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# Shoulder Injury and Disability

Discussion paper prepared for

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## INJURY AND DISABILITY INVOLVING THE SHOULDER

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THIS PAPER HAS BEEN PREPARED TO HELP NON-MEDICAL PERSONS UNDERSTAND MEDICAL PROBLEMS INVOLVING THE SHOULDER.

### 1. Anatomy of the Shoulder

#### 2. A. Bones. (Figure 1).

Three bones form part of the shoulder:

1. The collar bone (**clavicle**) located in front, at the base of the neck.
2. The upper arm bone (**humerus**) connecting the shoulder with the elbow
3. The **scapula** or shoulder blade is located on the back of the rib cage. Where it reaches the area of the shoulder, it has two processes (prolongations) (a and b), and two **articular cartilage** surfaces (covered with a white, glistening, smooth surface) (c and d).
  - a. The **acromion** on top of the shoulder
  - b. The **coracoid process** in front of the shoulder
  - c. The **glenoid cavity** for articulation with the upper arm bone head of the humerus
  - d. The **acromial articular cartilage** for articulation with the clavicle bone.

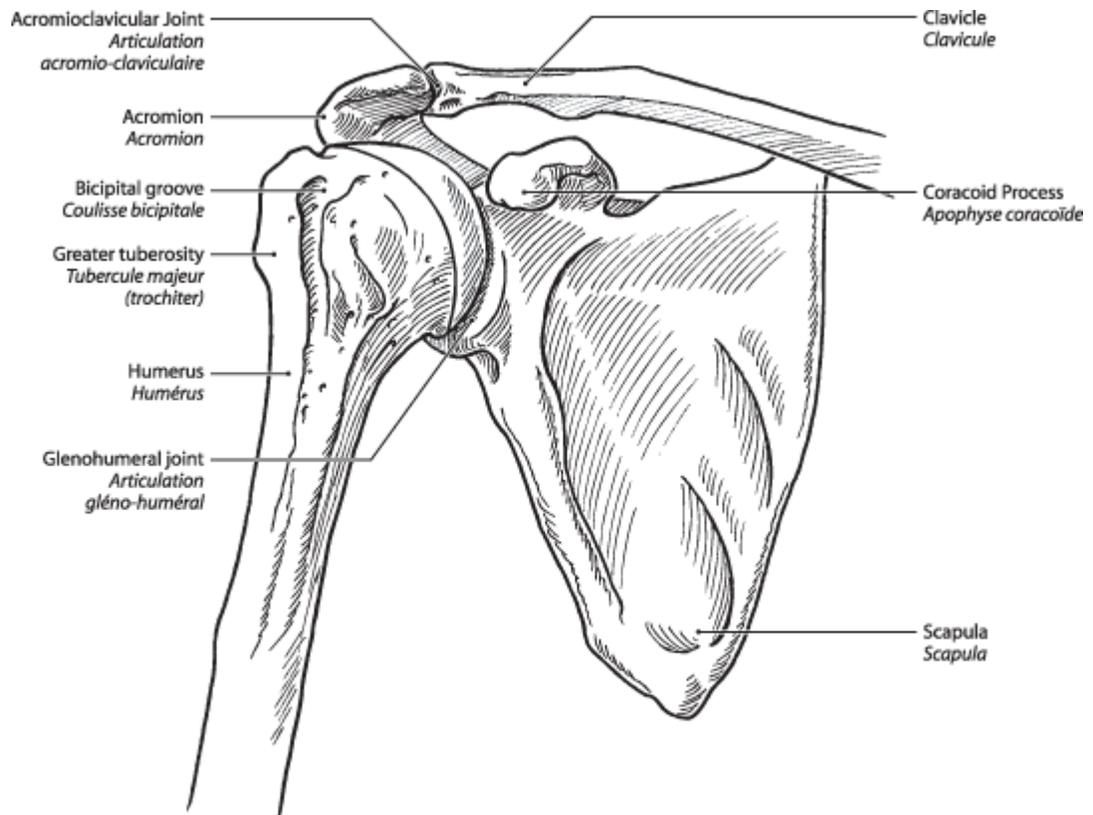
#### B. Joints (Figure 1)

The main shoulder motions take place at three levels.

1. The articulation or joint between the shoulder blade and upper arm bone is known as the **glenohumeral** joint. If the contact between these bones is lost, the patient says that his shoulder is out of joint, and the doctor talks about **shoulder dislocation**. If contact is lost only partially, we, as doctors, speak about a **subluxation**. Dislocation and subluxation can occur in different directions, the most frequent one being displacement in the front, **anterior** dislocation (**Figure 2**). If a shoulder joint dislocates more than once, we speak about recurrent dislocation. The force needed to get this joint out of place for the first time is considerable, and usually trivial at the subsequent dislocations. Anterior weakness and/or repeated subluxations can result from

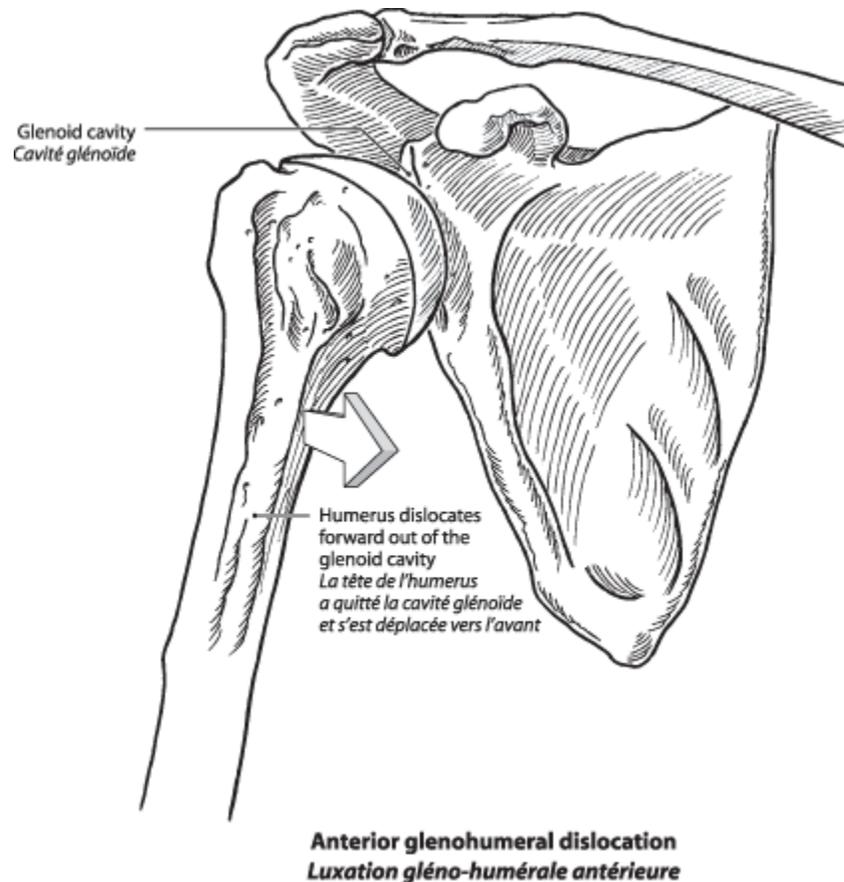
## Shoulder Injury and Disability

tears in the glenoid labrum at the time of initial injury. These labrial tears may not heal. The unhealed tear of the labrum is known as "Bankart Lesion". Some persons are able to dislocate their shoulder at will - a condition called voluntary or habitual dislocation without a history of injury.



**Bones of the shoulder**  
**Les os de l'épaule**

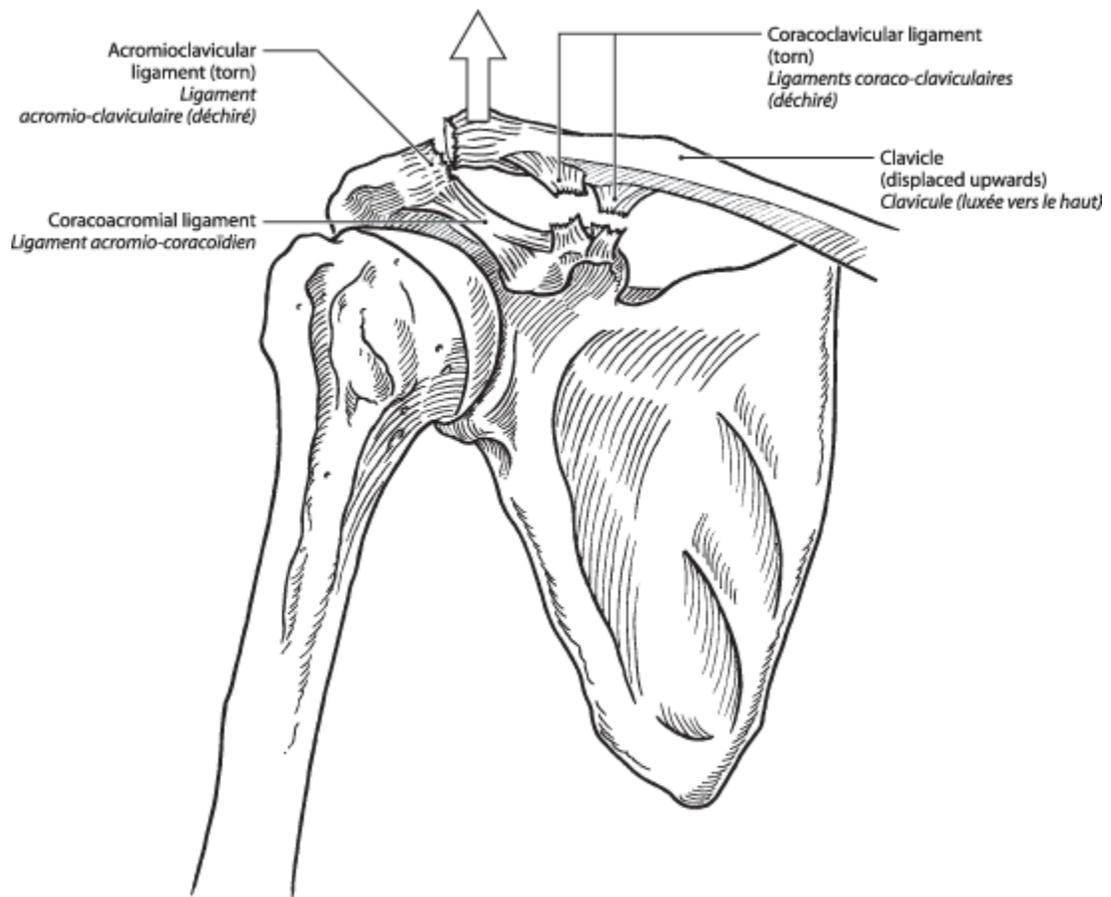
**Figure 1.**



**Figure 2.**

2. Motion also occurs between the shoulder blade and rib cage (**scapulothoracic** motion). There is no joint or articulation at this level. There is a gliding motion between the two neighbouring, muscle-covered bones.

1. During scapulothoracic movement, motion also occurs between shoulder blade and collarbone (at the **acromio-clavicular joint**). As stated before, the acromion is part of the shoulder blade that acts somehow as a roof to the upper portion of the humerus, the humeral head. If the collarbone loses its articulating contact with the acromion, patients talk about a shoulder separation and doctors prefer to talk about an **acromioclavicular dislocation (Figure 3)**. A subluxation, a partial separation, can also occur.

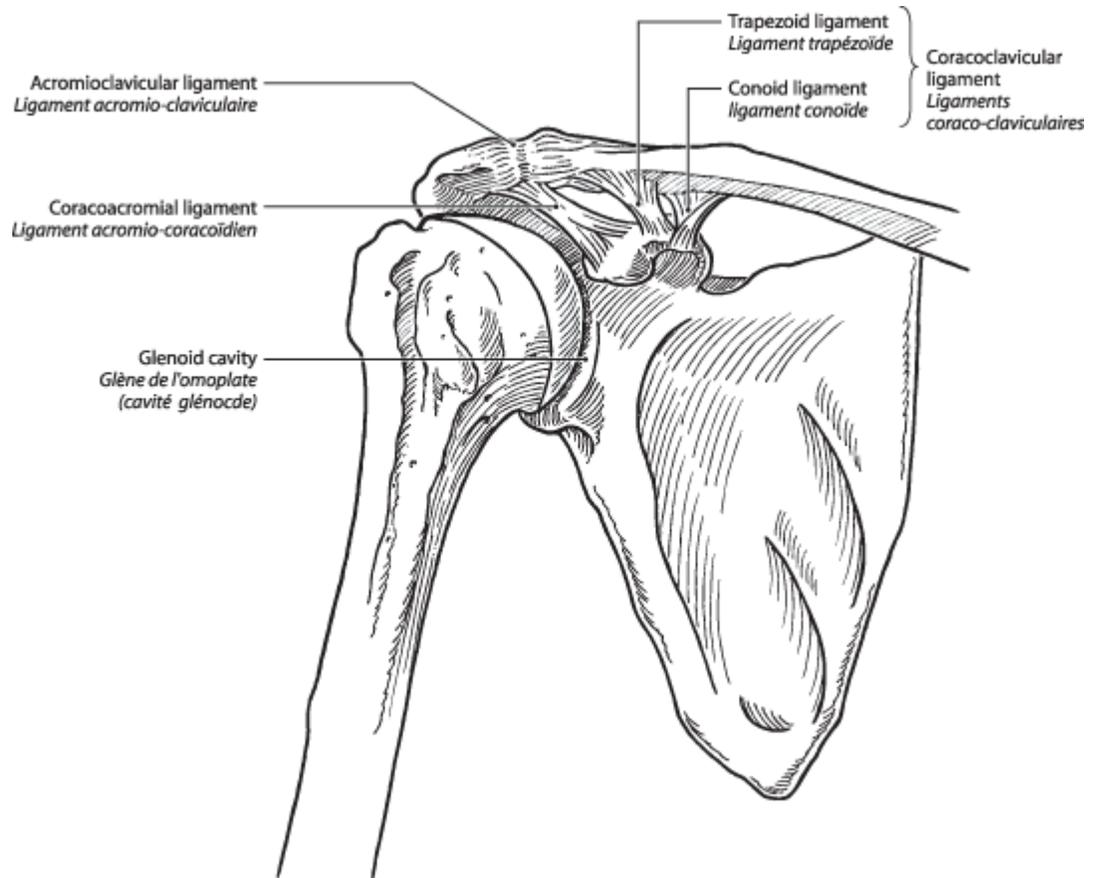


**Superior acromio-clavicular dislocation**  
**Luxation acromio-claviculaire supérieure**

**Figure 3.**

### **C. Capsule and Ligaments (Figure 4)**

At the level of any joint, the bones are held together by a sheet of tissue (the capsule), and by strong bands (the ligaments). The bones, covered by articular cartilage, and the capsule form the joint cavity. The capsule makes a joint watertight; this means that the joint fluid (the synovial liquid) produced by the innermost layer of cells of the capsule (the synovium) cannot escape. Joint fluid ensures the lubrication of a joint, and the nutrition of articular cartilage cells. If the amount of joint fluid is increased, we speak of an **effusion**. This condition is often accompanied by an inflammation of the innermost layer of the capsule, a condition known as **synovitis**.



Ligaments of the shoulder  
*Ligaments de l'épaule*

**Figure 4.**

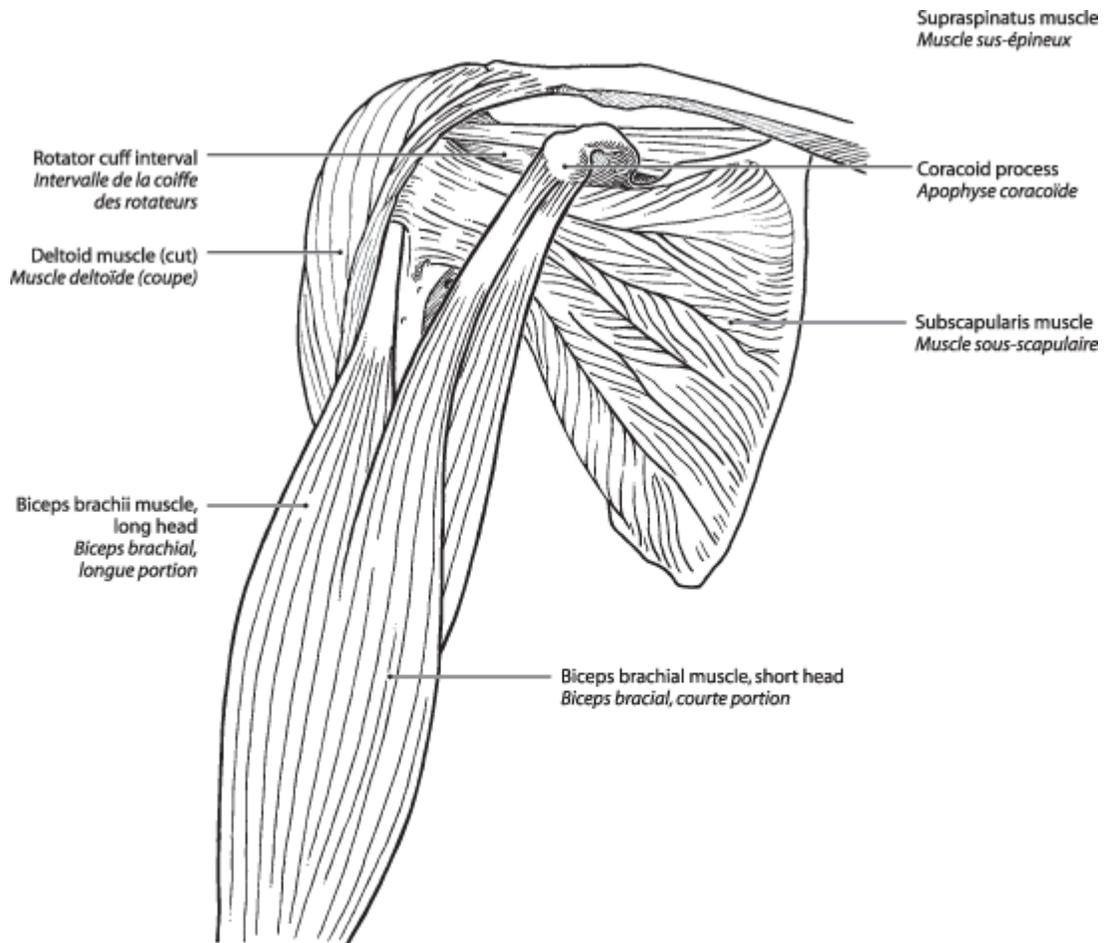
Ligaments function as checkreins. At the joint between shoulder blade and humerus, the anterior (**glenohumeral**) ligaments are one of the most important. They have to be torn, as well as the capsule ruptured, before the shoulder can dislocate. If these structures do not heal after the first dislocation, and a hole remains in the capsule, the shoulder can re-dislocate with a minor effort. In such a case, surgery is needed to close the defect, to restore the original tension of ligaments and capsule. Many episodes of recurrent dislocation can lead to **arthritis** meaning that the smooth gliding surfaces of the opposing bones (articular cartilage) are getting rough and irregular, sometimes to a point where entire areas of articular cartilage are

lost and the underlying bone is exposed. A dislocation sometimes produces a dent in the humeral head, known as a Hill-Sachs lesion. Since articular cartilage does not contain calcium like bones, it cannot be seen on plain x-rays. Instead, we see an apparent space between the bones on x-ray films. When the articular cartilage wears down, becoming thinner, the bones get closer to each other; we speak about a narrowing of the joint space, a definite sign of arthritis. Joint space can be defined as the distance between two bones at the level of an articulation as seen on plain x-ray films.

A separation of the shoulder, the **acromioclavicular** dislocation (**Figure 3**), is also only possible when ligaments tear, either the ligaments reinforcing the capsule or the ligament holding the clavicle down to the scapula (coracoclavicular ligament). The latter ligament is not situated at the level of the acromioclavicular joint but further medial, between the mid part of the collar bone and coracoid process. To keep the clavicle in its normal position after a dislocation, surgery is required. This then is contrary to the glenohumeral dislocation that is stable after reduction. A reduction is a manoeuvre whereby the components of a joint are replaced in their normal, anatomic relationship. Fortunately, unreduced acromioclavicular subluxations are often well tolerated. On the other hand, unreduced glenohumeral dislocations need surgical attention.

One other ligament needs to be mentioned, the **coraco-acromial** ligament (**Figure 4**). It spans from the acromion to the coracoid process (both are part of the shoulder blade) and all three elements form the coraco-acromial arch, a structure which covers the humeral head. In between the arch and head, we find the rotator cuff tendons (**Figure 5**). The area occupied by all the above mentioned elements: the acromial arch, together with the rotator cuff and the humeral head play a role in the **impingement syndrome**.

Any joint can be put through a range of motion by the examiner without any help from the person to be examined; this is known as passive motion. Under normal circumstances, only the capsule and ligaments, as well as the configuration of the joint, will limit the range of passive motion. Motions done by the examinee are known as active movements. The extent of mobility is known as the range of motion (ROM).



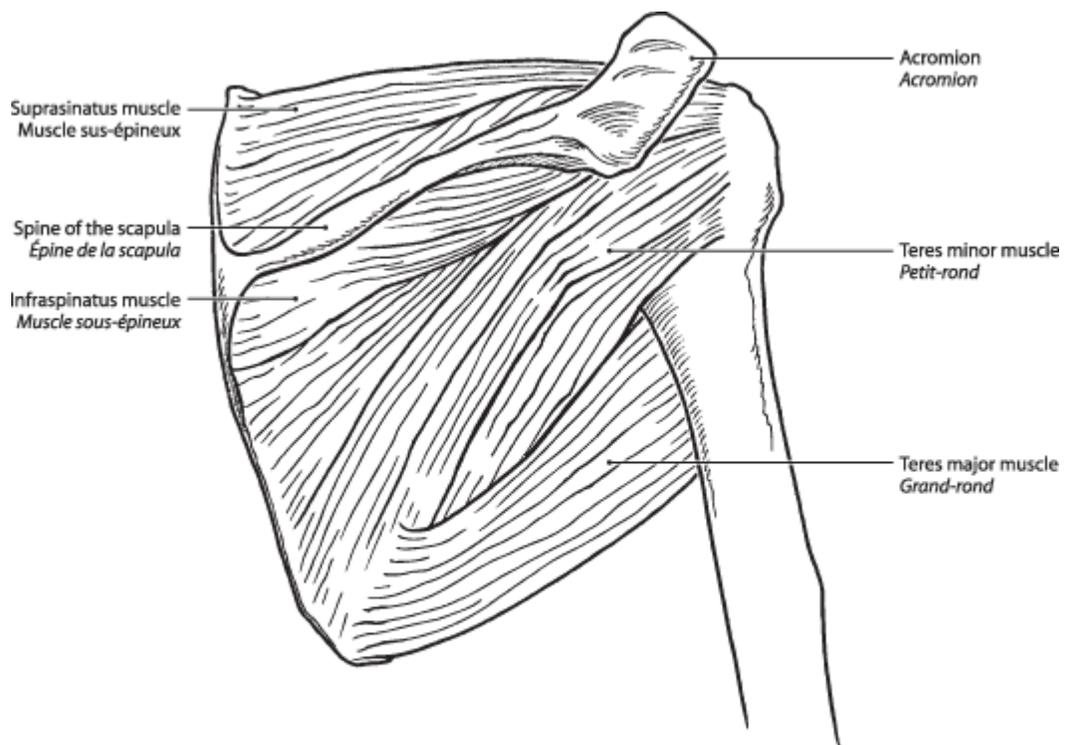
**Anterior view of the muscles of the shoulder**  
***Vue de face des muscles de l'épaule***

**Figure 5.**

### **D. Muscles and Tendons (Figures 5 & 6)**

Active motion, as opposed to passive motion, is only possible through the action of the muscles of the person examined. During testing of the active range of motion, the examiner can determine the function, as well as, the

strength of muscles. Obviously, the prerequisite is the co-operation of the examinee. Strength is often tested by active movements against resistance. Pain, provoked by movements, may be one reason for the limitation of the active and passive range of motion. Another reason could be the unwillingness of the examinee to reveal to the examiner the exact extent of mobility.



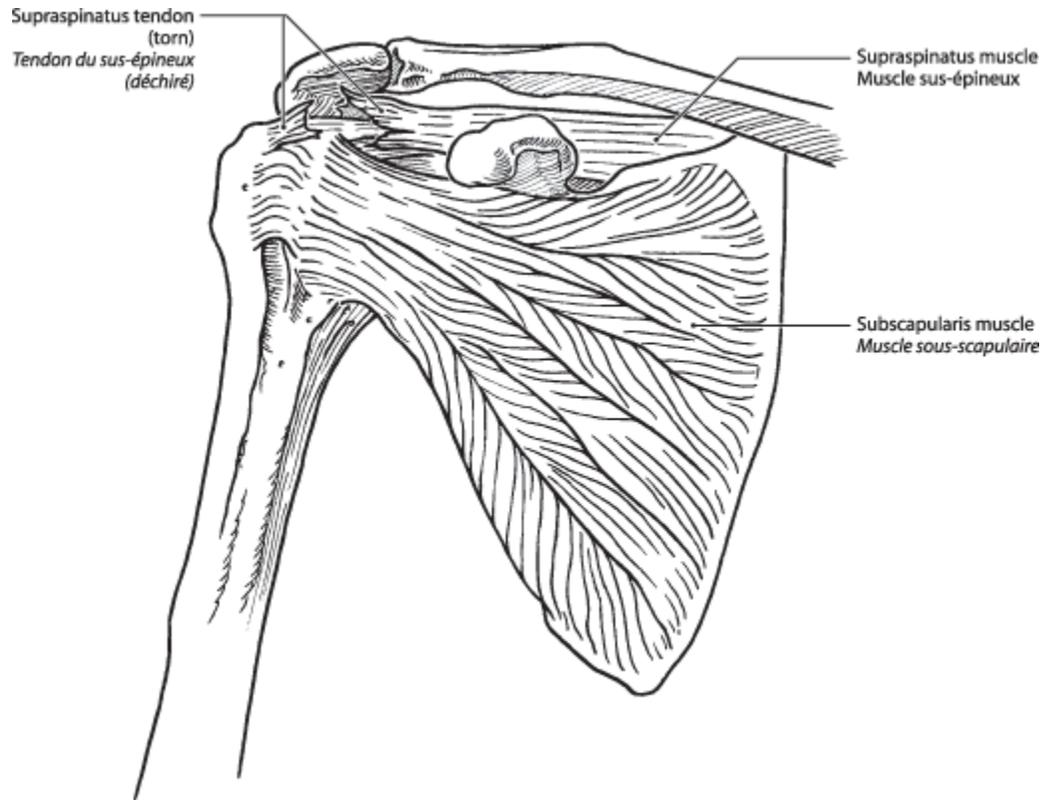
**Posterior view of the rotator cuff muscles**  
*Vue dorsale de la coiffe des rotateurs (muscles)*

**Figure 6.**

Muscle is a fleshy tissue that the body uses to move a joint. Active muscle contraction is a prerequisite for such a movement during which the joint acts as a hinge. At some sites, the muscle spans the entire distance between its origin from one bone and its insertion into the other, crossing on its way a joint. At other sites, we have a **muscle-tendon unit** where the muscles originate from one bone, then continue in form of a tendon, which, in turn, inserts into the other bone, again having crossed at least one joint. An example is a finger flexor where the muscle is situated in the forearm; at the level of the wrist it continues as a tendon that crosses the hand to insert into a finger.

At the level of the shoulder, muscle contractions allow forward bending (**flexion**), backward movement (**extension**), turning (external or internal **rotation**), as well as, movements toward (adduction) or away from the body (**abduction**).

At the **glenohumeral joint** (between humerus and shoulder blade), we distinguish between a deep and a more superficial (directly under the skin) group of muscles. The deep group of muscles comprises the **subscapularis** in front, the **supraspinatus** on the top and the **infraspinatus** and **teres minor** behind the humeral head. Their tendinous continuations form a hood over the humeral head, known as the **rotator cuff**. The rotator cuff interval is situated between the tendons of the supraspinatus and the subscapularis muscles. The main function of all four muscles is to stabilize the humeral head in the glenohumeral joint. The second function is active motion. The subscapularis rolls the arm inward (internal rotation), the supraspinatus brings the arm away from the body (abduction) and the infraspinatus and teres minor roll the arm outwards (external rotation). Rotator cuff tendons may tear in response to a severe injury where the external force is greater than the strength of a healthy tendon (young individuals). In this instance, a piece of bone is often avulsed (torn away by force) from the greater tuberosity of the humeral head together with the tendon.

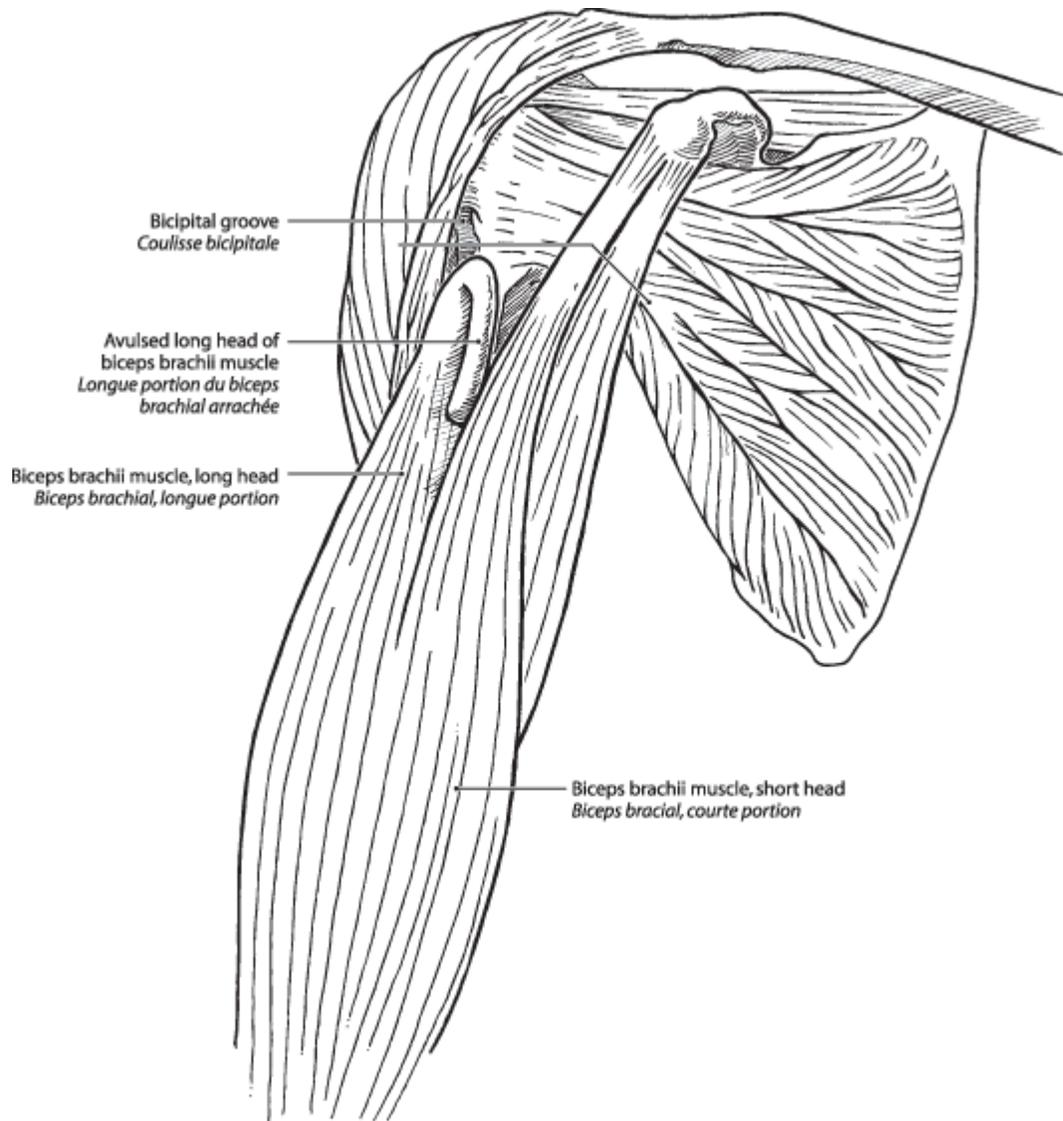


**Rotator cuff tear**  
**Déchirure de la coiffe des rotateurs**

**Figure 7.**

The more common type of tear, the rotator cuff tear (**Figure 7**) occurs in older individuals with a moderate external force, such as during the lifting of objects. It causes a tear of a tendon at its insertion into bone. This site has been weakened by age-related and, maybe by activity-related, changes (middle aged and older persons), already present at the time of the incident. Following a tear, active movements are restricted or impossible since the continuity between origin and insertion of the muscle-tendon-bone unit is disrupted. As the supraspinatus tendon is usually affected, it results in impaired abduction. The person cannot hold his/her arm in a position at 90 degrees away from the body. If the infraspinatus is torn, external rotation is weak and if the subscapularis is disrupted, internal rotation is affected.

Another deep structure is the long head of the **biceps muscle**, a muscle effecting forward flexion of the shoulder and flexion of the elbow (it spans two joints). The long head of the biceps originates inside the glenohumeral joint. It then travels in an interval between the subscapularis and supraspinatus tendons, and glides through a groove between two bony prominences of the humeral head (**lesser and greater tuberosities**). It is then joined below the exit from the groove by the short head of the biceps which originates from the coracoid process (biceps = two heads). The biceps inserts into one of the two forearm bones, the radius. Its action at the shoulder is to bring the arm forward and at the elbow to bend the forearm. A tear of the long head of the biceps (**Figure 8**) is often seen in patients suffering from a rotator cuff tear. As a result, the biceps muscle shortens and becomes more prominent (thicker) in front of the upper arm. Obviously, elbow bending becomes weaker.



**Tear of the long head of the biceps**  
**Déchirure de la longue portion du biceps**

**Figure 8.**

The superficial muscle covering the entire shoulder is called the **deltoid muscle**. For purposes of functional activity, doctors distinguish between an anterior, middle and posterior part. The parts contribute to forward elevation (**flexion**), to moving the arm away from the body (**abduction**) and pushing the arm backwards (**extension**). Paralysis causes a functional disability. Tears are unknown. During shoulder surgery, the muscle is sometimes detached from its bone origin. If sutures are not strong enough or fail to hold the muscle to bone during healing, the muscle will not heal back to the bone, a space remains between muscle and bone (**dehiscence**) resulting in a considerable loss of function.

### E. Bursae

**Bursae** are flat bags containing small amounts of fluid. They allow gliding between two neighbouring structures. During movements, the humeral head together with the rotator cuff tendons covering it, glides against the acromion and the coraco-acromial ligament. The smoothness of gliding is made possible by, the **subacromial bursa**, a narrow but extensive sac filled with small amounts of lubricating fluid (synovial fluid). It extends also under the deltoid muscle, and this part is known as the **subdeltoid bursa**. Under normal circumstances, the subacromial bursa does not communicate with the glenohumeral joint cavity. It does so, however, after a complete tear of the rotator cuff. When the amount of fluid increases, we speak of an effusion; it is often accompanied by a thickening of the wall of the bursa, known as **bursitis**. A bursitis always develops in response to other pathology. Therefore, the diagnosis of bursitis should always be accompanied by the diagnosis of the condition that caused the bursitis. It is unfortunate that some physicians use the diagnosis bursitis for a painful shoulder condition they are unable to define exactly.

In front of the humeral head, a gliding motion also exists between the subscapular tendon and the underlying capsule. In this space we find the subscapular bursa. There always exists a communication between this bursa and the joint cavity. Both the glenohumeral joint and the subacromial bursa can be inspected with an arthroscope.

## 2. Diseases and Disability of Shoulder

### A. Bursitis

Bursitis usually refers to the subacromial-subdeltoid bursa that has become inflamed. This means that the bursal walls are thickened and that the amount of fluid in the bursa is increased. Bursitis almost always develops in response to an irritation by neighbouring structures. A bony outgrowth (spur of the acromion or osteophyte from an arthritic acromio-clavicular joint) or a thickened or a partially torn tendon of the rotator cuff may lead to an irritation of the bursa. With the exception of rheumatoid arthritis, bursitis can never be a primary or free standing diagnosis. It is always secondary to an underlying disease.

### B. Tendonitis-Tendinitis

In the strict sense of the word, it means an inflammation of a tendon. However, microscopic sections rarely show the presence of inflammatory cells. The process is rather characterised by other, usually degenerative tendinous changes that lead to a thickening of the tendon. A special condition known as **calcified tendinitis** or calcifying tendinitis is due to the deposition of calcium salts in a tendon. The swelling accompanying intratendinous changes causes pain. Any increase in contents of the space between the humeral head and acromion causes a rise in pressure in this subacromial space since it is unyielding and cannot expand. Often the diagnosis of tendinitis is based on a clinical examination. All too often, additional testing later on reveals an incomplete tear of a cuff tendon. It is therefore my opinion, that the diagnosis tendinitis should only be provisional; more detailed examinations (ultrasound, or MRI) should be done to exclude partial tears.

### C. Impingement Syndrome

Between the head of the humerus and the overlying acromial arch, composed of acromion, coraco-acromial ligament and coracoid process, we find the rotator cuff tendons covered by the subacromial bursa. The distance between both bones (humeral head and acromion) can usually not increase. It can narrow, however, due to bony outgrowths (**spurs, osteophytes**) from the acromion or the outer end of the collarbone. Another possibility is an upward movement of the humeral head in instances of a complete tear of the rotator cuff. Bony outgrowth will squeeze the rotator cuff tendons and the

bursa. This pinching, that can be increased by certain movements (such as internal rotation and forward elevation), is called **impingement**. Another cause of impingement syndrome is an increase in the thickness of tendons and often of the overlying bursa. As stated above, the space between the humeral head and acromial arch cannot expand to accommodate an increase in contents nor accommodate new bone formation (spurs). Impingement is usually responsive to non-operative treatment. Occasionally, removal of a bony spur or osteophyte (**acromioplasty**) is indicated. Removal of a calcium deposit causing impingement may also be indicated.

It is sometimes argued that impingement may cause a rotator cuff tear. This is an exception. In most instances, the tendon is the site of the original disease, leading to a tear due to the structural weakening of the tendon; the resulting impingement will make the situation worse. In fact, outgrowths of the acromion (bony spurs) form in response to a continued pressure of thickened tendon against the acromial arch. This is important, as the argument often goes that spurs lead to a tendinitis. Degenerative processes inside the rotator cuff can be made worse by repeated activities with the hands at shoulder level or above it. Such an activity, when performed repeatedly over a period lasting years may also affect the acromioclavicular joint leading to a joint degeneration and the formation of osteophytes. Impingement affects both genders equally. Impingement can start at an early age (around age 20) particularly in athletes. It can develop spontaneously in older people (around 50 to 60 years of age).

### **Is there a relationship between isolated and recurrent injuries to the shoulder and impingement syndrome?**

I do not think that an isolated injury can induce an impingement syndrome. However, recurrent injuries and, more so, repetitive work can cause an impingement, usually secondary to wear and tear of the rotator cuff tendon.

### **D. Rotator Cuff Tear (Figure 7)**

As stated before, severe trauma can cause a tear, particularly in younger individuals. In these instances, a piece of bone from the humeral head (greater tuberosity) is usually avulsed together with the tendon. In middle aged or older people, changes inside the tendon (degenerative changes) make the tendon weaker to a point where a lesser effort or a trivial trauma can cause a tear. Work requiring repetitive or prolonged use of arms above the shoulder level may accelerate the progress of degenerative tendinitis and

thus, may predispose to tears. Small tears may not cause any symptoms. Bigger tears cause a weakness and pain, mostly on abduction. The symptoms are usually made worse when attempting to lift the arm away from the body and the weakness is felt when performing activities with the arm at shoulder level or above it. A change of work is often required. Although degenerative tears of rotator cuffs of both shoulders are not uncommon, they very rarely occur at the same time. If a well executed non-operative treatment fails, in particular as it relates to pain relief, surgery should be considered. In younger individuals, immediate surgery is recommended.

### **Is there a relationship between isolated or recurrent injuries and partial or complete rotator cuff tears?**

There is definitively a strong relationship. However, since most partial and complete tears occur in the middle aged and older person, pre-existing degenerative changes causing a weakness in tension of the tendon must have contributed. As already stated, certain repetitive movements required by work can accelerate the development of degenerative changes. This raises the question of the importance of a pre-existing condition, which in certain workmen can be work related.

Even after a most successful repair of a rotator cuff tea, a complete recovery of function and strength cannot be expected in the middle aged and older worker.

### **E. Calcific Tendinitis - Calcifying Tendinitis**

This condition is neither caused nor aggravated by any particular activity. It affects females more often. Calcific deposits in the opposite shoulder occur in up to 40% of patients. Calcific tendinitis can not be attributed to factors associated with work.

### **F. Recurrent Shoulder Dislocation (Figure 2)**

This question has been addressed before. A first traumatic dislocation always precedes it. If the tear in capsule and ligaments does not heal spontaneously thereafter, and permits the humeral head to slip out easily, surgical repair is indicated. If dislocation recurs without a significant trauma, one must conclude that the repair has not been successful. If, on the other hand, a severe trauma leads to re-dislocation, we are dealing with a new independent injury. Anterior dislocations are usually caused by very forceful

external rotation with the arm in abduction (the arm in a position away from the body), a position assumed by pitchers. There is one exception to the above-mentioned cause of events. This concerns people having an inborn laxity of all ligaments (Ehlers-Danlos syndrome). In these people, a first time dislocation can occur without trauma. Repeated dislocations may lead to arthritis.

Posterior dislocation of the shoulder is much less common than anterior. It may be precipitated by the three "E"s - ethanol, electric shock or epilepsy. Posterior dislocations are often missed on physical examination and even on x-ray. The key physical finding is loss of external rotation.

### **What is the relationship between subluxation and dislocations and specific accidents at the workplace?**

First time dislocations and subluxations require a definite injury. Without such a history, we must be dealing with a recurrence and not a first time condition.

## **G. Shoulder Instability**

This term is often used to describe a certain laxity of the capsule and ligaments of the shoulder leading mostly to subluxation. Patients complain about a feeling of insecurity while attempting certain movements. Proper exercises may resolve the situation by strengthening the muscles. Surgery attempting to tighten the capsule and ligaments in instances of unidirectional instability usually resolves the instability satisfactorily. The same can not be said for multidirectional instability.

## **H. Frozen Shoulder**

This term is used to describe a severe, often painful and incapacitating limitation of passive and active movements. It can follow a prolonged immobilization of the shoulder or it may be due to a tendinitis. This condition usually resolves with adequate intensive physiotherapy but it can take months. Surgery, be it open or arthroscopic, is sometimes needed to divide the contracted structures. It does not always resolve and stiffness may be permanent.

## **I. Arthritis**

The most common form is degenerative osteoarthritis seen in the middle aged and older population. It is often attributed to wear and tear. Although

inflammation of a joint is sometimes stated as a cause, an actual inflammatory process is most uncommon except for rheumatoid arthritis. Deformation or incongruity of opposing joint surfaces, as may result from fractures extending into the joint, can also lead to arthritis. Such a condition is known as post-traumatic osteoarthritis.

In instances of arthritis, bony outgrowths often form at the periphery of the joint surfaces; they are known as marginal osteophytes. Post-traumatic, as well as degenerative osteoarthritis usually leads to a decrease in the range of motion of a joint and to pain. At the shoulder, both the glenohumeral and the acromioclavicular joints can be the site of osteoarthritis.

### **Is there a relationship between isolated or recurrent injuries to the shoulder and osteoarthritis?**

a) Glenohumeral osteoarthritis.

This joint can be affected after repeated episodes of dislocations or, as in the post traumatic form, after intraarticular fractures. I do not believe that repetitive work can lead to osteoarthritis of the glenohumeral joint.

b) Acromioclavicular joint.

Osteoarthritis can develop after an unreduced subluxation or dislocation, as well as after repetitive work requiring activities with the hands above shoulder level.

### **K. Shoulder-hand syndrome**

This autonomic dystrophy is known to occur in 10 to 30% of patients having had a myocardial infarction, a stroke, or injury to the upper limb and hand. It is characterised by shoulder stiffness.

### **L. Neck problems and shoulder problems**

There is no doubt that pain from cervical spine problems, in particular in instances of degenerative disc disease, can radiate to the shoulder. A good clinical examination will help to distinguish between symptoms originating in the shoulder and those referred to the shoulder. It is known that the conditions of certain occupations can cause the development of cervical degenerative disc disease. In my opinion, a thoracic outlet syndrome is not caused by conditions associated with work, the exception being a displaced fracture of the first rib.

### **M. Value of certain examinations**

#### a. MRI

As previously stated I believe that an MRI as well as ultrasound and a CT can give us the necessary information to reach an exact diagnosis.

#### b. Arthroscopy

It is a most valuable tool in confirming a diagnosis (diagnostic arthroscopy) and in performing surgery. Arthroscopic surgery, when performed by experienced orthopaedic surgeons, is a much less invasive procedure than open surgery. When properly executed, the incidence of complication is very low.

Since ultrasound, CT and MRI are non-invasive procedures they should be done before an arthroscopy.

### **What can be expected after a debridement of the shoulder?**

The most beneficial effect seems to be temporary reduction of pain and thus a better function. I do not think that the effect is long lasting.