"Healthy Tennis" - *Shoulder Injuries in Tennis*

The shoulder girdle is the anatomical link between the arm and the body which transmits force from the lower body and torso to the racket. This joint plays a pivotal role because of its tremendous range of motion. It is precisely because of this reason that the shoulder is prone to injury. The shoulder joint has more range of movement then any other joint in the body. It is also the least stable, and therefore most sensitive, of our large joints. The shoulder moves in three dimensions allowing for a swing path which is non-linear. This in turn creates racket trajectories during ground strokes and particularly serves that can impart both spin and pace to the ball. In order to generate the pace of a professional caliber serve the shoulder must rotate roughly through an arc of motion of 120-180 degrees! 130 mph plus serve velocity is achieved by generating tremendous torque in the shoulder which accelerates the racket head rapidly through this range of movement. It is the repetitive forces during these movements that can potentially lead to injury. To better understand the types of injuries and their causes we must delve into the functional anatomy of the shoulder girdle.

The shoulder girdle is made up of the clavicle (collarbone), scapula (shoulder blade), and glenohumeral joint (shoulder joint) (Figure 1). The shoulder girdle is attached to the rest of the body by the connection of the clavicle with the sternum. The other end of the clavicle is attached to an outcropping of the shoulder blade known as the acromion. This joint is called the acromioclavicular joint (AC joint). The shoulder blade is attached to the rib-cage and spine by several muscles. The shoulder blade is a rotating platform which moves along the chest wall to help position the shoulder joint and the rest of the arm. The glenohumeral joint is a modified ball and socket joint which is the connection between the humerus (upper arm bone) and the glenoid (socket portion of the shoulder blade).

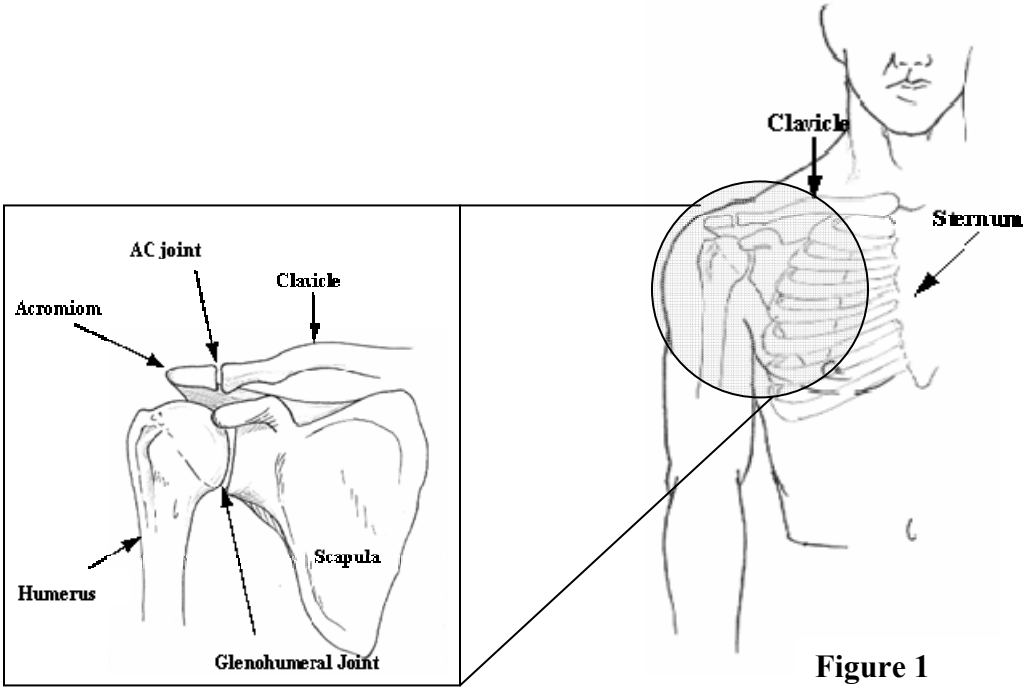


Figure 1

The articulating surfaces of the humerus and glenoid are covered with cartilage which provides for smooth, low friction movement of the joint. A small amount of fluid in the joint further lubricates the surfaces.

The shoulder joint is stabilized in two main ways: dynamic stabilizers (muscle forces) and static stabilizers (ligaments, joint geometry). There are four small muscles that attach to the shoulder blade and the humerus which provide both movement and stability to the shoulder joint. These muscles include the subscapularis, supraspinatus, infraspinatus, and teres minor. Collectively these muscles are referred to as the rotator cuff (Figures 2 & 3). The term "rotator cuff" originates from the fact that the muscles aid in *rotation* of the joint and their tendons form a *cuff* around the humerus. When these four muscles contract together they squeeze the joint together in such a way that when the arm moves the ball (humerus) remains centered on the socket. Even with extremes of movement in the normal shoulder the ball slides no more than 1/16 th of an inch in any direction!

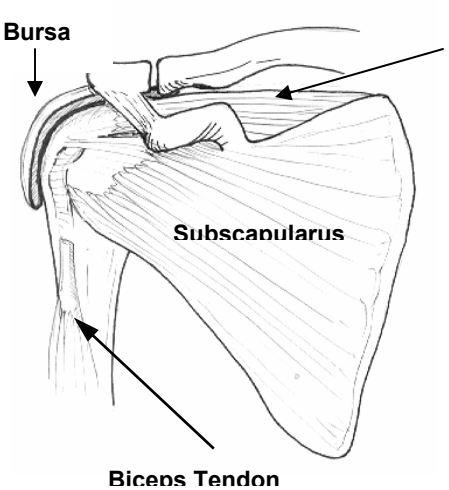


Figure 2: Rotator Cuff muscles (front view)

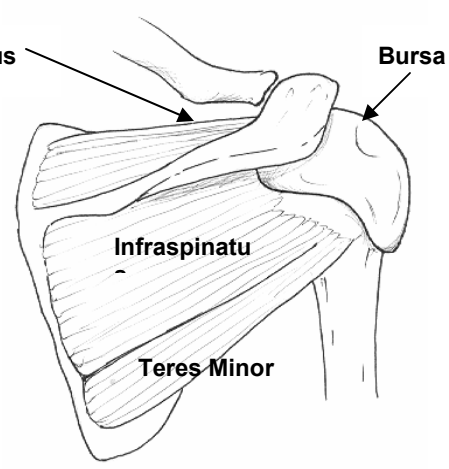


Figure 3: Rotator Cuff muscles (back view)

During normal shoulder motions the muscles contract in a synchronous fashion allowing smooth, coordinated movement of the scapula and glenohumeral joint. The power muscles such as the deltoid, pectoralis, latissimus dorsi, and other muscles work together with the rotator cuff so you can raise your arm. In total, there are 22 muscles which surround the shoulder girdle that must work in perfect harmony to allow maximum function. Any change in muscle function that disrupts this delicate balance leads to a decline in the function of the shoulder girdle.

The muscles do the majority of the work stabilizing the joint, but at extreme positions the muscles are at a mechanical disadvantage and can't effectively stabilize the joint. This is where the ligaments come into play. Ligaments are tough, fibrous tissues that connect bones with other bones. In normal ranges of movement the ligaments are slack but in extreme positions they become tight and function as sort of a check-reign preventing partial or complete dislocation of the joint. The ligaments can be excessively loose leading to instability of the shoulder joint. The looseness can be inherited, can occur from repetitive overuse (causing stretching of the ligaments), or sudden trauma (tearing of the ligaments). The joint is further stabilized statically by the natural concave shape of the socket and the labrum which forms a fibrous "gasket" further stabilizing the joint

(Figure- 4).

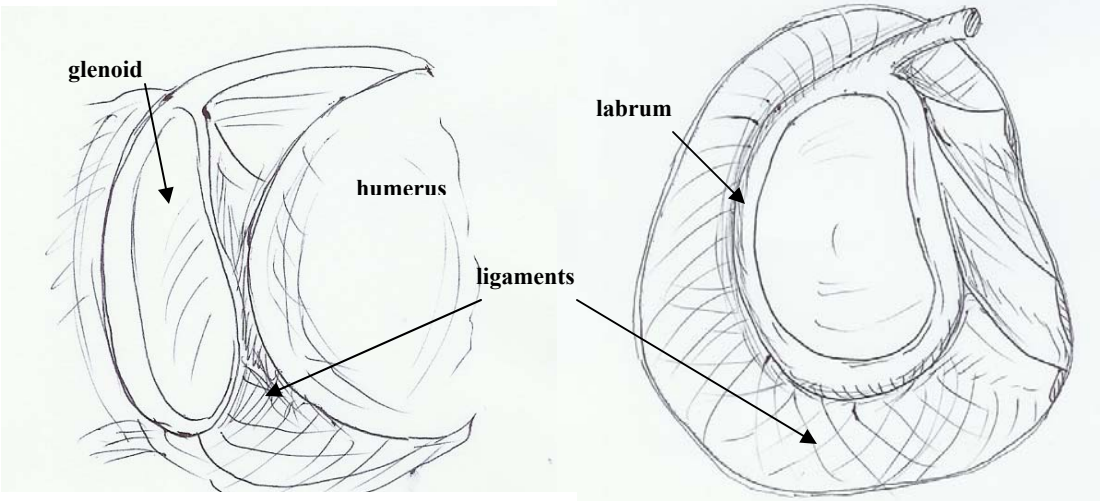
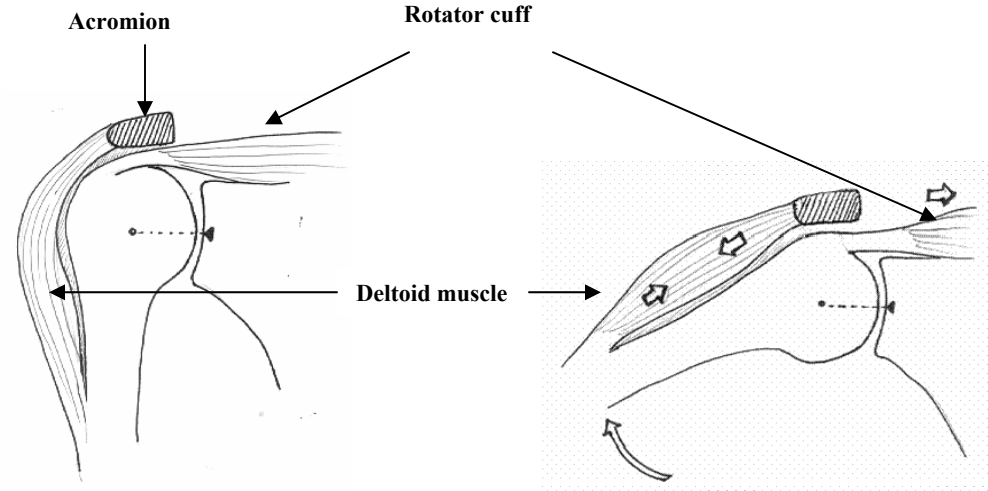


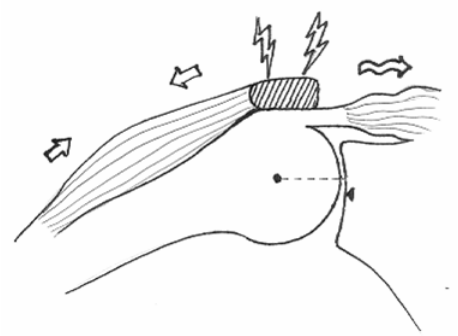
Figure 4- the glenohumeral joint as seen from the back

A side view of the glenoid with the labrum and surrounding ligaments

The most common cause of shoulder injury is repetitive overuse. Overuse can be the result of too much play in a short time interval, too long of a season, or poor stroke mechanics. Acute injuries caused by a single traumatic event are far less common. Repetitive overuse interacts with other factors such as age, general fitness, and genetics to produce a range of injuries. The cycle of repeated trauma can lead to a vicious cycle which ultimately can lead to soft tissue injury of the muscles, tendons, and ligaments (Figure 4).



During normal shoulder movement the deltoid muscle and the rotator cuff contract in a balanced fashion to raise the arm while keeping the joint centered. This allows the rotator cuff tendon to move under the acromion without impingement.



When the rotator cuff fatigues, the deltoid muscle contracts unopposed. This causes instability and upward migration of humerus resulting in impingement of the rotator cuff tendon under the acromion.

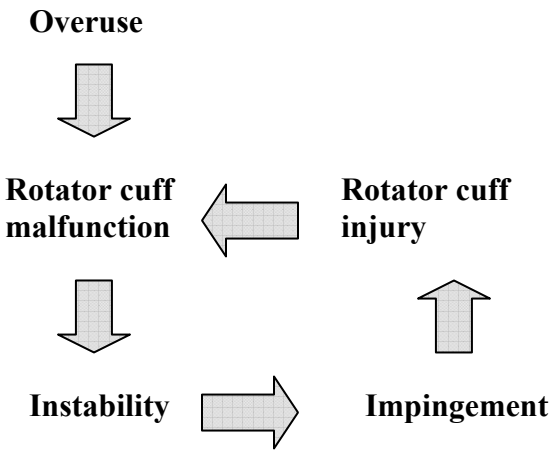
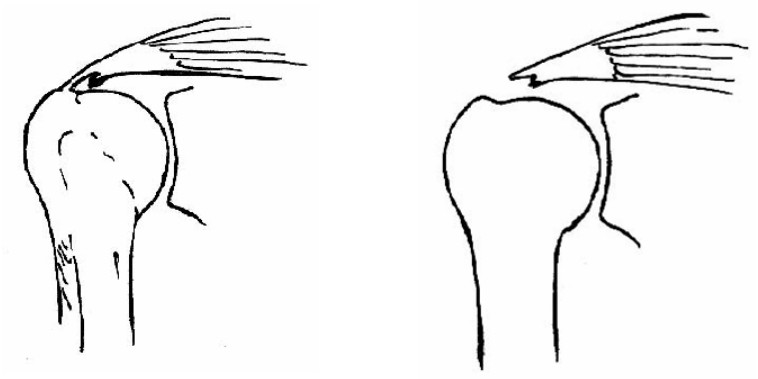


Figure 4- the overuse vicious cycle

Rotator cuff injuries- injury to the tendon attachment of the rotator cuff is the single most common injury in tennis. Injuries can range from a simple tendonitis/ strain to tearing of the tendon insertion from bone. Milder injuries are seen in younger age groups while more severe injuries are associated with higher levels of play. Typically overuse of the muscles result in fatigue of the rotator cuff muscles which in turn impairs the dynamic stabilizing effect of the muscles. Persistent use eventually results in a strain injury to the rotator cuff tendon and further trauma due to impingement of the tendon. In older players chronic impingement can lead to the formation of a bone spur on the

underside of the acromion which further exacerbates the process by reducing the space available for the tendon. In professionals and high level amateur players playing week in and week out the injury can ultimately evolve into a partial tear (Figure 5). Complete tears are rarely seen in players under age 35 but become more common with advancing age. In senior players rotator cuff problems including complete tendon tears are even more common. Complete tears can result in impairment not only of tennis but also daily activities.



Partial rotator cuff tendon tear complete tear

Figure 5

Treatment for strain injuries consists of relative rest, icing, analgesic medications and physical therapy. Rest from the offending cause is mandatory; however, the patient is encouraged to continue pain free exercises so that fitness can be maintained. Medications typically include over the counter or prescription anti inflammatory drugs aimed at reducing pain and swelling. Therapy restores movement and muscular function through a series of hands-on treatments and exercises. In older patients who have chronic impingement of the rotator cuff due to a bone spur, arthroscopic removal of the spur provides excellent relief of their symptoms with full recovery typically in 2-3 months. Patients who have incomplete or chronic complete tears may also benefit from the previously mentioned treatment regimen. Those who have a partial or complete tear and have failed conservative treatment are candidates for rotator cuff repair surgery. The

surgery involves sewing the torn tendon back its bony attachment site. The surgery can be typically performed arthroscopically via small cosmetic incisions. Recovery may take 4-6 months in most cases.

Instability- The contour of the shoulder joint consists of a large ball (the humerus) and a small, relatively flat socket (the glenoid). Thus, there is less stability from the bony architecture as compared to the hip joint which has a deep socket and is therefore every stable. It is not surprising then that the shoulder derives stability mainly from the rotator cuff muscles and the ligaments. Ligament looseness is maximal during the growth spurt in adolescence which correlates with a peak incidence of instability problems in this age group. Add to this that during this phase of rapid growth and development muscular strength typically lags behind skeletal growth. The relative lack of strength and the increased laxity of the ligaments is a perfect recipe for creating instability. Once the shoulder becomes unstable the rotator cuff becomes overtaxed trying to control the joint and a secondary tendon strain injury frequently develops. Although a minority of patients will sense overt slipping of the joint most will simply complain of pain or a "dead arm" sensation after practice or play. Once players reach physical maturity (20s-30s) instability tends to be either a continuation of a chronic adolescent condition or an acquired condition caused by slowly stretching the ligaments over time because of repetitive use. Left unchecked a small number of players can develop labral tears with or without partial rotator cuff tears. This injury is very common in professional players on the ATP tour and usually leads to surgery and an extensive layoff from the tour. Acute, traumatic tearing of the ligaments causing abrupt onset instability is rarely encountered in tennis. Senior players rarely have any type of instability problems because the shoulder joint naturally stiffens with age.

Conservative treatment is almost always indicated in the management of shoulder instability. A very similar regimen is utilized as described for rotator cuff disorders. The exercise regimen is tailored specifically to address instability. In patients who have chronic instability and have failed therapy or those who have a symptomatic labral and/or partial rotator cuff tear surgery may be necessary. A ligament tightening procedure is

performed in those patients who have symptomatic laxity of the ligaments. This procedure is accomplished by arthroscopically pleating the ligaments. Both the labrum and the rotator cuff can also be repaired arthroscopically with a high degree of success. The recovery time for instability or labral repair can be prolonged often requiring 6-10 months before returning at full strength to competition.

Tennis is a relatively safe and healthy sport that can be played by all age groups. Occasionally players can suffer an injury which can sideline them indefinitely. It is important to treat injuries before they become chronic as the success of treatments are more predicable the earlier they are implemented. If you sustain an injury that persists don't hesitate to seek care from a qualified health professional.

In this article I have covered the functional anatomy and common injuries to the shoulder relevant to tennis. There are many other less frequent problems such as shoulder arthritis, nerve injuries, etc. that are beyond the scope of this article. If the reader is interested more information is available at the website of the American Academy of Orthopedic Surgeons, www.aaos.org.