Rehabilitation after Shoulder Arthroscopy

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Bachelor Thesis

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Abstract

‘’Rehabilitation after Shoulder Arthroscopy’’

Current Thesis introduces a postoperative state after Arthroscopy of shoulder joint. The operation, was performed on May 2011, due to partial tear of supraspinatus tendon, successfully. In this study I present the therapeutic process that I followed during my practice. Thesis is divided in two parts.

In the first part of my study I describe the anatomy and movement complexes of shoulder joint. The enclose muscles and their relation with the outer forces from biomechanical view. In addition, I cite the development of Arthroscopy on Shoulder joint and the differentiation with Arthroplasty in our days.

In the second part I review and record all the documents from the past and present state of the patient. I continue with detailed examination taking in mind all the related factors that can be possibly affected after the surgery. Finally, I retell and analyze the therapeutic methods that I applied during post operative state.

Key words:

Supraspinatus tendon tear, Arthroscopy, Physiotherapy.

Declaration

In this case study I cite the research that I have been working. I refer the methodology that I have been followed with detailed description of Bibliography.

Case study was done under guidance of Miroslava Jalovcova Mgr.

Practice of my study took place in CLPA Hospital under supervision of Zaher El Ali Mgr.

Prague, 2011 Pavlos Matsangos

Acknowledgment

In my effort to fulfill my thesis in the most integrated and scientific way, I had by my side a respectable person, my professor Miroslava Jalovcova Mgr. Her great experience and knowledge, but mainly the substantial relation, she has managed to built with her students, helped me in the best way to complete this work. It would be a deficiency if I did not mention the great role of my supervisor Mr. Zaher El Ali Mgr. in C.L.P.A Hospital while I was having my practice. His guidance and constructive comments helped me to complete my Thesis.

Dedicate

Approaching the end of my study, I feel the need to dedicate this work to those, who supported me all these years. I would like to express, my deepest gratitude, mainly to my family who tried to encourage and give strength to go on, in every way it was possible.

In addition, I would like to express my sincerest appreciation to my Professor and advisor Mrs. Miroslava Jalovcova Mgr. for her valuable guidance and support.

Content

1. Shoulder Anatomy

The shoulder complex consists of the clavicle, scapula, and humerus; the glenohumeral and acromioclavicular (AC) joints that unite them and the sternoclavicular (SC) joint, the only connection of the complex to the axial skeleton. In addition, a scapulothoracic and a subacromial joint are often included in anatomical descriptions of the shoulder complex. Together, these articulations provide the shoulder with a range of motion that exceeds any other joint mechanism. Movements of the human shoulder represent a complex dynamic relationship of many muscle forces, ligament constraints, and bony articulations. Static and dynamic stabilizers allow the shoulder the greatest range of motion of any joint in the body and position the hand and elbow in space. Full mobility is dependent on coordinated, synchronous motion in all joints of the shoulder complex. This wide range of mobility, together with elbow motion, allows positioning of the hand anywhere within the visual work space and affords the ability to engage in a myriad of activities. However, this range of motion is not without risk. The bony architecture of the glenohumeral joint, with its large articulating humeral head and relatively small glenoid surface, relies heavily on ligamentous and muscular stabilizers throughout its motion arc (as opposed to the hip with its congruent "ball-in-socket" anatomy). If any of the static or dynamic stabilizers are injured by trauma or overuse, the shoulder is at increased risk for injury. Shoulder injuries account for 8% to 20% of athletic injuries[1,2]. While some occupations and sporting events require this wide range of movement, most activities of daily living can be performed despite loss of shoulder complex motion, providing mobility is unimpaired in the cervical spine and distal upper extremity joints[3].

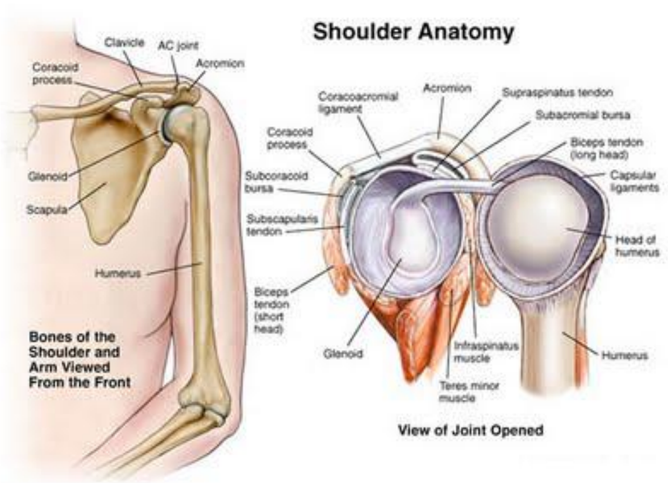


Figure 1
Normal shoulder anatomy
http://brain.jorgjansen.com/files/2010/03/shoulder-anatomy.jpg

1.1 Bony Anatomy

1.1.1 Humerus

The humerus is the largest and longest bone of the upper extremity. Its nearest portion consists of the halfspheroid articulating surface or head, greater tuberosity, bicipital groove, lesser tuberosity, and the proximal humeral shaft. The head is inclined relative to the shaft at the anatomical neck at an angle of 1300 to 150° and is retroverted 26° to 310 from the medial and lateral epicondylar plane[4]. The tendons of the supraspinatus, infraspinatus and teres minor insert into the three facets of the greater tuberosity. The site of insertion of the subscapularis, completing the rotator cuff, is called the lesser tuberosity.

The facets provide for a continual ring insertion of the rotator cuff from posterior inferior to anterior-inferior on the neck of the humerus. This insertion is interrupted only by the bicipital groove, through which the long head of the biceps brachii passes laterally and distally from its origin on the superior lip of the glenoid.

1.1.2 Scapula

The scapula is a large, thin, triangular bone lying on the posterolateral aspect of the thorax, overlying from the second to the seventh rib, that serves mainly as a site of muscle attachment. Projected muscle groups from scapula are supraspinatus,

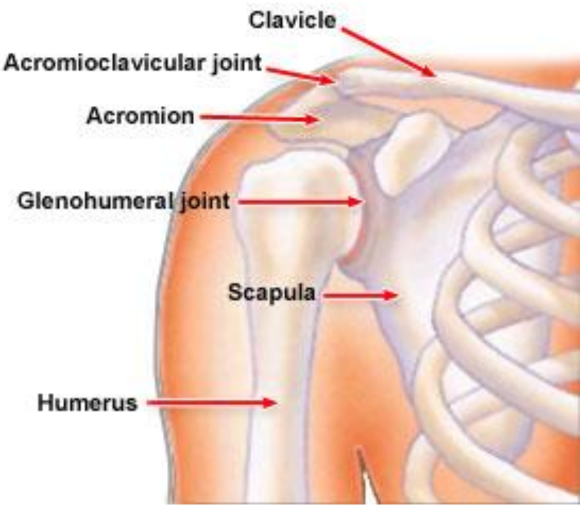


Figure 2
Osseous anatomy of the shoulder. The clavicle, the acromion, the humerus and the scapula are highlighted.
http://orthoinfo.aaos.org/topic.cfm?topic=A00394

infraspinatus, teres major, teres minor and subscapularis muscles. The posterior part of deltoid originates in the lower margin of scapula as caput breve from biceps brachii outgrowths from coracoid process. Trapezius, levator scapulae, rhomboideus (major-minor) and serratus anterior are the rest of the muscle groups were inserted in scapular bone. The supraspinatus muscle is sepatated from the infraspinatus by the the superior process or spine which extends superiorly and laterally to form the base of the acromion. The spine functions as part of the insertion of the trapezius muscle, as well as the origin of the posterior deltoid muscle. The acromion serves as a lever arm for function of the deltoid and articulates with the distal end of the clavicle, forming the acromioclavicular joint. It forms a portion of the roof of the space for the rotator cuff, and variations in acromial shape can affect contact and wear on the cuff (impingement)[5,6]. The impingement of the humeral head and overlying rotator cuff against the coracoacromial arch often result in tendinitis and bursitis. Impingement is often seen in overhead athletes who perform repetitive motions.

The coracoid process projects anteriorly and laterally from the upper border of the head of the scapula. The superior surface serves as the origin of the two coracoclavicular ligaments that are torn, along with the acromioclavicular ligament, in acromioclavicular (AC) joint separations. The fall onto the point of the shoulder, as it often occurs in football is the most common cause of injury. The coracoid tip plays the role of the origin of the coracobrachialis muscle and the short head of the biceps brachii, as well as the insertion of the pectoralis minor muscle. The coracohumeral and coracoacromial ligaments originate on the coracoid as well. The scapular notch lies just medial to the base of the coracoid and is spanned by the transverse scapular ligament. The suprascapular nerve passes beneath the ligament to innervate the supraspinatus and infraspinatus muscles[7,8].

The bony articulating surface for the humerus is represented by the glenoid fossa, or cavity. Its articular surface is only one third to one fourth compared to that of the humeral head, and hence it provides only a small contribution to the stability of the glenohumeral. The glenoid surface is retroverted on average 4^0 to 12^0 with respect to the scapular plane[9]. The scapular plane lies 30^0 to 45^0 anterior with respect to the coronal plane of the body and, thus, articulates with the retroverted humeral head[10]. The extensive normal range of shoulder motion owes its existence to its bony foundation which is provided by the orientation of the scapula towards the coronal plane of the body and humeral head.

1.1.3 Clavicle

The clavicle serves as the sole bony strut connecting the trunk to the shoulder girdle via the sternoclavicular join medially and the acromioclavicular joint laterally.

It has a double curve along its long axis and is subcutaneous in its full extent. The flat outer third serves as an attachment point for muscles and ligaments, whereas the tubular medial third accepts axial loading. Its thinnest portion is the middle-third transitional zone which is a weak area mechanically[11]. Besides being a site for muscle attachments the clavicle also contributes in the protection of underlying neurovascular structures and in the stabilization of the shoulder complex as it prevents it from displacing medially with the activation of the pectoralis and other axiohumeral muscles. Moreover, the clavicle prevents inferior migration of the shoulder girdle through the strong coracoclavicular ligaments. In high-grade AC joint separations, when this stability is lost, the shoulder girdle displaces inferiorly away from the clavicle. As a result, on physical examination, the distal clavicle appears to displace superiorly.

1.2 Joint Articulations

1.2.1 Sternoclavicular Joint

The sternoclavicular joint is a synovial articulation. Its function resembles a ball-and-socket articulation, eventhough the structure of the joint is of the plane variety[12]. The articular surfaces lack congruity. About half of the large, rounded medial (internal) end of the clavicle protrudes above the shallow sternal socket. The sternal surface of the clavicle has a small, upper nonarticular area which commonly seves as an attachment for the important intra-articular disk. The remaining surface of the clavicle is saddle shaped, anteroposteriorly concave, and downwardly convex[12,13]. Its medial end is bound to the sternum and to the first rib and its costal cartilage. The fibrous capsule is strengthened anteriorly, posteriorly, superiorly, and inferiorly by the ligaments. The articular disk and the costoclavicular ligament consist the principal joint structures that stabilize the joint, resist to the tendency for medial displacement of the clavicle, and limit the clavicular component of arm movement[12,14].

The articular disk is fibrocartilaginous, strong, almost circular, and completely divides the joint cavity. The disk itself is attached superiorly to the upper medial end of the clavicle and passes downward between the articular surfaces to the first costal cartilage[12]. This scheme enables the disk and its attachments to function as a hinge, thus a mechanism that contributes to the total range of joint movement. Disk attachment also secures the joint against forces that are applied to the shoulder and are transmitted medially through the clavicle to the axial skeleton. Forces transmitted medially would tend to cause the clavicle to override the sternum, resulting in medial dislocation, without this attachment. The costoclavicular ligament is a strong, bilaminar fasciculus attached to the inferior surface of the medial end of the clavicle and the first rib. The anterior component of the ligament passes upward and laterally (externally), while the posterior part passes upward and medially. The ligament strongly binds the medial end of the clavicle to the first rib, it becomes taut when the arm is elevated or the shoulder protracted and it is a major stabilizing structure[12].

The joint capsule is supported by oblique anterior and posterior sternoclavicular ligaments. Both of these ligaments pass downward and medially from the sternal end of the clavicle to the anterior and posterior surfaces of the manubrium. In contrast to the anterior ligament that is lax, the posterior ligament becomes taut during the process protraction while during retraction, it is vice versa. Across the superior aspect of the sternoclavicular joint, joining the medial ends of the clavicles runs an interclavicular ligament. This ligament provides stability to the superior aspect of the joint through its deep fibers that are attached to the upper margin of the manubrium[12,15].

Movements of the clavicle affect different areas between the articular surfaces and the intra-articular disk. When the clavicle moves in one direction during elevation, depression, protraction, or retraction, the ligaments on the side of the motion become lax. Those on the opposite side of the joint become taut, causing this way the compression of the clavicle, disk, and sternum and thus finally limiting the movement. Most motion occurs between the clavicle and the disk during the processes of elevation and depression of the clavicle while during protraction and retraction, the greatest movement occurs between the disk and the sternal articular surface[13]. This mechanism is important in maintaining stability in the plane of motion. Forces that act on the clavicle from the upper limb can rarely cause dislocation of the sternoclavicular joint. In contrast it is the excessive forces that are applied to the clavicle which are most likely to cause a fracture of the bone medial to the attachment of the coracoclavicular ligament[16].

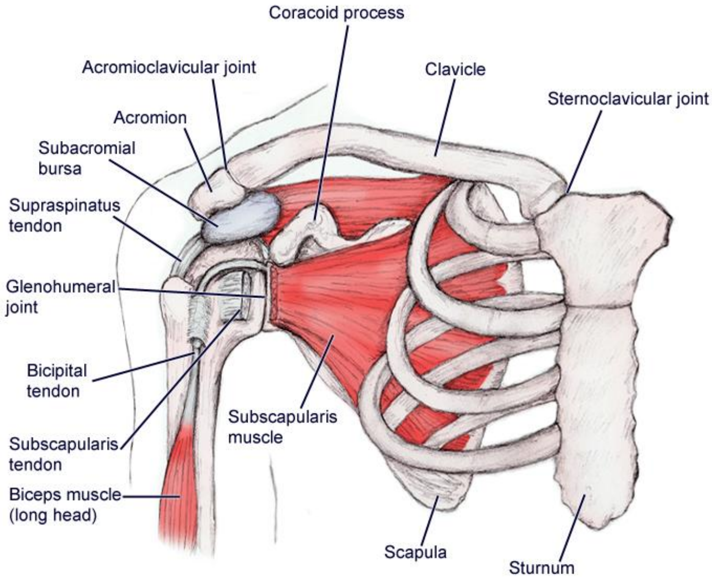


Figure 3
Schematic representation of the main shoulder components position. The joint articulations (sternoclavicular joint, acromioclavicular joint and the glenohumerao joint) are highlighted.

http://emedicine.medscape.com/article/1899211-overview

Movements such as elevation and depression of the clavicle, as well as protraction and retraction are allowed through the kinetis of the sternoclavicular joint. The axis for all these movements lies close to the clavicular attachment of the costoclavicular ligament[17].

1.2.2 Acromioclavicular joint

The acromioclavicular joint is a synovial plane joint between the small, convex oval facet on the lateral end of the clavicle and a concave area on the anterior part of the medial border of the acromion process of the scapula[12,15].

The articular surfaces are such that the joint line is oblique and slightly curved. The ability of the acromion, and thus the scapula, to glide forward or backward over the lateral end of the clavicle is permitted through the curvature nature of the joint. It is this movement of the scapula that keeps the glenoid fossa continually facing the humeral head. The oblique nature of the joint is such that forces transmitted through the arm will tend to drive the acromion process under the lateral end of the clavicle with the clavicle overriding the acromion. The importance of the joint is great because besides transmitting forces between the clavicle and the acromion, it also contributes to total arm movement[12,18].

The acromioclavicular joint contains a fibrogen capsule and a superior acromioclavicular ligament so as to strengthen the upper aspect of the joint. The coracoclavicular ligament is the major ligamentous structure that stabilizes the joint and binds the clavicle to the scapula. The most efficient means of preventing the clavicle from losing contact with the acromion are formed through this ligament even if it is placed medially and separate from the joint[19].

The coracoclavicular ligament consists of two parts: 1) the trapezoid and 2) the conoid. These two components, despite the fact that they are united at their corresponding borders, are functionally and anatomically distinct. Anteriorly, the space between the ligaments is filled with fat. These types of structures are usually called as bursa. Between the medial end of the coracoid process and the inferior surface of the clavicle the space is also filled by a bursa. These bony components are often found to be closely opposed (in up to 30% of subjects) and may form a coracoclavicular joint. These ligaments suspend the scapula from the clavicle and transmit the force of the superior fibers of the trapezius to the scapula.

The trapezoid ligament, the anterolateral component of the coracoclavicular ligament, is broad, thin, and quadrilateral. It extends from below to the superior surface of the coracoids process. The ligament passes laterally and almost horizontally in the frontal plane so as to be attached to the trapezoid line on the inferior surface of the clavicle. The acromion tends to be driven under the clavicle, by a fall on the outstretched hand, because of the tilt of the articular surfaces. The trapezoid ligament opposes this overriding[20].

The conoid ligament is thick and triangular, which has its base attached from above to the conoid tubercle on the inferior surface of the clavicle. It is located partly posterior and medial to the trapezoid ligament. The apex is attached to the "knuckle" of the coracoid process (ie, medial and posterior edge of the root of the process) and it is directed downward. The conoid ligament is oriented vertically and twisted on itself[25] and limits the upward movement of the clavicle on the acromion. When the arm is elevated through abduction, the rotation of the scapula causes the coracoid process to move. This way it is not only the distance between the clavicle and the coracoid process that it is increased but also the tension on the conoid ligament, thus causing a backward axial rotation of the clavicle. The clavicle has a shape resembling a crank if it is viewed from above. The coracoids process is pulled downward and away from the clavicle when scapular angulation occurs. Is then that the taut coracoclavicular ligament acts on the outer curvature of the crank-like clavicle and effects a rotation of the clavicle on its long axis. During full abduction of the arm, the clavicle rotates 50 degrees axially. This clavicular rotation permits the glenoid fossa to continue to elevate and increase the possible degree of arm elevation. The arm can be abducted actively to only 120 degrees if the clavicle is prevented from rotating[19].

The total arm movement is primarily affected by the movement of the acromioclavicular joint, which is considered to be an important component. A major role of the joint in the abduction of the arm is to permit continued lateral rotation of the scapula after about 100 degrees of abduction when sternoclavicular movement is restrained by the sternoclavicular ligaments. The acromioclavicular joint has three degrees of freedom. Thus movement can occur between the acromion and lateral end of the clavicle, about a vertical axis and a sagittal axis and around a frontal axis. Functionally there are two major movements of the acromioclavicular joint. These are a gliding movement which occurs as the shoulder joint flexes and extends and an elevation and a depression movement which occurs to conform with changes in the relationship between the scapula and the humerus during abduction[15-17]. The sternoclavicular and acromioclavicular joints have been found and proved to play essential and distinct roles in the movements of the shoulder complex.

1.2.3 Glenohumoral Joint

The glenohumeral joint is a multiaxial ball-and-socket synovial joint. The articular surfaces, the head of the humerus and the glenoid fossa of the scapula, although reciprocally curved, are oval and are not sections of true spheres. The head of the humerus is larger than the glenoid fossa and this is why only part of the humeral head can be in articulation with the glenoid fossa in any position of the joint. The joint is loose packed and the surfaces are not congruent. Full congruence and the close-packed position can be obtained when the humerus is abducted and rotated laterally. The joint can be described as an "incongruous" human joint because it has the most typical design characteristics of these joints. It has a movable axis of rotation, its surfaces are

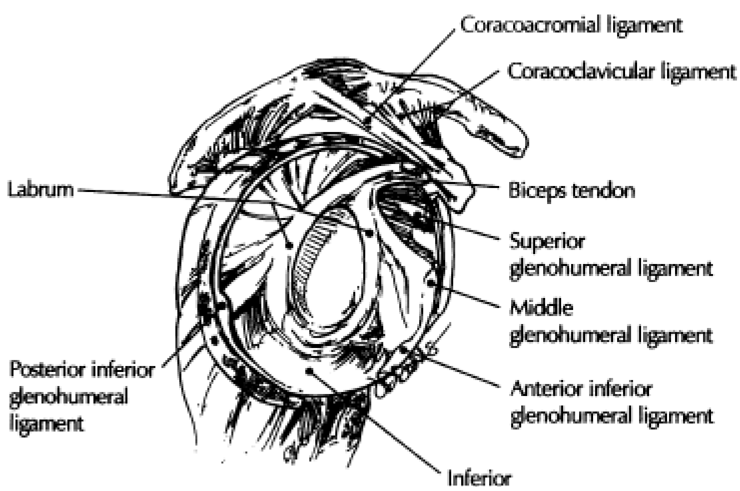


Figure 4
Cross-sectional view of the glenohumeral joint (with the humeral head removed showing the glenohumeral ligaments and associated structures. http://www.shoulderdoc.co.uk/article.asp?article=831

asymmetrical, and its muscles that are related to the joint are essential in maintaining stability of the articulation[15]. The humeral articular surface has a radius of curvature of 35 to 55 mm. The joint surface makes an angle of 130 to 150 degrees with the shaft and is retroverted about 20 to 30 degrees with respect to the axis of flexion of the elbow[20,21].

The glenohumeral joint's mismatched large humeral head and small glenoid articular surface makes the joint suitable for extreme mobility. At any given time, only 25% to 30% of the humeral head is in contact with the glenoid fossa[22]. However, despite this lack of articulating surface coverage, the normal shoulder precisely constrains the humeral head to within 1 to 2 mm of the center of the glenoid cavity throughout most of the arc of motion[23-26]. The coaction of static and dynamic forces results in this precise constraint of the center of rotation through a large arc of motion. The stabilizing effect of the articular surfaces and capsulolabral ligamentous complex is magnified by muscle forces, which produces a concavity compression effect directed toward the glenoid center[27]. Biomechanical dysfunction from injury to the bony anatomy, static capsulolabral ligamentous structures, or dynamic muscle stabilizers through a single traumatic event or a series of repetitive microtrauma results in loss of this precise constraint of the center of rotation, or instability. Glenohumeral dislocation, with or without associated fracture of the proximal humerus, is an often result of the application to the shoulder of substantial forces (such as those seen in contact sports). When fractures do occur, they commonly involve one or more of the tuberosities, which are then displaced in line with the force generated by the portion of the rotator cuff attached to that tuberosity. For example, a fracture of the greater tuberosity will be pulled superiorly and posteriorly secondary to the combined pulls of the supraspinatus, infraspinatus, and teres minor. The superior force on the humeral shaft by the deltoid and the medial force of the pectoralis major muscle can also influence the final fracture position[28].

A relatively common site of fractures in the elderly is the surgical neck of the humerus which is located just distal to the tuberosities at the level of the metaphyseal flare[29]. The incidence of proximal humerus fractures increases with age over 40 years and is considered to be related with osteoporosis[30]. The surgical neck has also been implicated as a possible factor in glenohumeral dislocation through abutment on the acromion in extreme positions, such as hyperabduction[31]. In this case, the humeral head is levered inferiorly out of the glenoid fossa[32].

1.3 Structural Contribution Mechanisms of Shoulder Stability

1.3.1 Articular Surface

The bony radius of the curvature of the glenoid is slightly flattened with respect to the humeral head. However, the glenoid articular cartilage is thicker at the periphery, thus creating significant articular surface conformity and resultant stability[33]. This articular conformity provides additionally the foundation for the concavity compression effect which is provided by the rotator cuff and the surrounding musculature. The normal glenohumeral joint contains normally less than 1 ml of joint fluid under slightly negative intra-articular pressure, which provides a suction effect to resist humeral head translation, thereby increasing stability. It is fully sealed by the capsule and in addition, adhesion and cohesion forces are created when fluid separates the two closely opposing surfaces and, thus, the surfaces cannot be pulled apart easily[34]. The contribution of these factors in stability is probably minor and functional only at low loads[35].

1.3.2 Glenoid Labrum

The glenoid labrum is located at the glenoid margin. It is a dense, fibrous structure, which is triangular on cross-section[36] and plays a central role in the extension of the conforming articular surfaces, thereby in the increase of the contact surface area, adding this way to the stability of the shoulder complex. The glenoid labrum is a rim of fibrocartilaginous tissue attached around the margin of the glenoid fossa. In contrast to some theories that support the hypothesis that the labrum deepens the articular cavity, protects the edges of the bone and assists in lubrication of the joint there are others that claim

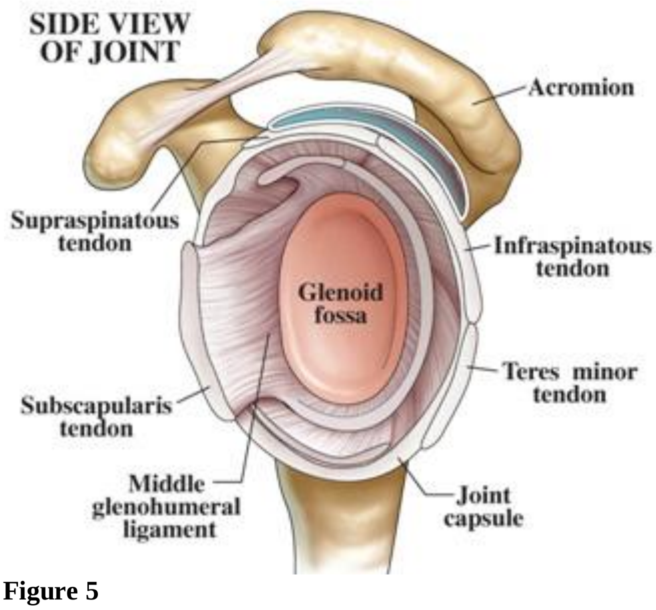


Figure 5
The anatomy of the shoulder joint from side lateral view. The humerus bone was removed showing the lateral side of the scapula bone. In this figure the glenoid process of the scapula and the labrum over it can be seen. http://www.edoctoronline.com/medical-atlas.asp?c=4&id=22157

that the labrum does not increase the depth of the concave surface substantially. Moseley and Overgaard considered the glenoid labrum as a fold of capsular tissue composed of dense fibrous connective tissue[37]. The inner surface of the labrum is covered with synovium while the outer surface is attached to the capsule and is continuous with the periosteum of the scapular neck. The shape of the labrum is formed this way so it can adapt to accommodate rotation of the humeral head, adding flexibility to the edges of the glenoid fossa. The tendons of the long head of the biceps brachii and triceps brachii muscles play a prominent role to the structure and reinforcement of the labrum. The labrum seems to represent a fold of the capsule. Its major function may be to serve as an attachment for the glenohumeral ligaments. The labrum can also enhance the stability by deepening the concavity of the glenoid socket at an average of 9 mm in the superoinferior planes and 5 mm in the anteroposterior planes[38], and loss of the integrity of the labrum (through injury) decreases resistance to translation by 20%. The labrum can also act as an anchor point for the capsuloligamentous structures[37].

1.3.3 Joint Capsule

As joint capsule is called the capsule that surrounds the joint and is attached medially to the margin of the glenoid fossa beyond the labrum. Laterally, it is attached to the circumference of the anatomical neck, and the attachment descends about a half-inch onto the shaft of the humerus. The capsule is loose fitting to the extent that the joint surfaces can be separated two to three mm by a distractive force[17]. The capsule would contribute little to the stability of the joint by itself because it is relatively thin. The reinforcement of the capsule by ligaments and the attachment of the muscle tendons of the rotator cuff mechanism is of extreme importance because both the integrity of the capsule and the maintenance of the normal glenohumeral relationship depend on it [17,20,22].

Figure 6
The capsule tightens in extreme abduction and external rotation, taking up the redundant capsule.

The superior part of the capsule is important in strengthening the superior aspect of the joint and resisting the effect of gravity on the dependent limb[39]. The coracohumeral ligament contributes also decisively in this matter. Anteriorly, the capsule is strengthened by the glenohumeral ligaments and the attachment of the subscapularis tendon while posteriorly the capsule is strengthened by the attachment of the teres minor and infraspinatus tendons. The subscapularis tendon is a major dynamic stabilizer of the anterior aspect of the shoulder. Inferiorly, the capsule is thin and weak and contributes little to the stability of the joint. This part of the capsule is subjected to considerable strain because it is stretched tightly across the head of the humerus when the arm is elevated. The inferior part of the capsule, which is considered to be the weakest area, is lax and lies in folds when the arm is adducted. These redundant folds of the capsule adhere to one another in capsular fibrosis of the shoulder. Kaltsas compared the collagen structure of the shoulder joint with that of the elbow and hip[40]. According to this study the shoulder joint capsule showed a greater capacity to stretch than to rupture when the joint capsules were subjected to a mechanical force. Another finding of the study was the fact that when the capsule was tested to failure, the structure ruptured anteroinferiorly[41]. The frequency of anterior dislocation that was observed clinically demonstrates the weakness of the inferior part of the capsule.

The movement of the glenohumeral joint is influenced by the orientation of the capsule. With the arm by the side, the capsular fibers are oriented with a forward and medial twist which has the tendency to decrease in flexion and to increase in abduction. The capsular tension in abduction compresses the humeral head into the glenoid fossa. As the process of abduction progresses, the capsular tension exerts an external rotation moment. This external rotation "untwists" the capsule and allows further abduction. The configuration of the joint capsule may assist in the external rotation of the humerus during abduction[42]. The capsule is lined by a synovial membrane attached to the glenoid rim and anatomical neck inside the capsular attachments. The tendon of the long head of the biceps brachii muscle passes from the supraglenoid tubercle over the head of the humerus and lies within the capsule, emerging from the joint at the intertubercular groove. A synovial sheath covers the tendon so as to facilitate its movement within the joint. At the point at which the tendon arches over the humeral head and the surface, on which it glides, changes from bony cortex to articular cartilage it can be said that the structure is susceptible to injury.

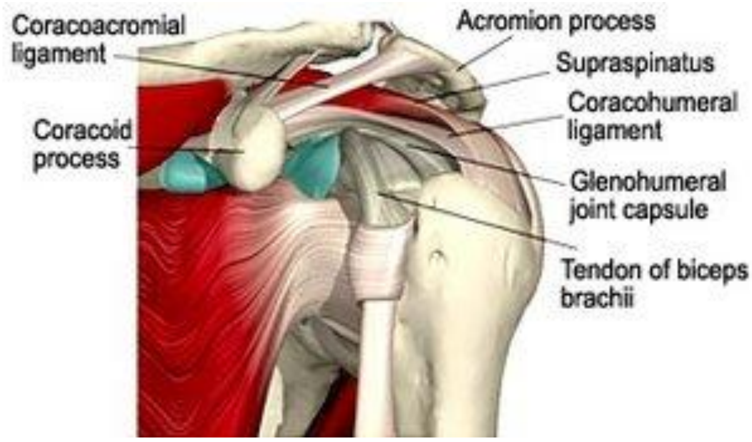
1.4 Ligaments

1.4.1 Coracohumeral Ligament

The coracohumeral ligament is attached to the base and lateral border of the coracoids process and passes obliquely downward and laterally to the front of the greater tuberosity, blending with the supraspinatus muscle and the capsule. The ligament is considerd to be one of the most important ligamentous structures in the shoulder complex. It blends with the rotator cuff and fills in the space between the subscapularis and supraspinatus muscles. In contrast to the anterior border of the ligament which is distinct medially and merges with the capsule laterally, the posterior border is indistinct and blends with the capsule.

The coracohumeral ligament is regarder to be important in maintaining the glenohumeral relationship. The superior capsule and the coracohumeral ligament counteract the downward pull of gravity on the arm. These structures function together with the supraspinatus and posterior deltoid muscles. Another use of the lateral slope of the glenoid fossa is to provide support to the humeral head. The ligament checks lateral rotation and extension. This is primarily ought to the fact that the coracohumeral ligament is located anterior to the vertical axis about which the humerus rotates axially. Shortening of the ligament would maintain the glenohumeral relationship in medial rotation and would restrict lateral rotation severely.

Figure 7
Anterior-lateral view of the shoulder showing the coracoacromial arch and tissues at risk of impingement. http://www.massagetoday.com/mpacms/mt/article.php?id=13403



1.4.2 Glenohumeral Ligaments

All three glenohumeral ligaments lie on the anterior aspect of the joint. They are frequently described as being thickened parts of the capsule. The superior glenohumeral ligament passes laterally from the upper part of the glenoid labrum and the base of the coracoid process to the upper part of the humerus between the upper part of the lesser tuberosity and the anatomical neck. The ligament lies anterior to and partly under the coracohumeral ligament and together they constitute the rotator interval region between the anterior border of the supraspinatus and the superior border of the subscapularis[43,44]. The complex consisted of the superior glenohumeral ligament, the supraspinatus muscle and the coracohumeral ligament, assists in preventing downward displacement of the humeral head[45].

The middle glenohumeral ligament is the most variable of the three glenohumeral ligaments. It has a wide attachment extending from the superior glenohumeral ligament along the anterior margin of the glenoid fossa down as far as the junction of the middle and inferior thirds of the glenoid rim. From this attachment, the ligament passes laterally, it gradually enlarges, and finally it attaches to the anterior aspect of the anatomical neck of the humerus. The ligament lies under the tendon of the subscapularis muscle and partly adheres to it. One of the most important functional roles of the middle glenohumeral ligament is to limit the lateral rotation up to 90 degrees of abduction. It is regarded as an important anterior stabilizer of the shoulder joint, particularly effective in the middle ranges of abduction[45].

Last but not least the inferior glenohumeral ligament is the thickest of the glenohumeral structures. The ligament attaches to the anterior, inferior, and posterior margins of the glenoid labrum and passes laterally to the inferior aspects of the anatomical and surgical necks of the humerus. Its anterosuperior edge is thickened and is called the superior band. While this edge is thick its inferior part is thinner and broader and is termed the axillary pouch. The superior band supports the joint most effectively in the middle ranges of abduction while moreover it strengthens the capsule anteriorly. A broad buttress-like support for the anterior and inferior aspects of the joint is provided by the inferior component of the inferior glenohumeral ligament. This part of the ligament has been proved to support the joint most effectively in the upper ranges of abduction and to also prevent anterior subluxation and dislocation[45].

1.4.3 Rotator Cuff Muscles

The subscapularis, the supraspinatus, the infraspinatus, and teres minor, comprise a group of muscles that is called the rotator cuff. These muscles act as a dynamic steering mechanism for the humeral head. The dynamic interplay between the muscles comprising the rotator cuff and the static stabilizers result in providing the humeral head with the ability to perform three dimensional movements or rotations. Humeral head rotation and depression in positions of abduction are a consequence of the rotator cuff activation. Compared to the larger, more superficial muscles such as the deltoid, pectoralis major, latissimus dorsi, and trapezius the rotator cuff muscles, as a group, have been found to be significantly smaller in cross-sectional area and size. Their lever arm is shorter, and a smaller generated force results because they lie much closer to the center of rotation on which they act. Given this anatomical location, the rotator cuff is very well situated to provide stability to a dynamic fulcrum during glenohumeral abduction.

Contraction of the rotator cuff results in concavity compression, and asymmetric contraction acts to cause humeral head rotation or "steering" during shoulder motion. Additionally, force couples occur at the glenohumeral joint in multiple planes. Force

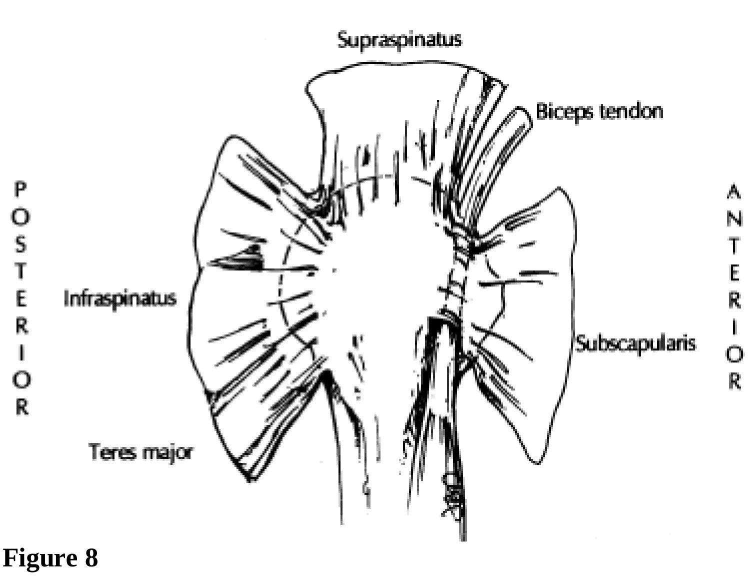


Figure 8
Sites of origin for the rotator cuff muscles.

couples occur when the resultant force of two opposing muscle groups achieves a given moment. Inman et al.[46] have found that the cephalad force of the deltoid counteracted by the inferior, or depressing, force of the subscapularis, infraspinatus, and teres minor.

The supraspinatus muscle is inserted forward and laterally at the superior aspect of the greater tuberosity while it originates from the supraspinous fossa. The tendon blends into the joint capsule and below the infraspinatus tendon. The arm elevation movement is served by the stabilization of the glenohumeral joint by the supraspinatus, along with the deltoid. Innervation is from the suprascapular nerve.

The infraspinatus initiates from the infraspinous fossa and extends laterally to its tendinous insertion on the middle facet of the greater tuberosity. Along with the teres minor, it provides the primary external rotation force. Another important contribution is its participation in the stabilization of the glenohumeral joint against posterior subluxation. Once more, innervation is from the suprascapular nerve.

In concert with the infraspinatus, the teres minor is an external rotator and glenohumeral stabilizer. It originates from the mid to the upper regions of the axillary border of the scapula and extends laterally and superiorly to its insertion on the most inferior facet of the greater tuberosity. As before innervation is from the axillary nerve.

The subscapularis muscle comprises the anterior portion of the rotator cuff. It originates from the subscapular fossa to extend laterally to its insertion on the lesser tuberosity of the humerus. The tendon of the subscapularis is intimately associated with the anterior capsule. The axillary nerve passes along the inferior border of the scapula and is, therefore, subject to trauma from anterior dislocation. The subscapularis functions as an internal rotator, especially in maximum internal rotation. In contrast to other muscles in this case innervation is both from the upper and the lower subscapular nerves.

Due to its intimately function with the rotator cuff as a humeral head depressor the long head of the biceps must also be considered here. According to Rodosky et al.[47] the contraction of the long head of the biceps during the late cocking phase of throwing can significantly reduce anterior translation and increase torsional rigidity of the joint resisting external rotation. Pagnani et al.[48] also noted that in lower elevated positions, the long head of the biceps stabilized the joint anteriorly when the arm was internally rotated and stabilized the joint posteriorly when the arm was externally rotated. An excessively strenuous throwing program can cause injuries to the long head of the biceps and superior labrum and can also produce loss of stability, decreased performance, and increasing symptoms.

1.4.4 Coracoacromial Ligament

Coracoacromial ligament is a strong triangular ligament which has a base attached to the lateral border of the coracoid process. It passes upward, laterally and slightly posteriorly, to the top of the acromion process. Superiorly, the ligament is covered by the deltoid muscle while posteriorly, the ligament is continuous with the fascia that covers the supraspinatus muscle. Anteriorly, the coracoacromial ligament has a sharp, well-defined, free border. The ligament forms an important protective arch over the glenohumeral joint together with the acromion and the coracoids processes. A secondary restraining socket for the humeral head is formed by this arch, preventing thus dislocation of the humeral head superiorly and protecting the joint from trauma from above. The supraspinatus muscle passes under the coracoacromial arch, lies between the deltoid muscle and the capsule of the glenohumeral joint, and blends with the capsule. The supraspinatus tendon is separated from the arch by the subacromial bursa.

During arm elevation in both processes of abduction and flexion, the greater tuberosity of the humerus may apply pressure against the anterior edge and the inferior surface of the anterior third of the acromion and the coracoacromial ligament. The impingement also may occur against the acromioclavicular joint in some instances. The position of the hand in front of the shoulder and not lateral to it is the way that the most upper extremity functions are performed. This is agreement with the fact that the shoulder is used most frequently in the forward and not the lateral position. The supraspinatus tendon passes under the anterior edge of the acromion and the acromioclavicular joint when the arm is raised forward in flexion. The critical area, for performing this movement, for wear is centered on the supraspinatus tendon and it can also involve the long head of the biceps brachii muscle[49,50].

1.5 Bursae

Several bursae are found in the shoulder region[17]. As far as the clinician is concerned there are two bursae particularly that are important: the subacromial and the subscapular bursae[23]. The other bursae, which are located in relation to the glenohumeral joint structures, are between the infraspinatus muscle and the capsule, on the superior surface of the acromion, between the coracoid process and the capsule, under the coracobrachialis muscle, between the teres major and the long head of the triceps brachii muscles, and in front of and behind the tendon of the latissimus dorsi muscle. Bursae have a major function in the shoulder mechanism because they are located where motion is required between adjacent structures. The subacromial bursa is located between the deltoid muscle and the capsule. It extends from under the acromion and the coracoacromial ligament and between them and the supraspinatus muscle. The bursa adheres to the coracoacromial ligament and to the acromion from above and to the rotator cuff from below. Eventhough the bursa does not usually communicate with the joint, a communication may be developed if the rotator cuff is ruptured. The subacromial bursa has been found to be important for allowing gliding between the acromion and the deltoid muscle and the rotator cuff while it plays a central role in the reduction of friction on the supraspinatus tendon as it passes under the coracoacromial arch[20].

The subscapular bursa protects the subscapularis tendon where it passes under the base of the coracoid process and over the neck of the scapula. It lies between this tendon and the neck of the scapula. The bursa communicates with the joint cavity between the superior and middle glenohumeral ligaments[20].

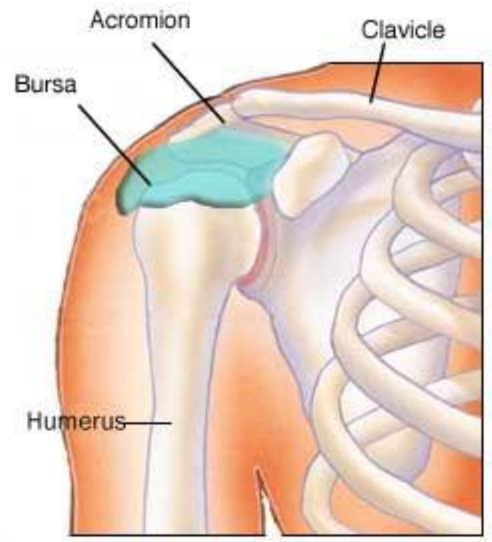


Figure 9
Bursa's are small fluid filled sacs that help to cushion and protect the area in between the bones, tendons and muscles around your joints. Bursa's help to reduce the tension between the bones which allows you to move your joints freely and effortlessly. These many bursa's can be found in pretty much every major joint in your body but the most common areas are the shoulders, elbows, and knees. http://bursitisshoulder.org/

2. Movements of the Shoulder Complex

The design of the shoulder complex has been made in order to provide the upper limb with an extensive range of movement. Its design characteristics enable the hand to function effectively in front of the body in the visual work space[51]. All four joints of the shoulder complex contribute to total arm movement i.e. the glenohumeral, the acromioclavicular, the sternoclavicularand the scapulothoracic.

2.1 Movement of the Humerus and Scapula

The displacement of the articular surfaces at the glenohumeral joint are considered as movements of a convex ovoid surface relative to a concave ovoid surface. The articular humeral head can roll, slide, and spin and the multiaxial design of the glenohumeral joint permits an infinite variety of combinations of these movements[17]. It should be noted that the rolling occurs in a direction opposite that of the sliding. The joint is considered to permit the movements of flexion-extension, abduction-adduction, circumduction, and medial-lateral rotation[17]. Displacement of a reference point of the convex ovoid surface relative to the concave ovoid surface is amplified by the distal end of the extremity in the movements of the glenohumeral joint. This can be interpreted that all possible displacements of the distal end of the upper extremity do occur in a curved segment of space which is termed the ovoid of motion or field of motion. The shortest distance from one point to another on an ovoid surface is termed a chord, and the shortest displacement is a cardinal displacement. At the glenohumeral joint spin or axial rotation is involved when two cardinal displacements occur one after the other at a right angle. This is regarded as an important feature of glenohumeral joint movement.

The mechanical midposition of the glenohumeral articulationoccurs in the frontal plane when the arm is elevated 45 degrees midway between flexion and abduction with slight medial rotation, when the center of the humeral head is in contact with the center of the glenoid fossa[52]. The position of the best fit when the joint is in the close-packed position, however, occurs in full abduction with lateral rotation. The lateral and forward direction of the glenoid fossa is determined by the position of the scapula. The plane of the scapula is 30 degrees to 45 degrees anterior to the frontal plane. Movements of the humerus in relation to the glenoid fossa can be described in relation to the frontal and coronal planes or in relation to the plane of the scapula[53]. When movements are performed in relation to the scapula the glenohumeral structures are in a position of optimum alignment. Some authors have suggested that "true abduction" of the arm occurs not in the frontal plane but rather in the plane of the scapula. In the plane of the scapula, the capsule is not twisted, and the deltoid and supraspinatus muscles are aligned optimally for elevating the arm.

The mechanism of elevation of the arm is quite complex as it includes both glenohumeral and scapulothoracic movement. These components are important to consider when studying this mechanism. Poppen and Walker stated that, in the relaxed position with the arm by the side, the long axis of the humerus makes an angle from the vertical plane of 2.5 degrees with a range from -3.0 to 9.0 degrees.32 The angle between the face of the glenoid fossa and the vertical plane, the scapulothoracic angle, ranges from -11.0 to 10.0 degrees[54,55].

The scapula moves only slightly when compared with the humerus, especially when compared within the first 30 degrees of arm abduction. The same researchers reported a ratio of 4.3:1 for glenohumeral to scapulothoracic movement. Within this same range, the humeral head moves upward on the face of the glenoid fossa by about 3 mm. As abduction progresses, the glenoid fossa moves medially, then tilts upward, and finally moves upward as the arm approaches full elevation. The scapula rotates from 0 to 30 degrees about its lower midportion while after 60 degrees, the center of rotation shifts toward the glenoid fossa[54].

Poppen and Walker stated that lateral rotation of the scapula is accompanied by a counterclockwise rotation of the scapula, when abduction of the arm is viewed from the side. This movement occurs about a frontal axis and during its process the coracoid process moves upward while the acromion moves backward. The mean amount of this twisting is 40 degrees at full elevation. In this movement, the inferior angle moves into the body in contrast to the superior angle of the scapula which moves away from the body wall. This motion is important functionally when considered together with the lateral rotation of the humerus during abduction of the arm. As the humerus itself rotates laterally it occurs the counterclockwise rotation of the scapula, during which the acromion process moves backward. Due to the need of the relative amount of rotation between the two bones to be small the humerus and scapula move synchronously. Lateral rotation of the humerus in relation to the scapula is essential, however, because it allows the greater tubercle to clear the acromion, thus preventing impingement. The lateral rotation is a function of the activity of the infraspinatus and teres minor muscles and of the possible force of the twisting of the glenohumeral capsule[56]. If the arm is rotated medially, only 60 degrees of glenohumeral movement is possible either passively or actively.

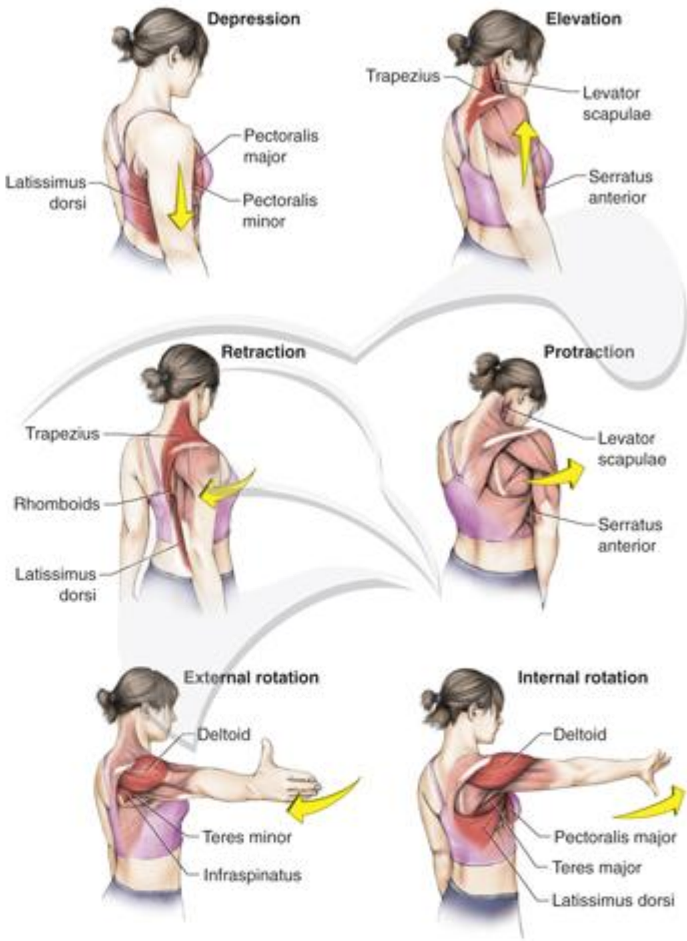


Figure 10
The movement of body structures is accomplished by the contraction of muscles. Muscles may move parts of the skeleton relatively to each other, or may move parts of internal organs relatively to each other. All such movements are classified by the directions in which the affected structures are moved. In human anatomy, all descriptions of position and movement are based on the assumption that the body is its complete medial and abduction stage in anatomical position. All motions are considered to be a mixture of or a single contribution by the following types of movement. Flexion is the bending movement that decreases the angle between two parts while extension is the opposite; a straightening movement that increases the angle between body parts.
http://www.quailridgestudios.com/med3.html

The rotation of the clavicle and the scapula about an imaginary axis extending from the sternoclavicular joint to the root of the spine of the scapula characterizes the movement of arm abduction after 30 degrees. The root of the spine is stationary relatively despite the fact that the clavicle and the scapula move together. This design provides to the shoulder girdle considerable stability. This movement of the scapula and the clavicle continues until the the costoclavicular ligament becomes taut at about 100 degrees of elevation, rendering impossible any further movement of the sternoclavicular joint about the sternoclavicular root of the spine axis. Becoming the center of rotation is the only option for the scapula-clavicle link is for the acromioclavicular joint because the scapula has to continue to rotate laterally. In this movement, the root of the spine of the scapula moves laterally while it is generally stationary.

The acromioclavicular joint stops to move when the trapezoid ligament becomes taut, as the arm approaches full elevation. After this action, the scapula and the clavicle again move as a single unit. During this range of abduction, the clavicle rotates about its long axis. This crankshaft rotation is imposed on the clavicle by the tension of the coracoclavicular ligament. Glenohumeral and scapulothoracic joint movements occur simultaneously and contribute to elevation of the arm after the initial 30 degrees of abduction. The ratio of glenohumeral to scapulothoracic motion is reported as 1.25:1,32 1.35:1,33 2:1,7 and 2.34:1.34. The ratio of glenohumeral to scapulothoracic motion may vary with the plane and arc of elevation, the load on the arm, and the anatomical variations among individuals[57].

To sum up it can be said the initial 30 degrees of arm abduction are essential to the result of glenohumeral motion. From 30 degrees up to full arm abduction, the movement occurs mainly at the scapulothoracic and glenohumeral joints. The movement of the sternoclavicular and acromioclavicular joints results in the movement of the scapula. Approximately 40 degrees of the total range of abduction are the product of sternoclavicular motion, and 20 degrees the contribution of the acromioclavicular joint. A similar relationship occurs if the arm is elevated through flexion. Medial rotation of the humerus accompanies shoulder flexion[58].

Viewed from above, at rest, the scapula makes an angle of 30 degrees with the frontal plane and an angle of 60 degrees with the clavicle[59]. The result of this movement is the direction of the glenoid fossa forward and laterally. The position of the scapula against the chest wall is critical in providing a stable base for movements of the upper limb. The scapulothoracic relationship is not that of a true joint, but is the contact of the anterior surface of the scapula with the external surface of the thorax. The anterior surface of the scapula is concave and corresponds to the convex thoracic curvature. The scapula is retained in place principally by the muscle masses that pass from the axial skeleton to the scapula: the trapezius, serratus anterior, rhomboid major and minor, and levator scapulae muscles[60]. The movements of the scapula are related essentially to the functional demands of the upper limb and to the requirements for positioning and using the hand. Movements of the scapula, when considered primarily as movements of the scapulothoracic relationship, are elevation, depression, protraction, retraction, and medial and lateral rotation.

3. Shoulder Biomechanics

3.1 Forces Acting On The Shoulder

During daily function significant loads are applied to the joint eventhough the glenohumeral joint is frequently referred to as nonweight bearing. The exact amount of compression forces at the shoulder varies between the different calculations among investigators and range from 50% to over 90% of body weight[61]. In most joints, passive forces from ligaments and joint surfaces contribute more stability than at the shoulder where equilibrium of the humeral head is achieved largely through interaction of active forces[62,63].

Poppen and Walker after considering the various muscles as active in each phase of abduction, they calculated then the compressive, shear, and resultant forces at the glenohumeral joint[64]. According to their findings the resultant forces increased linearly with abduction until they reached a maximum of 0.89 times body weight at 90 degrees. After 90 degrees of abduction, the resultant force started to decrease until it was decreased to 0.4 times body weight at 150 degrees of abduction. The shearing component up the face of the glenoid fossa was a maximum of 0.42 times body weight at 60 degrees of abduction. At 0 degrees, with the arm by the side, the humeral head was subluxating downward while from 30 to 60 degrees, the resultant force was close to the superior edge of the glenoid fossa, indicating a tendency to subluxate upward. Later on the head of the humerus was compressed directly into the center of the glenoid fossa. Poppen and Walker concluded that lateral rotation provides greater stability than medial rotation. They based their conclusion on the theory that inherent joint stability in the scapular plane increases the closer the force vector is to the center of the glenoid fossa.

A muscle that acts on the humerus must function together with other muscles to avoid producing a subluxating force on the joint. This is ought to the glenohumeral joint potentially instability. The multiple joint system of the shoulder is so complex that it requires that some muscles may span, and so influence, more than one joint. Moreover the relative positions of the bones do influence the muscle function. It is evident that the influence a muscle will have on the joints will vary throughout the range of shoulder movement.

The abduction of the humerus cannot be performed without the essential motor components; the deltoid muscle and the rotator cuff mechanism. The force of elevation, together with the active downward pull of the short rotator muscles, establishes the muscle force couple necessary for elevation of the limb. When the arm is by the side, the direction of the deltoid muscle force is upward and outward with respect to the humerus, whereas the force of the infraspinatus, teres minor, and subscapularis muscles is downward and inward. The force of the deltoid muscle, acting below the center of rotation, is opposite to that of the force of the three short rotator muscles, which is applied above the center of rotation. These forces act in opposite directions on either side of the center of rotation and produce a powerful force couple. The magnitude of the force required to bring the limb to 90 degrees of elevation is 8.2 times the weight of the limb. After 90 degrees, the force requirement decreases progressively, reaching zero at 180 degrees. At 60 degrees of abduction, at which time the force requirements are 9.6 times the weight of the limb, the force requirements of the short rotator component of the muscle force couple reach the maximum. After 90 degrees, the magnitude of the force decreases rapidly, reaching zero at 135 degrees.

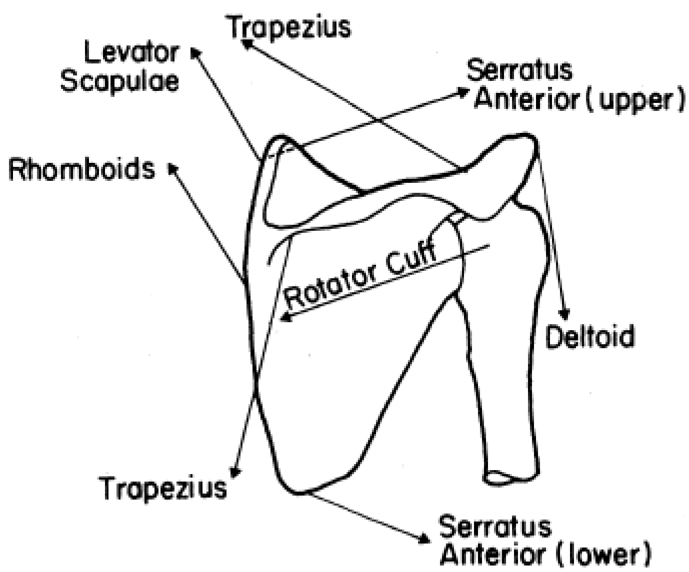


Figure 11
The major muscle forces acting on the shoulder girdle.
http://www.upstate.edu/cdb/education/grossanat/limbs3.shtml

The pull of the deltoid muscle forces the humerus more directly into the glenoid fossa during the progress of abduction. In higher ranges, the pull of the deltoid muscle forces the head of the humerus downward. The rotator cuff, including the supraspinatus muscle, can produce abduction of the arm with 50% of normal force if the deltoid muscle function is completely lost. In the case of absence of only the supraspinatus muscle, provided the shoulder is pain free, in the higher ranges of abduction a marked loss of force is produced. The force in abduction is lost rapidly, and when 90 degrees of combined humeral and scapular motion are reached, the weight of the arm only barely can be lifted against gravity.

The stabilization of the glenohumeral articulation during abduction is also assisted by the long head of the biceps brachii. The tendon of the biceps brachii muscle has a pulley-like relationship with the upper end of the humerus, and it exerts a force downward against the humeral head. The long head of the biceps brachii muscle functions as a pulley to assist in abduction of the arm if the arm is rotated laterally so that the bicipital groove faces laterally.

3.2 Force Equilibrium Of Rotator Cuff Muscles

The intrinsic rotator cuff muscles, thus the subscapularis, the infraspinatus, the teres minor, and the supraspinatus are active during abduction and lateral rotation[65]. The teres minor and the infraspinatus muscles are often considered as a single unit when the subject studied is the influence of these muscles on the glenohumeral joint. Morrey and Chao described an equilibrium analysis of glenohumeral forces that was based on three notions: 1) Each muscle acts with a force in proportion to its cross-sectional area, 2) each muscle is equally active, and 3) the active muscle contracts along a straight line connecting the center of its insertion to the center of its origin[66].

When the arm is abducted to 90 degrees and in lateral rotation the three-dimensional equilibrium configuration is shaped as follows: a compressive force of 70 kg, an anterior shear force of 12 kg and finally an inferior shear force of 14 kg. The resultant of the three forces is directed 12 degrees anteriorly. The primary rotator cuff muscle responsible for preventing anterior displacement of the humeral head is the subscapularis muscle. The anterior shear force can be increased up to almost 42 kg if the shoulder is extended backward 30 degrees in 90 degrees of abduction and is loaded so that all the rotator cuff muscles are contracting maximally. This force must be counteracted by the capsule and ligaments because the articular surfaces provide little stabilizing effect. The tensile strength of the ligament complex and the capsule averages 50 kg. The combined tensile strength of the anterior structures is about 120 kg when the subscapularis muscle is added to the capsule and ligaments[66].

There are several factors which are related to the forces acting on the glenohumeral joint and as the limb assumes different positions the relationship of these forces alters. The principal factors influencing the nature and degree of the glenohumeral forces are:

- The articular surfaces
- The deltoid muscle,
- The supraspinatus muscle
- The weight of the arm
- The rotator cuff muscles
- The capsule and ligaments
- The position of the arm

3.3 Scapulothoracic Forces

All muscles connecting the scapula with the axial skeleton except for the upper fibers of the trapezius and pectoralis minor muscles are inserted near or on the medial border of the scapula. These include the upper and lower digitations of the serratus anterior muscle, the rhomboid major and minor muscles, the levator scapulae muscle, and the lower fibers of the trapezius muscle. A consistent mechanical pattern can be noticed if the forces and moments developed about the base of the scapular spine during the early stages of abduction of the arm are considered. The major influence of the upper fibers of the serratus anterior muscle and the abduction force applied to the scapula by the rotator cuff muscles are balanced by the rhomboid, levator scapulae, and lower fibers of the trapezius muscles. This way the root of the spine of the scapula, which is the center of rotation for movement up to 100 degrees of abduction, is stabilized.

The principal source of activity lies in the lower part of the serratus anterior muscle while rotation of the scapula progresses past this point. The upper part of the trapezius muscle primarily opposes the pull of the deltoid muscle, and it has limited influence on scapular rotation. In addition to upwardly rotating the scapula the serratus anterior muscle is an essential factor in stabilizing the scapula in the early phase of abduction. The lower fibers of the serratus anterior muscle are oriented to exert moments effectively about both the root of the scapular spine and the acromioclavicular joint during the initial and later phases of abduction. The longest moment arm of the relevant muscles belongs to the serratus anterior muscle while its reduced activity has been demonstrated in both neurological and soft tissue lesions affecting the shoulder complex[67-69]. While few are known regarding the passive and viscoelastic forces that influence movement and position of the skeletal component, the influence of the scapulohumeral, axioscapular, and axiohumeral muscles of the shoulder complex has been extensively studied[70].

4 Supraspinatus Tendon

Rotator cuff pathology is a significant cause of morbidity and disability particularly in the middle-aged and elderly population[71-77]. Up to date there is an incomplete understanding of the structure and functional anatomy of the normal supraspinatus tendon which results in poor comprehension of the etiology of cuff pathology. According to gross and microscopic dissections, there are four structural subunits within the supraspinatus tendon. The following associated structures were identified: tendon proper, attachment fibrocartilage, rotator cable, and capsule. The tendon proper extended from the supraspinatus musclo-tendinous junction to the attachment fibrocartilage. It enlarged and broadened towards the distal attachment manifesting as a thick, 'rope-like' structure in the anterior tendon and a thin 'strap-like' region that spread posteriorly, creating a broad point of attachment. The internal structure of the tendon proper consisted of collagen bundles, grouped as fibers and fascicles, running parallel to the axis of tension. The fascicles are separated by a thick endotenon region that stained prominently with alcian blue, indicating thepresenceof negatively charged GAG[78]. The loose connective tissue of the endotenon was a soft meshwork that allowed the fascicles to easily be separated and maneuvered. When fascicles in cross-sections of the tendon proper were manipulated with microdissection instruments under the stereomicroscope, the stout, solid fascicles slid past one another, and the

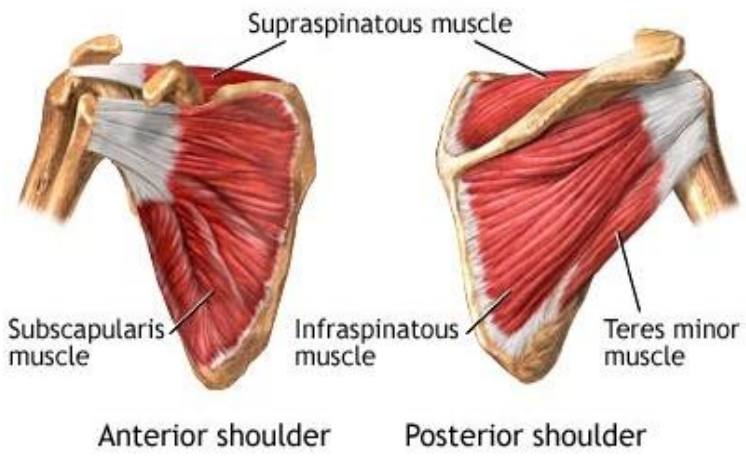


Figure 12
The supraspinatus is a relatively small muscle of the upper arm that runs from the supraspinatous fossa superior of the scapula (shoulder blade) to the greater tubercle of the humerus. It is one of the four rotator cuff muscles and also abducts the arm at the shoulder. The spine of the scapula separates the supraspinatus muscle from the infraspinatus muscle, which originates below the spine. http://spectrumwellness.net/shoulder-pain/

motion occurred in the region of the alcian blue staining endotenon. As the collagen network converted from the fascicular structure of the tendon proper to thebasket-weave of the attachment,fibrocartilageit appeared to compress and reorganize. This process originated in the thick anterior portion of the tendon proper, occurring closer to the bony attachment in the thinner, posterior regions.

The attachment fibrocartilage of the supraspinatus extended from the tendon proper to the greater tuberosity. This region encompassed the “critical zone” described by Codman where tears are often seen[79-80]. The collagenous ultrastructure of the fibrocartilage was a basket-weave of undetectable pattern with diffuse alcian blue staining, histologically resembling fibrocartilage subject to compression.

Rotator Cable. The rotator cable has been observed to be the thicker, the deeper one of the two extensions of the CH ligament into the supraspinatus structure. The first projection of the CH ligament is a thin layer of tissue enveloping the superior border the tendon proper. The second contribution of the CH ligament to the supraspinatus extends perpendicular to the axis of the tendon proper, deep to the tendon and superficial to the joint capsule. This thick collagenous strap traverses the tendon proper and extends into the infraspinatus tendon. It surrounds the fibrocartilage and the area correlating with the critical zone.

The joint cupsule is a thin collagenous structure that lines the articular surface of the rotator cuff. The capsule is a composite of thin collagen sheets; each individual sheet having a uniform fiber alignment, which differed slightly between sheets, combining to form a tough structure of varying fiber orientation. The capsule becomes inseparable from the attachment fibrocartilage just medial to the point of attachment to the greater tuberosity. The capsule and the infraspinatus tendon remain distinct structural entities until close to the point of attachment, where the entire rotator cuff becomes a solid structure, in the vicinity of the supraspinatus tendon.

An additional area of interest is the rotator interval (the region between the supraspinatus and subscapularis). It is a thick, soft, collagenous tissue that is well vascularized. It serves as the connection between the supraspinatus and subscapularis tendons and stains heavily with alcian blue. Its structure has been observed to be solid and porous. The deposit is 4-6 mm in thickness with no consistent shape, and is confined to the area abutting the tendon proper of the supraspinatus.

4.1 Supraspinatus Disorders

It has been described that the supraspinatus tendon passes through a narrow tunnel below the scapular spine. A bony overgrowth or calcification of the ligament above this tunnel may hamper the smooth movement of the tendon while constant friction on the tendon leads to inflammation known as supraspinatus tendonitis and causes pain during shoulder movements. This painful phase is usually resolved spontaneously and the tendon injury may last for about a week or two. However, persisting friction may result in tendon degeneration known as supraspinatus tendinosis. Tendinosis is a patholigc condiotion that weakens the tendon, but the patient often does not feel any pain and continues to use the shoulder. As a result the most often outcome of this condition is a supraspinatus tendon tear (partial thickness tear or full thickness tear). Since the function of the supraspinatus muscle is partly compensated by the other shoulder muscles, lifting the arm is still possible even after a complete supraspinatus tendon tear. This fact is the cause why a supraspinatus tear may not as obvious and thus not imminently diagnosed as other tendon tears, for example, Achilles tendon tear. A supraspinatus tear is insidious and may be missed altogether by the patient.

4.2 Diagnosis Methods

4.2.1 History

One of the most important piece of information so as to make the diagnosis is the patient's medical history. Physical examination and diagnostic studies should be used to confirm the diagnosis. Many patients may not be able to pinpoint a specific event, unlike acute tendon injuries, although they are often able to say when the pain began becoming a problem for them. Valuable information can be provided by discussing with the patient the course of events since the onset of symptoms, emphasizing on the activities that seem to make the pain worse and on those which seem to relieve the pain.

4.2.2 Physical Examination

The physical examination includes inspection, palpation and functional examination while a good knowledge of musculoskeletal anatomy and biomechanics is essential to establish the correct diagnosis.

4.2.3 Diagnostic Studies

X-rays are primarily useful for the identification of associated bony abnormalities, such as Haglund's deformity, or calcifications in the area of the tendon, such as in rotator cuff tendinitis or occasionally in jumpers' knee. Arthrography is primarily useful for diagnosis of complete rotator cuff tears with an accuracy rate of up to 99%. Arthrography is much less accurate for partial thickness rotator cuff tears (67%). Ultrasound is reported to be a commonly used method in Europe for visualizing tendon pathology. It is safe, non-invasive, easily obtainable and inexpensive. Ultrasound can be used in the office and gives immediate results. The primary disadvantages are that ultrasound is operator dependent, has limited soft tissue contrast and is not as sensitive as MRI. MRI is at this time the gold standard for visualization of tendon pathology. MRI provides both high intrinsic tissue contrast and high spatial resolution. This allows exact identification of the structure of interest by its anatomic site as well as providing the ability to differentiate normal tendon from adjacent abnormal tendon. Through the use of MRI it is possible to evaluate not only the location of the injury, but also the extent.

4.3 Suprasinatus Tendonitis

According to Wolf[83] there are two pathways causing shoulder tendinitis and ultimate rotator cuff tear: the impingement syndrome, which occurs primarily in the over 40 age group, and the traction overload tendinitis, in the younger athletic population. Impingement syndrome is caused by impingement between the structures in the subacromial space including the cuff, the subacromial arch including the coracoacromial ligament, the subacromial bursa, which can become very thick, and the biceps tendon.

The rotator cuff functions to hold the humoral head centered within the glenoid fossa preventing impingement that could occur if the head were to ride partially out of the glenoid. This is the mechanism by which instability can cause symptoms that may mimic impingement. Rotator cuff tendonitis refers to inflammation of the rotator cuff muscles (most commonly the supraspinatus tendon), followed by the infraspinatus tendon. Tendonitis is usually the result of repetitive lifting of the arm above the head, trauma, or shoulder instability. The primary causes of tendonitis in the younger patient are improper athletic activity, poor muscular conditioning, eccentric overload, and glenohumeral instability. In the middle aged and elderly patient tendonitis can be more insidious. Activities as those that require internal rotation of the arm, overhead reaching, or abduction of the arm are those that patients typically report pain with. Pain is usually located in the lateral deltoid region and may have a mild radicular component. Patients frequently complain of symptoms at night, causing them to sleep on the contralateral side. Physical examination reveals pain with abduction over 90 degrees. At this point the patient will often substitute scapulothoracic motion for glenohumeral motion and can be seen to 'hunch' the affected shoulder up in order to abduct the arm. The pain is often worse as the arm is lowered than when it is going up. The subacromial space can be confirmed as the source of the pain by injecting local anesthetic into the subacromial space. If there are sufficient intact anterior and posterior fibers of the rotator cuff the arm can still be fully abducted despite a complete tear of the supraspinatus.

Physical findings include limited abduction between 70–120°. Pain is reproducible with deep palpation of the lateral deltoid, just inferior to the acromion process. Muscle atrophy may be noted in longstanding cases. Provocation tests mentioned above can confirm the tendonitis; therefore, the diagnosis can be made on the initial presentation in most cases[84]. The diagnostic study of choice for rotator cuff problems is MRI. In athletes symptoms are more commonly due to partial tears or degenerative areas in the rotator cuff. An MRI arthrogram will provide information about other structures that can cause similar symptoms.

Initial management of tendonitis involves rest and modification of activities. Physical therapy with modalities so as to help decrease the discomfort and allow stretching and exercise is the main treatment for shoulder tendinitis. The goal should be to restore symmetry between the two arms with respect to (a) range of motion, especially internal rotation which is commonly decreased on the affected side; (b) quality of motion, with decreased scapulothoracic substitution; (c) strength, with emphasis of strengthening the rotator cuff to hold the humoral head centered within the glenoid and strengthening the periscapular muscles to provide a stable base for glenohumeral motion and to move the coracoacromial arch away to prevent impingement. The vast majority of patients will have progressive relief of their symptoms with such a program. Patients should be encouraged to continue performing the exercises and stretch even after the symptoms disappear in order to avoid recurrence. Nonsteroidal anti-inflammatory drugs (NSAIDs) are commonly used to reduce inflammation and provide analgesia. Once symptoms have improved, the next step is to strengthen the rotator cuff muscles through the use of exercises that involve internal and external shoulder rotation. In order to stabilize the humeral head and prevent approximation of the humerus and the acromion process a strengthening program should be applied. Exercises should be performed slowly and smoothly with low resistance. Exercise has been shown to be effective in short-term recovery and long-term improvement in function[85].

If conservative measures have been unsuccessful, corticosteroids may be of small benefit; the results are best in the short term[86]. A larger, more recent meta-analysis has shown benefit from subacromial corticosteroid injections for up to nine months[87]. This review also reported that corticosteroid injections, when compared with NSAIDs, had a number needed to treat to show benefit of 2.5. There is insufficient evidence to suggest that intra-articular steroids are effective for supraspinatus tendonitis while the dose and frequency of steroid use are areas that remain uncertain. Referral to an orthopedic surgeon should be reserved for those with significant pain and disability who have failed 6 months of nonoperative therapy, or those who have a history of shoulder instability[88].

4.4 Supraspinatus Tear

The final outcome of a common pathway involving both intrinsic and extrinsic causes is most likely the pathogenesis of rotator cuff tears. Intrinsic causes include agerelated metabolic and vascular changes leading to degenerative tearing and differential shear stress within the tendon leading to intratendinous tears[89-92] while the extrinsic ones contain subacromial impingement, glenohumeral instability, internal impingement, acute traumatic events, and repetitive microtrauma[93-97].

Age-related degenerative changes have been shown in the rotator cuff and are likely irreversible. Lohr and Uhthoff have shown that in degenerative rotator cuff tears decreased cellularity, fascicular thinning and disruption, accumulation of granulation tissue, and dystrophic calcification are usually found. A zone of relative hypovascularity is found on the articular surface of the rotator cuff lateral to the rotator cable, extending to within 5 mm of the cuff insertion[98-100].

The 5-layer histologic structure of the rotator cuff also lends itself to differential shear stresses within the tendons[101-105]. Nakajima et al[103] found the articular side of the rotator cuff to be composed of an array of tendon, ligament, and capsular tissue. This less uniformly arranged composition is less tolerant of deformation and shows approximately half the ultimate stress to failure as that of the bursal side. According to Bey et al[101] partial-thickness articular surface tears increase intratendinous strain at angles of abduction greater than 15^0. Similar findings of increased strain and tear propagation resulting from partial-thickness tearing have been also shown by both Reilly et al[104] and Yang et al[105].

The extrinsic theory of subacromial impingement as a progressive spectrum of cuff tendinopathy resulting from impingement of the rotator cuff against subacromial osteophytes or the coracoacromial ligament was proposed by Neer. Although this theory is biologically plausible, conclusive support in the literature is not to be found. 200 cadaveric shoulders were examined by Ozaki et al[106]. A lesion in the anterior one-third of the undersurface of the acromion that was always associated with a bursal-sided tear was found. However, the undersurface of the acromion was almost always intact in articular-sided tears. Schneeberger et al[107] created iatrogenic impingement in rats and found exclusively bursal-sided tears.

Extrinsic causes of partial-thickness rotator cuff tears are not limited to subacromial impingement but include microinstability, repetitive microtrauma, acute events, and internal impingement. The posterosuperior glenoid and the articular surface of the rotator cuff at the supraspinatus-infraspinatus interval appear to be in contact as an Internal impingement is described most commonly in the overhead athlete[108-110] and is influenced by anterior instability, posterior capsular tightness, decreased humeral retroversion, poor throwing mechanics, and finally scapular dyskinesis. Pain and stiffness of the affected shoulder is often reported by patients. Nocturnal pain and pain exacerbated by overhead activity are common but not

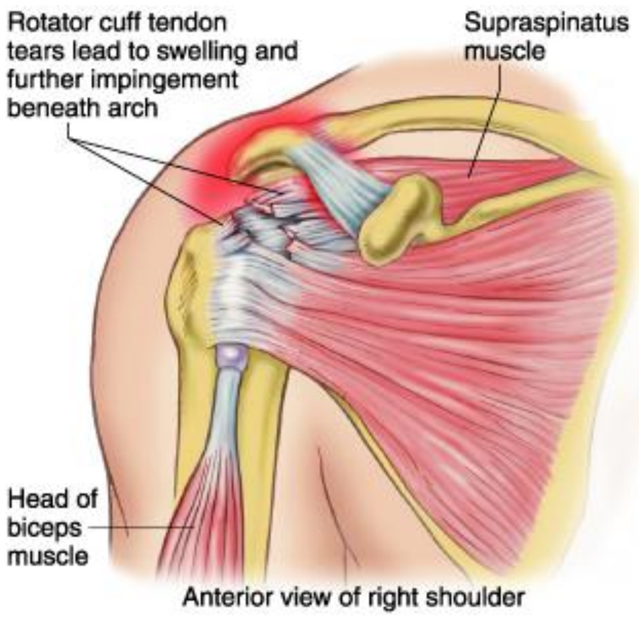


Figure 13
A rotator cuff injury can include any type of irritation or damage to the rotator cuff muscles or tendons. Rotator cuff tears are among the most common conditions affecting the shoulder. The tendons of the rotator cuff, not the muscles, are most commonly torn. Of the four tendons, the supraspinatus is most frequently torn. The tear usually occurs at its point of insertion onto the humeral head at the greater tubercule
http://danvillecapainrelief.com/conditions-treated/rotator-cuff-injury-shoulder-pain

specific for partial thickness tearing. The physical examination often elicits a painful arc, positive impingement signs, and real or apparent weakness with rotator cuff strength testing. Signs of unidirectional or multidirectional instability should be pursued when one is evaluating the overhead athlete with complaints of shoulder pain and should definitely not be overlooked.

The initial evaluation of the patient with shoulder pain and dysfunction should always include a complete series of plain radiographs of the shoulder. Radiographs are necessary to evaluate other causes of shoulder pain and to assess acromial morphology although these are rarely helpful in making the specific diagnosis of a rotator cuff tear. The imaging modalities of choice for most clinicians and investigators are ultrasonography (US) and MRI. Recent advances in MRI, specifically sequence alteration, contrast arthrography, and differential arm positioning, have greatly improved its accuracy in identifying rotator cuff pathology. The abduction external rotation view has been shown to improve visualization of intratendinous tears when combined with magnetic resonance (MR) arthrography[111].

If the patient suffers from a partial-thickness rotator cuff tear, a trial of nonoperative treatment is a reasonable treatment option. Activity modification with the avoidance of provocative activity and the judicious use of nonsteroidal anti-inflammatory medications should be included in this approach. Supervised physical therapy regimen is also advised to reestablish or maintain normal shoulder dynamics including attention to capsular stretching. Strengthening exercises focusing on the rotator cuff and periscapular musculature should be initiated only when pain is decreased and motion is improved.

As far as the overhead athlete is concerned, particular attention should be paid to the kinetic chain and the institution of an interval throwing program as symptoms dictate. Unfortunately, the available literature lacks high-quality evidence evaluating the efficacy of subacromial corticosteroid injections for the treatment of partial-thickness rotator cuff tears while there are no standardized, long-term follow-up studies evaluating the clinical outcomes of patients with partial-thickness rotator cuff tears treated non-operatively. Improvement of symptoms with appropriate nonoperative treatment measures is considered to be possible eventhough available basic science indicates that tears progress with time. Operative intervention should be considered however, if the patient is not satisfied with his or her outcome after 6 to 12 months of dedicated nonoperative treatment. The clinician should always bear in mind the overall constellation of symptoms and their improvement with time, as well as the patient's activity level and concomitant shoulder pathology. Surgical intervention is generally limited to tear debridement with or without acromioplasty or tear repair with or without acromioplasty. When involving 50% or more of the tendon thickness repair of tears is in general recommended. Acute traumatic tears, bursal-sided tears, and tears in the more physically active patient are the primary indications for tear repair.

5 Shoulder Arthroscopy

Arthroscopy has emerged as the gold standard for the evaluation of the rotator cuff, the subacromial space, and the glenohumeral joint itself. The past decade has seen advances in arthroscopic skills such that many shoulder surgeons repair all rotator cuff tears with arthroscopic techniques, and a growing number of orthopedic surgeons in general are treating simple rotator cuff tears with "minimally invasive" procedures. As we progress in both our learning and our teaching, the gold standard for the treatment of rotator cuff pathology will likely become arthroscopic repair. Early reports of all-arthroscopic repairs have been encouraging in demonstrating consistency in technique and excellent clinical outcomes. Thus, it is important to recognize the advantages of arthroscopic evaluation and repair of the rotator cuff, and also to be aware of the possible pitfalls and how they can be avoided with meticulous attention to technique.

Because an increasing number of surgeons have developed the skills necessary to perform these operations, the pioneers of shoulder arthroscopy have amassed sufficient experience to document the success of arthroscopic rotator cuff repair. In the last 5 years, the sports medicine and arthroscopy literature has introduced papers documenting the short- and longterm success of these techniques. Reports by Wolf, Snyder, Gartsman, and others have documented "good and excellent" results in 84% to 94% of patients, comparable with the literature for mini-open and traditional repairs. Although there have been no prospective comparisons of arthroscopic and open repairs, the successful outcomes and satisfied patient population validate the incorporation of arthroscopic rotator cuff repair into the armamentarium of any surgeon with the appropriate skills.

5.1 Arthroscopic findings of instability and their classification

The exact classification of shoulder instabilities is a prerequisite for choosing an optimal therapy.

The large number of findings allows for the establishment of different classification systems. From the descriptive point of view, a classification that considers grade, frequency, etiology, and direction of instability is most commonly used. In addition, a concept emphasizing etiology is expressed in the acronyms TUBS and AMBRII[112]. Several diagnostic difficulties in the existing classification systems led Gerber to propose a new classification of shoulder instabilities that we consider useful both from the theoretical and practical points of view[113]. This classification system defuses the surgeon's actual problem, namely to use a classification that assesses the conditions relevant for therapy and prognosis. The clinical distinctions made by Gerber, which relate predominantly to the laxity of the capsule, can easily be combined with the arthroscopic classification of intraarticular findings presented below.

Arthroscopy of the shoulder joint reaches a new level of quality in the subtle classification of the structures of the capsule-ligament apparatus. Alterations versus normal situations can be more exactly recorded and integrated into the therapy concept. In addition to the evaluation of the glenoid labrum, it is possible to recognize multiple accompanying pathologies, for example alterations in areas near the biceps tendon, dorsal labrum, or rotator cuff. These alterations may be extremely relevant clinically and are hard to assess in the case of open exploration.

In the literature, different classifications of labrum alterations have been described[114-115], which are complicated to refer to or fail to describe the complexity of the damage sufficiently. Therefore, to supplement the clinical classification, the following arthroscopic classification of instability findings regarding the capsule-ligament apparatus has been proposed.

The individual finding constellation of capsule-labrum alterations in unstable shoulder joints depends on three factors:

- Site of the primary lesion
- Congenital laxity of the joint
- Frequency of dislocations experienced

A situation of instability can produce principally three sites of damage to the capsule-ligament apparatus:

- Glenoid labrum
- Ventral joint capsule with its strengthening cords
- Humeral insertion of the capsule

For complete arthroscopic evaluation, it is necessary to inspect all of the three locations in question.

According to the literature, the detachment of the glenoid labrum from the glenoid (referred to as a Perthes lesion, or Bankart lesion in the English literature) is a very frequent finding in the case of initial dislocation of the shoulder joint[116]. The complete tear manifests as the typical arthroscopic finding of an unidirectional instability without hyperlaxity (type 2 according to Gerber). There is an association mostly with Hill-Sachs lesions which, like the complete manifestation of a Bankart lesion down to the 6 o'clock position or up to the biceps anchor, support a traumatic genesis in cases of normal laxity.

Another typical location showing damage of the capsule- labrum complex at the bone-tendon insertion is a humeral dissociation of the joint capsule. Such a case is also characterized by unidirectional instability without hyperlaxity.

On the other hand, increased laxity of the joint capsule leads to intraligamentous lesions. Like the weakest link of a chain, the capsule, which is more elastic owing to increased laxity, gives way under mechanical strain. Typically, the glenoid labrum is completely preserved. In contrast, there is a marked anteroinferior capsular pouch.

In addition to the primary site of the lesion, which is closely associated with congenital hyperlaxity, the number of dislocations experienced plays an essential role in the intraarticular capsular and labral damage. With the number of redislocations increasing, the arthroscopic findings of the ventral labrum-capsule complex are as follows:

- insertion of the labrum-capsule complex inferiorly and medially
- degeneration and breakdown of the glenoid labrum (bucket-handle or related lesions)
- anteroinferior capsular pouch
- structural failure of the ventral capsule, especially the glenohumeral ligaments
- enlargement of the rotator interval

After summarizing the high number of arthroscopic findings of instability, a simplified classification which evaluates not only the condition of the labrum, but also the function of the IGHL is recommended.

5.1.1 Perthes-Bankart lesion

An acute or recurring shoulder dislocation is often related to avulsion of the labrum-capsule complex from the anterior glenoid, which is called a Perthes-Bankart lesion, after the authors who were the first to describe this entity[117,118]. However, it is unclear to what extent the loosening of the labrum is responsible for redislocations. Speer et al.[119] reported that after having artificially established a Bankart lesion in cadavers, there was no marked increase of anterior translation leading to dislocation. In fact, biomechanic studies revealed[120] that with the IGHL complex under tension, plastic irreversible alterations of the shoulder capsule occur at first, followed by definite avulsion of its origin in the sense of a Bankart lesion. This led to the conclusion that other factors are involved if redislocations occur.

Arthroscopically, a Perthes-Bankart lesion is characterized by an avulsion of the labrum from the glenoid rim. In typical cases, this occurs without any significant elongation of the IGHL. This does not exclude intrinsic damage to the capsule, however. In the case of further dislocations, one encounters increasing degeneration of the labrum. In such cases, the repeated dislocations prevent the capsule from healing, so that capsular instability will be the consequence.

Avulsion of bony fragments from the ventral glenoid rim, also referred to as a Bankart type 4 lesion, occurs in 15%–50% of cases of anterior instability[121]. Larger fragments can and, if possible, should be reduced and fixed by open osteosynthesis. Smaller fragments require only refixation of the capsule and the labrum in the sense of a Bankart operation. In such a case, the fragment can either be ignored or integrated into the reconstruction of the soft tissue. The existence of a bony avulsion of the glenoid strongly supports a traumatic genesis of instability.

5.1.2 Avulsion Lesions

In chronic cases, the glenoid labrum is connected to the glenoid at a site located too far medially. This misinsertion is caused by an intact periosteal sleeve at the neck of the scapula. It pulls the freshly avulsed labrum to medial, where it undergoes scarring (ALPSA lesions). Neviaser reports that avulsions occur in more than half of the cases after acute dislocations[122]. In addition to avulsion of the labrum, there is significant capsular instability. The remaining labrum may show substantial degenerative alterations. After several dislocations and scarring, specific glenohumeral ligaments often cannot be identified.

5.1.3 Capsular Lesions

In addition to avulsion of the labrum and capsule from the glenoid, capsular elongation obviously constitutes an essential pathomorphological substrate for recurrent anterior shoulder instability. The irreversible stretching and plastic deformation of the capsule prior to the occurrence of a Bankart lesion was proven experimentally. In contrast, Taylor and Arciero[116] reported that after traumatic initial dislocations, isolated loosening of the labrum-capsule complex was found during arthroscopy in 97% of the patients, without any recognizable rupture of the capsule. However, this does not exclude the presence of ultrastructural alterations, because these cannot be demonstrated arthroscopically.

Clinically, this concept is of great relevance because plastic deformation of the capsule should be suspected in virtually all cases of shoulder dislocation. This capsular deformation must be integrated into the therapeutic concept. This means that isolated arthroscopic refixation of the labrum does not always address the entire field of pathology, and therefore it should be critically questioned. In contrast to open surgery, during arthroscopic stabilization there is no capsular shortening caused by the operative approach and subsequent scarring. This explains to some extent the higher rate of redislocations after arthroscopic procedures.

From the arthroscopic point of view, the labrum is relatively well preserved in these cases, and the main finding manifests in separation or elongation of the capsular complex from the glenoid rim. After several dislocations, a deep anteroinferior capsular pouch with a ruptured IGHL develops, whereas the genuine labrum is located at the rim of the glenoid. Patients with a habitual component (multidirectional hyperlaxity) frequently develop this type of instabilty, when the hypotrophic labrum is intact and the glenohumeral ligaments are of soft consistency. If the capsular tissue is more stiff, the labrum will also be affected, and it is possible that after several dislocations the labrum will completely vanish.

5.1.4 Humeral Lesions

A special form of anterior instability manifests in humeral avulsions of the joint capsule (HAGL lesions). The humeral capsular insertion of the IGHL is ruptured in such a case so that under conditions of anterior translation, the IGHL cannot resist the humeral head. This may apply to those patients with a history of a major trauma caused by initial dislocation, but without arthroscopic evidence of a Perthes-Bankart lesion. The humeral avulsion of the glenohumeral ligaments[123] is rare and was described first in isolated cases. In principle, a combination of glenoid and humeral avulsions of the capsule is also possible[124]. Other authors reported on a considerably higher frequency of humeral avulsion lesions. Bokor et al. reported that in 41 of 529 cases, HAGL lesions were the cause of the shoulder instability.

5.1.5 Associated Lesions

A chondral or osseous Hill-Sachs lesion, which is typical for traumatic anterior instability, can be easily diagnosed arthroscopically at the posterolateral aspect of the humeral head. In contrast, inverse lesions in the anterior region of the humeral head near the minor tubercle indicate posterior instability.

A special type of lesion occurring primarily in the elderly is the traumatically caused interval lesion. Patients over 40 years old, in particular, are frequently affected by rotator cuff ruptures that are related to traumatic shoulder dislocations. Probably, tendon elasticity is involved, as it decreases with increasing age. If the lesions occur in the anterior part of the cuff, the rotator interval will be affected.

If there is a complete avulsion of the glenoid labrum from the ventral glenoid, this lesion may extend cranially and affect the anchor of the biceps tendon. The instabilities seen at the upper part of the labrum are referred to as SLAP lesions (superior labrum lesions from anterior to posterior). The avulsion of the labrum can be seen to continue from anterior to cranial. Combined SLAP-2/Bankart lesions belong to those traumatically induced forms of lesions that have a favourable prognosis after arthroscopic refixation. Therapy must include ventral stabilization on the one hand and refixation of the upper part of the glenoid on the other hand.

Combinations with damage to the cartilage can manifest in glenoid impression fractures of the anteroinferior cartilage substance. These lesions, which affect not only the cartilage but also the adjacent areas of the labrum, are referred to as GLAD lesions (glenolabral articular disruption). According to Neviaser[125], who was the first to describe these lesions, the alterations heal within 3 months without any complications. In chronic cases, under conditions of instability-associated alterations, both the humeral and, in particular, the glenoid damage to the cartilage can be recognized arthroscopically in this location. These findings should be interpreted as the onset of omarthritis. The combination of a persisting minimal anterior shoulder incongruence with simultaneously occurring strain (throwing athletes) most probably plays an essential role in the development of instability-induced degenerative arthritis. The treatment of the capsular instability after recurrent shoulder dislocations seems to be the key in arthroscopic stabilization. During arthroscopy, the pattern of pathomorphology can be evaluated, which allows the surgeon to have a clear idea of all the structures to reconstruct.

5.2 Arthroscopic Techniques

Surgical techniques for the arthroscopic treatment of Bankart lesions have undergone many revisions and refinements as knowledge and equipment have improved. The earliest technique of Bankart lesion repair was the staple technique. This was first described by Johnson, in 1982, as a modification of the commonly performed open procedure. It was performed in the lateral position via a three portal approach. An abrasion arthroplasty was performed on the glenoid rim to produce bleeding cancellous bone. The staple arms were then used to engage the detached portion of the glenoid labrum, portions of the subscapularis tendon and the anterior capsule. A mallet was then used to drive the staple into the scapular neck[126]. This technique, however, was abandoned largely due to an unacceptably high complication rate[127].

Hawkins retrospectively reviewed 50 cases of arthroscopic stapling for shoulder instability in 1989. He found a 16% recurrence rate of subluxation or redislocation, which he felt was due to failure to immobilize the shoulders for 3 weeks postoperatively. They also determined that a significant learning curve existed with the procedure and that good surgical technique and patient compliance were paramount for successful outcome[128]. In 1993, Lane and coworkers[129] retrospectively reviewed 54 patients who underwent arthroscopic staple capsulorrhaphy for stabilization. Their study found a 33% recurrence rate of instability along with an 18.5% rate of subsequent open reconstructive procedures. They also reported a 26% rate of staple loosening in the postoperative period. Of these, 42% were discovered due to recurrent instability of the shoulder, with the remaining being discovered on routine follow-up. One of the staples had migrated into the area of the brachial plexus, necessitating subsequent removal. Hardware around the shoulder is not without inherent risk, as described by Zuckerman and Maatsen[127] in a review of 37 patients. They found that 16 of their patients had problems related to the use of staples for conditions including capsulorraphy, subscapularis advancement, or rotator cuff repair. The remaining 21 patients had problems related to screw fixation of transferred coracoid process to the glenoid. The most common patient complaint was pain, followed by decreased glenohumeral motion, and radiating paresthesias. Thirty-four of the 37 patients underwent additional surgical procedures for implant removal. Fourteen of these patients suffered permanent shoulder dysfunction because of damage to the articular cartilage imparted by the screws or staples.

The technique of arthroscopic transosseous suture repair was first described by Morgan and Bodenstab in 1987. They evaluated 25 patients who had traumatic unidirectional anterior shoulder instability that was stabilized arthroscopically using their suture technique. The patient is placed in the lateral decubitus position with the operative arm suspended. Once the lesion is identified, the glenoid rim and scapular neck are abraded to create a bleeding bed of cancellous bone in preparation for the repair of the Bankart lesion. Suture material in the form of #1 PDS is passed through the soft tissue of the Bankart lesion and glenoid bone from anterior to posterior with a modified Beath pin. Next, the pin is used to spear the IGHL near the attachment to the separated anterior glenoid labrum. This process is repeated once more to create a large horizontal mattress suture with tails that exit the scapular neck and skin posteriorly via two separate incisions. Care must be taken not to angle the pins in an extreme medial position, as this places the suprascapular nerve at risk. The PDS is then tensioned and tied over the posterior fascia in an effort to bring the Bankart and IGHL into an anatomic position. In a 17 month postoperative follow-up period, they rated all results as excellent with all patients achieving full and painless range of motion without instability[130].

Others have attempted to reproduce these results with variable degrees of success. Benedetto and Glotzer[131] reported on 31 patients with no incidence of recurrence in a 2-year follow-up period. Grana and associates[132], however evaluated 27 patients over a 3-year follow-up and found a recurrence rate of 44%.24 Disadvantages of the transosseus suture technique were the need to tie sutures over the posterior fascia, as well as possible iatrogenic injury to the suprascapular nerve while passing the suture. In a cadaveric study, Bigliani and colleagues25 determined a "safe zone" for blind pin passing to avoid injury to the suprascapular nerve. They determined that inferiorly directed pins averaged 16 mm from the nerve, with none passing closer than 12 mm. This was in contrast to the medially directed pins that averaged a distance of 4 mm and pins parallel to the articular surface that averaged 6 mm. They determined the relative safe zone to be in the inferior and lateral portion of the posterior glenoid neck[133]. This technique has since been abandoned, due to variable success rates in follow-up studies as well as the advent of newer techniques[134].

In 1988, Wiley27 studied the effectiveness of arthroscopic rivets for use in the treatment of Bankart lesions. The rivet was designed as a removable metallic device for affixing the torn labrum and the inferior glenohumeral ligament (IGHL) to the glenoid margin. It was then removed after a period of 4 to 6 weeks. The rivet technique had the advantage of only penetrating the glenoid anteriorly, as opposed to through the glenoid neck with the transossesous suture technique, which decreases risk to the suprascapular nerve. Ten cases were presented and followed for a period of 6 months to 2 years with one recurrence reported. This case series was the only report regarding this technique and it never gained acceptance or widespread use[135].

The Suretac cannulated bio-tack (Acufex Microsurgical, Mansfield, Massachusetts) had the advantages of avoiding posterior glenoid penetration and having a shorter learning curve. The lesion is identified and special attention is paid to stripping and mobilizing the IGHL superiorly and medially. The device is then placed as close as possible to the articular margin. Proper positioning was ensured by the anterosuperior arthroscopic portal[136]. The device was noted to be resorbed over a period of 4 weeks[137]. Small Bankart lesions were enlarged to allow for superomedial shift of the IGHL. The fixation of the IGHL was performed with two Suretac devices after obtaining a bleeding bed of cancellous bone on the scapular neck. Two additional Suretac devices were then used to repair the Bankart lesion. Kartus and coworkers[138] reviewed their results using the Suretac device in 81 consecutive patients over a follow-up period of 107 months. They reported a postoperative complication rate of 38%, with 11 patients experiencing episodes of subluxation and 16 having recurrent dislocation. There was also an increase in the degenerative appearance of the glenohumeral joint on radiographs. Negative aspects of this technique include the inability to address capsular laxity and a synovial reaction to the absorbable polyglyconate polymer.

Suture anchors were the next technological advance in the treatment of anterior shoulder instability. They were first described by Wolf in 1993, who studied 50 patients with Bankart lesions treated arthroscopically. He reported promising results including no hardware complications and only one recurrence of dislocation. The advantages noted for this technique include multiple points of fixation, no posterior glenoid penetration and pullout strength approaching that of transosseous sutures, especially when using later generations of suture anchors. In this procedure, Wolf described the patient being placed in the lateral decubitus position. The debridement and preparation of the bleeding bed of cancellous bone is best accomplished via the anterosuperior portal. Insertion of the drill and drill guide is optimized through the anteroinferior portal, and the three drill holes should be placed as far apart from each other as possible on the glenoid rim. It is important to place the drill bit on the anterior border of the cartilaginous surface and not on the medial scapular neck. The suture material is then passed through the detached labral-ligament complex after the anchor is secured[139]. Various types of suture anchors are available including metal, bioabsorbable, and bioinert.

Kim and associates[140] reviewed their results of arthroscopic repair of the Bankart lesion using suture anchors, retrospectively evaluating outcomes in 167 patients. They found that all patients had improved shoulder scores after surgery. There was a 4% rate of recurrence in the form of one patient dislocating, two subluxations, and four patients with positive apprehension tests postoperatively. Cole and Romeo[141] reviewed 45 patients with traumatic unidirectional anterior shoulder instability treated arthroscopically with suture anchor technique with 2-year follow-up. They found no recurrent dislocations in their patients and 96% good to excellent results. All athletes were able to return to contact sports.

5.3 Technical Considerations of Arthroscopic Shoulder Stabilization

Historically, a number of ambitious surgical techniques for arthroscopic stabilization of the shoulder joint were invented, but these could not keep up with the expectations. On the other hand, analyzing the mistakes and setbacks was a prerequisite for discovering the problems associated with arthroscopic procedures.

According to the general belief, arthroscopic procedures for shoulder stabilization are complicated by higher recurrences of shoulder dislocations. However, some authors disagree. Since the arthroscopic procedures vary, their results as a whole cannot be compared with open surgical procedures. Accordingly, most surgeons apply arthroscopic as well as open surgical techniques with respect to individual pathological findings. Meanwhile it has been proved that both approaches show excellent results with appropriate indications.

5.3.1 Preferred Portals

A major problem, especially in the diagnosis of humeral lesions, is the limited field of view using the 30-deg scope from the posterior portal. Structures behind the anterior rim of the glenoid cannot be visualized. Additionally, large parts of the labrum and capsule are concealed by the humeral head and glenoid. The correct diagnosis can easily be missed. Only in an extremely loose shoulder joint with a positive 'drive-through sign' can all of the articular lesions be diagnosed from a posterior portal alone. Switching from the posterior to the anterior portal is mandatory for the diagnosis of a glenoidal avulsion or a humeral capsular lesion. Furthermore, surgical procedures at the anterior inferior part of the joint are difficult to check safely from the posterior portal.

Since the reconstruction of labral lesions requires the use of the conventional anterior portal, an additional anterior portal for viewing is mandatory. This portal can easily be located superior to the anterior working cannula in a suprabicipital position. For switching the scope from posterior to anterior, the posterior portal should be preserved in all cases and be secured with an additional switching stick. In most cases it is not necessary to insert a cannula into the suprabicipital portal. It is sufficient to slide the scope into the joint on a switching stick. Thus, unnecessary damage to the rotator interval is minimized.

The stringent use of a suprabicipital portal during critical surgical steps of arthroscopic reconstruction facilitates the handling of all of the instruments used. Alternatively, the inferior glenoid can be visualized with a 70-deg arthroscope. However, a 30-deg arthroscope seems to be more useful, since the surgeon has to get used to a 70-deg arthroscope in terms of orientation and interpretation of the findings. Furthermore, the use of additional sterile wraps for the camera is time-consuming and costly. In addition to the use of a suprabicipital portal, the arthroscope may be guided through the posterior portal in an inferior direction and then the optical angle turned ventrally. The anterior glenoid rim is visualized while viewing around the inferior border of the glenoid. However, only the most inferior parts of the IGHL are seen. This is why surgical procedures might be difficult to pursue with this optical portal. The instruments are visible just when reaching the anterior inferior portion of the joint. Nevertheless, the posterior approach is very helpful for inspection of the anterior inferior glenoid rim, especially after a ventral capsular shift. An additional anteroinferior portal for shoulder stabilization was described by Resch et al.[142,143]. Other authors modified the technique[144-146], but the fact remains that with the use of inferior portals, the cephalic vein and axillary nerve are at risk.

5.3.2 Debridement of the Glenoid

In primary shoulder dislocations, debridement of scar tissue is not necessary. In chronic cases, the removal of scar tissue as well as bony debridement are obligatory. This is the only way to guarantee the healing potential between the labrum and the glenoid. As already mentioned, the visualization of the inferior part of the glenoid is improved by changing the arthroscope to the superoanterior portal.

Several instruments are suitable for the debridement of the glenoid.Using the angled Bankart rasp, the glenoid can be reached down to the 4 o'clock position. In order to gain access down to the 6 o'clock position, the rasp can be rotated by 180 deg. In contrast to the former belief that debridement down to cancellous bone improves the healing capacity, animal studies showed that debridement down to the cortical bone is sufficient to promote healing[147]. A meticulous cortical debridement of the glenoid rim with punctuate bleeding is a prerequisite. For the mobilization of the capsule, an electrical resection instrument with an angled neck may be applied, with which the entire glenoid rim may be accessed. Consecutively, debridement of the ventral glenoid rim with an angled rasp or a soft-tissue shaver is performed. A burr is not recommended for this step, since it is difficult to control.

Sometimes burring small troughs into the anterior glenoid rim is suggested for inserting suture anchors or staples more easily. This step, which leads to a decrease in the glenoid contact area, is not necessary if small, selfcutting suture anchors are used, which are inserted under direct visualization. With the respective rotational maneuver of the arthroscope, an optimal visualization of the anterior glenoid rim can be attained. For the visualization of the glenoid up to the 4 o'clock position, the arthroscope can be positioned anteriorly and thus does not interfere with the instruments. At the inferior part of the glenoid, optimal visualization is achieved by rotating the arthroscope medially to the instruments.

5.3.3 Mobilization of the Labrum and Capsule

The detachment of the labrum and capsule is done stepwise from the 2 o'clock to the 6 o'clock position. In case of an avulsion lesion, the preparation should start at the false insertion of the labrum at the bony glenoid rim. For a complete mobilization, the periosteum has to be detached from the neck of the scapula medially, so that the subscapular muscle is visible. Inferiorly, this step should be performed carefully in order to respect the anatomy of the auxiliary nerve. In case of an isolated Perthes-Bankart lesion, only the repositioning of the labrum to its anatomic position is necessary. The correct repositioning of the labrum can be examined easily with a probe. However, Perthes-Bankart lesions coincide very often with a capsular insufficiency, so that an additional capsular procedure should be considered while testing the reposition of the labrum. A probe, temporary sutures, or a grasper are needed in order to ascertain the result of the repositioning of the capsule and labrum. The instruments or sutures can be inserted through the anterior or posterior portal.

For the reinsertion of the labrum and capsule, all adhesions at the glenoid should be mobilized in different directions. In case of an excessive capsular instability with an inferior pouch, temporary sutures may be helpful. Temporary traction sutures can be placed with the same suture devices which are used for the definite fixation. The use of temporary sutures allows the stepwise mobilization and repositioning of the capsule. The surgeon should use his or her favorite suture instrument for this step.

5.3.4 Reposition and Perforation of the Labrum-capsule Complex

The result of labral and capsular mobilization should be tested by the ability to reposition the labral-capsule complex onto the glenoid rim. This step is crucial in all arthroscopic techniques used for reconstruction of the capsule and labrum. Not every technique is useful for every case. Sufficient arthroscopic visualization, however, is a prerequisite for all techniques. This means that specific procedures demand specific adjustments of the arthroscope. In most cases positioning the scope in the anterior portal allows a much better view than in the posterior portal.

The development of a tremendous variety of arthroscopic techniques, each of which is recommended by different specialists, is difficult to survey. The 'one-step techniques' utilize direct fixation of the capsule or labrum with a suture anchor or staple, which is fastened to the glenoid during the maneuver. The advantage here is given by the fact that additional instruments do not have to be worked through the capsule and ligaments. This can be time-saving, but optimum placement of the anchors or staples can be difficult, since the simultaneous arthroscopic control is limited due to the perforated and attached capsule and labrum. Repositioning and fixation are done in the same step, so that controlling both procedures simultaneously can be intricate. Additionally, it may be demanding to grasp enough capsule in order to tension the capsule and fix it securely.

The 'two-step techniques' consist of two consecutive steps: fixation of the anchor and transport of the sutures through the soft tissue. Although this is more time-consuming, both steps are separately controllable. A wide variety of suture anchors is available for secure fixation of the sutures to the bone. The decisive part of these techniques is the type and the handling of the respective suture transporters, which are the instruments of utmost importance.

Each surgeon should be familiar with several suture transporters in order to master the situation in case of any technical difficulties. For capsular shift procedures performed in the inferosuperior and medial-lateral directions, special suture instruments are necessary which are used to transport the capsule to the attachment site at the glenoid rim. The instrument has to fit through the working cannula and should be long enough to enable surgical procedures in the inferior part of the joint. Furthermore, the instrument should be able to grasp a sufficient amount of tissue for fixation, and it should be stiff enough to prevent bending from mechanical stress during the repositioning. Additional use of a posterior working cannula can enhance the handling of sutures or transport devices inside the shoulder[148].

Several systems use transport sutures (Shuttle relay, Lasso), which themselves are not used for definite fixation of the labrum. Instead, the transport suture is used for trafficking the definite sutures for fixation. Other instruments do not rely on transport sutures, but use a forceps- like mechanism or a flexible wire in order to transport the definite sutures directly through the labrum or capsule. It is essential that the suture material not be harmed by the suture retriever device or the inserted anchor. Sharp edges can lead to sawing of the sutures, which can be disastrous for the fixation.

As regards the high failure rates of arthroscopic shoulder stabilization[149], it is obvious that capsular shortening is essential for stabilizing the shoulder. Recent arthroscopic techniques can perform capsular shortening in several ways, especially with adequate suture transport devices.

5.3.5 Sutures, Anchors, or Tacks?

Most labral or capsular reconstruction techniques depend on the attachment of the soft tissue to the glenoid. Such a fixation can be done either with transglenoidal sutures, with suture anchors, or with tacks.

Using staples or tacks is not an easy procedure, and the sheer size of the implants is responsible for several technical problems. Complications include capsular destruction, implant migration, intraarticular positioning of implants and consequent cartilage defects at the humeral head[150-152]. If the surgeon prefers to fix the labrum at the 5 o'clock position with an extraarticular technique[153], an anteroinferior approach is necessary[154], and this will include some risk to the auxiliary nerve. At present, most surgeons prefer suture anchor techniques as a standard method. The classic transglenoidal suture technique (one-step technique) according to Morgan and Bodenstab[155] relies on the fixation of the sutures on the dorsal aspect of the glenoid with the help of stopping knots (known as 'mulberry knots'). The sutures are pulled back anteriorly, and the stopping knot locks the sutures on the dorsal neck of the scapula. Ventrally, the sutures are tied with a knot pusher in order to achieve a mattress suture. The positioning and the draping of the patient may be painstaking for an easy approach to the dorsal scapula.

Another technique was developed by Caspari[156]. After grasping the capsule and labrum by multiple sutures, a drill hole is made transglenoidally, and the sutures are pulled through in the dorsal direction and tied on the infraspinatus fascia (two-step technique). By using this suture technique with knots positioned dorsally, local problems may occur.

Recently, a change towards fixation of the sutures to the bone by anchors took place. The application of small suture anchors facilitates the exact implantation and minimizes the osseous defect. The stability of titanium suture anchors concerning the pullout force is sufficient. Localized osteoporosis may decrease the stability. However, the soft tissue represents the weak point concerning the fixation of the capsule and labrum. Nowadays, titanium anchors predominate, and they do not interfere with follow-up MRI investigations. In all cases, the suture anchors need to be visualized by conventional radiographs in order to determine their localization.

Follow-up radiographs of displaced suture anchors can reveal their location and may allow a surgical revision. Secondary migration of metal implants may create substantial problems in the shoulder joint, especially when friction with the cartilage occurs. Therefore, suture anchors have to be implanted completely into the bone, because implants that stand out can lead to substantial loss of cartilage. Reconstructed tissue, such as a newly built labrum, does not protect the joint cartilage from metal implants in the long term. Ensuring sufficient engagement of the implanted anchors by switching the arthroscope to the superoanterior portal is generally recommended. With the help of a probe, sufficient countersinking of the implants can be ascertained. It is not of great importance whether resorbable or nonresorbable suture anchors are used in surgical shoulder stabilization. Similar results can be achieved with the help of both types of implants. Optimal biocompatibility and sufficient functional stability are the main selection criteria for biodegradable suture anchors. Initial resorption of the implant which interferes with the locking mechanism may lead to insufficient fixation at the bony interface. Since synovitis is reported with the use of fast resorbable PGL devices, slowly resorbable materials are preferred.

In the case of implant malpositioning or migration, fewer problems are to be expected with biodegradable implants. However, up to now, biodegradable implants are more capacious, and more bone resection is needed prior to implantation. Furthermore, it is necessary to drill holes before their implantation, as they are not self-cutting. From the experience with PLLA screws used for anterior cruciate ligament fixation, it is known that the process of resorption takes years. Therefore, noncrystalline materials are being developed for the fixation of sutures at the glenoid. The time needed for their degradation ranges from 1 to 2 years. Since the size of the bony defect plays a role in its regeneration, small suture anchors are recommended. In most cases, nonresorbable braided sutures number 2 are used. Braided sutures are more convenient for arthroscopic knot tying. Furthermore, the ends of the sutures of some anchors (Fastak, Arthrex, Karlsfeld, Germany) are glued so that the sutures are easier to handle with the knot pusher.

Although there are no reports that nonresorbable sutures cause any side effects, resorbable sutures are desirable for young patients. Fast resorbable sutures such as Vicryl, which last less than 3 months, are not suitable for providing sufficient strength during the healing process. Alternatively, Polydioxan (PDS, Ethicon) can be used. However, handling monofilamentous and stiff material is more difficult. Furthermore, it is known that PDS lengthens under the influence of synovial fluid. The newly developed Panacryl (Ethicon, Germany) is a degradable braided suture which has a longer resorption time than Vicryl. Presently, there are no controlled animal studies for its use in shoulder surgery.

5.3.6 Thermal Capsular Shrinkage

In the past few years, thermal capsular shrinkage has been introduced for the treatment of shoulder instability. This was done in addition to arthroscopic capsulolabral repair[157,158] and as an isolated procedure for shrinking the redundant capsule and ligaments in cases of internal impingement[159] and multidirectional instability[160]. The effect of the thermal energy induces mechanical and ultrastructural changes to soft-tissue collagen at or above 60°C. Microscopically, unwinding of the collagen triple helix, loss of fiber orientation, and contraction of fibrils may be seen. The shortened collagen seems to form a scaffold for the ingrowth of reactive fibroblasts, which then initiate collagen repair. Thermal capsulorrhaphy is quite easy to do. The radiofrequency (or Ho:YAG laser) probe is placed via the anterior cannula in direct contact with the tissue. After activation of the probe, the capsule begins to shrink with a short delay of 1 to 2 s. Care must then be taken to keep the probe in motion so as to avoid overheating or ablation of the tissue. Tissue treated with multiple radial passes in a grid-fashioned pattern showed better mechanical properties 6 weeks later when compared with tissue treated in a uniform manner[161]. The reason may be that the grid pattern leaves more viable tissue adjacent to the treated areas, which accounts for faster healing.

In the auxiliary recess, the treatment must be minimized or the probe temperature reduced in order to avoid injury to the underlying auxiliary nerve. As a rule, the shrinkage should be started in the inferior parts of the joint, progressing posteriorly, anteriorly, and superiorly, and ending at the rotator interval. Savoie and Field believe that shrinkage of the rotator interval is hardly ever effective and that its closure is better done by suture plication. This is also true for Bankart or SLAP lesions that make a labral or capsulolabral repair mandatory.

The biomechanical properties of the tissue appear to be undamaged if shrinkage is limited to less than 15%. However, the optimum amount of energy needed for shrinkage without unintended tissue destruction is not known. In animal studies, thermal shrinkage increased the risk of creep and failure at low physiologic stresses. These findings suggest that loading of thermally treated tissues should be done cautiously during the early phase of rehabilitation. Patients with prior operations or multiple dislocations are at risk for early failure after thermal capsulorrhaphy. The procedure should also be used with prudence in patients with multidirectional instability or in those who are involved in contact sports.

5.3.7 Conclusions

Arthroscopic techniques have advanced considerably during the past few years, and new techniques achieving a desirable capsular shortening were developed. With these advanced techniques, a surgeon can handle cases with associated increased laxity or damage to the capsule. But it is not clear how much capsular shift is possible and useful in a given situation.

The arthroscopic techniques theoretically seem to be superior to the open methods in many ways. The operative morbitiy can be reduced, and the period of recovery can be shortened so that the cost of the treatment decreases substantially. In terms of function, there is a difference in external rotation in favor of the arthroscopic technique[162,163]. The technique facilitates the view within the shoulder joint, minimises postoperative pain, and provides the possibility to perform other procedures simultaneously.

As we know that the number of dislocations influences the redislocation rate[164], the indication for arthroscopic reconstructions should also take into account the number of preoperative shoulder dislocations.

Nowadays, considering all the new technical possibilities of arthroscopic shoulder reconstruction including capsular shift procedures, most cases are suitable for arthroscopic reconstruction in cases of anterior shoulder instability.

Second part

6. Methodology

My Clinical case study took place in C.L.P.A hospital – (Centrum léčby pohybového aparátu, Address: Sokolovská 810/304, 190 00 Praha-Vysočany). I choose a patient after Arthroscopy in the Shoulder joint because of partial tear of Supraspinatus tendon. I visit my patient from Monday, 6th of June 2011 until Friday, 17th of June 2011. I meet him also on Monday, 20th to make my final Kinesiological examination. In this period I fulfill 10 sessions and one day which have been given with my supervisor’s permission to allow me have a clearly conclusion for my case.

Patient signed a written informed agreement which gives me the authority to use with respect to the signer, his case study to analyse and develop my Bachelor thesis. Project of thesis is in a written formed consent by the Ethics Committee of the faculty of Physical Education and Sport at Charles University.

7. Presenting Complaint

On summer of 2010 during surfing he felt an intensive pain in his right shoulder. The pain is located in the region of the anterior part of deltoid muscle and acromioclavicular joint while increases when he provides external rotation or maximal flexion/ abduction. Rarely is present at rest or during sleep.

According patient’s assessment, the level of pain in a scale from 0 to 10, has been estimated to 5. After the injury he has a protective mechanism on the right shoulder during intensive activities. Since the accident he became insecure with the control of his right extremity and sometimes worries to load it even in daily activities.

Personal data

- Name: P.D
- Sex: Male
- Date of birth: 25-12-1983
- Height: 182 cm
- Weight: 73 kg

8. Anamnesis

8.1 Personal Anamnesis

Fall during skiing on February 2010, injured right shoulder. After the injury, patient went back to the camp, where ice packs administrated from a local doctor. In the first week there was a sharp intensive pain, located in the right shoulder joint. Since then has difficulties on daily activities with decrease range of motion.

Pain often presents on the shoulder during sports, carrying weights and sometimes at rest condition. On October and December of 2010 visited a doctor to administrate him cortisone injections on the shoulder to relief the pain.

8.2 Ambulatory Documentation

On February MRI examination showed, torn in supraspinatus tendon. Patient hospitalized from 13th until 17th of May in CLPA hospital where submitted in preliminary tests before the surgery.

Pre operation state:	Post operation state:
Larynx and nodules	Right shoulder fine
Breathing was normal	Absence of redness on shoulder area
Regular heart rate	Swelling in not present
No pain and swelling in stomach.	Is able to move the upper extremity
Right shoulder fine	Decrease range of motion on shoulder joint

On 16th of May underwent for arthroscopy on right shoulder. After one day accommodation in the hospital returns at home wearing splint on right arm.

8.3 Medical Surgeon Documentation

In the first three days after the operation patient should rest at home. Ice packs administration for 20 minutes, 3 times a day. Progressively starts to move his right shoulder while excessive exercises or loading are not allowed. He instructs him to often move the right upper extremity into flexion and extension, in elbow and fingers. External rotation of shoulder joint is not allowed. Painkillers can be used in acute pain or antipyretic drugs in case of fever. Patient will wear cast of the next 3 weeks after the operation.

8.4 Medical Rehabilitation Documentation

- Hydrotherapy
- Health regeneration exercises technique
- Soft tissue technique
- Post isometric relaxation

8.5 Present State

Patient came on 6th of June to CLPA rehabilitation department with splint on the right upper extremity. There is swelling in the anterior side of right shoulder and restriction in all planes of movement in the joint. Pain is present during maximal movements while there is slight redness around the scars from posterior and anterior side of shoulder. According patient report did not use painkillers or anti-inflammatory drugs during 3 weeks recovery.

Personal Data:

- Name: P.D
- Sex: Male
- Date of birth: 25-12-1983
- Height: 182 cm
- Weight: 73 kg

8.6 Family Anamnesis

Father: Operation on lower back when he is 20 year old.
On 2010 had arthroscopy for rotator cuff tendinitis.
Mother: Healthy
Sister: Healthy

8.7 Social Anamnesis

Single, lives with his family in an apartment with 2 floors and 1 internal stair.

8.8 Occupation

Student. Master degree in Economics

8.9 Previous Operations

Appendectomy when he was 13 years old.

8.10 Childhood Anamnesis

The most common childhood diseases.

8.11 Medication

First, two days usage of NSAID to relief the pain.

8.12 Abuses

Rarely smokes and social usage of alcoholic beverages.

8.13 Allergies

None.

9. Initial Kinesiology Examination

9.1 Inspection

Patient is in normal mental state with physiological response in our instructions.
There is a typically flat, pale scar in the anterior and posterior side of deltoid muscle.
Skin areas around the scar are slightly reddish with edema in the anterior/ medial side of shoulder and auxiliary fold. In the first day patient came wearing the splint. His

upper trunk is shifted to the left side with elevation of right shoulder. Head is in slight lateral flexion to right side.

9.2 Postural Examination

Anterior aspect:

Normal base on feet.
Increased foot arch.
Asymmetry of patellas
Right patella is facing outward.
Umbilicus in neutral position.
Asymmetry in thorocohumeral triangles.
Elevation of right clavicle
Elevation of right shoulder.
Lateral flexion of the head to the right side.

Lateral aspect:

Slight semi flexion of right knee joint.
Slight lumbar hyperlordosis.
Semi flexion of right elbow joint.
Physiological kyphosis in low thoracic spine.
Protraction in both shoulders (greater observed in the right)
Hyperkyphosis in middle and upper thoracic spine.
Elevation of right shoulder.
Slight head protraction.

Posterior aspect:

Asymmetry of popliteal line.
Right popliteal fossa facing inwards.
Asymmetry in thorocohumeral triangles.
Lateral flexion of thoracic spine on left side.
Scoliosis of the middle thoracic spine to the left.
Elevation, ER and ABD of right scapula.
Scapulas are slightly apart from the spine.
Elevation of right shoulder with lateral flexion of the head to right side.

9.3 Muscle Trophy Evaluation

Anterior aspect:	Right ex.	Left ex.
Pectoralis major m.	Hypo trophy	Normal trophy
Deltoid (anterior) m.	Hypo trophy	Normal trophy
Biceps brachii m.	Normal trophy	Normal trophy
Lateral aspect:		
Deltoid (middle) m.	Hypo trophy	Normal trophy

Posterior aspect:		
Latissimus dorsi m.	Nomal trophy	Normal trophy
Rhomboideus m.	Hypo trophy	Hypotrophy
Triceps brachii m.	Hypotrophy	Normal trophy
Deltoid (posterior) m.	Hypo trophy	Normal trophy
Trapezius m.	Hyper trophy	Normal trophy

(1)

9.4 Palpation

9.4.1 Cutaneous & Sub cutaneous Level:

There is restriction of the skin around the scars of the right shoulder. Patient did not have pain during palpation in the area of the shoulder.

Restriction observed in the following areas of the skin and sub skin level:

- Deltoid muscle in caudal to cranial direction (greater in the anterior portion).
- Trapezius muscle in all direction with greater emphasis of upper part of the muscle.
- Around the clavicle in caudal to cranial and the opposite direction.
- Insertion of pectoralis major in the area of humerus, close to auxiliary fold.

9.4.2 Muscle Tone Evaluation

Triger points founded in the area of Trapezius m (upper part), deltoid m. (middle and anterior part), triceps brachii m and pectoralis major m.

Anterior aspect:	Right ex.	Left ex.
Pectoralis major m.	Hype rtone	Normal tone
Deltoid (anterior) m.	Hyper tone	Normal tone
Biceps brachii m.	Normal tone	Normal tone
Sternocleidomastoid m.	Hypertone	Hypertone

Lateral aspect:		
Deltoid (middle) m.	Hyper tone	Normal tone

Posterior aspect:		
Latissimus dorsi m.	Normal tone	Normal tone
Rhomboideus m	Hypo tone	Hypo tone
Triceps brachii m.	Hyper tone	Normal tone
Deltoid (posterior) m.	Hyper tone	Normal tone
Trapezius m.	Hypertrone	Normal tone

(2)

9.5 Breathing Examination

After examination observed upper thoracic breathing with decrease function of abdominal wall. Respiratory rate is 10 to 14 breaths per minute.

9.6 Pelvis Examination

Standing position:

Sagittal plane: Anterior tilt of pelvis

Coronal plane: Elevation of right iliac crest.
Elevation of right posterior superior iliac spine.
Elevation of right anterior superior iliac spine.

Lying position:

Coronal plane: Symmetrical iliac spines.
Symmetrical posterior superior iliac spines
Symmetrical anterior superior iliac spines.

9.7 Anthropometric Measurement

	Right ex.	Left ex.
Circumference of upper arm Measured in the middle of the distance between the acromion and olecranon	28 cm	29 cm
Circumference of forearm Measured in the place of highest volume	27 cm	27 cm
Length of upper extremity Measured from acromion to the tip of the third finger	80 cm	80 cm
Length of humerus Measured from acromion to the lateral epicondyle	37 cm	37 cm
Length of the forearm Measured from olecranon to the ulnar styloid process	27 cm	27 cm
Circumference of auxiliary fold Measured parallel from the anterior to posterior auxiliary line	48 cm	47 cm

(3)

Note: Circumference of auxiliary fold: Patient is in sitting position with slight abduction of shoulder joint. Therapist past the meter from axilla to the acromioclavicular joint and continues near to the auxiliary border

9.8 Range of motion examination

9.8.1 Shoulder Joint

Active movement:

Movements	Right ex.	Left ex.
EX, F	30-0-110	40-0-180
ABD	0-70	0-95
HADD, HABD	40-0-80	40-0-90
Rotary (ER-IR)	0-60	75-0-60

Passive movement:

Movements	Right ex.	Left ex.
EX, F	40-0-125	45-0-180
ABD	0-75	0-95
HADD, HABD	30-0-90	45-0-90
Rotary (ER-IR)	0-60	75-0-70

(4)

9.8.2 Elbow & Radioulnar Joint

Active movement:

Movements	Right ex.	Left ex.
EX, F	0-140	0-145
Rotary (S-P)	60-0-80	70-0-80

Passive movement:

Movements	Right ex.	Left ex.
EX, F	0-145	0-145
Rotary (S-P)	70-0-90	85-0-90

(5)

9.8.3 Wrist Joint

Active movement:

Movements	Right ex.	Left ex.
PF, DF	65-0-70	80-0-70
RD-UD	20-0-25	20-0-30

Passive movement:

Movements	Right ex.	Left ex.
PF, DF	75-0-70	90-0-80

RD-UD	20-0-30	20-0-30

(6)

9.9 Muscle Strength Tests (by Kendall)

Muscle groups	Grades	
Anterior aspect:	Right ex.	Left ex.
Pectoralis major m.	4	5
Deltoid (anterior) m.	4	5
Biceps brachii m.	4+	5
Serratus anterior m.	4	5
Coracobrachialis m.	3+	4+
Wrist flexors m.	5	5
Lateral aspect:	Right ex.	Left ex.
Deltoid (middle) m.	4-	5
Posterior aspect:	Right ex.	Left ex.
Latissimus dorsi m.	4	5
Rhomboideus m.	4	4+
Internal rotators of the cuff	3+	5
External rotators of the cuff	-	5
Triceps brachii m.	4	5
Wrist extensors	4+	5
Deltoid (posterior) m.	3+	4
Trapezius m.	5	5

(7)

9.10 Muscle Length test

Muscle groups	Evaluation	
Anterior aspect:	Right ex.	Left ex.
Pectoralis major m.	Short	Normal
Biceps brachii m.	Short	Normal
Serratus anterior m.	Short	Normal
Coracobrachialis m.	Short	Normal
Wrist flexors m.	Short	Short
Posterior aspect:		
Latissimus dorsi m.	Short	Normal
External rotators of the cuff	Normal	Normal
Triceps brachii m.	Short	Normal
Wrist extensors	Normal	Normal

(8)

9.11 Dynamic Tests

Flexion:

Normal mobility.
Patient touch with his tip fingers the ground.
Decrease range of motion during flexion in lumbar spine
Increase range of motion in thoracic segments with greater mobility in the middle part.
Scoliosis in the middle thoracic spine on the left side observed during examination.
Complain for pain in the right shoulder at the end of exercise.

Lateral flexion:

Hypomobility.
Decrease range of motion during lateral flexion in lumbar spine
Increase range of motion in thoracic segments.
Greater mobility in the left side, during lateral flexion.
Slight pain was present during the exercise on the right side.

Extension:

Normal mobility.
Increase range of motion during extension in lumbar spine with greater mobility
on the upper segments.
Decrease mobility on thoracic spine with flat curve in the middle segments.
Increase mobility observed in the cervical spine.

9.12 Gait Examination

Stance phase:

Greater loading on heels
Weight is divided on outer aspect of foot.
Greater loading on left lower extremity.
Remains for longer period during stance on left leg.
Slight lateral flexion of the trunk in the left side, especially during loading response and mid stance on the left leg.
Increase pelvis tilt on the right side when he loads his weight on the left leg.

Swing phase:

Great extension of toes during walking
Decrease knee flexion during mid swing.
Distance between initial to terminal swing is greater on the left leg.
Increase movement of pelvis during walking.
Slight asymmetry between contralateral upper and lower extremities.

Decrease movement of the trunk
Decrease movement of the right upper extremity with absence of movement in elbow joint.
Normal position of head

Note: During examination patient took of the cast. The evaluation of gait took place in the gym of the rehabilitation department. Patient did not complain for pain during walking.

9.13 Scale Test

Patient is standing in front of two scales. We instruct the patient to put his right lower extremity in the first scale and the left one to other scale. Important part of this test, is to adjust the distance of scales the scales according patient's stance. Then we ask from the patient to stay in standing position completely relaxed. Comparing the loading of the patients' weight on its scale we can estimate the result.

- Individual's Weight: 73 kg
- Scale 1 (right): 31 kg
- Scale 2 (left): 42 kg

There is great difference between the two scales. Weight is not divided equally as there is great loading on the left lower extremity due to protective mechanism with his upper extremity.

9.14 Neurological Examination

Superficial sensation
Normal sensation in the dermatomes of both upper extremities (C5,C6,C7,C8 Th1).

Deep tendon reflexes

	Right extremity	Left extremity
Biceps reflex:	normal	normal
Triceps reflex:	normal	normal
Brachioradialis reflex:	normal	normal
Finger jerk reflex:	normal	normal

Note: Superficial sensation examined by neurological pin and deep tendon reflexes with a neurological hummer.

9.15 Evaluation of Joint Play (by Lewitt)

9.15.1 Shoulder joint	Right extremity	Left extremity
Caudal direction	restriction	normal
Ventral direction	restriction	restriction
Dorsal direction	restriction	restriction
Lateral direction	restriction	normal

(9)

9.15.2 Acromioclavicular Joint	Right	Left
Ventral – dorsal direction:	restriction	restriction
Cranial – caudal direction:	restriction	restriction

(10)

9.15.3 Proximal Radioulnar Joint	Right extremity	Left extremity
Ventral direction:	normal	normal

(11)

9.15.4 Cervical Spine

Active movement:	Right	Left
Flexion	normal	
Extension	hyper mobility	
Lateral flexion	normal	hypomobility
Rotation	normal	hypomobiltiy
Passive movement	Right	Left
Rotation C0- C1	restriction	restriction
Lateral flexion CO- C1	restriction	restriction
Lateral flexion C1-C2 to C5-C6	restriction	normal

(12)

Note: During examination in passive lateral flexion every segment examined independently from C1 to C6. On the right side because of hypertonicity of upper trapezius m and long immobility of the head there was restrtiction in most of segments.

Cervical Spine

Palpation: Patient did not complain for inter spinal pain between cervical spinal processes.

Anterior direction CO-C1	normal
Anterior direction C2-C3 to C5-C6	normal
Posterior direction C2-C3 to C5-C6	normal

Lateral direction C2-C3 to C5-C6	normal (right)	restricted (left)

(13)

9.15.5 Cervical - Thoracic Spine

Palpation: Patient did not complain for inter spinal pain between thoracic spinal processes.

Joint play examination	Right side	Left side
Rotation C7-Th1	restriction	restriction
Lateral flexion C7- Th1	restriction	restriction
Ventral- dorsal C7-Th1	normal	

(14)

Note: Examination of rotation took place in sitting position while examination of lateral flexion took place in side lying position.

9.15.6 Thoracic Spine

Breathing: There was not sign of interrupted movement between the spinal processes during examination

Palpation: Patient did not complain for inter spinal pain between thoracic spinal processes.

Active movement examination

Flexion: There was blockage in upper thoracic spine (C8- Th1, Th1- Th2, Th2- Th3)
Extension: Blockage in upper thoracic spine. (C8- Th1, Th1- Th2, Th2- Th3)
Lateral flexion: In both sides there was restriction in upper and middle thoracic spine with greater emphasis to the right side.
Rotation: During providing patient had difficulty and limited range of motion with great blockage in Th – L crossing to right side.

10. Examination Conclusion

After finishing the examination, determined atrophy in the muscles around the shoulder joint. There was great muscle tension in pectoral muscle group and the anterior- medial side of deltoid muscle. Significant tension there was also in biceps brachii and brachioradialis muscles. Low and middle fixators of scapulas are weak in both sides with more observable the right one, as scapulas are founded in postural examination, abducted with slight elevation.

Range of motion in right shoulder is limited in all directions with flexion and abduction nearly reach 110 and 70 degrees separately with shoulder elevation and overusage of trapezius strernocleidomastoid muscles. External rotation did not examined as the surgeon has recommended to avoid it until 4th to 5th week after the surgery. There is limited elbow extension because of high tension in biceps brachii and moderate atrophy of triceps brachii. There is slight internal rotation of the proximal radio-ulnar joint. Muscles of the forearm are in physiological condition. Normal range of motion in the wrist joint.

According patient state, pain was sharp and intensive the first days after the surgery. In our department he complain during the examination only in maximal flexion and abduction of the shoulder joint. Also during dynamic test examination when he had to provide maximal flexion and lateral flexion. After joint play examination during active and passive lateral flexion in the left side i observe shortness of right sternocleidomastoid muscle. Also there was some restriction in the right shoulder but patient did not complain for pain.

After my evaluation, patient's shoulder does not have problem inside the capsule as he did not complain for pain during joint play examination. Muscles around the shoulder have became short and hypertonic and causes restriction during movement of the shoulder. There is atrophy in all muscles around the shoulder but mainly in deltoid m and muscles around the scapula. Trigger points was present most on right trapezius m, anterior side of deltoid m and pectoralis major m.

11. Rehabilitation Plan

Release the trigger points and decrease the hypertonicity in the muscles around the shoulder. Decrease of swelling in the anterior side of deltoid m. Manipulation of clavicular and cervicotharacic segments of the spine. Elongation of short muscles to increase the range of motion. Strengthening and stability exercises to increase muscle power for better fixation of scapula and shoulder joint.

11.1 Short Rehabilitation Plan

- ❖ Relief of pain in the area of the right shoulder
- ❖ Soft tissue and PIR technique in the muscles with hypertonicity to increase ROM in the shoulder joint.
- ❖ Strengthen the weak muscles to achieve better stability of shoulder.
- ❖ Strengthen lower fixators of right scapula.
- ❖ Mobilization in cervical and thoracic spine in restricted segments
- ❖ Mobilization in acromioclavicular and sternoclavicular joint.
- ❖ Tapping to decrease edema in the anterior side of deltoid muscle.

11.2 Long Rehabilitation Plan

- ❖ Teach the patient how to provide strengthening exercises to regain his muscle power in then right upper extremity.
- ❖ Exercises for right upper extremity in the gym to regain completely his muscle strength.
- ❖ Make exercises to decrease scoliosis in the left side.

12. Sessions
12.1 Therapy: 1
Date: 06/06/2011

Subjective Report

Patient come to our department, with his right upper extremity in a cast.
He feels restriction in the range of motion and stiffness inside the joint.
Pain is present During the day especially in the early morning hours and when he provides maximal movements (flexion abduction and extension) in the shoulder joint. According his statement pain is sharp and localized in the anteroior-midial side of deltoid muscle, near in acromioclavicular joint.

Today's Reexamination

Trigger point in trapezius m, pectoralis major m. and in the anterior side of deltoid m. near in the insertion of humerus. Hypertonicity in trapezius m, triceps and biceps brachii m. There is shortness of pectoralis major, biceps and triceps brachii muscles as in sternocleidomastoid m. Atrophy of deltoid and triceps brachii muscle is in great level.

Therapeutic Appraisal

Hypewrtonicity in trapezius m. Atrophy in the muscles of the arm. Fixators of scapula and muscles around the shoulder joint are in moderate to great weakness (low fixators of scapula, rhomboids m and latissimus dorsi m. pectoralis major, coracobrachialis and deltoid muscle. internal rotators of shoulder joint)

Today's Therapeutic Unit

Empowering of muscles of the arm with great emphasis in the deltoid m. Relaxation of muscles with great hypertonicity. Soft tissue technique in the scars to release the restricted skin layers. Local pressure in the areas with trigger point.

Therapeutic Procedure

- Muscle strengthening technique of deltoid m (isometric), pectoralis major and coracobrachialis m. (isometric), and triceps, biceps brachii m (isotonic).
- Soft tissue technique in the three scars, with greater emphasis in the anterior part of shoulder. In anterior side of deltoid m and trapezius m. to release the trigger points and hypertonicity.
- Soft tissue technique in biceps, triceps brachii and latissimus dorsi to release hypertonicity
- PIR technique in pectoralis major and trapezius muscle for relaxation.

- Ice pack for 10 min in the anterior–medial side of shoulder.

Note

Muscle strengthening technique of deltoid m (isometric). Patient is in supine position. His upper extremity stands along the body with slight abduction of shoulder joint and flexion of elbow joint in 90 degrees. Manual contact is in the lateral side of humerus above the elbow with ispilateral hand. Therapist provides horizontal force into adduction of shoulder joint while patient instructed to hold his arm firlmly and kept it away from his body. Duration of contaction is 2 to 5 sec with 8 to 10 repetitions.

Today's Result

There is great hypertonicity and trigger point in the anterior part of deltoid. After therapy there was very slight difference. There was satisfactory decrease hypertonicity of trapezius muscle. Range of motion into flexion slightly increased after PIR of pectoralis major m and soft tissue technique of latissimus dorsi m.

Shelf Therapy

Instruct patient to stay in standing position in front of a wall and try to make a half circle on it with his right hand. Scapula must be fixated with patient starting with his arm parallel along the body and gradually increase it into flexion and abduction with his fingers be in contact with the wall until a point that his not painful for him. This exercise mainly recommended to empower deltoid muscle.

Note: During soft tissue technique of deltoid and trapezius muscles patient complain for slight pain of the muscle in the area of contact because of great hypertonicity.

12.2 Therapy: 2
Date: 07/06/2011

Subjective Report

Today he feels his shoulder more unblocked and all extremity not as heavy as it was yesterday. Pain is still present in the first two hours after woke up.

Today's Reexamination

There is restriction in the shoulder joint with very slight difference in the range of motion of the shoulder into FL, ABD, EX and IR after the first day of therapy. Scars are reddish and edema is still present.

Therapeutic Appraisal

Tone has decreased since first session in trapezius and deltoid muscles but are still in hypertension. Significant atrophy in deltoid and triceps brachii muscles.

Today's Therapeutic Unit

Empowering of deltoid m and the rest muscles of the arm. Relaxation of muscles with great hypertonicity. Soft tissue technique in the scars to release the restricted fascias. Cold therapy at the end of the therapy to to reduce the sweeling in the shoulder.

Therapeutic Procedure

- ❖ Muscle strengthening technique of deltoid m (isometric), pectoralis major and coracobrachialis m. (isometric), triceps and biceps brachii m (isotonic)
- ❖ Soft tissue technique in the scars, in Latissimus dorsi m, in anterior side of deltoid muscle, biceps and triceps brachii muslces to release the hypertonicity. In addition soft tissue technique in trapezius m to release trigger points.
- ❖ PIR technique in pectoralis major, trapezius muscle, in brachioradialis m and flexors of the wrist joint for relaxation.
- ❖ Ice pack for 10 min in the anterior–medial side of shoulder.

Today's Result

Tonus decreased in trapezius m. Range of motion into extension increased after PIR in pectoralis major. There is very slight semi flexion in the elbow joint. Also flexion and abduction in the shoulder increased. Pain was not present during therapy except some irritation in the shoulder joint during PIR technique in pectoralis major.

Shelf Therapy

Instruct patient to stay in standing position in front of a wall and try to make a half circle on it with his right hand. Scapula must be fixated with patient starting with his arm parallel along the body and gradually increase it into flexion and abduction with his fingers be in contact with the wall until a point that his not painful for him.

12.3 Therapy: 3
Date: 08/06/2011

Subjective Report

Informed us that pain in the early morning hours has decreased. His head has greater range of motion in rotation to the left and he feels his right upper extremity lighter since first time.

Today's Reexamination

Range of motion in shoulder is in the same level as yesterday. Deltoid and triceps brachii still have some atrophy.

Therapeutic Appraisal

There are not trigger points in trapezius m but still, is in hypertension as the same as deltoid m. Edema has decrease since first session. Today i will use tapping in the anterior side of deltoid to decrease edema with my supervisor's assistance.

Today's Therapeutic Unit

Isotonic exercises for muscles of the arm. Relaxation of muscles with great hypertonicity. Soft tissue technique in the scars to release the restricted fascias. Taping in the anterior side of auxillary fold to decrease the edema.
Cold therapy at the end of the therapy to to reduce the sweeling in the shoulder.

Therapeutic Procedure

- ❖ Muscle strengthening technique of deltoid m (isometric) & (isotonic). Pectoralis major and coracobrachialis m. (isotonic), triceps and biceps brachii m (isotonic)
- ❖ Soft tissue technique in the scars, anterior side of deltoid muscle and trapezius m to release the trigger point and hypertonicity.
- ❖ Soft tissue technique in biceps, triceps brachii and Latissimus dorsi to release hypertonicity
- ❖ PIR technique in pectoralis major and trapezius muscle, brachioradialis m and flexors of the wrist joint.
- ❖ Tapping in the anterior part of auxiliary fold and deltoid muscle.
- ❖ Ice pack for 10 min in the anterior–medial side of shoulder.

Today's Result

Tonus significantly decreased in deltoid and trapezius m. Range of motion into extension increased after PIR in pectoralis major. Normal semi flexion in the elbow joint. Patient was more tired but he did not complain for pain during the therapy.
Deltoid and triceps brachii still need strengthening. Flexion and abduction increased in the shoulder joint.

Shelf Therapy

We started today isotonic contraction of deltoid muscle into flexion and abduction and i instruct the patient to stop the exercises wcich I recommend in the previous days because i prefer not to overload it.
Gravity induce PIR for pectoralis major without external rotation.

12.4 Therapy: 4
Date: 09/06/2011

Subjective Report

Day by day pain during morning hours decreases. Range of motion in shoulder joint has increased in all directions except external rotation.

Today's Reexamination

Range of motion has increased in the shoulder joint most, into flexion.
Deltoid and triceps brachii muscles needs still strengthening. Trapezius has almost normal tonus and edema has been decreased.

Therapeutic Appraisal

Today we will make joint play in cervical spine and acriomiclavicular joint., while the tape band will remain in the shoulder until tomorrow.

Today's Therapeutic Unit

Isotonic exercises for muscles of the arm. Relaxation of muscles with great hypertonicity. Mobilization in the segments of Crevical spine to increase the joint play between the restricted vertebraes. Mobilization of acromioclavicular joint to unblock the segment, so to increase the range of motion in the shoulder joint.
Cold therapy at the end of the therapy to to reduce the sweeling in the shoulder.

Therapeutic Procedure

- ❖ Muscle strengthening technique of deltoid m (isotonic). Pectoralis major and coracobrachialis m. (isotonic), triceps and biceps brachii m (isotonic)
- ❖ Soft tissue technique in anterior side of deltoid m, trapezius m,triceps brachii m and latissimus dorsi m. to release hypertonicity.
- ❖ PIR technique in pectoralis major and trapezius muscle for relaxation.
- ❖ Mobilization of CO-C1 into lateral flexion and ante – flexion.
- ❖ Mobilization of occiput and atlas into dorsal direction.
- ❖ Mobilization of lower cervical spine in dorsal direction.

- Mobilization from C2-C3 until C5-C6 in lateral flexion in both sides.
- Mobilization from C2-C3 until C5-C6 into rotation in both sides.
- Mobilization of first rib.
- Repetetive movements of acromioclavicular joint into ventro-dorsal and cranio-caudal directions from joint play technique.
- Ice pack for 10 min in the anterior–medial side of shoulder.

Today's Result

Range of motion in ABD, FL and EX increased after joint play of acromioclavicular joint. ROM of the head and neck is better into lateral flexion and roation. Hypertonicity of deltoid has decrased but it sill needs soft tissue technique. Triceps and latissimus dorsi muscle is reach in normal tonus. Pectoralis major, coracobrachialis deltoid and biceps brachii muscles has strengthen since first day. Patient did not complain for pain during joint play mobilization.

Shelf Therapy

Gravity induce PIR for pectoralis major without external rotation.
Isotonic contractions with a rubber for anterior part of deltoid and lightweight dumbbells for biceps and triceps brachii muscles.

Shelf Therapy Exercises

Biceps brachii: Patient is in sitting position with elbow joint in semi flexion . Holds with his right hand 4 to 5kg dumbbell and provides elbow flexion 100 to 110 degrees. This exercise recommended with 8 to 10 repetitions of 4 to 3 sets.

Triceps brachii:
In lying position to avoid over loading of trapezius m. Shoulder joint is in 90 degrees flexion, 90 degrees internal rotation and 90 degrees elbow flexion. (neutral position of horizontal abduction). Hold with his right hand 1 to 2 kg dumbbell and provides elbow extension for 8 to 10 times in 3 to 4 sets.

Deltoid (anterior portion):
In lying position to avoid over loading of trapezius m. With right upper extremity parallel along the body hold the grip of the medical rubber. The end grip of the rubber passes in his right foot or tighted in the end of the bed. Then patient provides flexion of shoulder joint until 90 degrees with slight semi flexion in elbow joint to avoid any overloading in the of lateral epicondyle of humerus. Repetitions are 8 to 10 and sets 3 to 4.

Note: I instruct the patient to make these exercises in these repetitions and sets at home but in case he feels tired in any muscle group from the above to stop it. PIR of pectoralis major muscle will took place after the exercises.

12.5 Therapy: 5
Date: 10/06/2011

Subjectve Report

When he woke up there was just some stiffness in the shoulder but it was not painful. In head and neck feels better during movement. Feels like, right arm has empowered during daily activities. He is little tired since yesterday because of the exercises at home. Range of motion is increasing day by day.

Today's Reexamination

Edema is not present by inspection, i can feel just slight swollen by palpation. Hypertonic muscles have almost reach normal tone.

Therapeutic Appraisal

Trapezius muscle has relaxed but we will continue soft tissue technique and PIR after every therapy because during the exercises muscle is overload it and needs relaxation afterwards. I removed the tape band. Today I will not make a lot of repetitions during exercises in deltoid and triceps brachii muscle because he feels tired. Instead of it i will make isometric and then isotonic contractions for the internal rotators of the shoulder. I will give him, self therapy exercises for 11/06/2011 to strengthen deltoid and triceps brachii muscle because from next week we will start exercises for stabilization of shoulder and scapula and I need those two muscle empowered. Also I will make mobilization techniques of cervicothoracic, thoracic spine and sternoclavicular joint.

Today's Therapeutic Unit

Continue with strengthening for muscles of the arm and internal rotators of the shoulder. Relaxation of muscles with hypertonicity. Mobilization in the segments of the lower Crevical and upper Thoracic spine to increase the joint play between the restricted vertebraes. Manipulation of sternoclavicular joint to incrase shoulder mobility.
Cold therapy at the end of the therapy to to reduce the sweeling in the shoulder.

Therapeutic Procedure

- Muscle strengthening technique of deltoid m (isotonic), pectoralis major and coracobrachialis m. (isotonic), triceps brachii m (isotonic)
- Muscle strengthening for internal rotators of the shoulder joint (isometric and isotonic).
- Soft tissue technique in anterior side of deltoid m and trapezius m to release hypertonicity.
- PIR technique in pectoralis major and sternocleidomastoid muscle.
- Joint play technique in the shoulder joint in caudal to cranial direction (in lying position), in ventral to dorsal direction (in lying position) and in lateral direction (in lying position)
- Mobilization of C/Th into rotation in both directions
- Mobilization of C/Th into lateral flexion in both sides.
- Mobilization of C/Th in ventral to dorsal direction
- Mobilization of C/Th in dorsal direction in sidelying.
- Traction of middle and lower thoracic area.
- Manipulation of sternoclavicular joint – springing into distraction..
- Ice pack for 10 min in the anterior–medial side of shoulder.

Note: Mobilization of C/Th into lateral flexion took place in side lying position.

Today's Result

Almost normal tonus in anterior and middle part of deltoid m. Muscle power during internal rotation is great. Range of motion into rotation lateral flexion of the trunk increased after Joint Play technique. He did not have any problem during breathing after the surgery but after manipulation of sternoclavicular joint and PIR of sternocleidomastoid m he feels different.

Shelf Therapy

I instruct him to fully relax today and to provide the following exercises on 11/06/2011 and then to relax also at 12/06/2011 because I need all muscle groups refreshed for new type of exercises. In the end of therapy I ask from the patient to provide the exercise for the posterior part of deltoid to reinsure that he will not have any pain or to provide it with external rotation.

Shelf Therapy Exercises

Biceps brachii:

Patient is in sitting position with elbow joint in semi flexion . Holds with his right hand 4 to 5kg dumbbell and provides elbow flexion 100 to 110 degrees.
This exercise recommended with 8 to 10 repetitions of 4 to 3 sets.

Triceps brachii:

In lying position to avoid over loading of trapezius m. Shoulder joint is in 90 degrees flexion, 90 degrees internal rotation and 90 degrees elbow flexion. (neutral position of horizontal abduction). Hold with his right hand 1 to 2 kg dumbbell and provides elbow extension for 8 to 10 times in 3 to 4 sets.

Deltoid (anterior portion):

In lying position to avoid over loading of trapezius m. With right upper extremity parallel along the body hold the grip of the medical rubber. The end grip of the rubber passes in his right foot or tied in the end of the bed. Then patient provides flexion of shoulder joint until 90 degrees with slight semi flexion in elbow joint to avoid any overloading in the of lateral epicondyle of humerus. Repetitions are 8 to 10 and sets 3 to 4.

Deltoid (middle portion):

This exercise is similar for the anterior part of the muscles with the only difference that patient instead of doing flexion of 90 degrees provides abduction in the same degrees. He is in lying position, upper extremity parallel along the body hold the grip of the medical rubber. The end grip of the rubber passes in his right foot or tighted in the end of the bed. Then patient provides abduction of shoulder joint until 90 degrees with slight semi flexion in elbow. Repetitions are 8 to 10 and sets 3 to 4.

Deltoid (posterior portion):

Lying on the bed. Right upper extremity is in internal rotation and adduction in shoulder joint, lying diagonally in the left hip holding the grip of the rubber. The end grip is tied on the left foot. Patient provides flexion with steady internal rotation trying to put the right arm away from the body.

12.6 Therapy: 6
Date: 13/06/2011

Subjectve Report

There was not pain during morning hours or during providing of the exercises. Mobility in the shoulder increasing day by day. Today he feels great and refreshed.

Today's Reexamination

Range of motion by inspection comparing both hands has increased in the right shoulder approximately 130 to 140 degrees in flexion and almost 90 in abduction. Extension has almost equal range with the left arm. Edema has been disappeared from the shoulder. I also ask him to provide gently external rotation with his elbow in 90 degrees flexion.

Therapeutic Appraisal

Patient did not complain for pain during reexamination, he just had some discomfort and stiffness during providing. During the exercises my estimation about the muscles around the shoulder is that have significantly strengthen.
Pectoralis major and biceps brachii have reach grade 5. Deltoid and triceps brachii muscle have reach 4+. Today we will make stabilization exercise for scapular and shoulder joint in the gym.

Today's Therapeutic Unit

Strengthening of deltoid m. pectoralis major m, cocracobrachialis m, triceps brachii m. and internal rotators of the shoulder. Exercises to achieve greater stability in the whole shoulder mechanism Relaxation in the musclss with hypertension.
Hydrotherapy after therapeutic procedure to relax the muscles of the shoulder.

Therapeutic Procedure

- Muscle strengthening technique of deltoid m (isotonic), pectoralis major, coracobrachialis m. (isotonic) and triceps brachii m (isotonic)
- Muscle strengthening for internal rotators of the shoulder joint (isometric and isotonic).
- Stabilization of the shoulder joint with a ball (1)
- Stabilization for shoulder and scapula on the ground (2)
- Soft tissue technique in anterior side of deltoid muscle and trapezius m...
- PIR in trapezius m.
- Localized hydrotherapy in the anterior and middle side of shoulder for 20 minutes.

Note:

(1) Exercise for stabilization of shoulder. Patient is in standing position with shoulder joint in 90 degrees of flexion and extension in elbow joint firmly holds a medicine ball which is in contact with a wall. Scapulas are fixated with depression. Then patient tries to put forward force with his arm to the wall and at the same time to control the ball not to fall down keeping his right scapula unshakeable in fixated.

(2) Exercise for stabilization of scapulas. Patient is sitting on four. Shoulder joint is in 90 degrees flexion in both extremities with extension in elbow joint and fingers firmly touch the ground. Trunk is parallel with ground with both hips in 90 degrees flexion. Knees are 4 to 5 cm above the ground in 90 degrees flexion with plantar flexors of toes activation to hold half of his body weight with his toes. The other half of his weight is loaded in his arms. We instruct the patient to look his self in a mirror and try to have straight back, activating the abdominals. Then, tries to transport all of his weight in the anterior side of his body and lean forward to hold it with his arms, while he remains with straight back and scapulas fixated.

Today's Result

During the exercise on the ground in the beginning, patient was afraid to load his right extremity. There is moderate weakness in the deep stabilization muscles of both scapulas with greater emphasis on the right one. Patient is tired. Today I will not give him shelf therapy exercises only PIR for pectoralis major and trapezius muscles.

Shelf Therapy

Gravity induced PIR of pectoralis major and trapezius muscles.

12.7 Therapy: 7
Date: 14/06/2011

Subjectve Report

Feels great, there is no pain during the day.

Today's Reexamination

Range of motion seems increasing day by day. I made muscle strength test in isometric contraction according Kendall to evaluate in which state supraspinatus and the rest external rotators muscles are after four weeks. He did not complain for pain during providing. Muscle strength test sawn that patient can hold some moderate resistance. Grade was estimated at 3+ to 4.

Therapeutic Appraisal

Today I prefer not to start muscle strengthen technique for external rotators. I will continue the same exercises as in therapy 6, 13/06 to empower the stabilizators of shoulder and fixators of scapulas. In addition some exercise for rhomboids m, lower and middle part trapezius m and posterior part of deltoid muscle.

Today's Therapeutic Unit

Strengthening of deltoid m, triceps brachii m. and internal rotators of the shoulder. Exercises to increase stability in the shoulder and scapula region. Soft tissue technique to release the hypertonicity of trapezius and deltoid muscles.
Hydrotherapy after therapeutic procedure to relax the muscles of the shoulder.

Therapeutic Procedure

- ❖ Muscle strengthening technique of deltoid m (isotonic), triceps brachii m (isotonic)
- ❖ Isometric contraction for rhomboideus muscles (1)

- Muscle strengthening for internal rotators of the shoulder joint (isometric and isotonic).
- Stabilization of the shoulder joint with a ball (2).
- Stabilization for shoulder and scapula on the ground (3).
- Soft tissue technique in anterior side of deltoid m. and trapezius m.
- PIR in trapezius m.
- Localized hydrotherapy in the anterior and middle side of shoulder for 20 minutes.

Note:

(1) Patient is sitting in a 90 degrees bench with straight back. His elbows are in 90 degrees flexion and shoulders are in 90 degrees abduction (horizontal abduction). Physiotherapist is standing behind the patient. Manual contact is on the posterior side of each elbow respectively. Then we push both elbows ventraly and we instruct the patient to put resistance in our force and keep the shoulders stable.

(2) Exercise for stabilization of shoulder. Patient is in standing position with shoulder joint in 90 degrees of flexion and extension in elbow joint firmly holds a medicine ball which is in contact with a wall. Scapulas are fixated with depression. Then patient tries to put forward force with his arm to the wall and at the same time to control the ball not to fall down keeping his right scapula unshakeable in fixated.

(3) Exercise for stabilization of scapulas. Patient is sitting on four. Shoulder joint is in 90 degrees flexion in both extremities with extension in elbow joint and fingers firmly touch the ground. Trunk is parallel with ground with both hips in 90 degrees flexion. Knees are 4 to 5 cm above the ground in 90 degrees flexion with plantar flexors of toes activation to hold half of his body weight with his toes. The other half of his weight is loaded in his arms. We instruct the patient to look his self in a mirror and try to have straight back, activating the abdominals. Then, tries to transport all of his weight in the anterior side of his body and lean forward to hold it with his arms, while he remains with straight back and scapulas fixated.

Today's Result

Today there was better response from the patient during the stabilization exercise. He is not afraid to load his right arm. Weakness is still present especially in the right side as scapula is facing upwards during the exercise.

Self therapy

I instruct the patient to do also both of the stabilization exercises at home because in the next session we will make several of these as I must give interest also in external rotation of the shoulder. I also advice him to make exercises for tricep brachii and deltoid muscle because they are still needs some strengthening.

Triceps brachii:

In lying position to avoid over loading of trapezius m. Shoulder joint is in 90 degrees flexion, 90 degrees internal rotation and 90 degrees elbow flexion. (neutral position of horizontal abduction). Hold with his right hand 1 to 2 kg dumbbell and provides elbow extension for 8 to 10 times in 3 to 4 sets.

Deltoid (middle portion):

This exercise is similar for the anterior part of the muscle with only difference that patient instead of doing flexion of 90 degrees provides abduction in the same degrees. He is in lying position, upper extremity parallel along the body hold the grip of the medical rubber. The end grip of the rubber passes in his right foot or tighted in the end of the bed. Then patient provides abduction of shoulder joint until 90 degrees with slight semi flexion in elbow. Repetitions are 8 to 10 and sets 3 to 4.

Gravity induced PIR of pectoralis major and trapezius muscles.

12.8 Therapy: 8

Date: 15/06/2011

Subjectve Report

Patient made all of his exercises at home. He feels tired. Day by day he regain his confidence.

Today's Reexamination

After my reexamination, we provide active and passive movement into external rotation. Internal rotators of the shoulder joint are very short as external ratotors are weak. Reason which is causing limited range of motion into active external rotation. Passive movement has greater range. I observe that he felt discomfort in the maximal range of the movement as there was some irritation in the end of movement.

Note: I did not use goniometer during the examination of ER and IR. My assessment was during therapeutic process by aspection.

Therapeutic Appraisal

We will make several stabilization exercises and Isometric exercise for the external and internal rotators of shoulder according Kendall. According patient he did not complain for pain during reexamination. I will continue with PIR technique in external rotation and I will avoid to make relaxation technique for the internal rotators.

Today's Therapeutic Unit

Strengthening of internal and external rotators of the shoulder by isometric contractions. Exercises to increase stability in the shoulder. Relaxation of muscles with hypertonicity with great emphasis in external rotators of the shoulder.
Hydrotherapy after therapeutic procedure to relax the muscles of the shoulder.

Therapeutic Procedure

- ❖ Isotonic contraction for external, internal rotators and isometric contraction for rhomboideus muscles (1) (by Kendall)
- ❖ Muscle strengthening for internal rotators of the shoulder joint (isotonic).
- ❖ Stabilization of the shoulder joint with a ball (2).
- ❖ Soft tissue technique in anterior side of deltoid m and trapezius m.
- ❖ PIR technique in sternocleidomastoid m, trapezius and internal rotator muscles.
- ❖ Localized hydrotherapy in the anterior and middle side of shoulder for 20 minutes.

Today's Result

Range of motion in shoulder joint has almost reach the physiological state in FL, ABD, EX and IR. After PIR technique there was significant difference as range of motion external rotation increased and patient did not complain for pain.

Self Therapy

For shelf therapy I gave him the following isotonic exercise for the external rotators of the shoulder joint, as my estimation in muscle strength is between 3+ to 4. I ask him in case he feels pain or irritation in the shoulder to stop the exercise or PIR technique and we will continue with strengthening in the next therapy. I also advice him in case he did not feel tired to make the stabilization exercise with the ball.

Strengthening of external rotators:

Patient is sitting in a chair with both arms adducted parallel to the trunk. Elbows are in 90 degrees flexion. With one hand holds the one end of the medical rubber and with the other hand the other end. Patient provides external rotation in the shoulder joint in both upper extremities and simultaneously stretches the rubber to increase the resistance. Elbows must be stay flexed and arms in adduction in a contact with the trunk during the whole exercise. Repetitions must be around 8 to 10 in 4 sets.

Gravity induced PIR for the external rotators. (according Lewitt)
Gravity induced PIR for trapezius muscle. (according Lewitt)

12.9 Therapy: 9
Date: 16/06/2011

Subjectve Report

There was not pain during the exercises for external rotation in the previous day. Feels great as he has improve his strength and range of motion in the shoulder. That gives him motivation to work harder in every session.

Today's Reexamination

Range of motion, during active external rotation has slightly increased as internal rotators of the shoulder joint are still short inaf. In passive external rotation he still feels some irritation when he reaches the maximal range of the movement.

Therapeutic Appraisal

I will continue with isotonic exercise for the external and internal rotators of shoulder as yesterday he did not complain for pain during shelf therapy exercises. I provide active and passive movement into external rotation. Today I instruct him to provide the first and second flexion pattern for upper extremities from PNF technique to observe if he will complain for pain during maximal flexion. He complain for stiffness only in the end of movement during the second flexion pattern as he make maximal flexion and external rotation. For this reason we will make stabilization for shoulder and scapulas exercises and the first flexion pattern from PNF technique.

Today's Therapeutic Unit

Strengthening of internal and external rotators of the shoulder by isometric contractions. PNF technique for strengthening of the whole upper extremity.Exercises to increase stability in the shoulder and scapula. Soft tissue and relaxation technique in muscles with hypertonicity with. PIR for internal rotators.
Hydrotherapy after therapeutic procedure to relax the muscles of the shoulder.

Therapeutic Procedure

- ❖ Isotonic contraction for external, internal rotators and isometric contraction for rhomboideus muscles (1) (by Kendall)
- ❖ PNF technique, first flexion pattern. Slow reversal hold technique (by Kabat)
- ❖ Stabilization of the shoulder joint with a ball (2).
- ❖ Stabilization for shoulder and scapula on the ground (3)
- ❖ Soft tissue technique in trapezius m and in anteromidial side of deltoid m.
- ❖ PIR in trapezius m. pectoralis major m and internal rotators.

- ❖ Localized hydrotherapy in the anterior and middle side of shoulder for 20 minutes.

Today's Result

I am very satisfied with his progress. He is making a lot of effort in all exercises. He did not complain for pain or discomfort during PNF technique although he has some fatigue after today's session. Muscle power has increased in the fixators of both scapulas as he can load his weight on his arms without scapulas apparently go upwards.

Self therapy

I will not give him any exercise to do at home because he puts great effort today and I need to relax those muscles which took part in these exercises.
Gravity induced PIR for the external rotators. (according Lewitt)
Gravity induced PIR for trapezius muscle. (according Lewitt)
Gravity induced PIR for pectoralis major. (according Lewitt)

12.10 Therapy: 10
Date: 17/06/2011

Subjectve Report

He regains a great amount from his physiological muscle strength.
Pain is not present during the day. Range of motion of the right arm seems equivalent with the left one with only difference between them some stiffness during maximal external rotation and internal rotation.

Today's Reexamination

External rotation of the shoulder joint has increased since the 8th therapy. Pain during passive movement into lateral rotation has almost vanished. Joint play of the shoulder joint was slight restricted during ventral – dorsal and lateral directions.

Therapeutic Appraisal

Today I will work with the stabilization exercise on the ground to reinsure that patient can provide it without dealing any problems because this is one of the exercises that I will give him afterwards as a shelf therapy. Then we will continue with PNF technique and muscle strengthening exercises for deltoid muscle.
Today's Therapeutic Unit

Exercises for muscle strengthening of deltoid and rhomboideus muscles. PNF technique to empower the whole extremity. Mobilization of the shoulder joint to release any restriction that may have created after 10 days of therapy due to everyday loading in the shoulder. Relaxation of muscles with hypertension.

Therapeutic Procedure

- Isotonic contraction technique for deltoid muscle middle portion (4) and isometric contraction for rhomboideus muscles (1)
- PNF technique, first flexion pattern. Slow reversal hold technique (by Kabat)
- Stabilization for shoulder and scapula on the ground (3)
- Mobilization technique in the shoulder in ventral to dorsal direction (in lying position) and in lateral direction (in lying position)
- Repetetive movements of acromioclavicular joint into ventro-dorsal and cranio-caudal directions from joint play technique
- Manipulation of sternoclavicular joint – springing into distraction
- Traction of middle and lower thoracic spine
- Soft tissue technique in trapezius m and in anterior and middle part of deltoid.
- PIR technique in trapezius muscle m, in sternocleidomastoid m and in pectoralis major m.

Today's Result

After isotonic contraction exercise my estimation about the right deltoid is that muscle has reach grade 5 as I used great resistance and patient was capable to make abduction without significant use of trapezius muscle. I also made joint play technique in the shoulder joint as in acromioclavicular and sternoclavicular joint to release some blokages after all this period of exercises.

Note;

(4) Patient is sitting in a chair with arms along the body and elbows are in 90 degrees flexion. Each of my hand has manual contact on the lateral side of the elbows respectively (in the area of lateral epicondyle of humerus). Then I ask from the patient to make 90 degrees abduction in the shoulder joint while I put resistance with my hands on his elbows in caudal direction to make him activate deltoid muscle. During the exercise patient has been taught to keep the shoulders down with scapulas fixated to avoid overloading of trapezius muscle. Repetitions are 8 to 10 in 3 to 4 sets.

Self Therapy

I instruct him to make these exercises during the weekend and from next week I will give him instructions for exercises with dumbbells as deltoid and the orther muscles around the shoulder have empowered.

Deltoid (anterior portion):

In lying position to avoid over loading of trapezius m. With right upper extremity parallel along the body hold the grip of the medical rubber. The end grip of the rubber passes in his right foot or tied in the end of the bed. Then patient provides flexion of shoulder joint until 90 degrees with slight semi flexion in elbow joint to avoid any overloading in the of lateral epicondyle of humerus. Repetitions are 8 to 10 and sets 3 to 4.

Deltoid (middle portion):

This exercise is similar for the anterior part of the muscles with the only difference that patient instead of doing flexion of 90 degrees provides abduction in the same degrees. He is in lying position, upper extremity parallel along the body hold the grip of the medical rubber. The end grip of the rubber passes in his right foot or tighted in the end of the bed. Then patient provides abduction of shoulder joint until 90 degrees with slight semi flexion in elbow. Repetitions are 8 to 10 and sets 3 to 4.

Deltoid (posterior portion):

Lying on the bed. Right upper extremity is in internal rotation and adduction in shoulder joint, lying diagonally in the left hip holding the grip of the rubber. The end grip is tied on the left foot. Patient provides flexion with steady internal rotation trying to put the right arm away from the body.

Stabilization for shoulder and scapula on the ground (3)
Gravity induced PIR for the external rotators. (according Lewitt)
Gravity induced PIR for trapezius muscle. (according Lewitt)
Gravity induced PIR for pectoralis major. (according Lewitt)

13 Final Kinesiology Examination

13.1 Inspection

Edema has disappeared from the anterior and middle side of shoulder. There is no redness in the skin around the shoulder. Shoulders are in the same level with slight lateral flexion of the head in the right side.

13.2 Postural Examination

From anterior side there is no significant dissimilarity between the right and left side. Shoulders and clavicle are in the same level. There is still some slight difference in the trophy of the muscles (pectoralis major, anterior and middle portion of deltoid) between the right and left arm. Asymmetry in thoracohumeral triangles decreased significantly as patient did not keep the protection mechanism that he used to have after the surgery with his right arm.

From lateral side, between the two sides, as I mention previously there is slight deference in muscle trophy in the middle and posterior side of deltoid and triceps brachii. On the right side there is not semi flexion of elbow. Hyperkyphosis on the thoracic spine decreased after stabilization exercises, as fixators of scapula empowered. There still protraction of head.

On posterior side there is still scoliosis in the middle thoracic spine to the left side. Right scapula is slightly higher from the left one. Trophy of the muscles around the right scapula and rhomboid muscles has increased but still are consider hypotrophic. Scapulas seem in harmony with the spine as they are better fixated. Finally, position of the head is almost neutral in contrast with the initial examination were the head was in lateral flexion to the right.

13.2.1 Muscle Trophy Evaluation

Anterior aspect:	Right ex.	Left ex.
Pectoralis major m.	Normal trophy	Normal trophy
Deltoid (anterior) m.	Normal trophy	Normal trophy
Biceps brachii m.	Normal trophy	Normal trophy
Lateral aspect:		
Deltoid (middle) m.	Normal trophy	Normal trophy
Posterior aspect:		
Latissimus dorsi m.	Normal trophy	Normal trophy
Rhomboideus m.	Hypotrophy	Hypotrophy
Muscles around scapula.	Hypotrophy	Normal trophy
Triceps brachii m.	Hypotrophy	Normal trophy
Deltoid (posterior) m.	Hypotrophy	Normal trophy
Trapezius m.	Normal trophy	Normal trophy

(15)

13.3 Palpation

Cutaneous & sub cutaneous level:

In skin and sub skin layers there is still moderate stiffness in the trapezius m and in the region from the anterior side of auxiliary fold.

13.3.1 Muscle Tone Evaluation

Trigger point are not present in trapzius, triceps and pectoralis major muscles. There is still some slight stiffness in both layers of deltoid m, as also the tone of the muscle I would say that still needs some soft tissue technique.

Anterior aspect:	Right ex.	Left ex.

Pectoralis major m.	Normal tone	Normal tone
Deltoid (anterior) m.	Hyper tone	Normal tone
Biceps brachii m.	Normal tone	Normal tone
Lateral aspect:		
Deltoid (middle) m.	Normal tone	Normal tone
Posterior aspect:		
Latissimus dorsi m.	Normal tone	Normal tone
Rhomboideus m.	Normal tone	Normal tone
Muscles around scapula.	Normal tone	Normal tone
Triceps brachii m.	Normal tone	Normal tone
Deltoid (posterior) m.	Normal tone	Normal tone
Trapezius m.	Normal tone	Normal tone

(16)

13.4 Pelvis Examination

In this test I found that deviation between iliac spine decreased. The right posterior and anterior superior iliac spines are almost in the same level with the left ones. This result showed me that my patient used to have protection mechanism of his right arm for more than 3 weeks. This turns me as a result, that for so long he was loading more in the left side, having the tendency to bend the whole body to the left with elevation of pelvis and lateral flexion of the trunk.

13.5 Anthropometric Measurement

Important point in this measurement was that circumference of right upper arm increased from 28 cm to almost 29 cm which means that muscle trophy increased in the muscles of the forearm. In addition, circumference of auxiliary fold decreased from 48 cm to 46, 5 cm. Result which shows that edema has disappear from the anterior side of shoulder and auxiliary fold.

13.6 Range of Motion Examination

I was very satisfied after ROM examination as he managed to reach 180 degrees in flexion of shoulder joint. However I will mention that during active flexion of shoulder joint there was great activation of right trapezius muscle. Which refers to the fact that, he still needs great work to regain his physiological state in the right shoulder.

Also external rotation is limited, reaching approximately to 55 degrees. Needs exercises to strengthen the external rotators of the shoulder and combination of relaxation and stretching techniques to increase the range of movement.

13.6.1 Shoulder joint

Active movement:

Movements	Right ex.	Left ex.
EX, F	40-0-180	40-0-180
ABD	0-85	0-95
HADD, HABD	40-0-90	40-0-90
Rotary ((ER-IR)	50-0-55	75-0-60

Passive movement:

Movements	Right ex.	Left ex.
EX, F	45-0-180	45-0-180
ABD	0-90	0-95
HADD, HABD	30-0-90	45-0-90
Rotary (ER-IR)	60-0-60	75-0-70

(17)

13.6.2 Elbow & Radioulnar joint

Active movement:

Movements	Right ex.	Left ex.
EX, F	0-140	0-145
Rotary (S-P)	60-0-80	70-0-80

Passive movement:

Movements	Right ex.	Left ex.
EX, F	0-145	0-145
Rotary (S-P)	70-0-90	85-0-90

(18)

13.7 Muscle Strength Tests (by Kendall)

In this critical examination I manage to strengthen all the muscle groups were related with the movement of the shoulder joint. Most of muscles were estimated in the tests with grade: 5. However, to be more specific, because my patient used to be a sportsman requires more work out to be able to attain and reach his optimal muscle force. For this reason I advice him to continue some of the self therapy exercises at home, plus to start a work out in a gym with a personal trainer.

Muscle groups	Grades	
Anterior aspect:	Right ex.	Left ex.
pectoralis major m.	5	5
Deltoid (anterior) m.	5	5
Biceps brachii m.	5	5
Serratus anterior m.	5	5

Coracobrachialis m.	4+	4+
Wrist flexors m.	5	5
Lateral aspect:	Right ex.	Left ex.
Deltoid (middle) m.	5	5

Posterior aspect:	Right ex.	Left ex.
Latissimus dorsi m.	5	5
Rhomboideus m.	5	4+
Internal rotators of the cuff	4+	5
External rotators of the cuff	4	5
Triceps brachii m.	5	5
Wrist extensors	4+	5
Deltoid (posterior) m.	4	4
Trapezius m.	5	5

(19)

13.8 Muscle Length test

Muscle groups	Evaluation	
Anterior aspect:	Right ex.	Left ex.
Pectoralis major m.	Normal	Normal
Biceps brachii m.	Normal	Normal
Serratus anterior m.	Normal	Normal
Coracobrachialis m.	Normal	Normal
Wrist flexors m.	Short	Short
Posterior aspect:		
Latissimus dorsi m.	Normal	Normal
External rotators of the cuff	Normal	Normal
Triceps brachii m.	Normal	Normal
Wrist extensors	Normal	Normal

(20)

13.9 Dynamic Tests

In the initial examination, patient had complained for localized pain inside the shoulder joint during flexion and lateral flexion. In the final examination he informed me that pain disappeared. Scoliosis in the middle thoracic spine is still present. Mobility during lateral flexion on the right side increased.

13.10 Gait Examination

During walking I observe that trunk is firmly straight and he does not try to protect his right arm. In Stance phase I still think that he remains for longer period on his left leg but it is slight observable. Division of his weight is almost equal as in the initial examination was great visible that he was loading more on the left leg.

In Swing phase, there is better harmony between contra lateral arm and leg. There is fluent movement in the shoulder and elbow joint. Also movement of the pelvis and trunk increased.

13.11 Scale Examination

- Individual's Weight: 73 kg
- Scale 1 (right): 35 kg
- Scale 2 (left): 38 kg

The difference between the two scales is evaluated as normal.

13.12 Evaluation of Joint Play (by Lewitt)

13.12.1 Shoulder joint

There was not blockage in the whole right extremity, shoulder and acromioclavicular joint had physiological mobility in all directions, without patient complain for pain or irritation.

Shoulder joint	Right extremity	Left extremity
Caudal direction	normal	normal
Ventral direction	normal	restriction
Dorsal direction	normal	restriction
Lateral direction	normal	normal

(21)

Acromioclavicular joint	Right	Left
Ventral – dorsal direction:	normal	restriction
Cranial – caudal direction:	normal	restriction

(22)

Acromioclavicular joint	Right extremity	Left extremity
Ventral direction:	normal	normal

(23)

13.12.2 Cervical Spine

Lateral flexion of cervical spine improved into left side as the right Trapezius and sternocleidomastoid muscles released from the great hypertonicity. Although, restriction is still present in atlanto-accipital joint lateral flexion.

Active movement:	Right	Left
Flexion	normal	

Extension	hypermobility	
Lateral flexion	normal	normal
Rotation	normal	normal

Passive movement :	Right	Left
Rotation C0- C1	normal	normal
Lateral flexion CO- C1	normal	normal
Lateral flexion C1-C2 to C5-C6	normal	normal

Anterior direction CO-C1		normal
Anterior direction C2-C3 to C5-C6		normal
Posterior direction C2-C3 to C5-C6		normal
Lateral direction C2-C3 to C5-C6	normal (right)	restricted (left)

(24)

13.12.3 Cervical - Thoracic Spine

I did not find restriction in the segments of C7 and Th1 in lateral flexion. There was still blockage in the rotation between these segments to the right side.

Joint play examination	Right side	Left side
Rotation C7-Th1	restriction	normal
Lateral flexion C7- Th1	normal	normal
Ventral- dorsal C7-Th1	normal	

(25)

Note: Examination of rotation took place in sitting position while examination of lateral flexion took place in side lying position.

13.12.4 Thoracic Spine

In the last therapy I made traction in the middle and lower thoracic area because he had intensive schedule the whole week and I should release the vertebras in case of possible blockage between them.

During the examination I did not find restriction in the following directions except rotation, were the was blockage in both side.

Active movement examination

Flexion: unblocked
Extension: unblocked.

Lateral flexion: unblocked
Rotation: blocked in both sides with greater restriction on the right side (Range of motion of Th – L crossing is still limited)

14. Final Examination Conclusion

After 10 therapeutic sessions I made reevaluation to estimate the progress of patient's state. Three weeks of recovery after surgery patient came to our Rehabilitation center with great atrophy and weakness in the muscles around the shoulder joint. More specific, significant atrophy observed in deltoid m., triceps bachii m, in the low and middle fixators of scapula and pectoralis major muscle.
Hypertension founded in the same muscle groups plus sternocleidomastoid muscle. I followed soft tissue and PIR (by Lewitt) techniques as methods to release the hypertonicity and muscle strengthening techniques (by Kendall) to empower the weak muscles. All of the above muscle groups release with great success, helping at the same time to increase the range of motion in the shoulder. At the same time empowering of deltoid m. by strengthening and PNF techniques (according Kendal and Kabat) increase his power. Allowing to him, increase the range of motion in the shoulder, especially in flexion and abduction.

Edema was present in the anterior side of auxiliary fold. It vanished after 4th to 5th therapy after taping technique. Pain was present when patient reached maximal range of motion in the shoulder in all directions or during early morning hours. After the 5th to 6th session he did not complain for pain during morning hours and from the 7th therapy he started cautious to provide external rotation always under my supervision and until his pain threshold.

In addition, Shelf therapy indications and exercises, will motivate him to work out during the rest of the day, helping him to reach faster the desirable results.
Flexion in the shoulder joint reached from 110 to 180 degrees, abduction reached from 70 to 90 degrees while extension reached from 30 to 45 degrees. Internal rotation remained at 55 degrees. In the last therapies I worked to improve external rotation reaching it in 50 degrees in the shoulder.

In the final examination I also noticed, after Scale test, Pelvis examination, Dynamic tests and Gait examination, that he improved his posture alignment. His weight is divided equally in both sides after he overcame the protective mechanism that he used to have after the surgery. Trunk is straight with scapulas fixated near to the spine. Iliac crests are almost in the same level. There is movement synchrony, in the upper and lower extremities during waling.

15. Prognosis

Patient requires more therapeutic sessions to be able to reach in his physiological state. His shoulder joint still needs strengthening because he is a young, active person and his daily requirements are demanding. Thus, he should follow the exercises which I gave him at home. Exercises for stabilization of shoulder and scapula are important to increase his strength in the middle and low fixators of scapula. Medical rubber is also helpful for empowering all parts of deltoid muscle. Later one, he can also use dumbbells for strengthening or have some session in a gym with a personal trainer to take a program for muscle strengthening in the shoulder.

Finally, I believe that he was very cooperative patient, following respectfully our instructions. He is a positive, active person and I am sure that he will make all possible efforts to be able to achieve his goals.

16. Abbreviation

F: Flexion	EX: Extension
ABD: Abduction	ADD: Adduction
HABD: Horizontal Abduction	HADD: Horizontal Adduction
IR: Internal Rotation	ER: External Rotation
RD: Radial Duction	UD: Ulnar Duction
S: Supinaiton	P: Pronation
PF: Plantar Flexion	DF: Dorsal Flexion

ROM: Range of Motion

C: Cervical segments

Th: Thoracic segments

C-Th: Cervico- thoracic segments

Th- L: Thoraco- lumbar segments

MRI: Magnetic Resonance Image

PIR: Post Isometric Relaxation Technique (by Lewitt)

PNF: Proprioceptive Neuromuscular Facilitation (by Kabat)

17. Table Content

18. Figure Content

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