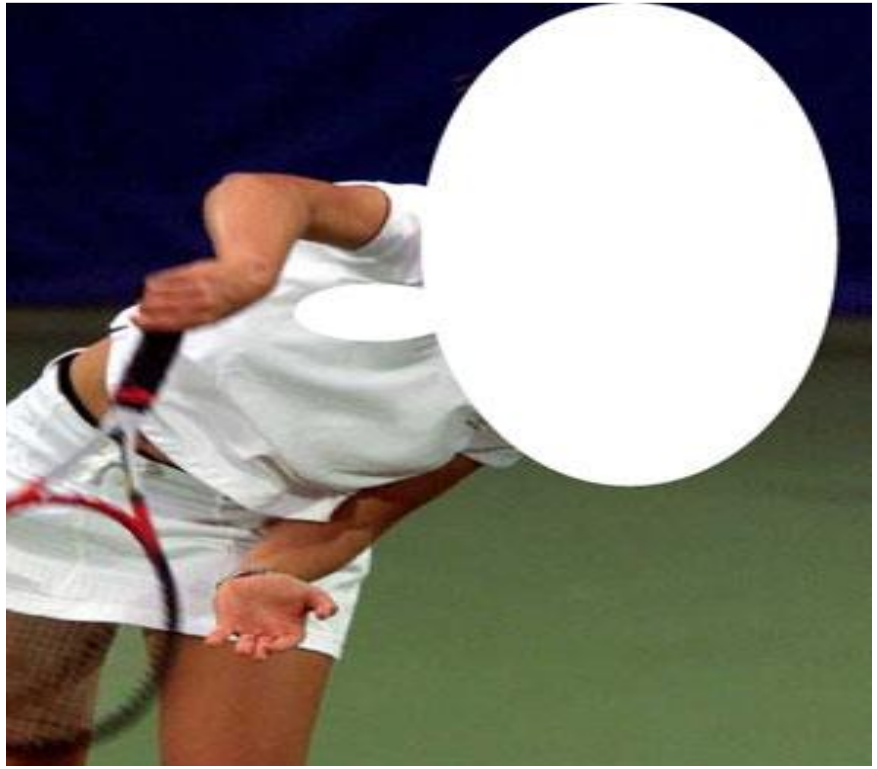
Habermeyer et al. developed a classification system for ASI:

- type I with an isolated lesion of the SGHL,
- type II with a lesion of the SGHL associated with a partial articular side supraspinatus tendon tear
- type III with a lesion of the SGHL associated with a partial subscapularis tendon tear
- type IV with a lesion of the SGHL associated with a partial tear of the supraspinatus and subscapularis tendon.

Habermeyer et al. believed that the cascade of ASI starts with the pulley lesion and instability of the LHB tendon caused by degenerative changes, microtrauma or repetitive microtrauma. The subluxated LHB tendon loses its anterior stabilizing effect on the humeral head, which leads to an increased anterior translation. Furthermore, Habermeyer et al. concluded that the subluxated LHB tendon could be responsible for a partial articular tear of the subscapularis tendon that permits a further anterior-superior translation of the humeral head.

Clinical history, physical examination ASI

- ASI typically involves middle-aged patients who are often involved in overhead manual labour or athletes



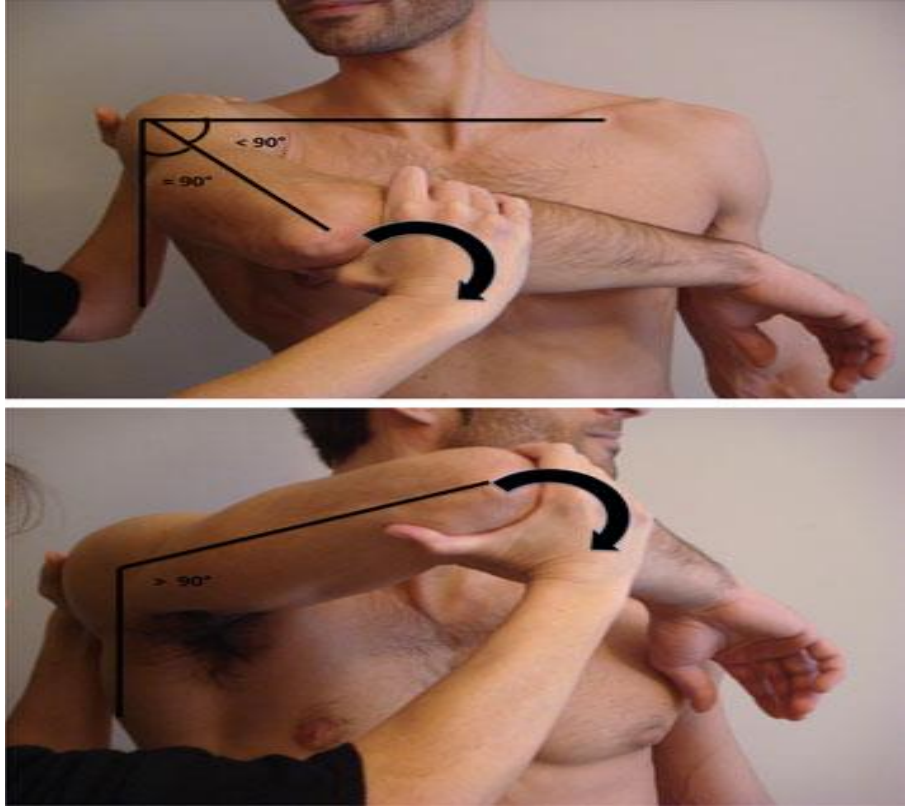
Repetitive use of the arm in the position of adduction, elevation and internal rotation can produce the phenomenon of anterior-superior impingement

Patients often complain of an insidious anterior shoulder pain, especially at night, without any history of trauma

Habermeyer et al. reported that several patients diagnosed with ASI recalled a history of minor trauma before they started to have symptoms. The traumatic mechanism reported to be associated with a pulley lesion is a fall on the outstretched arm, in combination with full external or internal rotation, or a fall backwards onto the hand or elbow

Gerber and Sebesta reported a modified impingement test that was positive in all patients.

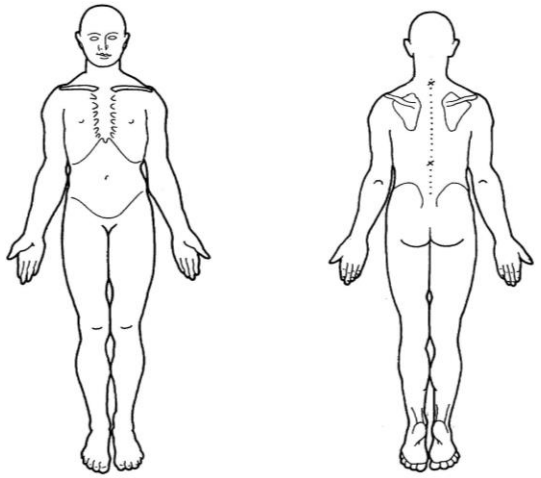
- they observed arthroscopically that internal rotation associated with an elevation of more than 120 degrees caused direct contact between the LHB tendon and the pulley region with the anterior-superior labrum



In addition, clinical tests suggesting pathology of the LHB or of the biceps anchor, such as the palm-up test (Speed's Test) or the O'Brien test were found to be positive.

A Systematic Examination of the Shoulder

HISTORY



A body chart can be used to record the patient's symptom distribution

Personal history:

- RC degeneration usually occurs in the 40s and 50s.
- frozen shoulder is more common in those aged 45–60 years

mechanism of injury

- Overhead exertion involving repetitive motions is a common mechanism for subacromial pathology
- A fall on an outstretched hand ("FOOSH" injury) can result in a sprain or strain injury to the wrist, elbow, and shoulder. fractures of the wrist and elbow, A-C separations, clavicular fractures, and G-H fractures and dislocations.
- A fall on the tip of the shoulder is a common mechanism for A-C separation.
- Forced horizontal extension of the abducted, externally rotated arm is a common mechanism for anterior dislocation.

pain

Type of pain: Radicular pain tends to be sharp, burning, and radiating. Bone pain is deep, boring, and localized. Muscle pain can be dull, aching, and hard to localize. Tendon pain tends to be hot and burning.

Aggravating factors: an RC tear include difficulty with elevation of the arm in abduction, as well as internal rotation, and when the patient attempts to put his or her hand on back , frozen shoulder difficulty in putting hand behind head

Relieving factors:

- Pain relieved with arm elevation overhead could indicate a cervicogenic cause.
- Pain relieved with the elbow supported is suggestive of A-C separation and RC tears.
- Pain relieved by circumduction of the shoulder with an accompanying click or clunk could indicate an internal derangement or subluxation.
- Pain relieved with arm distraction is suggestive of bursitis or RC tendinopathy.

the location of pain:

- Pain that radiates beyond the elbow is far less likely to be due to shoulder pathology, particularly if it is associated with any sensory disturbance in the limb such as distal radiation of pain, numbness, or paresthesia. In such cases the clinician should rule out thoracic outlet syndrome (TOS), cervical radiculopathy
- Anterior shoulder pain suggests bicipital tendinopathy
- Pain due to A-C joint pathology is usually located at the superior region of the shoulder or well localized at the A-C joint itself
- internal impingement produce posterior shoulder pain

Pain due to RC pathology and impingement, usually felt over the anterior, lateral part of the shoulder, is characterized by radiation down the upper arm, and is aggravated with overhead activities.

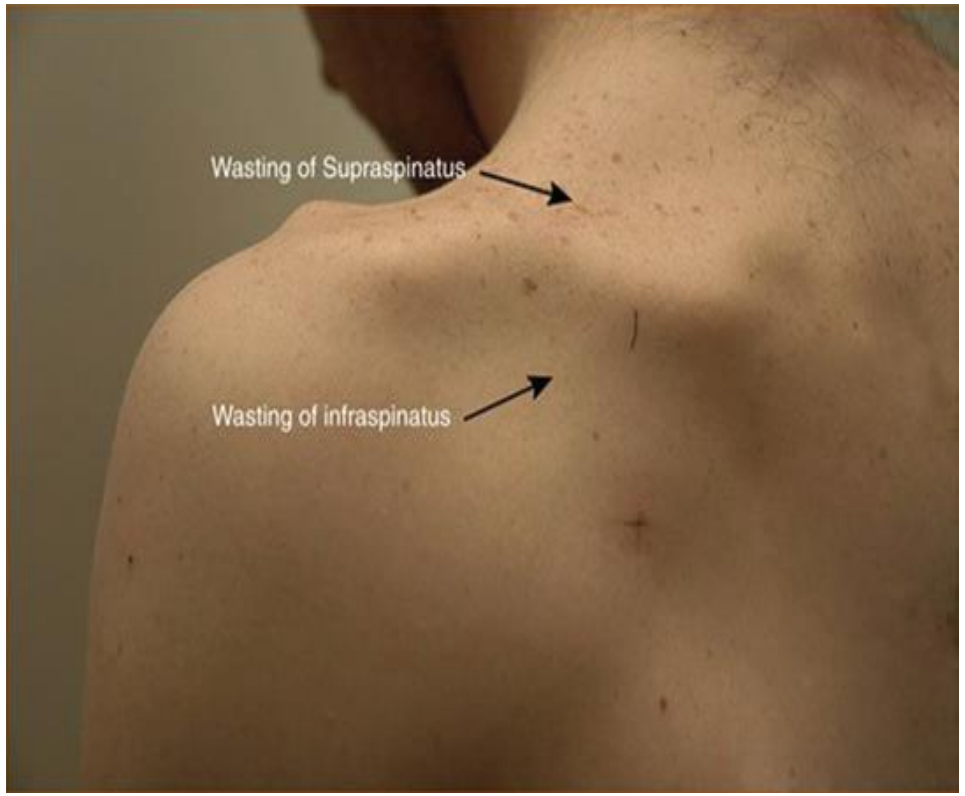
Inspection

(**a**) Rupture of proximal biceps: ‘Popeye’ sign; (**b**) rupture of distal biceps

Flattening of the deltoid acute anterior dislocation of the shoulder

Deltoid atrophy
an axillary nerve lesion

Wasting of supraspinatus and/or infraspinatus – rotator cuff tear or suprascapular nerve damage



Impingement of the suprascapular nerve can occur at the suprascapular notch and the spinoglenoid notch

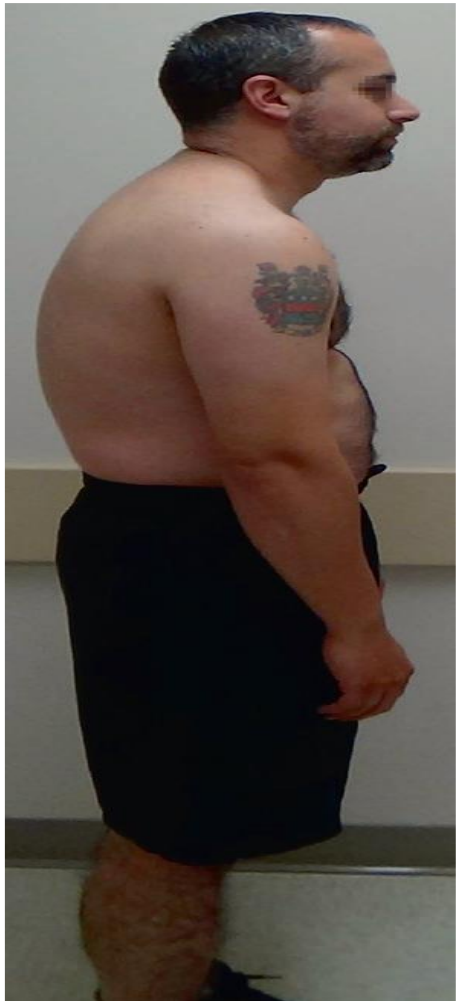
Prominent distal end of clavicle – AC joint dislocation/subluxation (compare with opposite side as it may be a normal variant)

SCAPULAR EVALUATION

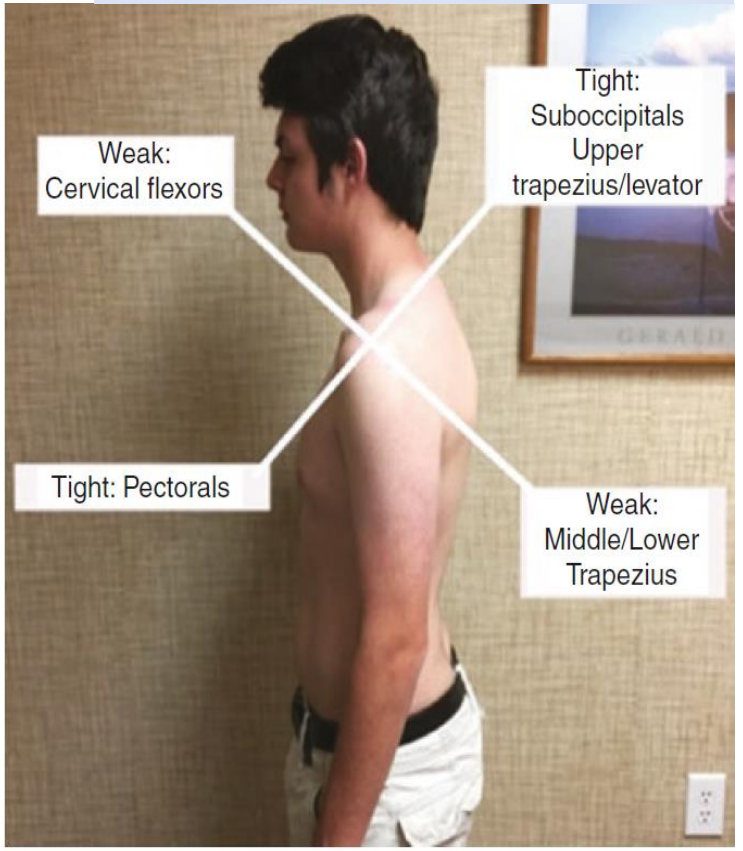
Visual Observation

visually inspect the scapula position at rest from the posterior view

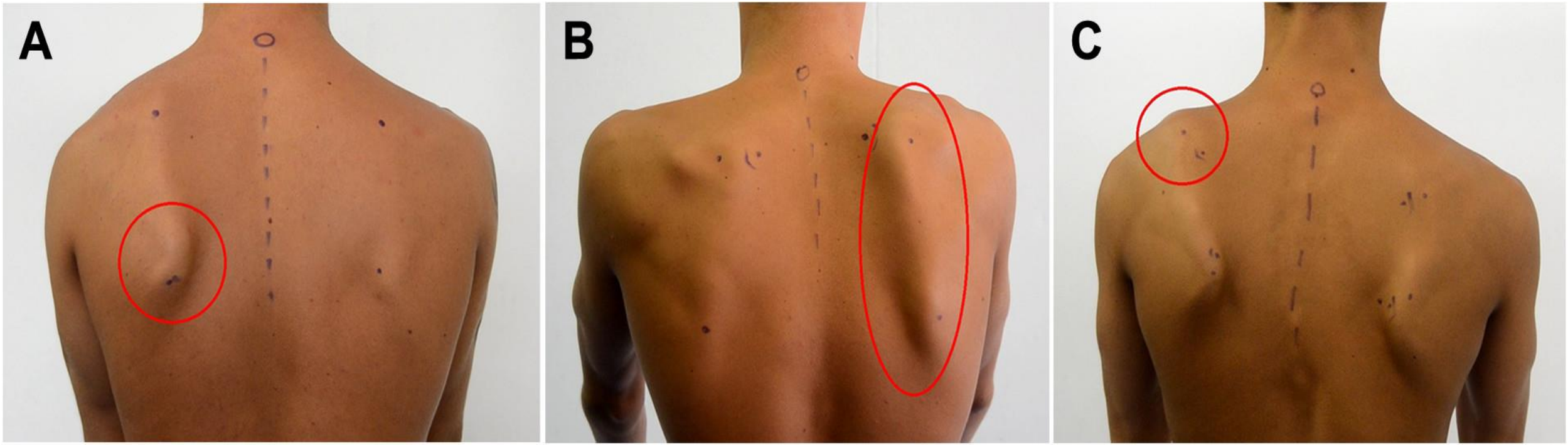
Forward head posture and increased thoracic kyphosis may contribute to scapular protraction



Upper Crossed Syndrome



Kibler classification of scapular dyskinesis



Type 1: Inferior angle prominence, Type 2: Medial border prominence, Type 3: Excessive superior border elevation

The scapular dyskinesis test is a visually based test for scapular dyskinesis that involves a subject performing weighted shoulder flexion and abduction movements, while visual observation of the scapula is performed

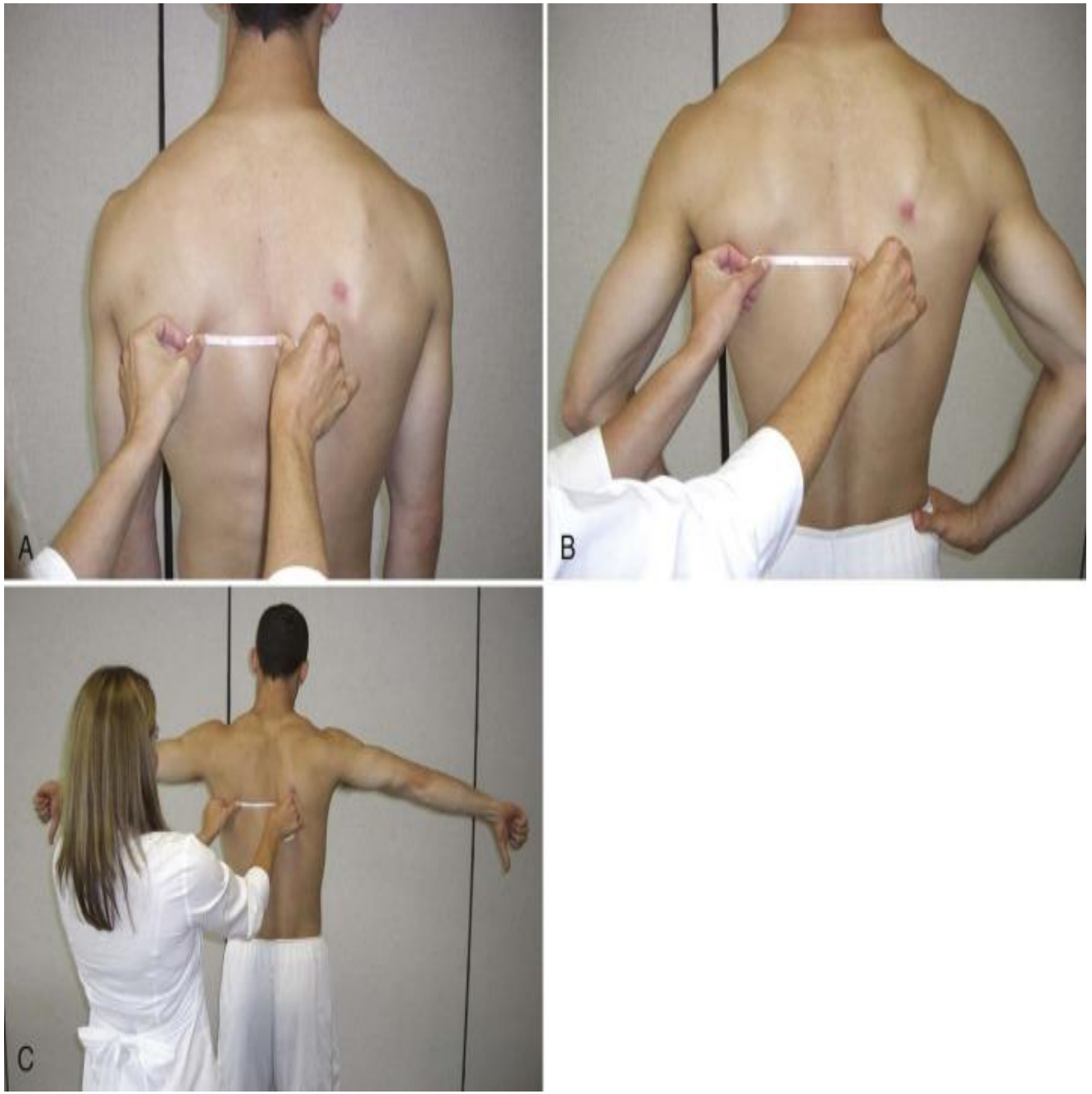
Dyskinesis is defined as the presence of either winging (prominence of any portion of the medial scapular border or inferior angle away from the thorax) or dysrhythmia (premature, or excessive, or stuttering motion during elevation and lowering)

prominence of scapular medial border winging on the right side

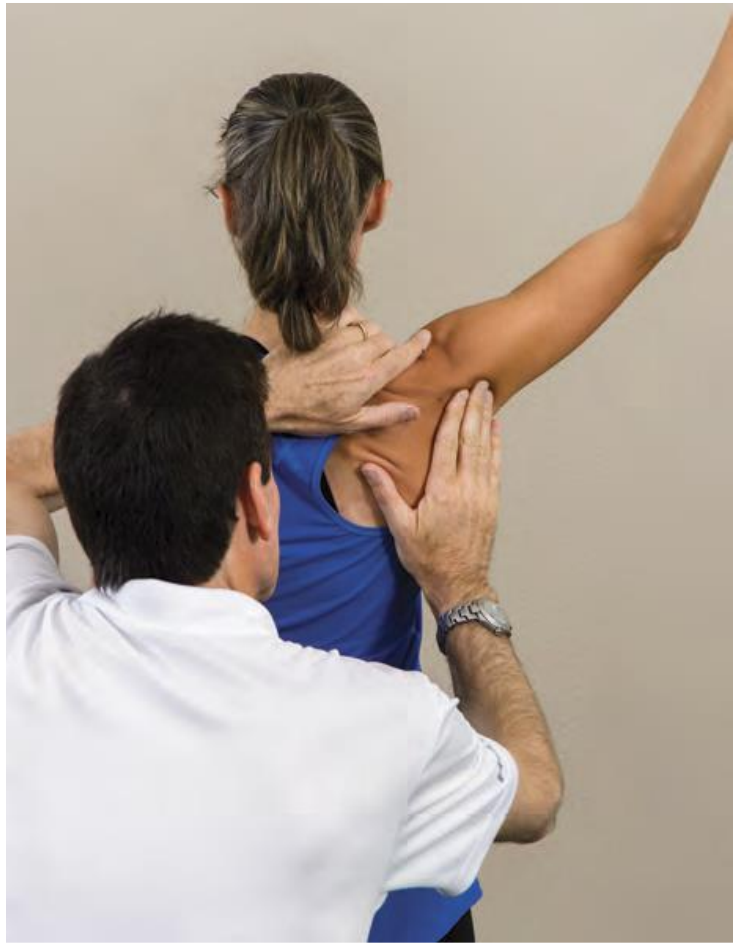
the premature or excessive scapular elevation that appears as *shrugging*. This pattern is of scapular compensation associated with rotator cuff pain, weakness, and fatigue and loss of glenohumeral motion.

Excessive and poor eccentric control of scapular downward rotation on the left side during arm lowering known as “dumping”.

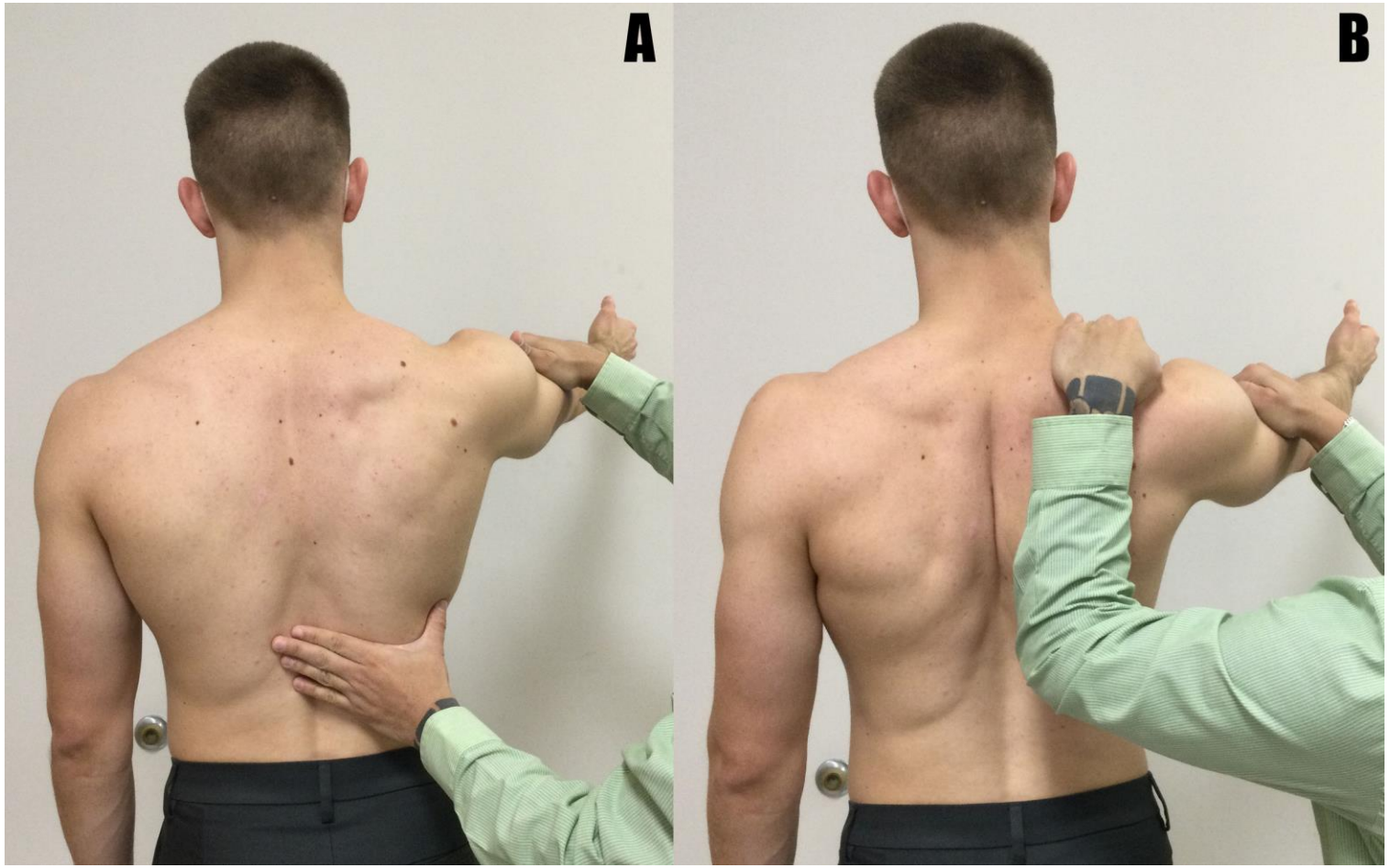
Lateral scapular slide test
with linear measurement from inferior angle of scapula to thoracic spinous process **A,** with arms at the side; **B,** with hands on hips; **C,** with shoulders abducted to 90 degrees and internally rotated.



Scapula Assistance Test



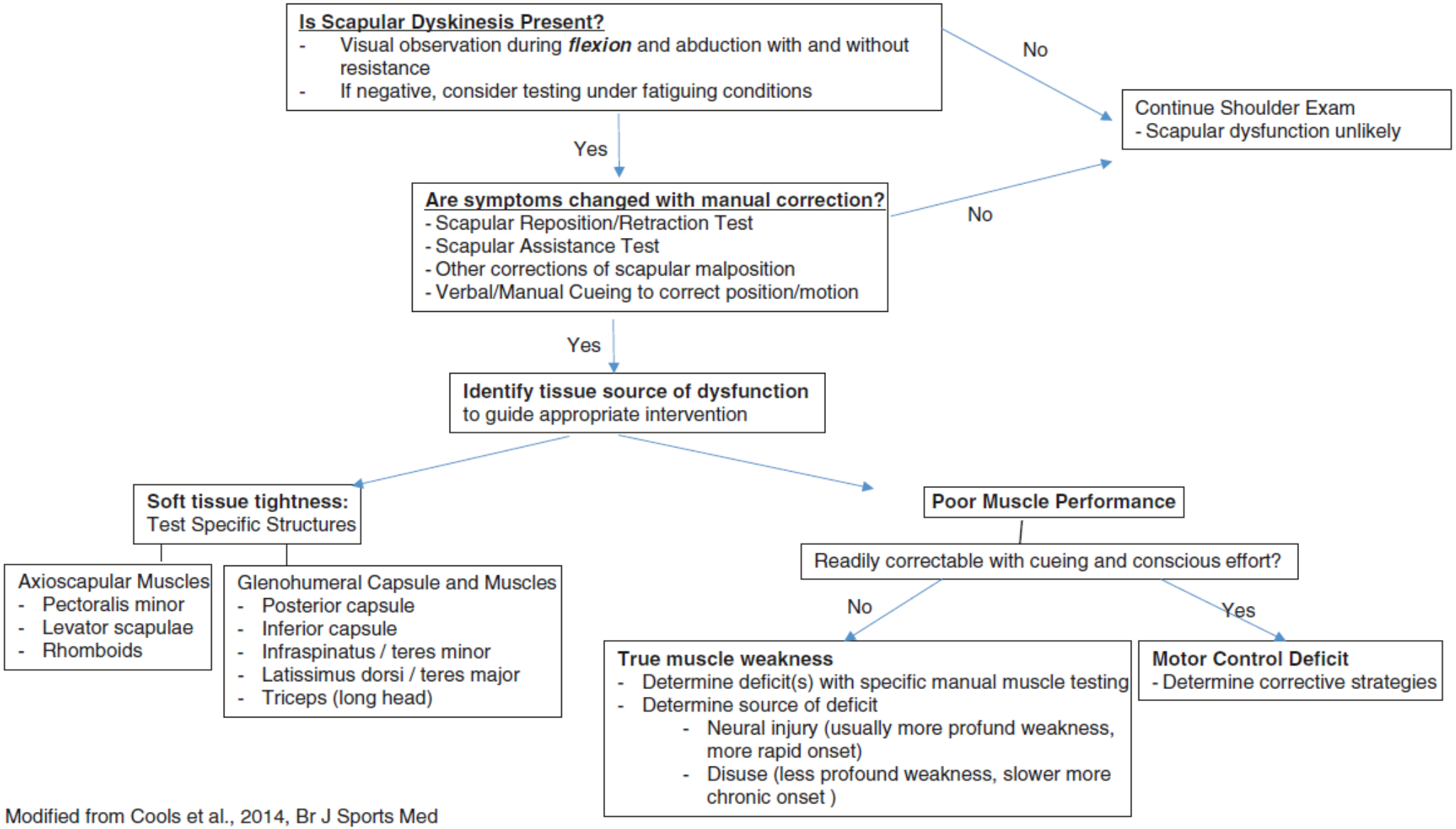
Scapular Retraction Test.



Flip Sign Test

Resisted ER at the side applied by the examiner with close visual monitoring to the medial border of the scapula during the ER resistance. A positive flip sign is present when the medial border of the scapular “flips” away from the thorax and becomes more prominent. This indicates a loss of scapular stability

Clinical scapular examination algorithm (Modified from Cools et al. 2014, Br J Sports Med)



Modified from Cools et al., 2014, Br J Sports Med

Palpate for tenderness in the following:

- Sternoclavicular joint
- Coracoid process
- Acromioclavicular joint
- Biceps tendon, most easily felt in the intertubercular groove, with alternating internal and external rotation the arm
- Subacromial palpation:

Anteriorly, with the arm in slight extension – supraspinatus

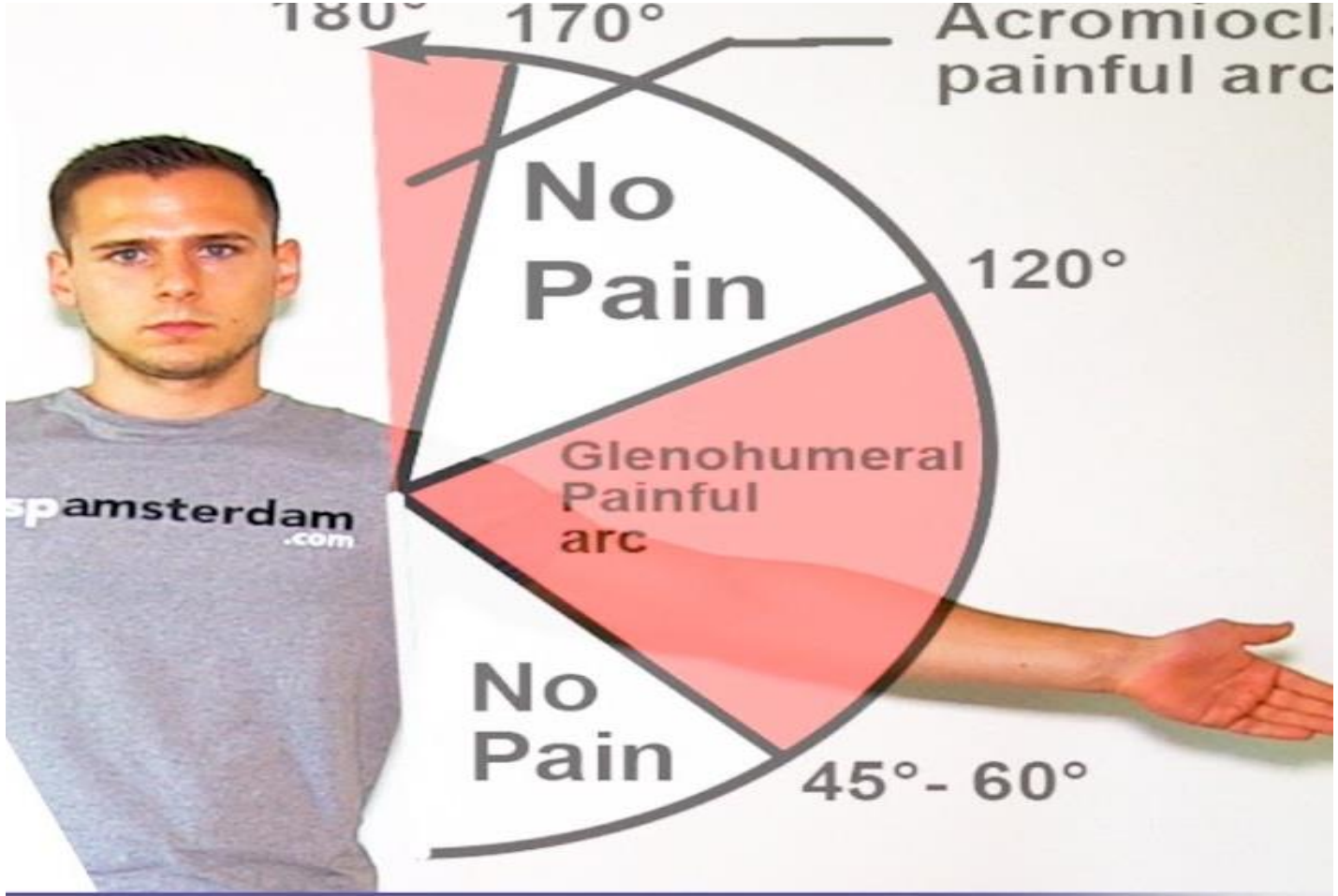
Posterolaterally, with the arm in slight flexion – infraspinatus

Palpating biceps tendon

JOINT RANGE OF MOTION assessment

Arm Elevation

- Pain that occurs between 70 and 110 degrees of abduction is deemed a “painful arc” and may indicate RC pathology.
- Pain which occurs in the 120–160/160–180-degree range is more likely to involve the A-C joint.

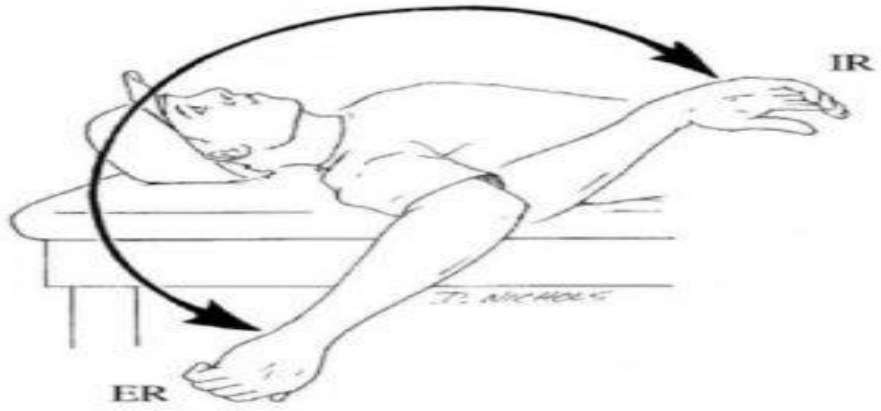


Measurement of several cardinal movements of the shoulder are important; however, glenohumeral joint IR, ER, and total ROM have significant clinical importance

A goniometric method using scapular stabilization by the examiner to minimize the scapulothoracic contribution or substitution is recommended by Ellenbecker to better isolate and represent glenohumeral rotational motion (Ellenbecker et al. 1993, Ellenbecker 2004a, Wilk et al. 2009). These included scapular stabilization using a C-shape type of grasp with the four lesser fingers on the scapula posteriorly and the thumb on the coracoid anteriorly

Most overhead athletes exhibit excessive ER and decreased IR

Burkhart and coworkers (2003) describe this loss of IR ROM as **glenohumeral internal rotation deficit (GIRD)** The thrower's paradox.



Glenohumeral Internal Rotation Deficiency GIRD

- Burkhart et al. (2003) have operationally defined GIRD as a loss of internal rotation of 20 degrees or more compared to the contralateral side.
- a loss of internal rotation greater than or equal to 10% of the contralateral extremities total rotation arc (Tokish et al. 2008).

Wilk and colleagues (Wilk et al. 2011) examined total range of motion in baseball players and found that those who exhibited GIRD and additionally had a loss of total rotation range of motion (TROM) greater than 5 degrees had a 2.5 times greater risk of developing shoulder problems.

- (anatomic or asymptomatic) a GIRD in which there is less than 18 degrees loss of IR with TROM within 5 degrees of uninvolved side. (Increased humeral torsion among athletes
- A (pathologic) pGIRD would be one in which the shoulder has greater than 18 degrees loss of IR and greater than 5 degrees loss of TROM (Manske R et al. 2013).

PROPOSED CAUSES OF GIRD

- tightness of the posterior capsule
- increases in humeral retroversion in throwing athletes
- Resiman et al. (2005) have demonstrated shortening of the muscle tendon unit following exposure to eccentric overload, a well-recognized characteristic of the follow-through phase of the throwing motion and overhead serve

In the presence of posterior capsular tightness, the humeral head will shift in an anterior superior direction

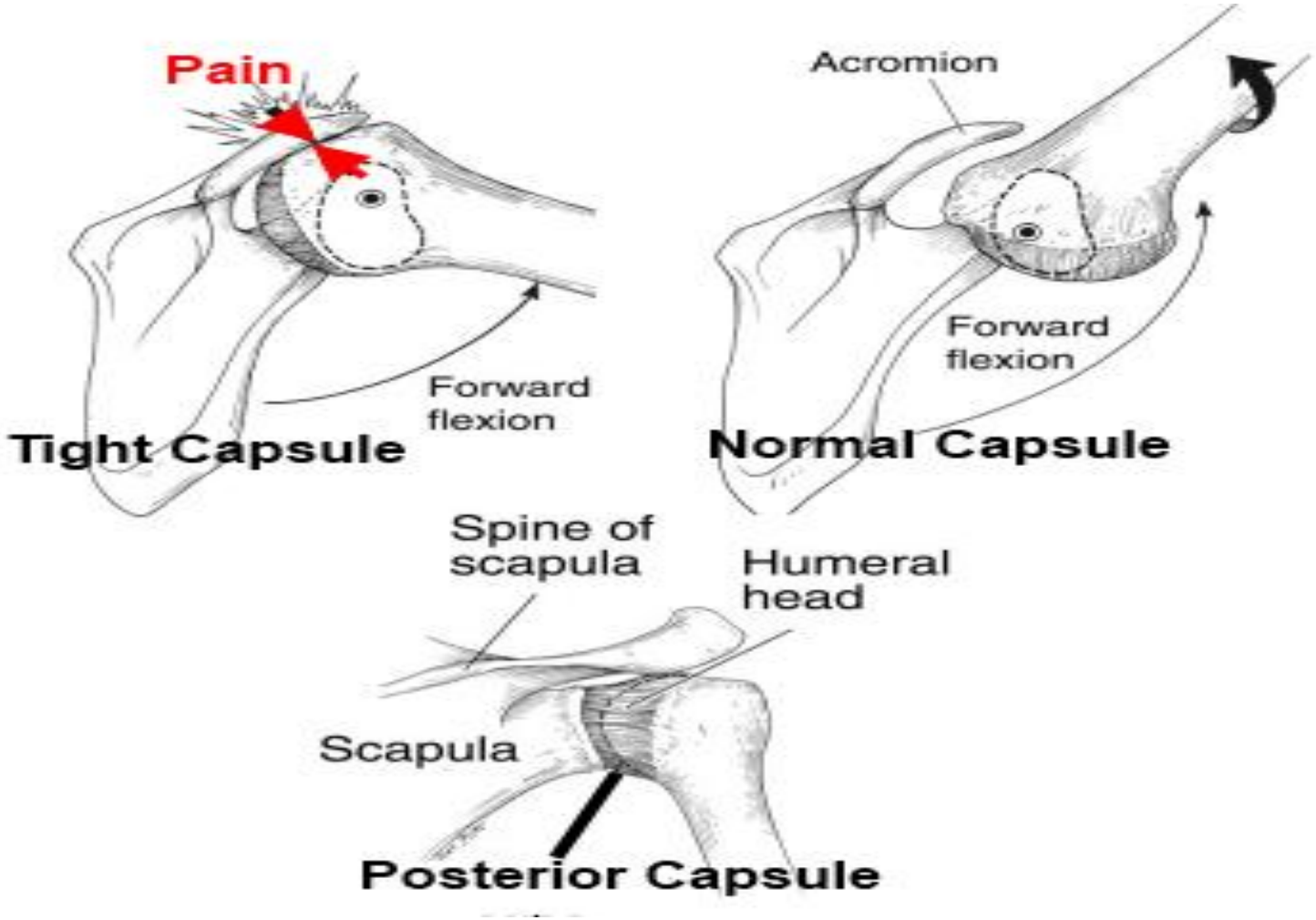
internal rotation stretching method allowing for internal rotation overpressure with stabilization

Sleeper stretch position

posterior glide mobilization

Cross-arm stretch position

Patients with tightness in the posterior shoulder will have a loss of internal rotation. Posterior capsular tightness leads to an obligate anterosuperior translation of the humeral head and resultant diminished subacromial outlet space, which is thought to contribute to the impingement problem (Burkhart 2003, Tyler 2000**).**



Passive ER from adducted arm (Assessment of RC interval tightness)

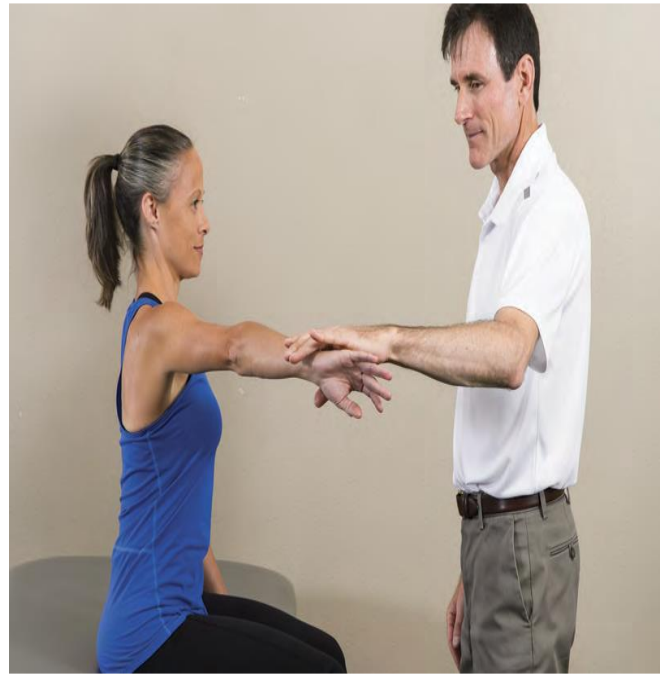
Passive ER from ABDUCTED arm (Assessment of ANERTIOR CAPSULE TIGHTNESS)

STRENGTH testing

Supraspinatus

- EMG studies compared muscle tests with the shoulder at 90 of abduction in the plane of the scapula with either external rotation or internal rotation. No study found a significant difference in the muscle activity of the supraspinatus muscle when the two positions were compared.
- However, these researchers recommended using the test with lateral rotation (thumb-up or “full can” position) because this is a position in which less subacromial impingement, and therefore less pain, is expected.
- Determining specific supraspinatus muscle weakness may not be possible because the deltoid muscle is always active with the supraspinatus muscle.
- Weakness detected with this muscle test often results from pain production that inhibits muscle contraction.
- Weakness in the absence of pain necessitates a differential diagnosis between a neurologic source and muscle or tendon rupture

full can



(empty can)

Infraspinatus and Teres Minor

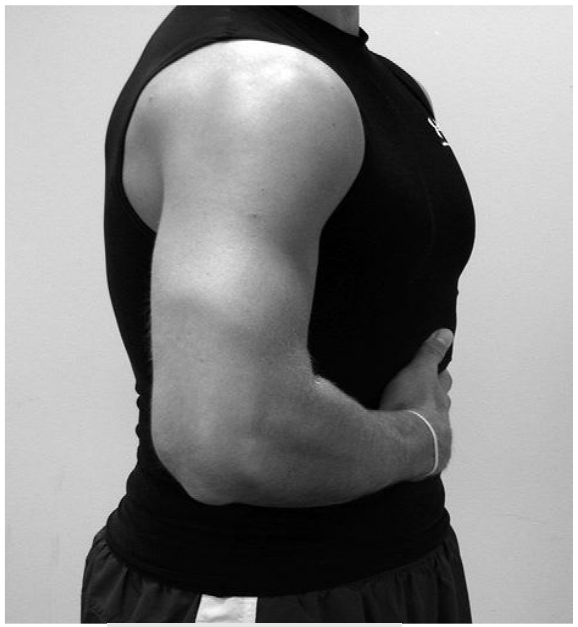
- the infraspinatus muscle activity is best with the shoulder in 0 of abduction and medially rotated approximately 45
- In end range of shoulder lateral rotation with 90 of abduction position, the glenohumeral joint is less stable and requires more activity from posterior deltoid and other rotator cuff muscles

Subscapularis

Greis et al and Kelly et al found that the activity on EMG of the subscapularis muscle is maximal and best isolated from the other shoulder internal rotators by the Gerber lift-off

Gerber lift-off

The belly-press activates the upper subscapularis muscle significantly more than the lift-off test, whereas the lift-off test produces greater activity in the lower subscapularis.



belly-press

Pectoralis Major

For the sternocostal part, the arm is brought toward the opposite hip, and for the clavicular part, the arm is taken toward the nose as resistance is isometrically applied.

sternocostal part of the muscle

clavicular part of the muscle

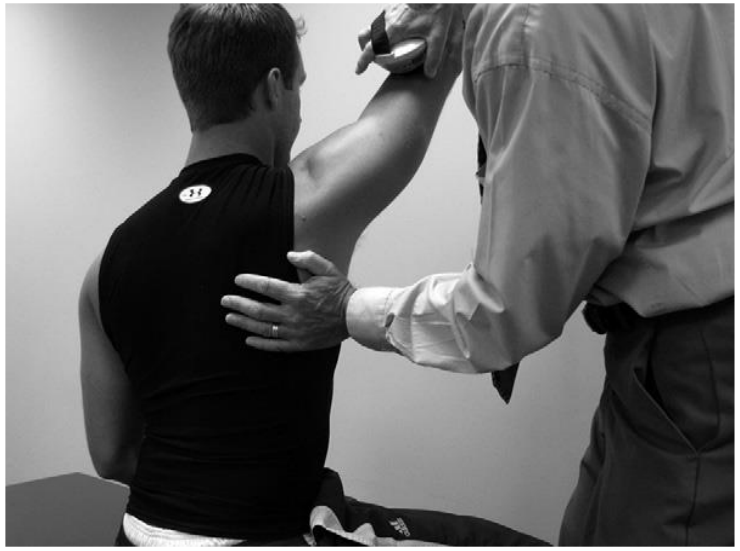
Trapezius

Lower trapezius

Middle trapezius

Serratus anterior

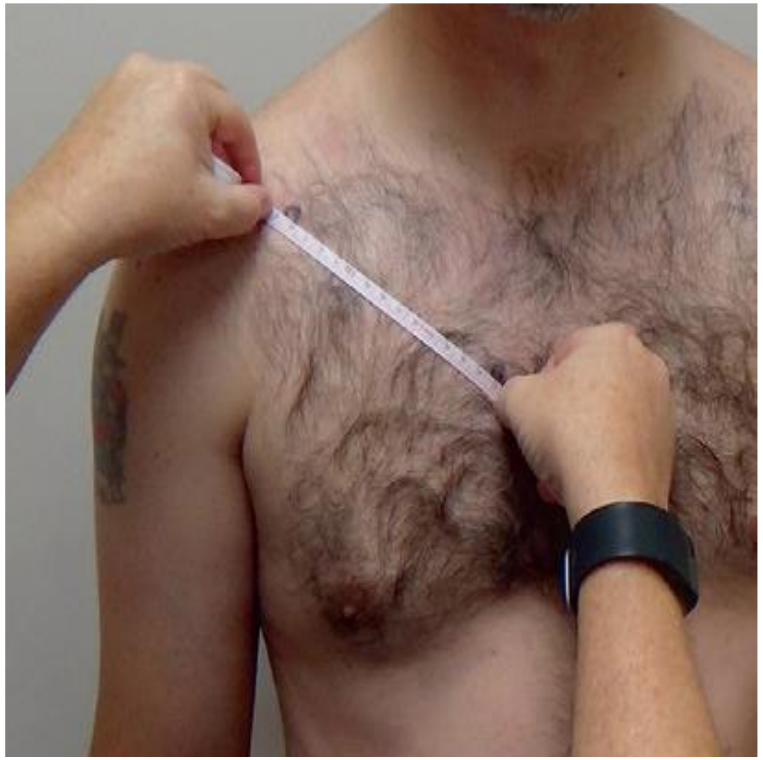
- shoulder is flexed or abducted in the plane of the scapula to 125 The scapula is upwardly rotated as a result of this position, and the examiner tries to derotate the scapula by applying simultaneous pressure downward on the arm and at the inferior angle of the scapula.
- Ekstrom et al demonstrated significantly more activity on EMG in the serratus anterior muscle when it was tested in this position as compared with a supine-scapular protraction test



Flexibility test

Pectoralis minor

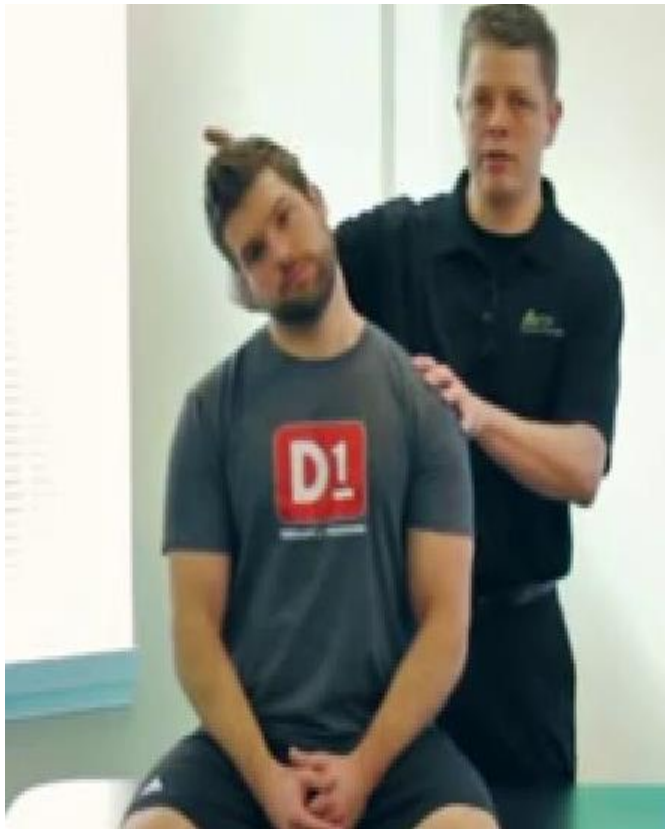
taking a linear measurement with the patient supine from the treatment table to the posterior aspect of the acromion,



Pectoralis minor length measured from the fourth rib to the coracoid process

Levator scapulae

Upper trapezius



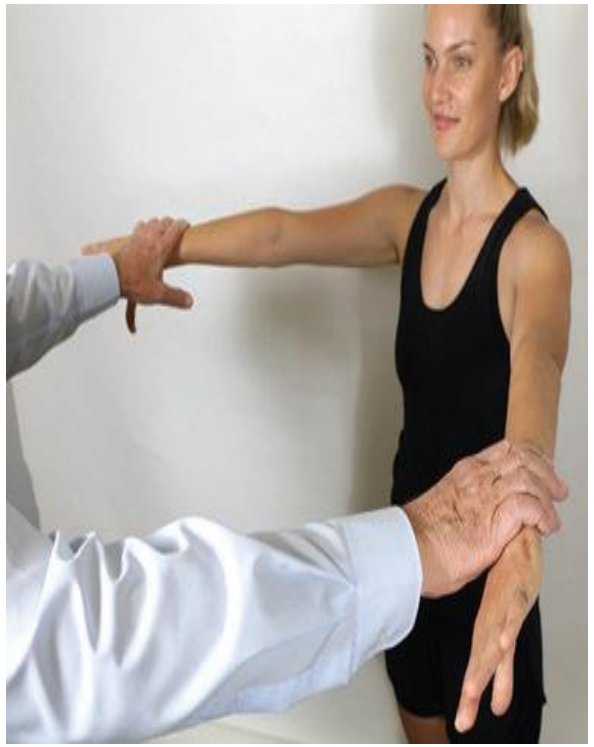
Impingement Tests

Neer test

External rotation lag test

Hawkins test

Empty can test’

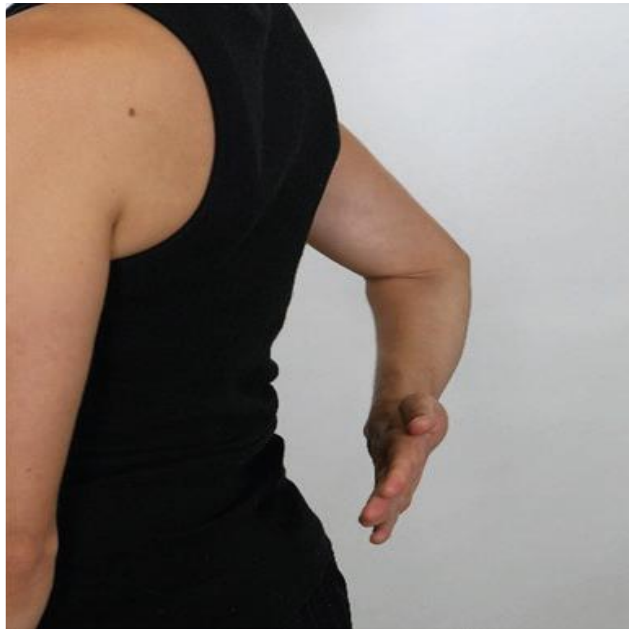


full can test’

Subscapularis (impingement)

Belly-press test

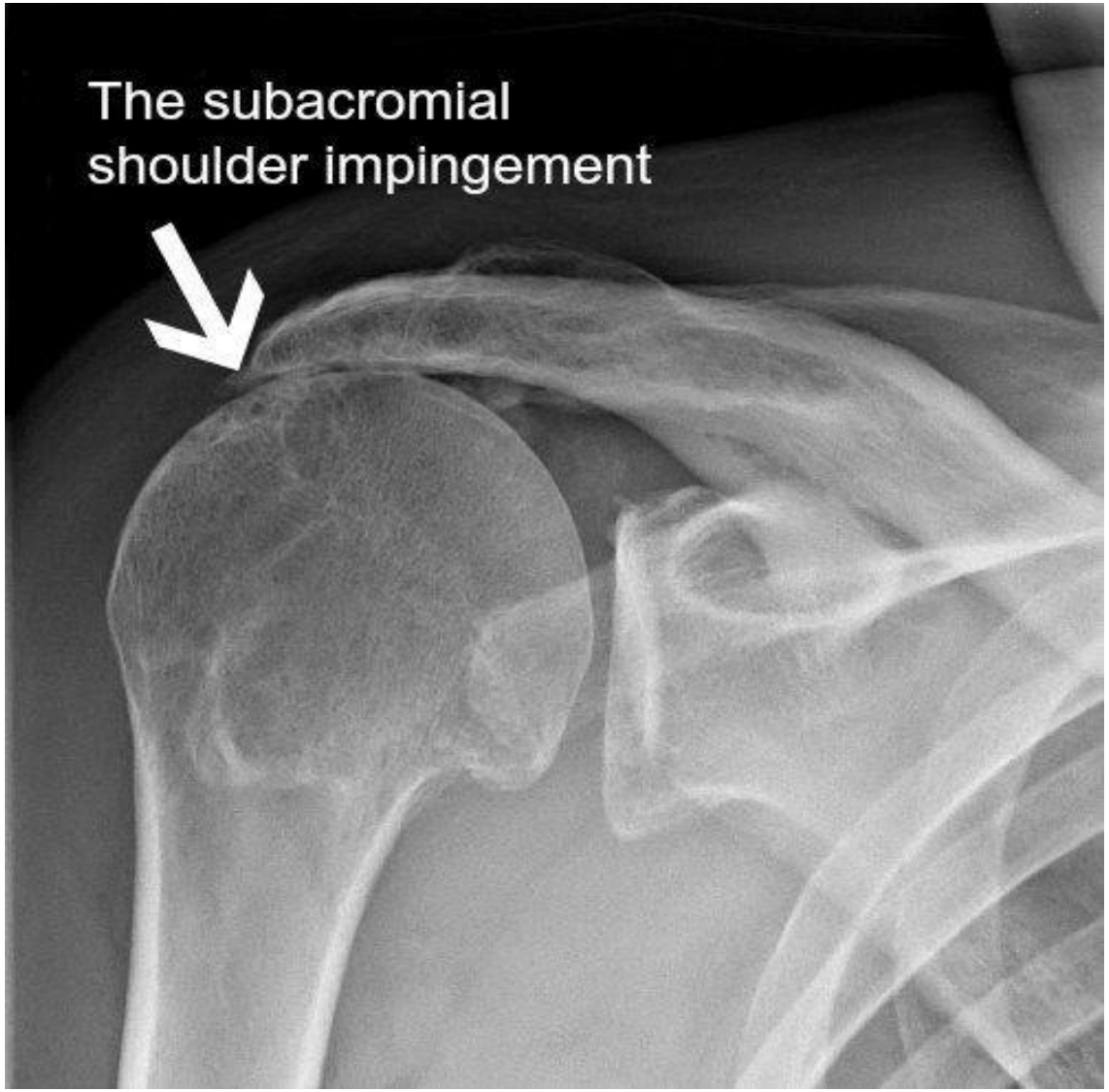
Lift-off test

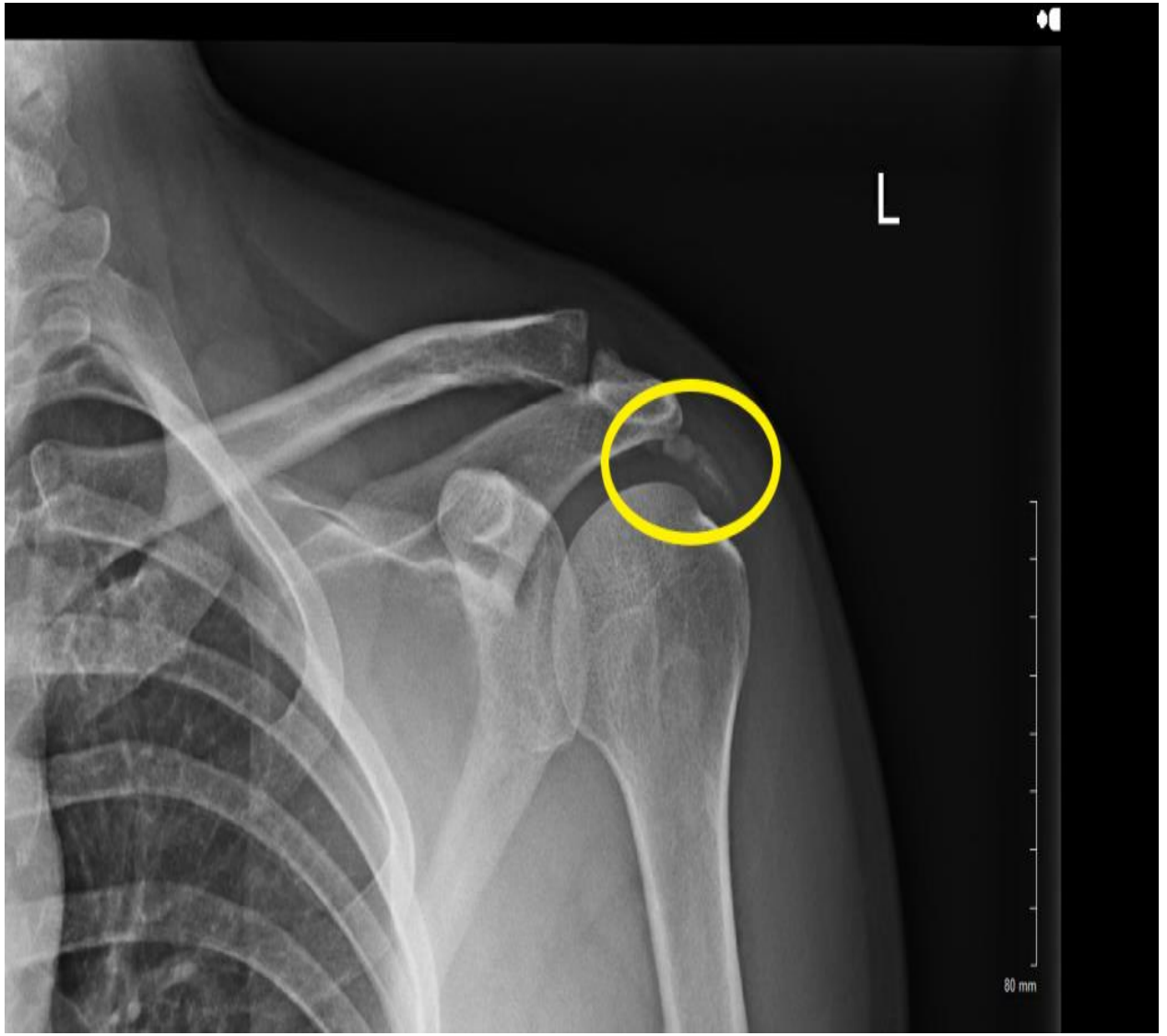


bear hug test

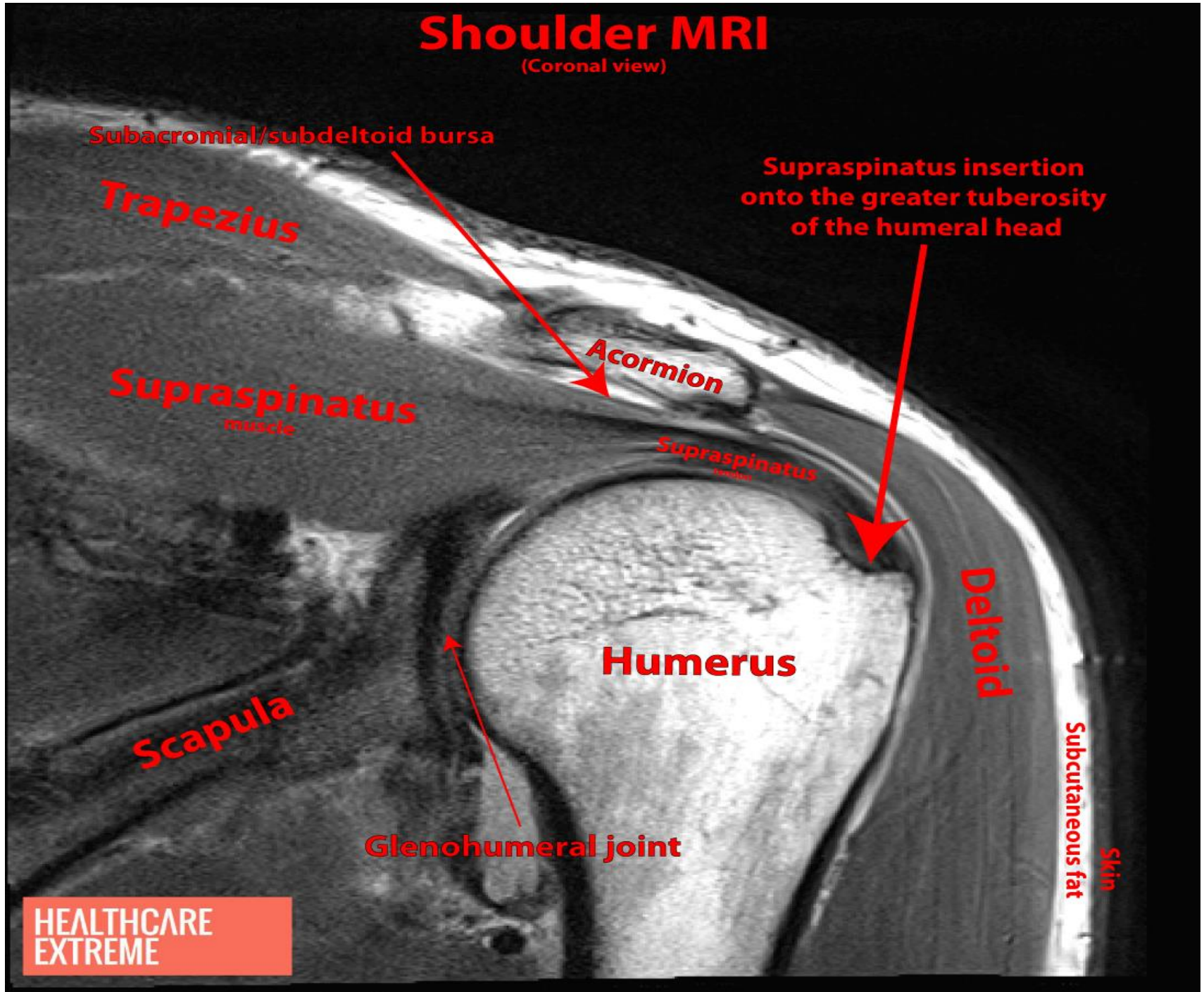
- **Drop-Arm Test**
- Abducted arm slowly lowered
  - May be able to lower arm slowly to 90° (deltoid function)
  - Arm will then drop to side if rotator cuff tear
- Positive test
  - patient unable to lower arm further with control

Cross arm test





X-RAY of the shoulder showing a calcium deposit in the rotator cuff

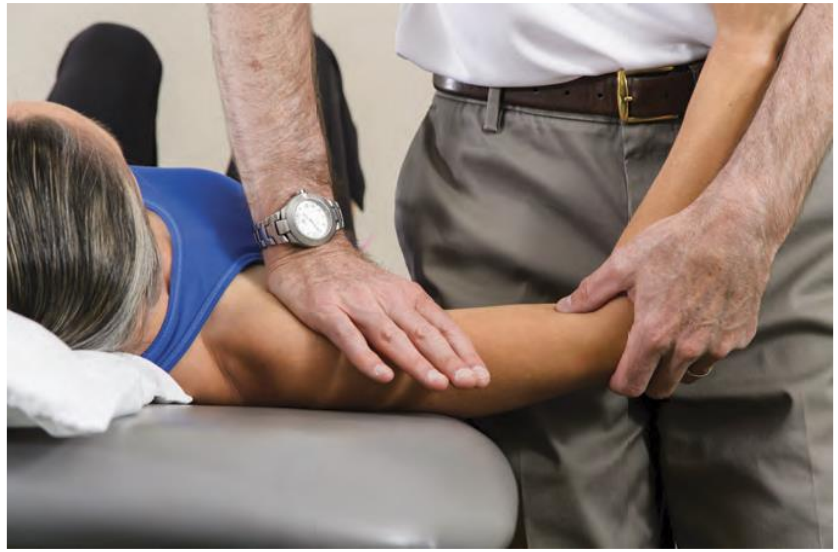

Shoulder MRI
(Coronal view)
Subacromial/subdeltoid bursa
Trapezius
Supraspinatus insertion
onto the greater tuberosity
of the humeral head
Acormion
Supraspinatus
muscle
Supraspinatus
tendon
Deltoid
Humerus
Scapula
Subcutaneous fat
Skin
Glenohumeral joint
HEALTHCARE
EXTREME

MRI – T2 Coronal of the Left Shoulder

- acromion
- supraspinatus tendonitis: the lighter contrast in the tendon represents increased fluid within the tendon, due to inflammation

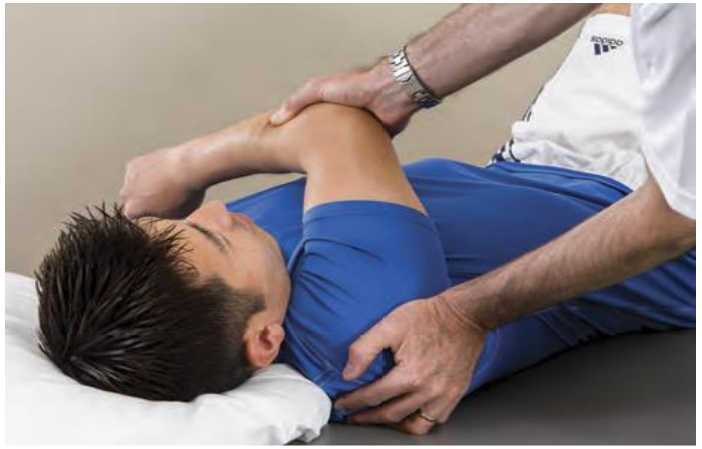
TREATMENT

Stretching for posterior capsule



posterior glide glenohumeral joint

Sleeper stretch



Cross-arm adduction stretch

(Posterior Capsule in General)
General Internal Rotation

With the patient in the side-lying position, the arm is placed in 90 of flexion in the sagittal plane with the elbow bent at 90. The PT rotates the patient's arm toward the patient's hips

(Lower Fibers of the Posterior Capsule)
30 of Extension and Internal Rotation

With the patient prone, the PT moves the patients arm back into 30 of shoulder extension. While the hand is resting on the patient's waist, the PT pushes the patient's scapula
against the patient's rib cage. The distance from the patient's elbow to the plinth is noted and compared with the contralateral arm

(Superior and Middle Fibers of the Posterior Capsule) Internal Rotation in 30 of Abduction in the Plane of the Scapula (30 Anterior to the Frontal Plane)

With the patient in the supine-lying position, enough to place the patient's shoulder in the scapular plane, the PT moves the arm into 30 of abduction. The PT then internally rotates the patient's arm

(Posterior Capsule)
60 of Abduction in the Frontal Plane and Internal Rotation

With the patient supine, the PT brings the patient's out to 60 of abduction. The PT then rotates the arm internally while making sure not to allow the scapula to come off the plinth.

Cools scapular training

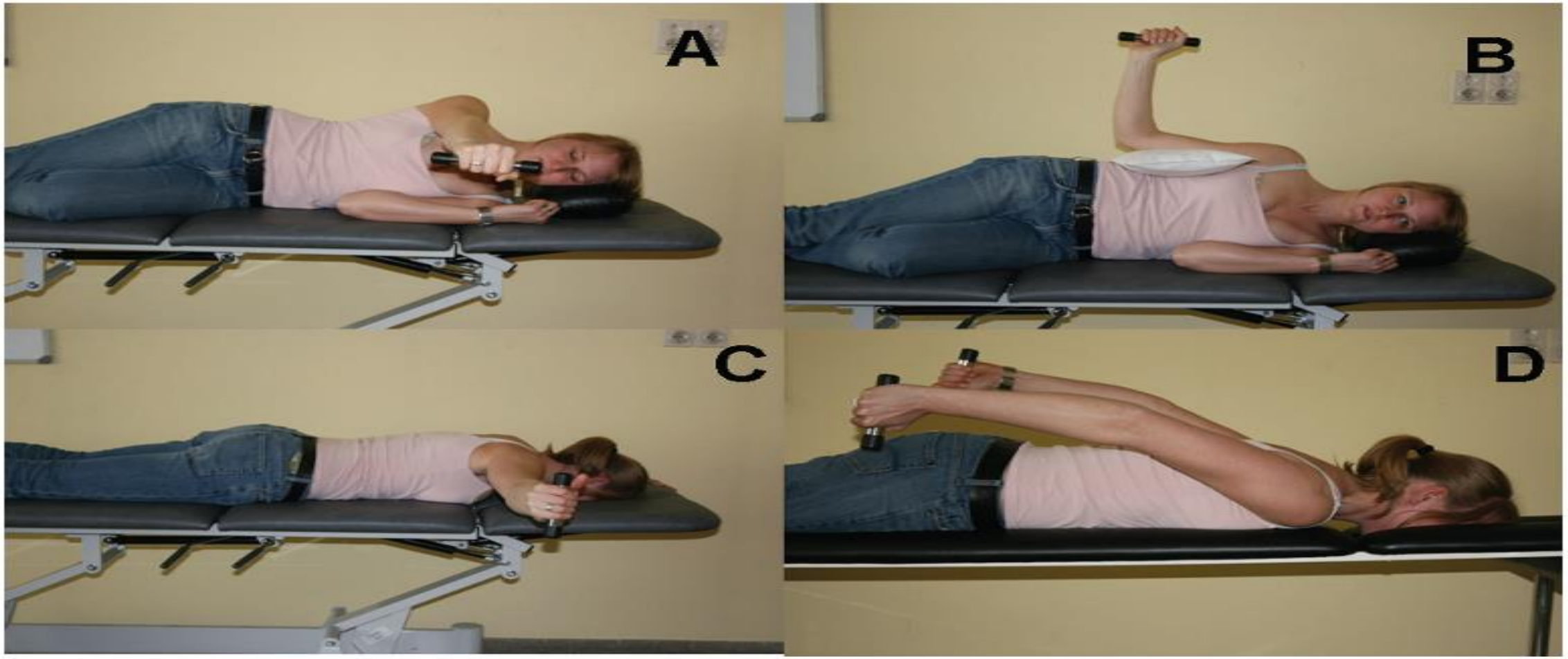
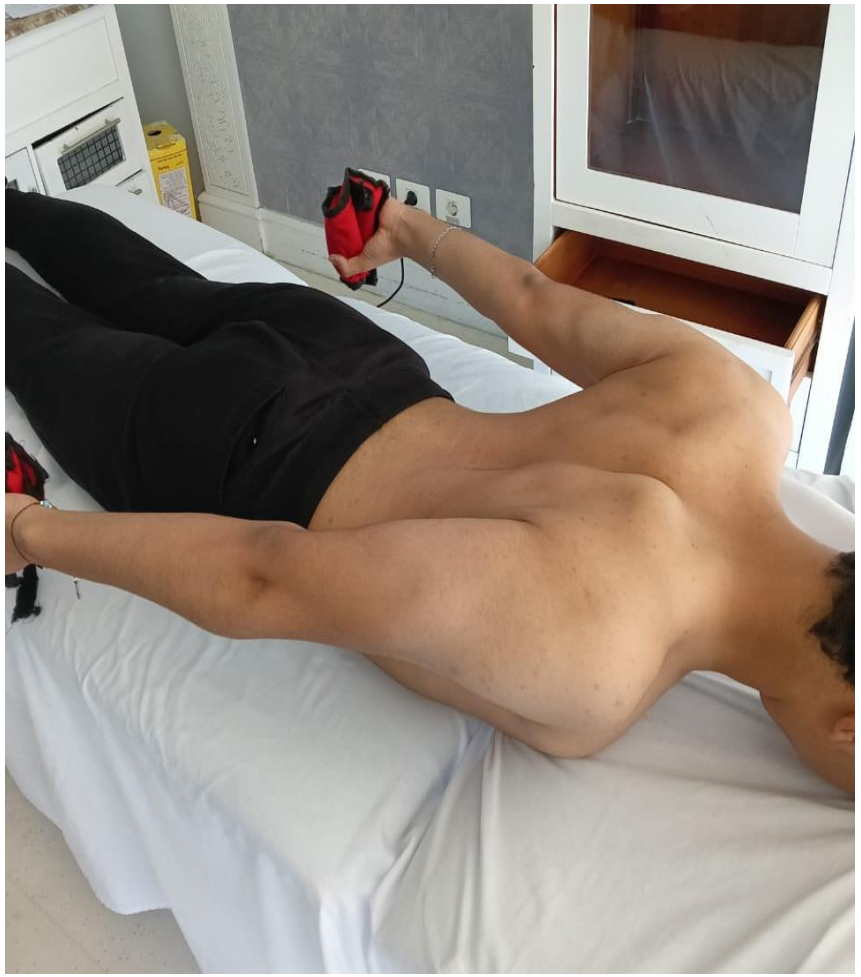
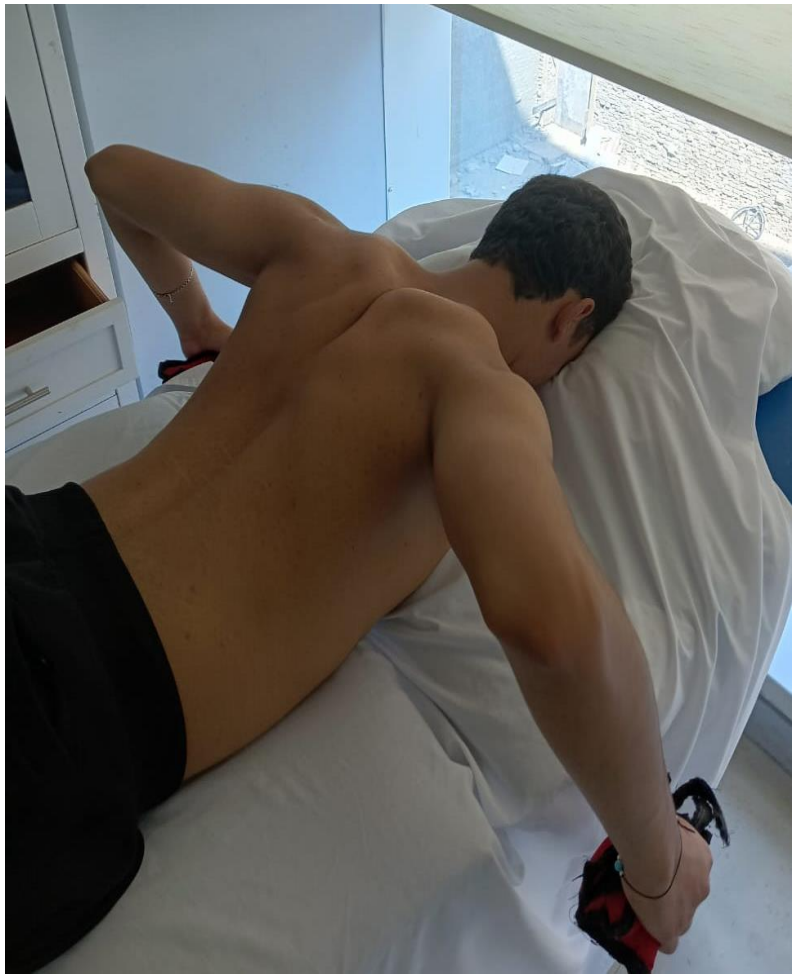
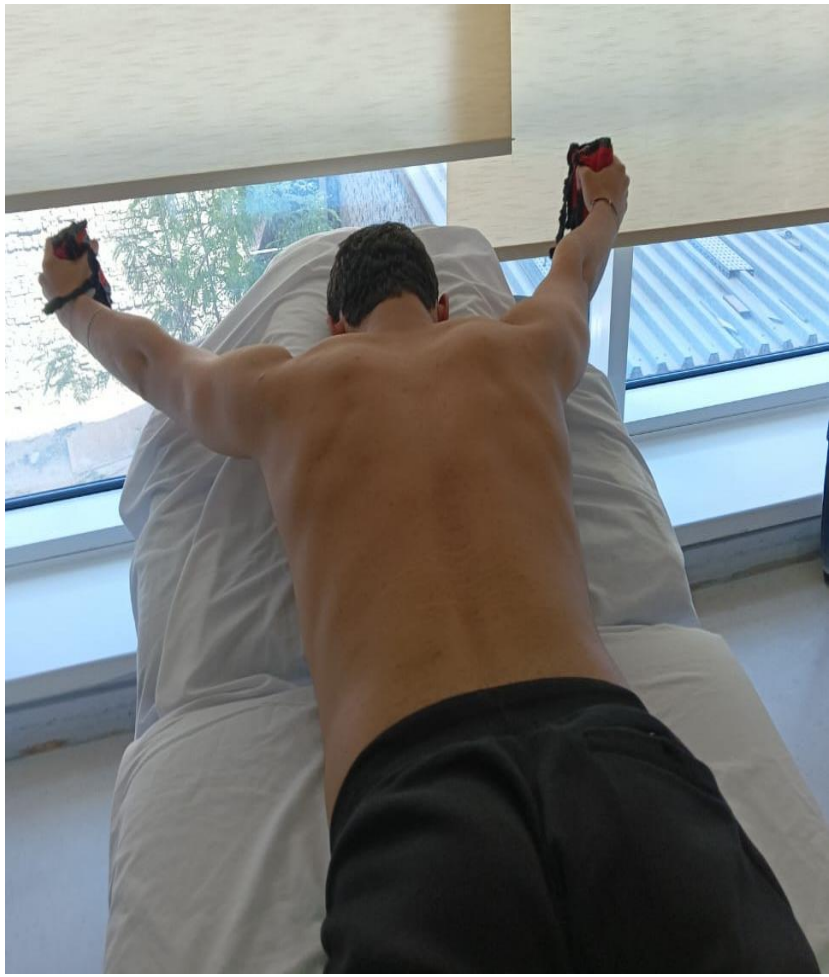
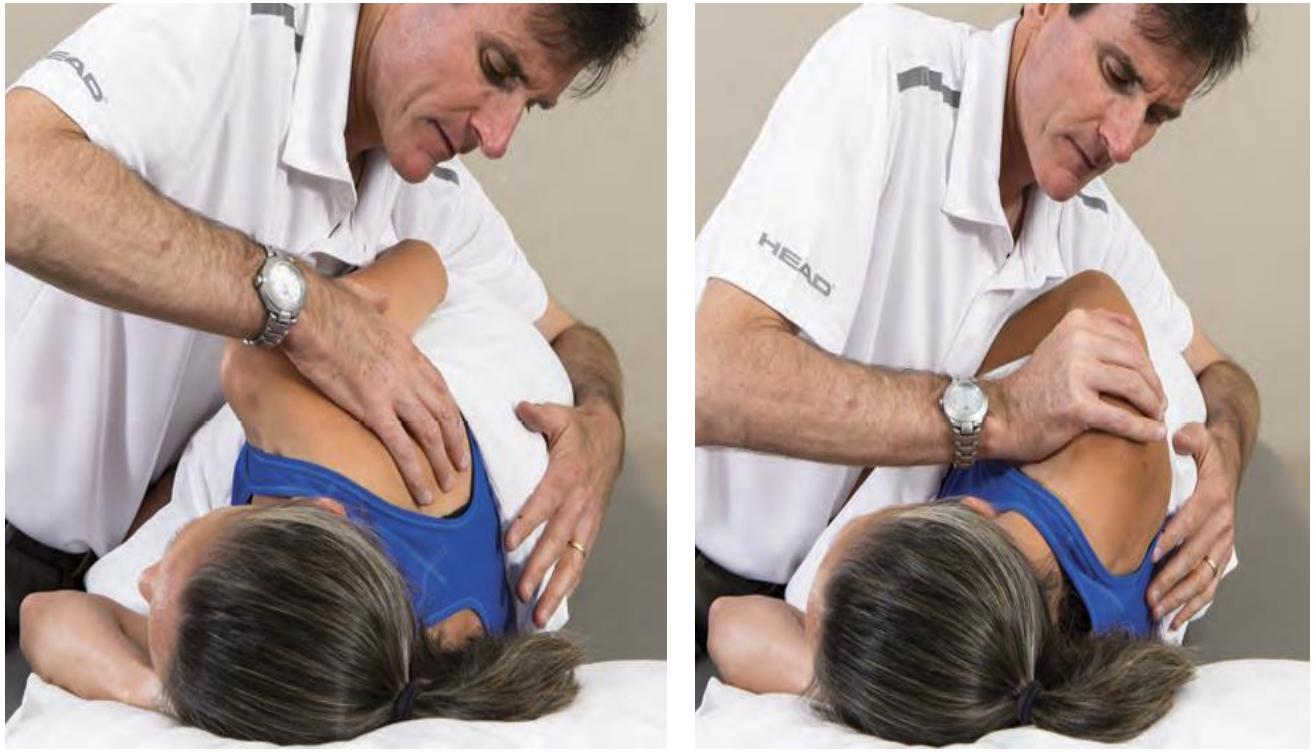


Figure 1. Exercises to restore intramuscular trapezius muscle balance. A, forward flexion in side-lying position; B, side-lying external rotation; C, horizontal abduction with external rotation; and D, prone extension. The results of this study suggest that the exercises A, B, and C are optimal for restoration of UT/LT muscle imbalances, and A, B, and D are optimal for restoration of UT/MT muscle imbalances. UT, upper trapezius; LT, lower trapezius; MT, middle trapezius.









Manual scapular stabilization in side-lying position for scapular retraction **(A)**, and protraction **(B)**.

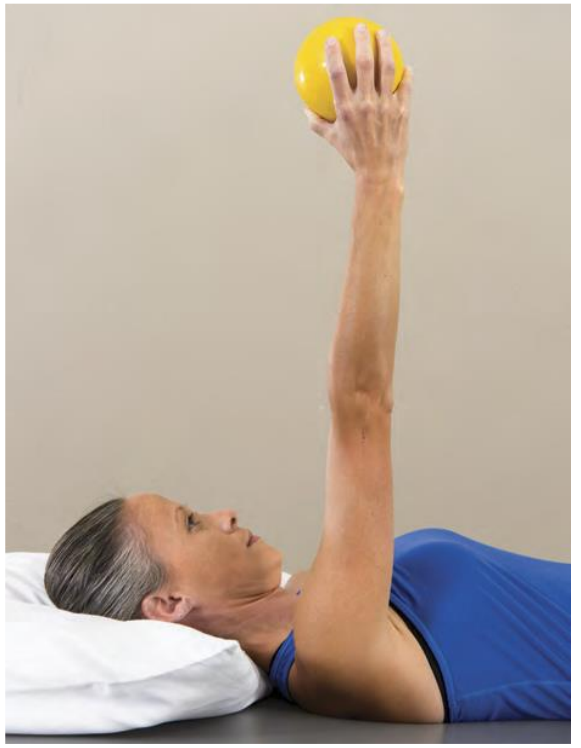
Rhythmic stabilization performed with scapular protraction.

Muscle energy techniqe for Pectoralis Minor

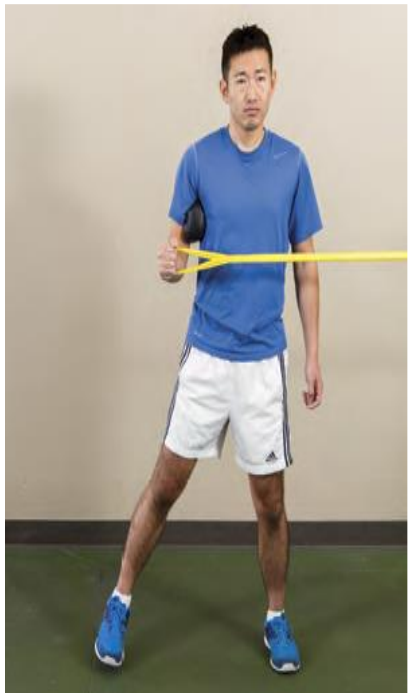
Pec Minor MET – post isometric relaxation PIR

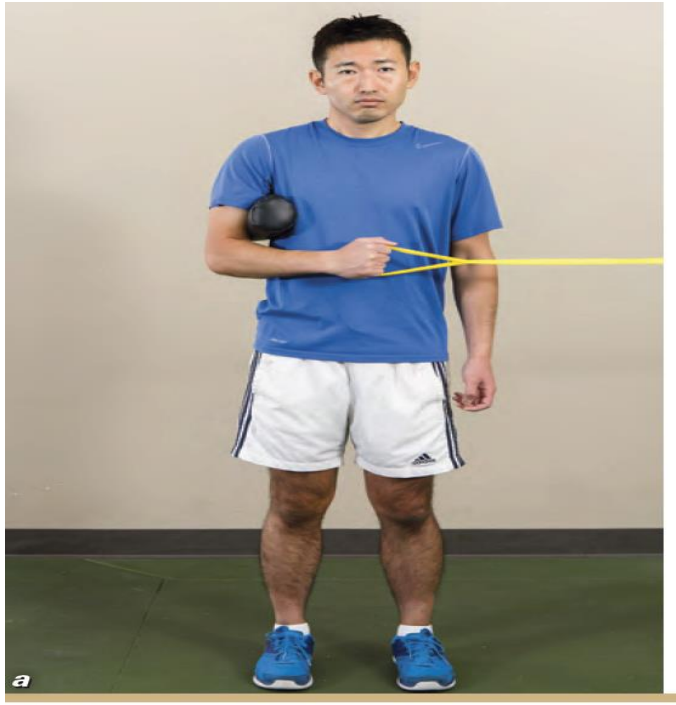
Pec Minor MET – reciprocal inhibition RI

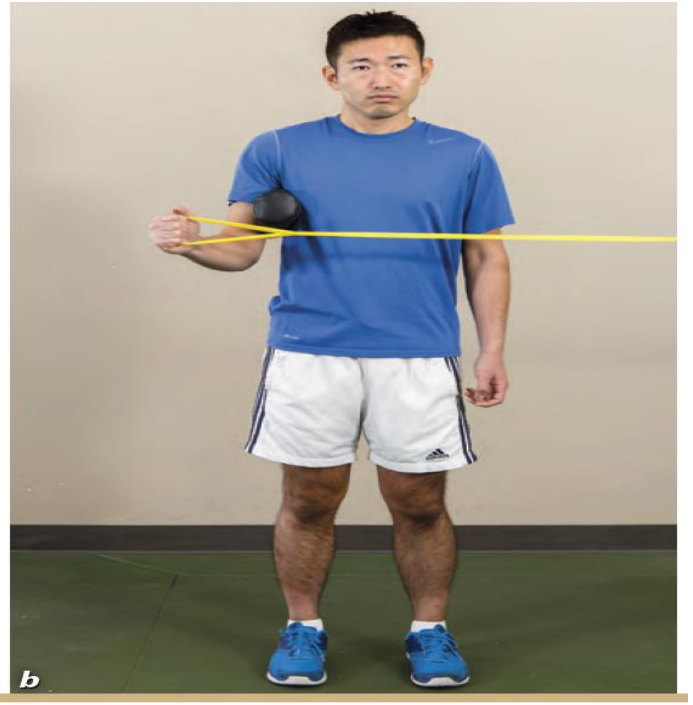
Scapular isometric step-out exercise



Serratus punch exercise.







e 5.22 External rotation at the side with elastic resistance: *(a)* start position and *(b)* end position.

External rotation isometric step-outs (“dynamic isometrics”).

Rotator cuff isotonic exercise program: *(i)* prone external rotation end position

Ball-on-the-wall rhythmic stabilization at 90° of elevation in the scapular plane.

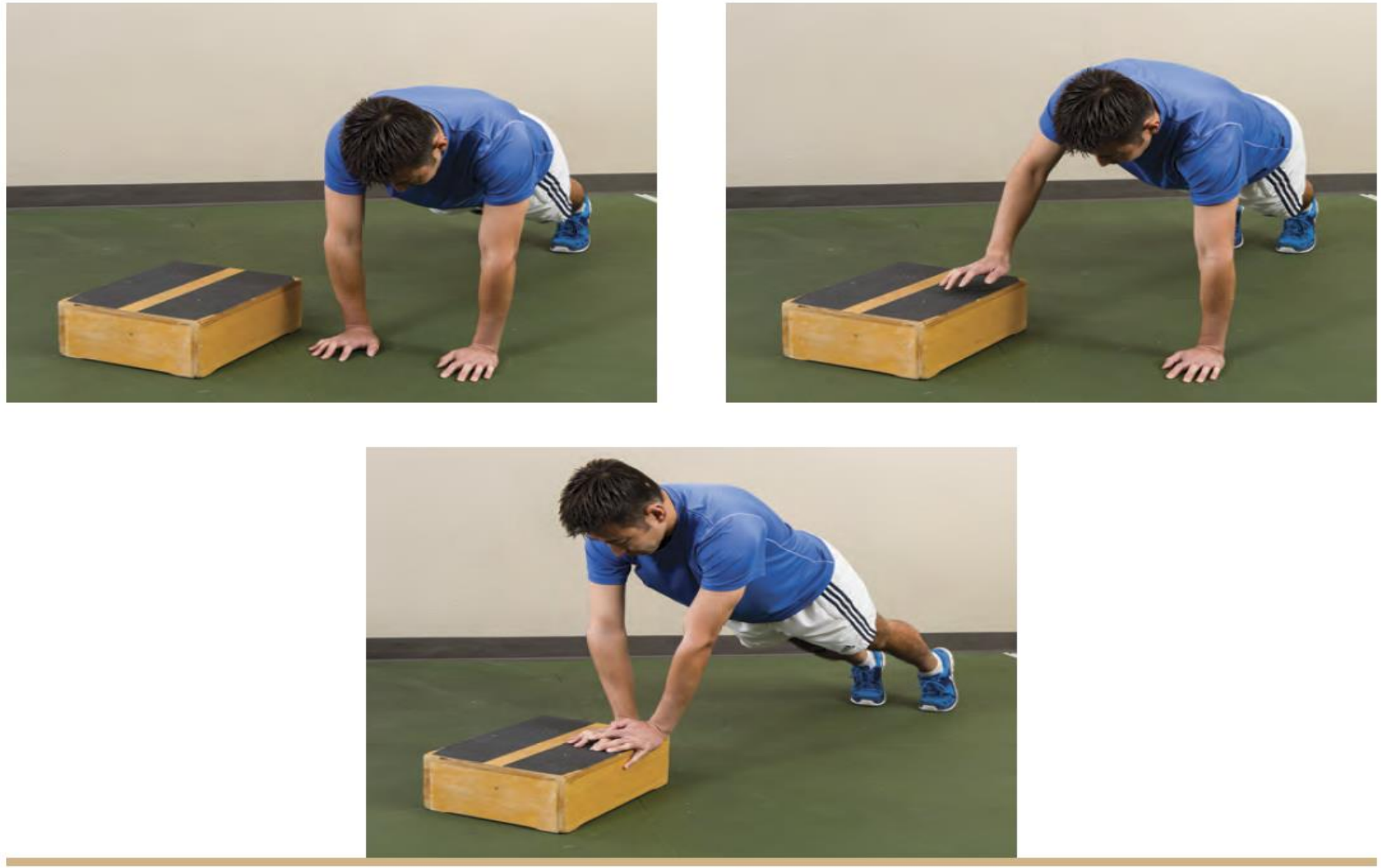


Figure 5.18 Closed chain step-up exercise.