**LAB 2**

**Superficial Back and Scapular Region**

**CASE REPORT:**

* 56 y/o male painter presents to his physician with a one-month history of pain in his right (dominant) shoulder. The pain is made worse with movement, especially when the arm is raised above his head. The patient states that he is awoken at night with a “toothache” type pain in his shoulder. He is unable to participate in his favorite pastimes of tennis and golf.

*Examination:*

* Shoulders appeared symmetrical
* No obvious swelling or deformity
* Patient reported pain on palpation directly over the greater tuberosity of the humerus
* Patient was unable to lift affected arm over his head
* Patient had pain and weakness when trying to abduct his arm at the glenohumeral joint
* Patient had paid and weakness with the “**empty can**” maneuver.

**ANATOMY OF THE SUPERFICIAL BACK:**

1. Muscles connecting the upper limb to the vertebral column – these muscles are extrinsic muscles of the back. They are supplied by the ventral rami of cervical nerves, not by the dorsal rami as one would expect. This is due to the posterior migration of the superficial back muscles during embryonic development. The dorsal primary rami, however, supply sensory to the skin of the back.
   1. **Trapezius Muscle** – Large diamond shape muscle of the superficial back that has three sections; Upper, Middle, Lower.
      1. Origin – medial 1/3 of the superior nuchal and external occipital protuberance (upper part); ligamentum nuchae (middle part), and spinous processes of C7 – T12 (lower part).
      2. Insertion – lateral 1/3 of the clavical (upper part); acromion and spine of the scapula (middle part); base of the scapular spine (lower part).
      3. Innervation – spinal root of the Spinal Accessory Nerve (CN XI) and the ventral rami of 3rd and 4th cervical nerves.
      4. Actions – Upper part elevates and upwardly rotates the scapula; middle part retracts the scapula; lower part depresses the scapula and rotates upward.
      5. Blood Supply – superficial transverse cervical artery
   2. **Latissimus Dorsi Muscle** – large fan shaped muscle that fills the lower half of the back.
      1. Origin – spinous process of the lower six thoracic vertebrae and allfive of the lumbar vertebrae, outer lip of the posterior aspect of the iliac crest, and the thoracolumbar fascia.
      2. Insertion – floor of the intertubercular (bicipital) groove.
      3. Innervation – thoracodorsal nerve from the posterior cord of the brachial plexus.
      4. Actions - Extension, Adduction, and Medial (Internal) Rotation of the humerus at the glenohumeral joint.
      5. Blood Supply – thoracodorsal artery from the subscapular artery
   3. **Teres Major Muscle** – although it does not connect the vertebral column to the upper limb it is discussed here because of its close relationship with latissimus dorsi. This muscle is technically a scapulohumeral muscle.

* + 1. Origin – dorsal surface of the inferior angle of the scapula.
    2. Insertion – medial lip of the intertubercular (bicipital) groove.
    3. Innervation – lower subscapular nerve from the posterior cord of the brachial plexus.
    4. Action – Same as latissimus dorsi - - Extension, Adduction, and Medial (Internal) Rotation of the humerus at the glenohumeral joint.
    5. Blood Supply – circumflex scapular and thoracodorsal arteries
  1. **Levator Scapulae Muscle** – superior and lies deep to trapezius.
     1. Origin – transverse processes of the upper four cervical vertebrae
     2. Insertion – superior angle and superior medial border of the scapula
     3. Innervation – dorsal scapular nerve from the C5 nerve root and third and fourth cervical nerves.
     4. Action – elevates the scapula and rotates it downward. It also aides in the cervical posture.
     5. Blood Supply – transverse cervical artery (both superficial and deep)
  2. **Rhomboid Muscles** – there is a rhomboid major and minor and sometimes they are indistinguishable from each other. Typically, the rhomboid major is about two times wider than the rhomboid minor.
     1. Origin – Minor – ligamentum nuchae and spinous processes of C7 and T1 vertebrae. Major – spinous process of T2 – T5 vertebrae.
     2. Insertion – medial border of scapula
     3. Innervation: dorsal scapular nerve from the C5 nerve root
     4. Action – retraction, elevation and downward rotation of the scapula.
     5. Blood Supply – deep branch of transverse cervical artery, if present, if not it receives blood from the dorsal scapular artery.

**Question**: Are you suspicious of any of the above muscles being involved with our case? Why or why not?

**Question:** Develop a differential diagnosis as you proceed through the rest of the anatomy. What structures COULD be involved?

**Question:** When performing your physical exam, how do you differentiate between muscle injury versus ligament or cartilage injury?

**ANATOMY OF THE SCAPULAR REGION:**

* Four muscles join the scapula to the humerus (scapulohumeral muscles): supraspinatus, infraspinatus, teres minor, and subscapularis are referred to as the **rotator cuff muscles** of the glenohumeral joint. They cover all of the glenohumeral joint, except the inferior aspect. All of them, except the supraspinatus, are rotators of the humerus. The rotator cuff protects the glenohumeral joint and gives it dynamic stability by contracting (dynamic) and holding the head of the humerus in the glenoid fossa of the scapula. This cuff may be damaged by injury or disease. Since the cuff strengthens the glenohumeral joint everywhere except inferiorly, if a person falls when the humerus is abducted, the head of the humerus may be levered out of the glenoid fossa, producing a dislocation of the glenohumeral joint (commonly referred to as a dislocated shoulder).

1. **Rotator Cuff Muscles**:
2. Supraspinatus Muscle - it **originates** in the supraspinus fossa of the scapula (superior to the spine of the scapula). It **inserts** on the upper most portion of the greater tuberosity of the humerus. It is **innervated** by the suprascapular nerve (NR C5, C6). Its main **function** is to pull the head of the humerus tightly into the glenoid cavity initiating the first 10-15° of abduction. This provides the deltoid with an optimum angle of pull to finish abduction. It also helps in external rotation of the arm. If the deltoid muscle is paralyzed, the supraspinatus muscle can still partially abduct the humerus. It receives its **blood supply** from the suprascapular artery.
3. Infraspinatus- it **originates** in the infraspinous fossa (inferior to the spine of the scapula). It **inserts** on the middle portion of the greater tuberosity of the humerus just below the supraspinatus. It is **innervated** by the suprascapular nerve (NR C5, C6). Its main **function** is external rotation. It also acts eccentrically during the throwing motion to try and decelerate the rotation of the humerus. It receives its **blood supply** from the suprascapular artery.
4. Teres Minor- it **originates** on the upper 2/3 of the lateral border of the scapula and it **inserts** on the lowest portion of the greater tuberosity of the humerus just below the infraspinatus. It is **innervated** by the axillary nerve (NR C5, C6). Its main **function** is external rotation. It also acts eccentrically during the throwing motion to try and decelerate the rotation of the humerus. It receives its **blood supply** from the circumflex scapular artery.
5. Subscapularis- it **originates** in the subscapular fossa on the anterior surface of the scapula. It **inserts** on the lesser tuberosity of the humerus. It is **innervated** by the upper and lower subscapular nerves (NRs C5, C6, C7). Its main **function** is internal rotation of the arm. It receives its **blood supply** from the subscapular artery.
6. **Other Muscles:**
7. Deltoid - it has three portions; anterior, middle, and posterior.

Anterior- **originates** from the lateral 1/3 of the clavicle and **inserts** with the other portions on the deltoid tuberosity on the shaft of the humerus. It is **innervated** by the axillary nerve (NR’s C5-C6). Its main **function** is forward flexion of the shoulder and internal rotation of the shoulder.

Middle- **originates** from the lateral border of the acromion and joins the other two portions to **insert** on the deltoid tuberosity on the shaft of the humerus. It is **innervated** by the axillary nerve. Its main **function** is abduction in the shoulder and it assists the anterior portion in forward flexion.

Posterior- **originates** from the spine of the scapula and **inserts** into the deltoid tuberosity with the other two portions. It too is **innervated** by the axillary nerve. Its main **function** is shoulder extension and external rotation.

The whole deltoid muscle receives its blood supply from the anterior and posterior circumflex humeral arteries. All three portions of the deltoid muscle converge to insert onto the deltoid tuberosity of the humerus. Additionally, all three portions are innervated by the axillary nerve.

1. Teres Major - it **originates** from the inferior angle of the scapula and **inserts** on the medial lip of the intertubecular groove (bicipital groove). It is **innervate** by the lower subscapular nerve (NRs C5, C6). Its **function** is adduction, extension and internal rotation of the arm. It receives its blood supply from the circumflex scapular and thoracodorsal arteries.
2. **Spaces of the Shoulder:**

**Quadrangular Space**- it is an area of the posterior shoulder in which the posterior humeral circumflex artery and the axillary nerve pass. Lateral border of the space is the surgical neck of the humerus, Medial border is the long head of the triceps, Superior border is teres minor, and the inferior border is teres major. Because the lateral border of the space is the surgical neck of the humerus a fracture may put the axillary nerve and posterior humeral circumflex artery at risk.

**Triangular Space**- it is an area in which the circumflex scapular artery passes. The lateral border is long head of triceps, superior border is teres minor, and inferior border is teres major.

1. **Collateral Circulation of the Scapula:**

* An anastomosis is a natural communication between two or more vessels.
* In regard to an arterial anastomosis it creates collateral circulation which enables blood to flow to or from a tissue when the principle vessel involved is obstructed.
* There is an elaborate anastomosis around the scapula and glenohumeral joint that provides a connection between the subclavian, axillary, and brachial arteries. The primary collateral branches around the scapula are:
  + **Suprascapular Artery** – parent artery = subclavian artery
  + **Circumflex Scapular Artery** – parent artery = axillary artery
  + Dorsal Scapular Artery – parent artery = subclavian artery

The additional collateral circulation around the glenohumeral joint is via the connection between:

* + **Acromial branch of thoracoacromial trunk** – parent artery = axillary artery
  + **Posterior circumflex humeral artery** and its ascending and descending branches – parent artery = axillary artery

1. Joints of the Shoulder Complex
   1. **Sternoclavicular Joint**:

It is a diarthrodial joint that is the only connection between the upper extremity and the trunk. The proximal end of the clavicle articulates with the manubrium of the sternum. The two articulating surfaces are saddle shape.

Congruence and stability of the two surfaces is improved by an intraarticular disc. It is a **fibrocartilage disk** that acts to absorb stress and strain around the joint.

There is a weak joint capsule around the joint that is reinforced by the anterior and posterior sternoclavicular ligaments.

**Anterior sternoclavicular ligament**- it is the strongest of the two ligaments, probably because it is reinforced with the tendon of the sternocleidomastoid muscle. The anterior and posterior sternoclavicular ligaments prevent upward displacement of the medial clavicle as well as inferior displacement of the lateral clavicle. This is because the fibers of the ligament run superiorly from the attachment on the sternum to insert on the superior aspect of the clavicle.

There is also an **interclavicular ligament** that passes from the superiomedial aspect of each clavicle to attach on the upper border of the manubrium. Helps resist superior translation of the clavicle.

**Costoclavicular ligament** runs from the first rib laterally to the clavicle. There is an anterior and a posterior portion. It is very important for the stability of the joint because it counteracts the pull of the sternocleidomastoid muscle on the clavicle.

**Blood supply** to the joint comes from the clavicular branch of the thoracoacromial artery.

Injuries to the sternoclavicular joint are uncommon, particularly dislocations. Dislocations generally are anterior or posterior in nature. Posterior dislocations are considered a medical emergency because of the potential impingement of the mediastinal and cervical structures that run in this area. Compression of the trachea and/or esophagus is also a potential serious complication of a posterior dislocation.

* 1. **Acromioclavicular Joint**:

Diarthrodial, synovial joint that is made up of the lateral end of the clavicle articulating with the medial border of the acromion process. There is a small fibrocartilage disc within the joint. In contrast to the disc of the SC joint, though, it is meniscoid shape.

The AC joint is enclosed with a joint capsule. This capsule is reinforced with the superior and inferior acromioclavicular ligaments. The joints integrity is mostly dependent on the superior acromioclavicular ligament and the attachment of the deltoid muscle and the trapezious muscle.

The **coracoclavicular ligament** is an extra-capsular ligament that also helps maintain the integrity of the joint. This ligament is separated into two distinct portions:

* + - **The Conoid**- which is a cone shape ligament that runs from the coracoid process to the conoid tubercle of the clavicle. This portion of the ligament also plays a vital role in the biomechanics of the shoulder as well see later. The second portion of the coracoclavicular ligament is the:
    - **Trapezoid**- this portion arises from the coracoid process and inserts on the trapezoid line of the clavicle, just lateral to the conoid tubercle. It plays mostly a stabilizing role.

All of these ligaments play a vital role in resistance to superior and anterior translation of the clavicle at the AC joint.

The coracoacromial ligament runs from the superior, lateral coracoid process to the acromion, just anterior to the AC joint. This ligament does not play a role in AC joint stability. It acts as a counter balance to the pulling forces placed on the coracoid process by the pectoralis minor and coracobrachialis muscles. The most significant role this ligament seems to play is in the pathology of impingement syndrome. This ligament forms **the “roof” of the shoulder** and has been implicated as one of the primary players in subacromial bursitis and rotator cuff tendonitis.

The **blood supply** to the joint is through the acromial branch of the thoracoacromial artery.

* 1. **Scapulothoracic Articulation**:

The gliding of the concave shaped scapula on the convex shaped rib cage is commonly called the scapulothoracic joint, however, it does not demonstrate all the traditional components of a joint. In fact, the only relation it has to a joint is it articulates, therefore, it is more correctly called the scapulothoracic articulation.

This articulation is extremely important in maintaining, and allowing, stability of the upper extremity. The scapulothoracic articulation contributes largely to the overall range of motion (ROM) of the shoulder, as we will see later. The movement of the scapulothoracic articulation along with the glenohumeral joint in contributing to shoulder ROM has been termed the “scapulohumeral rhythm. Scapulothoracic rotation contributes approximately 60° of motion out of the 180° of motion available at the shoulder.

* 1. **Glenohumeral Joint**:

This is what is usually thought of as the “shoulder joint”. It consists of the head of the humerus articulating with the glenoid fossa of the scapula. It is a diarthrodial joint that has a high degree of mobility. The joint is inherently unstable because of the shape and contour of the two articulating surfaces. The humeral head is approximately twice the size of the glenoid fossa. This means there has to be a good combination of both static and dynamic stabilizers to prevent chronic dislocation of the glenohumeral joint.

Static stability of the glenohumeral joint is provided by a joint capsule which has redundancies that form the glenohumeral ligaments. There are three glenohumeral ligaments:

* + 1. **Superior Glenohumeral** - The superior glenohumeral ligament (SGL) is the smallest and least understood of the glenohumeral capsular structures, and is reported to be present in 90% to 97% of shoulder studies. It originates from the upper pole of the glenoid cavity and the base of the coracoid process, and is attached to the MGL, to the biceps tendon, and to the labrum. It inserts just superior to the lesser tuberosity in the region of the bicipital groove. There is a normal foramen or opening between the SGL and MGL, allowing communication with the subscapularis bursa. The SGL is closely related to the extraarticular coracohumeral ligament. The coracohumeral ligament originates in the lateral aspect of the coracoid and inserts on the greater tuberosity. The SGL and the coracohumeral ligament contribute to the stabilization of the glenohumeral joint and prevent posterior and inferior translation of the humeral head. When present and well-formed (developed), the SGL represents the primary capsuloligamentous restraint to inferior translation of the unloaded, abducted shoulder joint.
    2. **Middle glenohumeral ligament**. The middle glenohumeral ligament (MGL) attaches to the anterior aspect of the anatomic neck of the humerus, medial to the lesser tuberosity. It arises from the glenoid by way of the labrum and scapular neck. Of the three glenohumeral ligaments, the MGL demonstrates the greatest variation in size and thickness. It may present as thin ligamentous tissue or appear cord-like and as thick as the biceps tendon. Wall and coworkers found that it was absent in up to 27% of specimens. When present, the MGL can be identified between the subscapularis tendon (as it passes across the subscapularis) and the anterior labrum or anterior band of the IGL. The MGL demonstrates a more vertical orientation with internal rotation and a horizontal orientation (elongation) with external rotation of the shoulder. The MGL functions in the stability of the shoulder joint from 0º to 45º of abduction. Along with the subscapularis tendon and the superior part of the IGL, the MGL contributes to anterior stability at 45º of abduction. In the lower and mid-ranges of abduction, it limits external rotation. The MGL has been shown to have a secondary role in anterior stability of the shoulder in 90º of abduction when the anterior band of the IGL is cut. Inferior translation of the abducted and externally rotated shoulder is limited as a secondary restraint function of the MGL.
    3. **Inferior glenohumeral ligament** (IGL) forms the thickest part of the joint capsule and is the largest and most important of the glenohumeral ligaments. It consists of three components, the anterior band, the axillary pouch, and the posterior band. The anterior and posterior bands are attached to and contribute to the formation of the anterior and posterior glenoid labrum. In adduction, the IGL is lax . It tightens with increasing abduction, and the anterior and posterior bands move superiorly with respect to the humeral head. At 90º of abduction, the IGL is the primary restraint for anterior and posterior dislocations. The axillary pouch is located between the anterior and posterior bands and attaches to the inferior two-thirds of the entire circumference of the glenoid by means of the labrum. Like the anterior and posterior bands, it is lax in the adducted position with the arm by the patient's side. It extends inferior to the body of the glenohumeral joint as a redundancy of thickened capsular tissue.

**Coracohumeral ligament**- it is a thick band that spans from the base of the coracoid process to the capsular ligament near the greater tuberosity. It is the ligament that becomes bound down during immobilization of the shoulder and thus restricting external rotation.

**Glenoid Labrum** - The glenoid labrum is made up of fibrocartilage. The labrum is a continuous structure surrounding the glenoid rim. Despite the continuous structure there are distinct differences in the morphology when comparing the superior and inferior portions. The superior and anterior portions have loose attachments to the glenoid rim. The inferior labrum, however, has a much firmer attachment. This may be because of the attachment of the glenohumeral ligaments in this area.

The main function of the labrum is to deepen the glenohumeral joint to increase the stability of the joint. The labrum doubles the depth of the glenohumeral joint. It also acts as a “bumper” against humeral head translation and as a shock absorber. The superior labrum also serves as an attachment site for the long head of the biceps tendon. This tendon has about 50% attachment on the labrum and 50% attachment on the supraglenoid tubercle. There are serious clinical implications here which will discuss later, with the biceps tendon itself.

The vascularity of the labrum is limited to the periphery and is more prevalent in the inferior and posterior portions. The blood flow comes from branches of the suprascapular artery, circumflex scapular artery, and the posterior humeral circumflex artery.

**Bursae**- there are several that lie within the vicinity of the shoulder joint. They are flattened fluid filled sacs that lie between tendons and bone. They help reduce the friction of a moving tendon on a bone or skin rubbing on a bony surface.

Subscapular Bursa- it is located between the subscapular tendon and the neck of the scapula.

**Subacromial Bursa**- lies between the deltoid muscle and the supraspinatus tendon and the fibrous capsule of the shoulder. It is located inferior to the acromion process and coracoacromial ligament. This is bursa is susceptible to trauma via repetitive overhead actions leading to subacromial bursitis (a form of impingement syndrome).

**Case Report Conclusion:**

Based on the examination and the most likely diagnosis would be a **rotator cuff tear**. The most likely muscle involved would be the supraspinatus. Remember the supraspinatus initiates the first 10 – 15 degrees of glenohumeral joint abduction. Additionally, the patient exhibited a positive empty can test which is indicative of a supraspinatus tear.

The patient was unable to lift their arm over their head. That could be due to the weakened state of the supraspinatus so the deltoid never gets into a position to take over. Or it could be because of pain from the torn tendon hitting the acromion process or coracoacromial ligament.

There are many things that could also cause similar symptoms. One way to differentiate is with a **MRI**.

Here is a long laundry list of possible pathologies with similar symptoms (Differential)… How many did you list?

* **Impingment (bursitis)**
* **Labral Tears**
* **Long Head Biceps Injuries**
* **Glenohumeral ligament injuries**
* **Acromioclavicular and/or coracoclavicular ligament injuries**
* **Osteoarthritis**
* **Adhesive capsulitis**
* **Proximal peripheral neuropathies (recall the suprascapular nerve entrapment – see posterior triangle lecture)**
* **Cervical radiculopathy**

Great! It is a perfect case.

A few comments: for the differential diagnostics list I would add and discuss referred pain (you already mentioned cervical root irritation), but I think it will be good to discuss that intra-thoracic processes (in case of Rt shoulder pain we should consider pulmonary embolism), and intra-abdominal processes (like subphrenic abscess around liver) may result in shoulder pain.

An easy test for supraspinatus integrity in primary care is a Drop arm test – fully abduct patient’s arm, and then ask them to slowly lower it to their side. If the supraspinatus is torn, at ~90 degrees the arm will seem to suddenly drop towards the body.

Natasha