"EVALUATION OF ROTATOR CUFF PATHOLOGIES WITH MRI"

By

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LIST OF ABBREVIATIONS USED

MRI	–	magnetic resonance imaging
CT	-	computed tomography
T1W	–	T1 weighted
T2W	–	T2 weighted
PD	–	Proton density
STIR	-	Short T1 Inversion Recovery
GRE	-	Gradient Echo.
FSE	–	Fast spin echo.
FS	–	fat saturated.
M	–	Male
F	–	Female
RF	–	radiofrequency
TR	–	Time to repeat
TE	–	Time to echo
FOV	-	Field Of View
AC joint	-	Acromioclavicular joint.
AHD	–	Acromiohumeral distance.
CHD	–	Coracohumeral distance.

ABSTRACT

Shoulder joint with its multi directional movement, has the widest range of movements among all the joints in the body. Various muscles, tendons, ligaments around the joint make this type of movements possible with substantial stability to the joint of these multiple shoulder stabilizers, rotator cuff tendons play a crucial role. Among the various modalities of imaging, MRI provides a better depiction of the soft tissues of the shoulder joint.

A descriptive MRI Study was undertaken in 50 patients admitted to Shri B.M Patil medical college and research center with suspected rotator cuff pathology. These patients were subjected to MR imaging at our Department from October 2013 to July 2015. All the MRI scans in this study were performed using 1.5 T MRI scanner (Phillips achieva). The purpose of this study was to describe the magnetic resonance imaging features of rotator cuff pathologies and to examine the influence of age, gender on rotator cuff pathologies among the study population.

In this study population the age range was between 19 and 78 years with a mean of 52.10 $\pm$ 2.08 and peak prevalence in the sixth and the seventh decade of life. The incidence of predisposing factors for rotator cuff tears also increase with age, as seen in the study type II &III acromions, acromioclavicular joint arthropathies, osteophytosis/spurs are common in the sixth and seventh decade of life. The gender distribution being almost equal with males constituting 54% and females constituting 46% in the study group.

Pain and stiffness were commonest presenting complaints in the patients with rotator cuff abnormality of affected shoulder joint.

The most commonly affected tendon was the supraspinatus tendon, followed by the subscapularis, infraspinatus and the least being teres minor tendon.

About 42% of the patients showed presence of biceps tendon abnormality along with cuff abnormalities.

Tendinopathies and partial tears were more common than the full thickness tear in this study. Among the partial tears articular surface tears are more common.

Type II & III acromion, anterior downsloping acromion were more frequently encountered with abnormal supraspinatus tendon.

A coracohumeral distance more than 10mm was more common with normal subscapularis tendon and this distance less than 6mm more frequent with abnormal tendon.

An acromiohumeral distance more than 10mm was more common with normal supraspinatus tendon and this distance less than 7mm more frequent with an abnormal supraspinatus tendon.

Presence of joint effusion and bursal are more common with abnormal cuff tendons and are good pointer for the presence of cuff lesions especially tears.

MRI provides good delineation of the tendon status along with information regarding the adjacent structures. Thus provides good insight about the management plan more suitable for the patient.

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1. INTRODUCTION

The shoulder joint is an elegant anatomic structure formed by the humerus, clavicle and the scapula; its range of motion exceeds all other joints, yet under most circumstances, it is stable. The shoulder complex comprises of three joints namely the sternoclavicular, acromioclavicular, and glenohumeral joints. The sternoclavicular joint and the acromioclavicular joint link the two bones of the pectoral girdle to each other and to the trunk. The combined movements at these two joints enable the scapula to be positioned over the thoracic wall with a wide range of movement of the upper limb.[1]

The acromioclavicular joint is a small synovial joint between a small oval facet on the medial surface of the acromion and a similar facet on the acromial end of the clavicle.

It allows movement in the anteroposterior and vertical planes together with some axial rotation.[1]

The glenohumeral joint is a synovial ball and socket articulation between the head of the humerus and the glenoid cavity of the scapula. Movements at the joint include flexion, extension, abduction, adduction, medial rotation, lateral rotation, and circumduction.

The shoulder joint is multiaxial with a wide range of movements provided at the cost of skeletal stability. Joint stability is provided by surrounding muscle tendons forming the rotator cuff, the long head of the biceps brachii muscle, a skeletal arch formed superiorly by the coracoid process and acromion and the extracapsular ligaments[1]

The rotator cuff muscles are namely supraspinatus, infraspinatus, subscapularis and teres minor. Tendons of these muscles blend with the joint capsule and form a musculotendinous collar that surrounds the posterior, superior and anterior aspects of the glenohumeral joint. This cuff of muscles stabilizes and holds the head of the humerus in the glenoid cavity of the scapula without compromising the arm's flexibility and range of motion. The tendon of the long head of the biceps brachii muscle passes superiorly through the joint and restricts upward movement of the humeral head on the glenoid cavity.

The common disorders involving the rotator cuff tendons include impingement and tendinopathy. It is a dynamic process leading on from degeneration to tears in these tendons. There is an emerging consensus that the rotator cuff pathologies are multifactorial – Extrinsic & Intrinsic mechanisms.[2] Microtrauma causing stress on the tendon leading on to microtear is the basis of extrinsic mechanism.[2]According to the intrinsic mechanism, degeneration of the tendon and zones of critical vascularity predisposes tear in the tendon even on low energy mechanism.

The factors which aid on to this progress including age, occupation, trauma, acromion type, slope & position, acromio-clavicular joint degeneration, proximal migration of the humeral head, bony spurs compressing on the tendons.

The most commonly affected rotator cuff tendon being the supraspinatus. The tears are further classified as complete/full thickness and partial tears depending on the involvement of the whole or part of the tendon.

Being one of the most important stabilizer of the shoulder joint, rotator cuff pathologies can cause major joint dysfunction, like stiffness, restricted/painful joint movements even to the extent of restricting daily activities.

A thorough understanding of the anatomy and function of the rotator cuff and of the consequences of rotator cuff disorders is essential for optimal treatment planning and prognostic accuracy. Identifying the disorder, understanding the potential clinical consequences and reporting all relevant findings at rotator cuff imaging are also essential.[3]

Various imaging modalities are currently available for evaluating shoulder joint particularly the rotator cuff pathologies including conventional radiography, ultrasonography, computed tomography, magnetic resonance imaging and arthrography.

Conventional radiography and CT give valuable information regarding the bones forming the joints like degenerative changes in the bones and joints, osteophytosis, spur formations. They also provide better assessment of acromio-humeral distance and coraco-humeral interval, reduction of which cause impingement of the underlying tendons. Calcifications of the tendons secondary to degeneration are better appreciated in radiography and computed tomography.

USG & MRI can provide good assessment of the soft tissue structures around the shoulder joint especially the cuff tendons. Assessment using USG and MR has shown almost similar results.[4] Sonography has the advantage of dynamic real time assessment, but USG is very operator dependent.

MRI has good spatial resolution for assessment of soft tissue, to identify tendon edema & tear in the muscle cuff. Classification of tears is also more conspicuous using MR. It also has additional advantages of providing good multiplanar delineation even without contrast and absence of radiation hazards. In addition to detailed information regarding cuff defects, MRI also provides information about adjacent structures, muscle atrophy, size of muscle cross-sectional area, and fatty degeneration which have implications for the physiologic and mechanical status of the rotator cuff.[3] Artifacts generated by respiratory and cardiac motion are not a problem in MRI of the joints as they are in MR scanning of the body.[5]

MR Arthrography has the advantage of providing excellent delineation of ligaments, labrum and the rotator cuff tears. But it is invasive and highly dependent on the operator’s skill.

Currently magnetic resonance imaging with the advent of surface coils is becoming the modality for the imaging of soft tissues around the shoulder joint .A good knowledge regarding the MR characteristics of rotator cuff tendons and the abnormality in these tendons is necessary for appropriate diagnosis and planning of management.

It is in this backdrop, the objectives set out in this research programme will enable us to understand the pathological conditions of the rotator cuff tendons of the shoulder joint and also provide an insight into the intricacies involved in the MRI characteristics of the rotator cuff disorders and the predisposing factors of the same. In addition the gender and age distribution among the study group, presenting symptoms and the implication associated with cuff pathologies if any will be examined

2. OBJECTIVES OF THE STUDY

The objectives of the dissertation titled **“MAGENTIC RESONANCE IMAGING OF THE ROTATOR CUFF PATHOLOGIES”** is as follows:

1. To describe the MRI characteristics of rotator cuff pathologies.
2. To describe the distribution of rotator cuff pathologies in terms of age, gender, symptomology and secondary changes/sequelae among the study population.

3. REVIEW OF LITERATURE

3.1HISTORICAL PERSPECTIVE

Magnetic Resonance Imaging is a relatively newer technology in imaging. It was independently discovered by Felix Bloch and Edward Purcell during the year 1946. Later in the year 1952 they were awarded the Nobel Prize for the same. The use of MR for imaging required a method for spatial localization. In 1973, Paul Lauterbur, a chemist and an NMR pioneer at the State University of New York, Stony Brook, showed how this could be done by applying a linearly varying magnetic field to the body[6].

The first human MRI examination occurred in 1977. Mansfield and Maudsley [7] in 1977 and Hinshaw et al in 1978[8] were the first to publish human in vivo images. Hawkes et al. in 1980 first demonstrated the multiplanar facility of MRI.The most significant advancement in MRIs occurred in 2003, when the Nobel Prize was won by Paul C. Lauterbur and Peter Mansfield for their discoveries of using MRIs as a diagnostic tool.[9]

3.2 THE BASIC PHYSICS OF MRI

Magnetic Resonance Imaging using the principle of nuclear magnetic resonance creates images of the human body and aides in medical diagnosis. It can generate thin-section images of any part of the human body - from any angle and direction. Using MRI it is possible to make such a picture of the human body when the body is exposed to an electromagnetic field.[10]

3.2.1 Biophysical basis of MRI

Nuclear magnetic resonance began within physics, at a confluence among particle physics, condensed matter physics, spectroscopy, and electromagnetic.[9] The human body is primarily made of fat and water. Numerous hydrogen atoms are present in the fat and water molecules, thus making the human body approximately 63% hydrogen atoms. Each hydrogen atom has a nucleus comprised of a single proton. The proton possesses a property called spin which can be thought of as a small magnetic field and will cause the nucleus to produce an NMR signal. MRI is based on magnetic spin properties of nuclei, particularly the hydrogen nuclei and how these nuclei recover after excitation with radiofrequency electromagnetic waves.[11]

When an unpaired electron of hydrogen atom placed in a strong external magnetic field is interrogated with radiofrequency pulse, it releases energy. This released energy is detected by a receiver coil which is then converted into an image by 3D Fourier transformation.[12]

T1 relaxation (spin-lattice relaxation) is due to release of energy into the surrounding tissues. It depends on the time the nuclei take to recover 63.2% of longitudinal magnetization. Chemical nature & physical state of a substance, liquid surrounding the protons, mobility of the protons, magnetic field strength and temperature influence the T1 value.

T2 relaxation (spin-spin relaxation) is due to exchange of energy between spins. It is determined by the time taken by the signal to lose 63% of its initial intensity in the transverse plane due to dephasing.

First, a steady state of magnetism is created within the human body by placing the body in a steady magnetic field. Second, the body is interrogated with radio waves to change the steady-state orientation of protons. Third, the MRI machine stops the radio waves and registers the body's electromagnetic transmission. Fourth, the transmitted signals are used to construct internal images of the body by computer programs. An MRI image is not a photograph. It is actually a computerized map or image of signals emitted by the human body.[13]

3.2.2 Imaging Hardware

An MR system consists of the following components: 1) a powerful magnet to generate the static magnetic field 2) homogenizing coils (called shim coils) to make the magnetic field as equally distributed as possible 3) an RF coil for radio signal transmission into the body part which is being scanned, 4) a receiver coil which detects the returning radio signals (echo), 5) gradient coils for detecting and providing spatial localization of the signals and 6) a computer system for reconstruction of the final image from radio signals received.

The basic hardware component on current imagers is the magnet which produces the B_o field for the imaging procedure. Within the magnet are the gradient coils for producing a gradient in B_o in the X, Y, and Z directions. Within the gradient coils is the RF coil. The RF coil produces the B_1 magnetic field necessary to rotate the spins by 90^o, 180^o, or any other value selected by the pulse sequence. The RF coil also detects the signal from the spins within the body.[16]

The patient is positioned within the magnet by a computer controlled patient table. The table has a positioning accuracy of 1 mm. The scan room is surrounded by an RF shield. The shield prevents the high power RF pulses from radiating out through the hospital. It also prevents the various RF signals from television and radio stations from being detected by the imager. Some scan rooms are also surrounded by a magnetic shield which contains the magnetic field from extending too far into the hospital. The magnet shield is an integral part of the magnet in newer magnets. 17.

The scanning operation is controlled from a central computer. This specifies the shape of gradient and radiofrequency waveforms, and timings to be used, and passes this information to the waveform generator, which outputs the signals and passes them to be amplified and sent to the coils. The NMR signal, once it has been phase sensitively detected, is turned to a digital signal by an analogue to digital converter. The digital signal is then sent to an image processor for Fourier transformation and the image is displayed on a monitor.

The raw data, that is the signal before Fourier transformation, is stored to enable the application of corrections to the data in post processing. To allow the use of fast Fourier transformation, matrix sizes of 2^n are usually used.

The array processor, located on some imagers, is a device which is capable of performing a two-dimensional Fourier transform in fractions of a second. The computer off loads the Fourier transform to this faster device. The operator of the imager gives input to the computer through a control console. An imaging sequence is selected and customized from the console. The operator can see the images on a video display located on the console or can make hard copies of the images on a film printer.

The signal intensity on the MR image might be determined by four basic parameters:

1. proton or spin density,
2. T*1* relaxation time,
3. T*2* relaxation time, and
4. flow. Proton density is the concentration of protons (hydrogen atom nuclei) in the tissue in the form of water and macromolecules (proteins, fat, etc). The T*1*

and T*2* relaxation times define signal behavior after excitation as well as the way the protons revert back to their resting states (equilibrium) after the initial RF pulse excitation.(18).

3.2.3 Image Artifacts

An image artifact is any feature which appears in an image which is not present in the original imaged object. An image artifact is sometime the result of improper operation of the imager, and other times a consequence of natural processes or properties of the human body. It is important to be familiar with the appearance of artifacts because artifacts can obscure, and be mistaken for, pathology. Therefore, image artifacts can result in false negatives and false positives.

Artifacts are typically classified as to their source, and there are dozens of image artifacts. The following table summarizes a few of these. [22]

Table 1: MRI Artifacts

Artifact	Causes
RF Offset and Quadrature Ghost	Failure of the RF detection circuitry
RF Noise	Failure of the RF shielding
B_0 Inhomogeneity	Metal object distorting the B_0 field
Gradient	Failure in a magnetic field gradient
Susceptibility	Objects in the FOV with a higher or lower magnetic susceptibility
RF Inhomogeneity	Failure or normal operation of RF coil, and metal in the anatomy
Motion	Movement of the imaged object during the sequence
Flow	Movement of body fluids during the sequence
Chemical Shift	Large B_0 and chemical shift difference between tissues
Partial Volume	Large voxel size
Wrap Around	Improperly chosen field of view
Gibbs Ringing	Small image matrix and sharp signal discontinuities in an image
Magic Angle	Angle between B_0 and dipole axis in solids.

Important artifact to be considered in MRI of shoulder is the **Magic Angle artifact** At approximately 55° to the main magnetic field, dipole—dipole interactions between tendon molecules disappear so that tendon signal increases particularly on images acquired at echo times less than 30 ms; this is called the magic angle phenomenon simulating a tear. Altering tendon obliquity or seeing the high signal vanish on longer TE images help in the recognition of this artifact, which can also occur in the glenoid labrum.

3.3 MR ANATOMY OF SHOULDER JOINT:

The shoulder girdle connects the upper limb to the axial skeleton. It allows movement at both the shoulder joint and the scapulothoracic joint. The shoulder joint is a multi axial ball-and-socket joint. Hemispheric humeral head articulates with shallow pear- shaped glenoid fossa. This joint is surrounded by a synovial-lined fibrous capsule. The fibrocartilage rim of tissue which surrounds the glenoid is the labrum. It deepens the fossa to provide stability. Cartilage thins in central glenoid and in periphery of humeral head.[10]

3.3.1 Bones:

The scapula overlies the posterolateral aspect of the chest wall; its inner surface is in close contact to the posterior aspects of the second to seventh ribs. The anterior and posterior surfaces of the scapula give attachment to many of the muscles of the rotator cuff. Laterally, the angle of the scapula forms the articular surface of the bone, known as the glenoid fossa which articulates with the humeral head.[12] Fibrocartilage labrum around glenoid increases the depth of the glenoid fossa thus increasing the stability of the joint. The bony tubercles above and below the glenoid fossa give attachment to the long heads of biceps and triceps respectively.

Coracoid process of the scapula arises from the upper border of the head of the scapula. It is bent sharply and projects forwards and slightly laterally.[11]

Normal distance between coracoid and lesser tuberosity is more than 11 mm with arm in internal rotation and is called the coracohumeral distance. Substantial reduction of this space can result in subscapularis impingement.[15]

The flattened lateral extension of the spine of the scapula is the acromion of the scapula. It articulates with the lateral end of the clavicle, forming the acromio-clavicular joint. It overlies the shoulder joint and provides some protection for both the joint and the overlying supraspinatus tendon of the rotator cuff[18].

The orientation of acromion ranges from flat to sloping, mediolaterally. Acromion is roughly classified into 4 types based on posterior to anterior shape

- Type I: Flat
- Type II: Curved, paralleling humeral head
- Type III: Anterior hooked
- Type IV: Convex undersurface.

The various shapes and orientation of the acromion has implication on the underlying tendons due to the reduction of the space around the tendons. Low-lying, anterior downsloping or inferolateral tilt decreases the volume of the coracoacromial outlet.[11]

The clavicle is an S-shaped subcutaneous bone which articulates with the manubrium of the sternum and the first costal cartilage medially. The clavicle articulates with the acromion of the scapula laterally. The clavicle helps in transmission of part of the weight of the upper limb to the trunk. The acromioclavicular joint is a complex synovial joint between the lateral border of the clavicle and the medial aspect of the acromion of the scapula. The joint contains an incomplete fibrocartilaginous disk and is surrounded by a weak synovial joint capsule[16]. Accessory ligaments - the aromioclavicular ligament and the coracoclavicular ligament provides a strong attachment of the clavicle to the scapula and lending stability to the joint.[9] The supraspinatus tendon runs immediately below the acromioclavicular joint. Any degenerative disease in the joint may cause irregularity of the under surface of the joint, which in turn causes wear and tear of the tendon, and loss of the normal tendon thickness[8].

The hemispherical head of the **humerus** articulates with the glenoid fossa of the scapula. The boundary of the joint capsule, located along the base of the articular surface forms the anatomical neck of the humerus. It represents the region of fused epiphyseal plate. The slightly narrowed junction between the head of the humerus & shaft, located 2 cm distal to anatomic neck is termed the surgical neck of humerus. There are two prominent tubercles, known as the greater and lesser tuberosities or tubercles in the lateral aspect of the humeral head. These tubercles are separated by the intertubercular or bicipital groove. The tendons of the rotator cuff insert onto the humeral tubercles: supraspinatus, infraspinatus, and teres minor attach to the greater tuberosity and subscapularis to the lesser tuberosity. The long head of biceps lies within a vertical channel known as the bicipital groove. [11, 15]

3.3.2 Muscles & Tendons:

Rotator cuff consists of supraspinatus, infraspinatus, teres minor and subscapularis muscles and tendons. These tendons appear as uniformly hypointense on all MRI sequences.

Cuff tendons blend with shoulder joint capsule. [2, 8]

Supraspinatus muscle originates from supraspinatus fossa of scapula and gets inserted into the superior facet (horizontal orientation) and portion of middle facet of greater tuberosity. It receives nerve supply from the suprascapular nerve. It is supplied by the suprascapular artery and circumflex scapular branches of subscapular artery. Action of supraspinatus muscle is abduction of humerus. It has anterior and posterior muscle bellies - Anterior belly is larger, has central tendon and is more likely to tear, Posterior belly is strap-like & has terminal tendon. [14, 20]

Supraspinatus is the most commonly injured rotator cuff muscle.

Originating from the Infraspinatus fossa of scapula, **Infraspinatus muscle** gets inserted into the middle facet of greater tuberosity of humerus. distal fibers of suprascapular nerve provides nervous supply to the muscle. Subscapular artery through its suprascapular artery and circumflex scapular branches supplies infraspinatus muscle. It externally rotates humerus and resists posterior subluxation

Teres minor muscle takes origin from the middle half of lateral scapular border, goes superio- laterally and inserts into the inferior facet (vertical orientation) greater tuberosity of humerus. It receives nerve supply through the Axillary nerve. Posterior circumflex humeral artery & circumflex scapular branches of subscapular artery supplies the teres minor. It is an external rotator of the humerus. teres minor muscle is the least commonly injured rotator cuff muscle. [11,15,20]

Subscapularis muscle takes origin from subscapular fossa of scapula and inserts in to lesser tuberosity usually. In up to 40% subscapularis muscle may insert at surgical neck of humerus. Upper and lower subscapular nerve supplies the subscapularis. Subscapularis artery provides the blood supply to the muscle. It is an internal rotator of humerus. It also causes adduction, extension, depression and flexion of the humerus. It has multipennate morphology with 4-6 tendon slips converging into main tendon, thus increasing strength.

FIG3.1: GRAPHIC IMAGE OF ROTATOR CUFF & BICEPS TENDONS-ANTERIORLY

Rotator cuff tendons receive blood supply from adjacent muscle, bone and bursae. The normal hypovascular regions in tendons is termed "critical zone" and is vulnerable to degeneration [10 ,11,16.]

Long head of **Biceps tendon** originates from the superior glenoid labrum. Portions may attach to supraglenoid tubercle, anterosuperior labrum, posterosuperior labrum and coracoid base. It courses superiorly in the intertubercular or bicipital groove. It stabilizes and depresses humeral head [17.]

Joint capsule typically inserts on base of labrum posteriorly. But the anterior joint capsule has variable insertion into the labrum either at its tip or base or into the scapular neck.

Rotator interval is a triangular space between supraspinatus and subscapularis tendons .The base of triangle is at coracoid process and the tip of triangle at transverse ligament. The borders of rotator interval includes coracoid base medially, bicipital groove & transverse ligament laterally, the floor by humeral head cartilage and roof by joint capsule .The contents of rotator interval are coracohumeral ligament, superior glenohumeral ligament, long head of biceps tendon. Coracohumeral ligament and superior glenohumeral ligament stabilize long head of biceps tendon as it enters bicipital groove.[10 11]

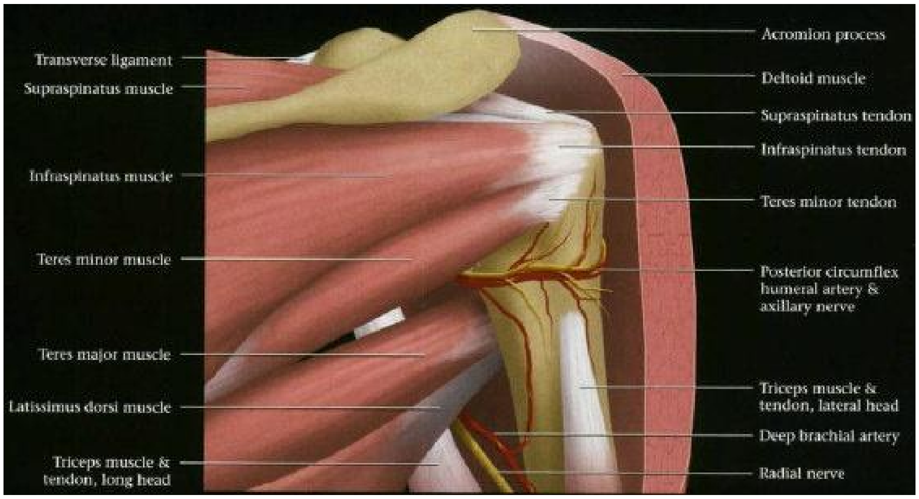


FIG 3.2 : ROTATOR CUFF ANATOMY POSTERIORLY

3.3.3 Ligaments:

Glenohumeral ligaments fuse with joint capsule and strengthen it. It is considered as folds in joint capsule and the presence of true ligaments is still debated. Collectively these are termed as *glenolabral periarticular fiber complex*. It is of various types:

• Type I: Classic three ligaments (SGHL, MGHL, IGHL)

• Type II: MGHL cord, pseudo-Buford

• Type III: Combined MGHL/IGHL cord,pseudo-Buford

• Type IV: No ligaments

Superior glenohumeral ligament (SGHL) stabilizes shoulder in adduction. It may originate from biceps tendon, anterior labrum, or in common with MGHL. It extends to lesser tuberosity in transverse orientation and fuses with coracohumeral ligament. It is visible on 30% of conventional MR, 85% of MR Arthrograms [15 20 21] .

Middle glenohumeral ligament (MGHL) stabilizes shoulder in abduction.

It originates from anterior labrum or scapular neck, extends along deep surface of subscapularis to lesser tuberosity in oblique orientation and blends with joint capsule and labrum anteriorly. It can be absent or hypoplastic in 30%.It may be enlarged and cord-like.

Buford complex – is thick or cord-like MGHL and absent anterosuperior labrum. This can be present in 1-6.5% population.*Pseudo-Buford* appearance can occur when middle and inferior glenohumeral ligaments are combined.

Sometimes middle glenohumeral ligament can fuse with the anterior band of IGHL[15, 20].

Inferior glenohumeral ligament (IGHL)complex resists anterior dislocation and stabilizes in abduction.It has anterior and posterior band. Anterior band is usually larger than posterior band.It extends from inferior glenoid labrum to inferior humeral anatomic neck in vertical orientation [21]

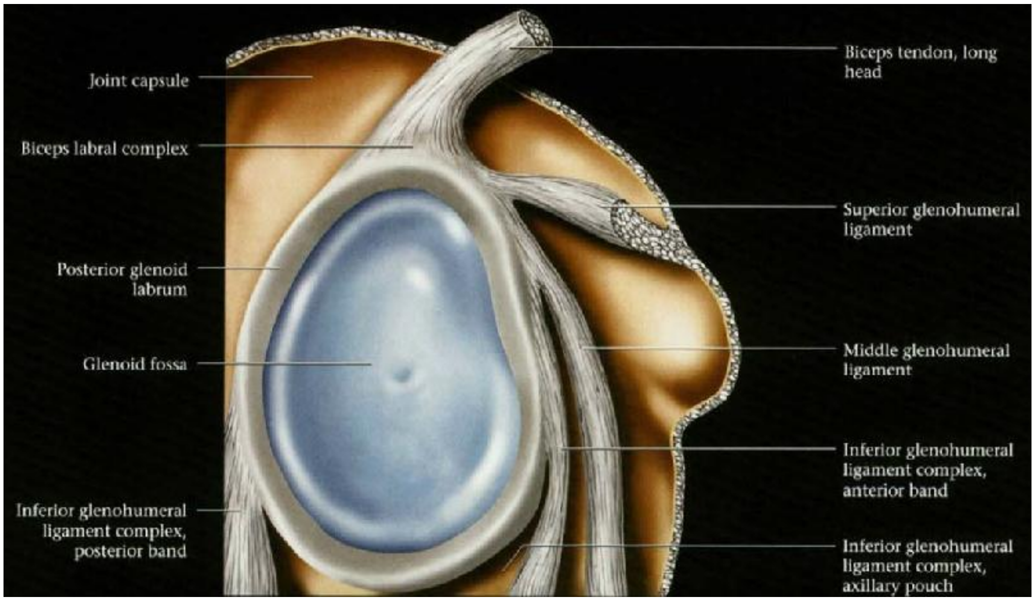


FIG 3.3 INTRA- ARTICULAR PORTION OF SHOULDER WITH HUMERUS REMOVED

Coracohumeral ligament extends from coracoid process base to greater & lesser tuberosities in horizontal orientation and fuses with supraspinatus tendon, subscapularis tendon, joint capsule and SGHL, forming the roof of rotator interval. It stabilizes long head of biceps tendon from subluxing medially into subscapularis. It also strengthens transverse ligament covering bicipital groove [19, 20].

Coracoacromial ligament forms the coracoacromial arch along with acromion and coracoid process .It helps in reinforcing the inferior aspect of acromioclavicular joint.It extends from distal two-thirds of coracoid to acromion tip [7,]

Coracoclavicular ligament extends from base of coracoid process to undersurface of clavicle.It is a major stabilizer of acromioclavicular joint.It is fan-shaped complex with two fascicule: 1.*Conoid ligament* which is posteromedial and vertical. 2. *Trapezoid ligament* which is anterolateral and oblique.

Acromioclavicular ligaments are two in number - Superior and inferior AC ligaments.It reinforces acromioclavicular joint capsule [7,14].

Transverse humeral ligament contains fibers from the subscapularis tendon. It extends between greater and lesser tuberosities ,covering the bicipital groove. **Superior transverse scapular ligament** converts suprascapular notch into a foramen through which the suprascapular nerve passes. This is a potential space for suprascapular nerve entrapment. Suprascapular vessels pass above the ligament **Inferior transverse scapular ligament** extends from scapular spine to glenoid rim, lateral to spinoglenoid notch and subscapular nerve passes beneath the ligament.

Glenoid labrum consists of hyaline cartilage, fibrocartilage and fibrous tissue .It increases joint circumference and depth .It also increases surface area and surface contact. It is approximately 4 mm wide and provides increased rotational stability. It can be of variable size, shape and signal intensity. Classical triangle or wedge shape on axial imaging is present in less than 50% of normal anterior labra and less than 80% of posterior labra. Normal shapes include round, blunted, crescentic, flat, notched and cleaved. It may be small or absent anteriorly. It can vary in signal intensity due to mucinous and myxoid contents [15,18,20].

Portions of labrum described as positions on face of clock (either shoulder) -12:00: Superior, 3:00: Anterior, 6:00: Inferior, 9:00: Posterior. Blood supply to the labrum is via periosteal and capsular vessels

The glenohumeral joint is surrounded by several bursae. The most clinically significant of these is the large **subacromial–subdeltoid bursa**, which lies between the supraspinatus and the inferior surface of the coracoacromial arch. This bursa does not communicate with the joint capsule unless the supraspinatus tendon is ruptured [17]. Spill of contrast medium into the bursa during joint arthrography therefore implies disruption of the supraspinatus muscle or tendon [14].

3.4 IMAGING TECHNIQUES

MR imaging of the shoulder has gained widespread utility in the evaluation of shoulder disorders since it offers excellent depiction of both soft tissue and osseous structures. Recent advances in MR imaging has lead to shorter scanning times and higher-quality images. A good understanding of imaging techniques, normal variants, technical artifacts, and diagnostic pitfalls will improve diagnostic accuracy on shoulder MRI studies.

3.4.1 Patient Positioning

The patient should be supine with the head directed toward the scanner bore. The patient's arms should rest to the side of the body and should not be placed on the abdomen to avoid transmission of respiratory motion. The preferred positioning of the patient's arm is neutral to slightly externally rotated. Use of supports under the elbows can assist in maintaining this position. In external rotation, the posterior labrum is well visualized [23, 24]. Internal rotation of the arm should be avoided. Internal rotation causes laxity of the anterior capsular structures and increased overlap of muscular and tendinous components of the rotator cuff, both of which can interfere with complete evaluation of the shoulder.

3.4.2 Surface Coils

The use of surface coils is requisite for shoulder MR imaging. The higher signal-to- noise ratio produced by these coils allows for improved spatial resolution; both of these factors improve the diagnostic ability of MR study. The most basic and commonly used coil is the single-loop coil. It is a linear coil in a curved configuration. Its main disadvantage is the sharp decrease in image homogeneity and signal-to-noise ratio with increasing distance from the center of the coil. The Helmholtz pair is a variant of the single-loop coil, which consists of a pair of flat circular surface coils.

One coil is placed anterior and one posterior to the shoulder joint. The advantage of the Helmholtz pair is that it has improved signal homogeneity across the field of view as compared to that obtained with a linear loop coil. Flexible coils are those that wrap around and conform to the anatomic area of interest. They offer improved patient comfort. Surface coils should be positioned on the patient's shoulder in the coronal oblique plane in order to maximize signal-to-noise ratio in the region of the rotator cuff [25].It is important that the coil be centered over area of primary interest.

Restraint bands should be used to restrict movement of the coil with respiratory or gross patient motion. Because the sensitive range of a surface coil is proportional to its diameter, coil size should be concordant with the size of the patient's shoulder [26].

3.4.3 Imaging Planes

Preliminary scout images are obtained in the coronal plane using short TR (repetition time) spin echo or gradient echo sequences. The primary purpose of these scout images is to serve as a localizer for subsequent pulse sequences. A small field of view (12 cm) and 3- to 4-mm-thick slice images in the three orthogonal planes are obtained.

Transaxial images should cover the area between the inferior glenoid fossa and the acromioclavicular joint. PD transaxial images provide good visualization of the joint capsule, labrum, subscapularis muscle, and long head of the biceps. Proton density- and T2-weighted fast spin echo images are also acquired in patients with glenohumeral instability to further evaluate the biceps tendon, labrum, capsule, and glenohumeral ligaments. Transaxial T2-weighted images are also useful in case of suspected abnormalities of the glenohumeral joint space or associated bursae, osseous or soft-tissue masses or injuries of the subscapularis muscle or tendon. Another purpose of transaxial images is to orient the appropriate plane for prescription of subsequent coronal oblique and sagittal oblique images.

Coronal oblique images are obtained in a plane parallel to the supraspinatus tendon. The course of the tendon is slightly oblique to the direction of the muscle fibers, and it also diverges slightly from the plane of the glenohumeral joint. Coronal oblique proton density- and T2-weighted fast spin echo sequences with fat saturation are the primary means of evaluation of the rotator cuff for potential tears or other abnormalities and for assessing the amount of retraction in patients with full-thickness rotator cuff tears. Coronal oblique images are also helpful for assessing the superior and inferior portions of the fibrocartilaginous glenoid labrum and the subscapularis notch.

Sagittal and oblique images are obtained in a plane perpendicular to that of the supraspinatus tendon. Coverage should extend from the glenoid fossa medially to the cortex of the humerus laterally. T1- and T2-weighted fast spin echo sagittal images are useful adjuncts to the coronal oblique images for the evaluation of the rotator cuff pathology and surrounding structures. T1-weighted images permit visualization of acromial abnormalities and evaluation of alterations in site and signal intensity of the rotator cuff musculature. T2- and proton density-weighted sagittal oblique images help confirm the presence of small rotator cuff tears and to determine their extent.

Coronal Oblique

- Infraspinatus muscle and tendon: *Longitudinally*
- Supraspinatus muscle and tendon: *Longitudinally*
- Acromioclavicular joint
- Acromion
- Glenohumeral joint
- Subacromial/subdeltoid bursa
- Labrum (superior and inferior portions)

Sagittal Oblique

- Supraspinatus muscle and tendon: *In cross section*
- Infraspinatus muscle and tendon: *In cross section*
- Teres minor muscle and tendon: *In cross section*
- Long head of biceps tendon (proximal portion): *In cross section*
- Subscapularis muscle and tendon: *In cross section*
- Rotator interval
- Acromion
- Coracoacromial ligament
- Coracoacromial arch
- Glenohumeral ligaments

Axial

- Long head of biceps tendon: *In cross section through bicipital groove*
- Subscapularis muscle and tendon: *Longitudinally*
- Labrum (anterior and posterior portions)
- Capsule
- Glenohumeral joint
- Glenohumeral ligaments

Table 2: Different Planes to evaluate various Shoulder Structures

3.5 PULSE SEQUENCES

3.5.1 Conventional Spin Echo

T1-weighted images provide the general anatomic information, to assess the size of the cuff muscles and clearly depict abnormalities related to the marrow space, peribursal fat planes and to look for fatty infiltration of the muscles. These images are also used for MR arthrography. Proton density-weighted images provide high signal-to-noise ratio and has high sensitivity for detection of injury to the rotator cuff and glenoid labrum-capsular.

complex. T2-weighted images contribute high specificity regarding rotator cuff and other pathology. They have poor signal-to-noise ratio but are essential for visualizing soft-tissue edema, fluid collections, for characterizing signal intensity alterations within the rotator cuff and fluid in the various bursae around the shoulder.

3.5.2 Fast spin echo

Fast spin echo images display similar tissue contrast to that seen on conventional spin echo images. However, small lesions can be obscured due to poor edge definition when short effective TE or long echo train length settings are used. Fat appears brighter on fast spin echo than on conventional spin echo images. This increased signal can obscure small lesions that are located adjacent to fat on T2-weighted fast spin echo images. Fat saturation techniques minimize this effect. Fast spin echo images have high sensitivity to depiction of fluid. These images have somewhat decreased sensitivity to magnetic susceptibility effects and generally display slightly less degradation from motion due to the rephasing effects of the multiple 180-degree pulses.

3.5.3 Fat Suppression

Fat saturation is routinely used in coronal and sagittal oblique proton density- and T2- weighted images. Fat suppressed sequences allow increased sensitivity in the detection of small amounts of fluid contained in small rotator cuff tears. The accuracy of detecting rotator cuff lesions with use of fat saturation has been reported to be 90% to 95% [28, 29, 30]. It improved depiction of marrow abnormalities and differentiation of fluid and fat at their interface.[31, 32, 33] It also helps to minimize artifacts due to motion and chemical shift misregistration. Disadvantages of fat saturation are that it lengthens imaging time by limiting the number of slices that can be obtained in a given TR. produces unfamiliar tissue contrast, and may produce incomplete suppression of fat and/or inadvertent suppression of water-containing tissues.

3.6 ROTATOR CUFF FUNCTION

The rotator cuff mechanism is very important to shoulder function. Electromyographic studies have showed that all four muscles of the rotator cuff are active during movement of the joint with varying force [34]. Biomechanical analysis has revealed that the rotator cuff contributes between one-third and one-half of the power of the shoulder in abduction which is predominantly carried out by the infraspinatus tendon and 80% to 90% in external rotation [35,36,37,38], primarily undertaken by the infraspinatus and teres minor. They counteract the superior translational force produced by the deltoid. In contrast, the subscapularis tendon functions in internal rotation.

The rotator cuff also functions as a dynamic stabilizer of the glenohumeral joint [39,40]. The function of dynamic stabilization may occur by compressing the humeral head into the glenoid fossa[41, 42]. The cuff musculature may directly reinforce the superior (suprapinatus and infraspinatus), anterior (subscapularis), and posterior (infraspinatus and teres minor) portions of the glenohumeral joint capsule.

The rotator cuff also functions in providing muscular balance to the glenohumeral joint; thus, its absence or weakness can potentially result in abnormal kinematics and abnormal humeral head excursion[40, 42].

The function of the rotator cuff in maintaining a water-tight joint space and allowing continuation of normal synovial fluid mechanics has also been described, suggesting that it may play a role in cartilage nutrition with prevention of secondary osteoarthritis[43].

3.7 ROTATOR CUFF DISEASES

3.7.1 IMPINGEMENT

Rotator cuff impingement may be divided into primary extrinsic impingement, secondary extrinsic impingement (secondary to instability), internal impingement (posterosubglenoid), and subcoracoid impingement.

3.7.1.1 Primary Extrinsic Impingement

When the shoulder elevates, the rotator cuff and surrounding soft-tissue structures impinge in the space beneath the coracoacromial arch. **Neer in 1983** [44, 45] stated that 95% of rotator cuff tears occur as a result of chronic impingement beneath this arch. The space below this arch is defined by the acromion superiorly, the coracoacromial ligament superomedially, and the coracoid process anteriorly[46]. Known sites of impingement in this arch include the anteroinferior edge of the acromion, the coracoacromial ligament, and occasionally the undersurface of the acromioclavicular joint[44, 45, 46, 47]. Any condition that limits the space within the coracoacromial arch can produce impingement on the subacromial bursa, the supraspinatus tendon, and the long head of the biceps tendon[48].

Bigliani and colleagues in 1986 [49]described three types of acromion based on their shape[50]as seen on supraspinatus outlet radiographs or scapular Y view radiographs of the shoulder with the occurrence of rotator cuff pathology. A Type I acromion has a flat surface, Type II has a curved undersurface, and Type III has a hooked undersurface. Type IV has also been recently described, has a convex inferior surface.

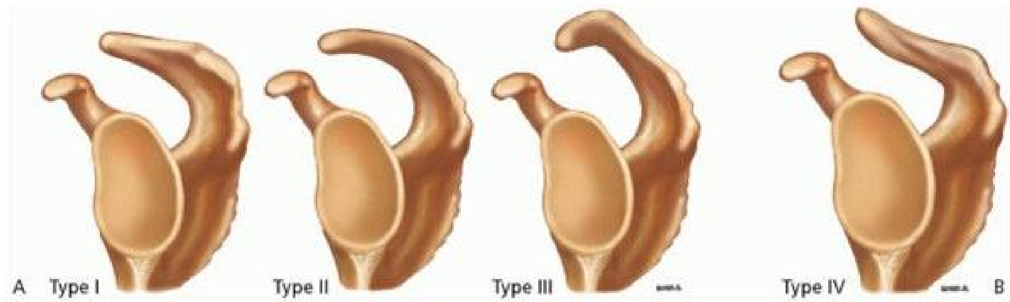


FIG 3.4: TYPES OF ACROMION.

Type I acromions have the least association with impingement syndrome. **In 1988 seegar et al.** described The hook- shaped acromion (Type III) has been shown to have the most significance[51] and may be the most common cause of anterior acromial impingement[51, 52, 53]. It has the highest correlation with rotator cuff pathology, particularly rotator cuff tears. Correlation with surgical and arthrographic results revealed a 70% to 80% association of rotator cuff tears with Type III acromions[51, 53].The Type III acromion may be a congenital variant or possibly be related to an acquired osteophyte due to traction on the coracoacromial ligament or calcification of the acromial attachment of the coracoacromial ligament[50].

Normally, the inferior cortex of the acromion is in line with the inferior cortex of the clavicle on coronal oblique views. A low-lying acromion is when acromion is placed lower than the clavicle. It causes narrowing of the acromiohumeral space, which may predispose to impingement.

Park JG se al. in 1994 described os acromiale is an accessory ossification center of the acromion that is normally fused by 25 years of age. An unfused os acromiale after this age can be seen in 15% of the population. It is associated with an increased incidence of impingement and rotator cuff tears, presumably because the os is mobile and thus decreases the space in the coracoacromial arch with motion[54].

The os acromiale is best identified on axial images [48].

Clyde et al. in 2009 described the slope of the acromion can be evaluated on sagittal and coronal oblique images. Normally, the lateral aspect of the acromion is oriented nearly horizontal or slopes downward posteriorly on sagittal oblique images. Sloping of the acromion in either direction increases the risk for impingement from mechanical trauma to the underlying distal supraspinatus tendon[48].

Variation in size and thickness of the coracoacromial ligament, especially the wide portion inferior to the acromion, may be an additional factor in narrowing the subacromial space [55]. The coracoacromial ligament has a trapezoid shape and attaches to the undersurface of the acromion in a broad or wide insertion. Its average thickness is 3.9 mm, with a range of 2 to 5.6 mm.Posttraumatic calcification or ossification of the coracoacromial ligament is another rare cause of impingement[50, 56].

3.7.1.2 Secondary Extrinsic Impingement (Impingement Associated with Instability)

Secondary impingement occurs mainly in athletes involved in sports requiring overhead motion of the arm and has a relationship to glenohumeral joint instability. It is a dynamic process with progresses from instability, to subluxation, to impingement, and finally to rotator cuff tear. Anterior instability was the primary lesion with microtrauma as a result of repetitive overhead use leading to breakdown or stretching of the static stabilizers of the shoulder. Tears of the anterior labrum and abnormalities of the inferior glenohumeral ligament were the most common pathologic lesions found in these patients. The resultant anterior instability also results in fatigue and overload of the dynamic stabilizers, the rotator cuff. These factors allow anterior and superior subluxation (translation) of the humeral head; when the arm is abducted and

externally rotated, the anterior subluxation causes “dynamic” impingement of the rotator cuff against the acromion and the coracoacromial ligament. Subluxation of the humeral head may then cause impingement by anterior and superior compression of the rotator cuff between the humeral head and coracoacromial ligament and anterior acromion.

3.7.1.3 Posterosubglenoid (Internal) Impingement

in 1983 Peterson et al. Impingement of the rotator cuff on the posterosuperior portion of the glenoid is also known as internal impingement[47]. This type of impingement occurs during the late cocking phase of throwing with abnormal contact between the posterosuperior portion of the glenoid rim and the undersurface of the rotator cuff[57]. It is thought to occur at the extremes of abduction and external rotation. Classically a triad of findings is seen in these patients, which includes injury to the rotator cuff undersurface at the junction of the infraspinatus and supraspinatus tendons, degenerative tearing of the posterosuperior glenoid labrum and subcortical cysts and chondral lesions in the posterosuperior glenoid and humerus due to repetitive impaction’[58]. There may be additional injury to the inferior glenohumeral ligament and anterior inferior labrum’[59]. The inferior glenohumeral ligament may be injured because it limits abduction and external rotation of the glenohumeral joint and is therefore under tension in this position [60,61].

3.7.1.4 Subcoracoid Impingement

Impingement beneath the coracoid process relates to encroachment of the subscapularis tendon insertion on the lesser tuberosity[65, 66], secondary to narrowing of this space between the coracoid process and the humeral head. Developmental enlargement of the coracoid process that projects more laterally can result in reduction of this space. This can be exacerbated by acquired conditions including fractures of the coracoid or lesser tuberosity, calcification of the subscapularis tendon, glenoid osteotomy, or procedures in which the coracoid process is transferred, such as the Bristow procedure for treatment of instability .

Subcoracoid impingement may occur when the distance between the coracoid and lesser tuberosity measures below 11 mm, with the arm positioned in maximal internal rotation[67].

Other causes of impingement includes supraspinatus muscle enlargement, as seen in weightlifters, swimmers, and other athletes, may induce impingement even if the coracoacromial arch and acromiohumeral intervals are normal, hypertrophic callus formation or malalignment of fracture fragments that involve the bones adjacent to the coracoacromial arch, narrowing the coracoacromial arch with resultant impingement.

3.7.2 PRIMARY ROTATOR CUFF DEGENERATION (INTRINSIC CAUSES)

Codman described a critical portion in the rotator cuff at the distal supraspinatus tendon approximately 1 cm medial to its insertion into the greater tuberosity. Codman[68, 69, 70] suggested that degenerative changes within the cuff itself can lead to tears,most likely secondary to vascular or ischemic basis. He referred to the pattern of degenerative cuff failure as a “rim rent” in which the deep surface of the cuff is torn at its attachment to the tuberosity. These tears tended to begin on the deep surface and then extend outward until they become full-thickness defects. The bursal surface are well vascularized, as compared to articular surface differentional vascularity predisposed the articular surface of the rotator cuff to degenerative changes and failure.

Trauma from a fall or dislocation may therefore complete or enlarge a preexistent small or incomplete tear or tear an already degenerated tendon. Norwood and cworkers[71], on the other hand, found that in patients with larger tears of more than one tendon, more frequently a history of acute trauma was elicited (80%). These patients however were generally older and nonathletic[50].

3.7.3 ROTATOR CUFF TEARS

A full-thickness rotator cuff tear is defined as one that extends from the articular surface to the bursal surface of the cuff tendons. **In 1937Codman[70]** defined a complete tear as one in which the whole thickness of the rotator cuff and capsule are torn, resulting in direct communication between the subdeltoid bursa and the joint cavity. Direct signs of Full-Thickness Tear includes 1) tendon discontinuity,2)fliud signal in tendon gap,3)retraction of musculotendinous junction. Associated findings like subacromial/sub deltoid bursa fluid, fluid around the tendon and muscle atrophy can also be seen[48].

Partial-thickness tears are tears that do not involve the entire thickness of the cuff. They involve only one surface of the cuff, either the inferior or the superficial surface. A special type of partial tear has been described which involves only the midsubstance of the cuff. Tears of the inferior surface are also referred to as deep or articular surface tears, those of the midsubstance as intrasubstance tears, and those of the superficial surface as superior or bursal surface tears. Retraction of tendinous fibers from the greater tuberosity may also be considered a partial tear[50, 73].

Dennis S. Weiner and Ian Macnab[66](1970) studied the acromion-humeral distance in 60 normal and 59 confirmed cases of the rotator cuff tears.they found a range of

7- 14 mm for the acromio-humeral distance.they found that naroowing of this distance was a frequent finding in the rotator cuff tears .An interval of 5millimeters or less was considered compatible with the tear and was due to upward migration of the humeral head.

Burk DL Jr and his associates[55](1989),in their prospective study for rotator cuff tears evaluated 38 patients at 1.5 T MRI.This was followed by the double contarast arthrography and they concluded that mri and arthrography were comparable in their sensitivity and specificity in diagnosis of the roatator cuff tears .They proposed MRI as preffered modality over arthrography (being non-invasive) for the rotator cuff evaluation.

Partial tears have been classified by **in 1990Ellman[74]** as: grade 1 (low grade) are less than 3 mm deep and only the capsule or superficial fibers are involved; grade 2 (intermediate) are 3 to 6 mm deep and less than 50% of the cuff thickness is involved; and grade 3 (high grade or deep) is greater than 6 mm, in which more than 50% of the cuff thickness is involved[50].

Another classification uses the number of tendons involved to size tears[75]. If the supraspinatus tendon alone is involved, the tear is classified as small (stage 1B). If the supraspinatus is involved and at least a portion of the infraspinatus, it is stage 2 and is considered moderate in size. With the involvement of the supraspinatus infraspinatus and subscapularis, the tears are stage 3 and are considered large or massive. Stage 4 is rotator cuff arthropathy[50].

Rafii et al.[98] (1990)in a study evaluated signal intensity patterns of rotator cuff lesions at magnetic resonance (MR) imaging were evaluated in 80 patients who had surgical correlation and in 13 asymptomatic individuals (14 shoulders). The signal intensity patterns of rotator cuff lesions at magnetic resonance (MR) imaging were evaluated in 80 patients who had surgical correlation and in 13 asymptomatic individuals (14 shoulders). Six cadaver shoulders were examined with MR, and histologic correlation was obtained in four. The average age of the patients evaluated was 47.8 years. Out of the 80 patients ,58 were male and 22 female.The most common and accurate pattern for full-thickness cuff tears (22 of 31 tears) was a region of intense signal seen on T2-weighted images. The intense signal pattern on T2-weighted images was also accurate, although a less common finding (seven of 16 cases), in the diagnosis of partial tears. Tendinitis was recognized as focal or diffuse regions of increased signal intensity or a nonhomogeneous pattern of increased signal often associated with tendinous enlargement.

Jerosh et al[71] (1991) in a cadaveric based study of the shoulder joint in 122 patients found that suprapinatus tendon tears were most common seen in 78% cases.It was observed that none of the tears occurred in the rotator cuff tendon without supraspinatus involvement.

In 1992Neer[76] classified rotator cuff tears according to etiology and divided them into impingement tears; traumatic tears due to single injury, or repetitive microtrauma; tears due to supreme violence; and “rotator interval tears due to multidirectional dislocation” and acute dislocations after the age of 40.

- Impingement tears – most common type, occurs in older than 40, commonly involves the supraspinatus.
- Traumatic tears occur in younger patients, are often incomplete, and involve the supraspinatus.
- Supreme violence results in massive cuff avulsion often with nerve injury.

Rotator interval tears result in enlargement of the rotator interval. Tears in acute glenohumeral dislocations occur after age 40, resulting in injuries of the rotator interval and subscapularis tendon.

Neviasar et al[82] (1993) used MR arthrography for the evaluation for rotator cuff tears in 37 of shoulder instability found 86% incidence of the rotator cuff tears .the incidence increased with age.

Getz at al[128](1996) in a study evaluated 394 scapula and found type I acromion in 22.8%,type II in 68.5% and type III in 10.2%.

Needell et al[129](1996) evaluated 100 patients for the rotator cuff pathologies using MRI .They useddifferent criteria for the pathologies.

- Normal:tendon normal in signal intensity and morphology
- Tendinopathy: increased signal intensity on Proton density with fading of signal on T2-weighted image without any tendon defect.
- Partial tear: partial intrasubstance tear or extending to any one of the surface with increased signal intensity on T2-weighted image.
- Complete tear: tendon defect extending to both surfaces with increased signal intensity on T2-weighted image.

18% patients showed tendinopathy,22% partial tear and 14% complete tears and rest were normal.The tendinopathy was more common in younger age group and tear were more common in later age group.MR evident rotator cuff abnormalities showed weakly positive correlation with the acromio-clavicular joint arthropathy.over 80% subjects withpartial tear and 100% cases with complete tears showe oateoarthrosis.bursal bluid was seen in the 75% cases of the partial and complete tears.

Lohr and Uhthoff[107] **(2004)** in a cadaveric study n 306 patients found partial tears to be more common than the complete tears for the rotator cuff muscles.

Jacobson et al[14](2004) in a ultrasoongraphy based study conducted in 50 patients with surgical correlation found articular surface partial tear more common than bursal surface partial tear occurring in 10 out of the 15 cases of partial tear.

Simank et al[82] **(**2006) while evaluating 65 patients with anterior dislocation(>40 years) found rotator cuff tears in 33 patients .They found that out of the 33 patients of the rotator cuff tear 54 % showed complete tears.

Freygand et al[128](2014)in a MRI based study on 137 shoulders for rotator cuff tears found 44% female and 56% male.out of these 44% patients gave the history of trauma.supraspinatus was the most common tendon with pathology seen in the 67% patients .subscapularis was the second most common tendon showing pathology seen in the 31.8% patients.infraspinatus tears were seen as the third most common involved tendon.partial tears were seen in more cases as compared to the complete tear.in supraspinatus tendon the partial tear was seen in the 57% patients and complete supraspinatus tear were seen in the 11% cases.

3.7.4 IMPINGEMENT AND THE BICEPS TENDON

The biceps tendon is also an integral part of the impingement syndrome, and bicipital problems are usually a manifestation of a more significant underlying impingement process. A similar zone of hypovascularity is thought to be present in the biceps tendon. A shallow or laterally placed bicipital groove may predispose the biceps tendon to impingement by the anterior one-third of the acromion[44, 76].

The subdeltoid bursa is involved in the impingement process as well, often resulting in subdeltoid bursitis and eventually fibrosis. The subacromial bursa tends to undergo proliferative or degenerative changes in patients with impingement syndrome.

mastan et al[91](1988) in ultrasnography and arthrography based study of rotator cuff and biceps tendon investigated in 106 patients. Out of this 75 were male and 31 female.Ultrasonography proved to be superior to arthrography in the examination of the normal and abnormal biceps tendon. Sonographically detectable effusions from the tendon sheath of the biceps were present in 19 per cent of this population of patients. This finding was statistically highly associated (90 per cent) with rotator cuff tears and other soft-tissue abnormalities of the shoulder.

David et al[126] (2005) in a study done in 100 patients with shoulder pain undergoing both MR and surgery found 23 patients with bicipital tendon abnormality.They further concluded that tears of the long head of the biceps had statistically significant association with the tears of the supraspinatus and subscapularis tendon.

Nadja s. et al [124]**(2006)** retrospectively evaluated 163 patients with for the presence of the fluid in thesubacromial –subdeltoid bursa or glenohumeral joint.67(41%) patients showed joint effusion,bursal fluid or both.Joint effusion alone was seen in the 35 patients and 21 of thses had rotator cuff tears(sensitivity,22%;specificity 79%;positive predictive value,70%).in 22 patients fluid was seen in both the bursa and join and 21 of thses had surgically proven rotator cuff tear.the combination of fluid in the bursa and joint space showed strong correlation with the rotator cuff tears.

3.7.5 TENDINOSIS/ TENDINOPATHY

It is used to describe the injured tendon in the absence of a tendon defect. Tendinosis appear as moderate increase in signal intensity within the tendon on short TR/TE and proton density images, oriented along the long axis of the tendon, which may be homogeneous (focal, diffuse, or bandlike)[77] or inhomogeneous, which fades or disappears on long TR/TE (T2-weighted images), whether obtained with conventional[77,78,79] or fast spin echo imaging sequences without fat suppression. Fat- suppressed conventional or fast spin echo T2-weighted sequences, or STIR imaging sequences, may make this signal more conspicuous and should be distinguished from true fluid signal as seen in a rotator cuff tear [77].Tendon thickening may be present, and increased and more diffuse thickening may be associated with more advanced tendinosis[80]. It is proposed that persistence of increased signal within the tendon on images with T2 weighting, but less intense. than fluid signal may indicate more advanced tendinosis, related to a greater degree of collagen breakdown in the tendon. Increasing disorganization of the tightly bound macromolecules of collagen allows increased absorption of water. The absorbed water is allowed more degrees of freedom, increasing the T2, so that images with relatively short TE show increased signal from the water molecules[50].

3.7.6 ROTATOR INTERVAL ABNORMALITIES

The rotator cuff interval is a triangular space between the supraspinatus tendon and the subscapularis tendon. The long biceps tendon courses through the rotator interval. This is the site on the anterior shoulder where arthroscopists enter the shoulder joint to avoid damaging tendons.

Rotator cuff interval tears may occur secondary to anterior glenohumeral dislocations or glenohumeral instability, or may represent a surgical defect. These tears are shown best on T2W or postcontrast T1W sagittal oblique images. When torn, the rotator interval may become patulous, and contrast material is identified extending anterosuperiorly through the coracohumeral ligament and the capsule (superior glenohumeral ligament) on arthrogram. These tears may communicate with the subacromial/subdeltoid bursa, mimicking a rotator cuff tear on a shoulder MR arthrogram, without a distinct tendon tear of the rotator cuff being identified.

The rotator interval is characteristically involved in adhesive capsulitis. Scar tissue forms around the superior glenohumeral ligament and the coracohumeral ligament in the rotator interval and obliterates the subcoracoid fat .Absence of subcoracoid fat on the T1W sagittal images to be a reliable indicator of adhesive capsulitis.

4. MATERIALS AND METHODS

The study was performed at the Department of Radio diagnosis, shri B.M patil medical college and research center bijapur to describe magnetic resonance imaging features of rotator cuff pathologies and to examine the influence of age and sex in the distribution of rotator cuff pathology among the population studied.

4.1 Source of data

The source of data for this study is patients referred to the Department of Radiodiagnosis, Shri B.M Patil Medical College and research center bijapur for MRI shoulder with suspected shoulder pathology. Patients who were found to have rotator cuff pathologies in the MRI examination were studied. This consists of 50 patients with Rotator cuff lesions detected on magnetic resonance imaging of the shoulder joint from October 2013 to June 2015.

The MRI was done on the advice of the referring doctor and no patient was made to undergo MRI for the sole purpose of this study.

This dissertation evaluates the magnetic resonance imaging characteristics of theRotator cuff lesions that were detected in these patients.

4.2 Study Period: October 2013 to June 2015.

4.3 Study Design: Descriptive study

4.4 Inclusion criteria

Patients who were suspected clinically with possible shoulder pathology, referred for MRI evaluation and shown to have rotator cuff tendon abnormalities were included in the study.

4.3 Exclusion criteria

- Post operative patients.

- Known case of rotator cuff lesions on treatment.
- All patients with clinical evidence of rotator cuff lesions in whom a MRI examination is contraindicated were excluded. eg. Patients with any electrically, magnetically or mechanically activated implants (including cardiac pacemakers, biostimulators, neurostimulators, cochlear implants, and hearing aids)

4.4 Data Acquisition

After clinical evaluation, once a patient satisfied the inclusion and exclusion criteria for this study, he or she would undergo the MRI evaluation after giving consent.

All the MRI scans in this study were performed using 1.5 T MRI scanner (Philips achiva)

4.4.1 MRI Protocol

MRI protocol consisted of the following

Patient is positioned in supine position with external rotation of the arm. Adequate support for head and the limb is provided.

Dedicated surface coil for shoulder is used.

Technique for MRI of shoulder:

After obtaining localizer in all three orthogonal planes, following sequences are obtained:

Axial STIR & PD FATSAT

Coronal T1, GRE and T2

FATSAT Sagittal T2 FATSAT.

Table 3 : Following parameters were used during acquisition of images.

	T1W	T2-FATSAT	GRE	STIR	PD FATSAT
TR	400	3400	35	4900	2880
TE	10	63	1	20	40
Matrix	256 x 160	256 x 224	384 x 192	320 x 192	256 x 224
No of excitations	2	3	2	2	3
Thickness mm	4	4	4	3	3
Section spacing mm	0.0	0.0	0.	1.5	1.5
FOV	18	16	1	17	17
Imaging time min	2min14 sec	2min40sec	2mins12se	4min20sec	3mins15sec

5. RESULTS

The present study was carried out to describe magnetic resonance imaging characteristics of rotator cuff pathologies. Fifty patients who have been found to have rotator cuff disease during the magnetic resonance imaging of the shoulder, fulfilling the inclusion and the exclusion criteria were included in the study

Findings in the patients studied were tabulated using Microsoft Excel and has been given as Annexure. All statistical analyses were conducted.

Some of the representative cases have been reported in detail, in the following section, along with their respective images.

5.1 Representative Cases:

CASE NO.1

AGE: 62 years

GENDER: Male

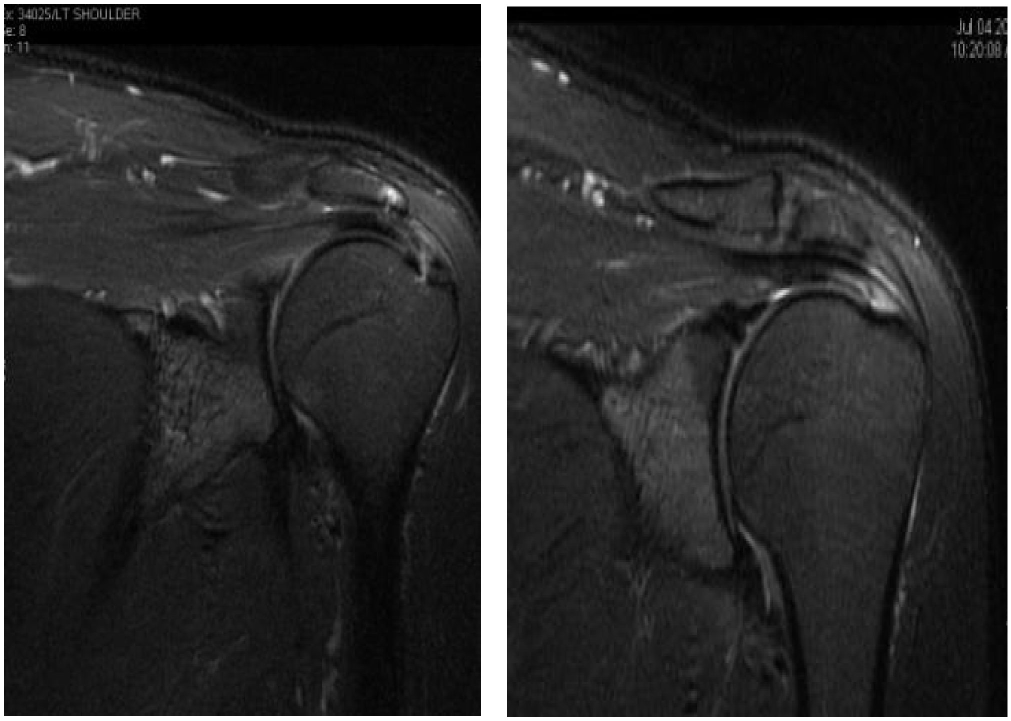
PRESENTING COMPLAINT: Right shoulder pain for 1 year

FINDINGS:

Type II acromion with focal edema.

Loss of fat plane between acromion and supraspinatus tendon Articular surface increased signal intensity at the insertion site of supraspinatus tendon with minimal adjacent fluid intensity -suggestive of partial tear.

Glenoid labrum shows mild degenerative fraying in its anterior aspect.



CORONAL T2 FS SHOWING TYPE II ACROMION WITH FOCAL EDEMA, LOSS OF FAT PLANE BETWEEN ACROMION & TENDON, ARTICULAR SURFACE PARTIAL TEAR OF SUPRASPINATUS TENDON, FRAYING OF ANTERIOR LABRUM.

CASE NO.2

AGE: 27 yrs

GENDER: Male

PRESENTING COMPLAINT: Left shoulder discomfort and weakness for 6 months

FINDINGS:

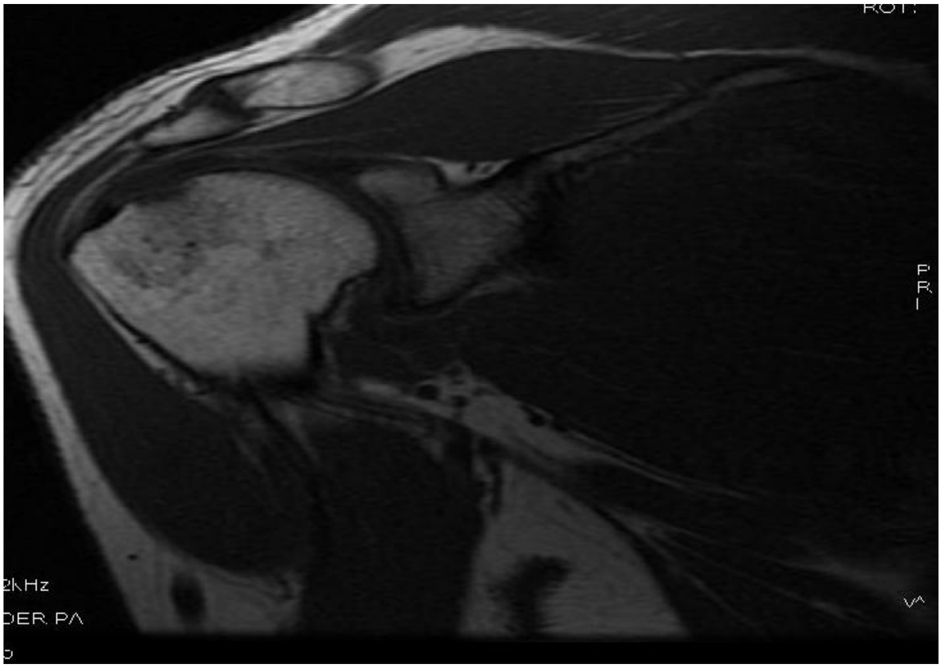
The lower border of the acromion is inferior as compared to the lower cortex of the lateral border of the clavicle suggesting a Low lying acromion.

Subtle intrasubstance hyperintensity in the supraspinatus tendon. Rest of the rotator cuff tendons are normal.

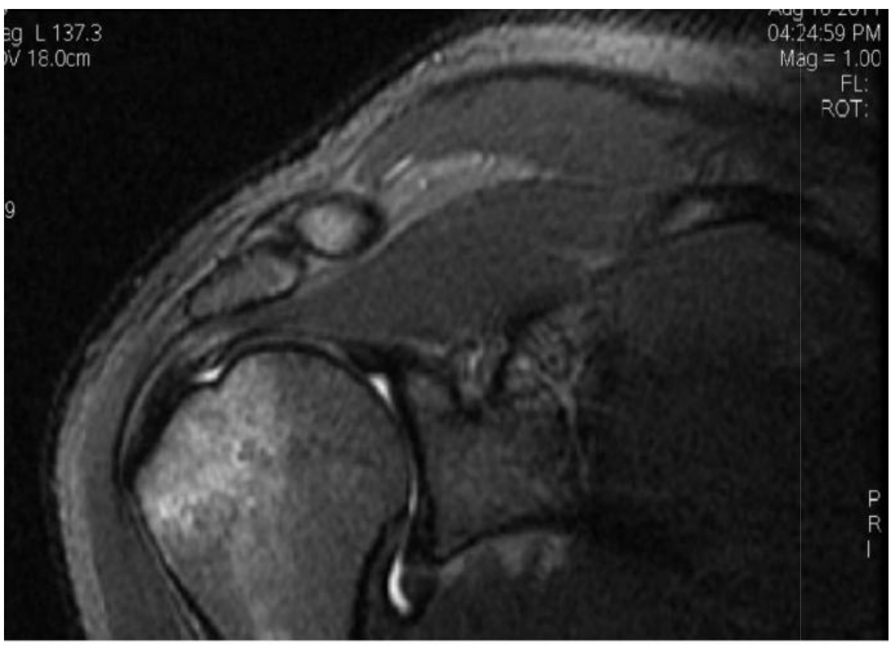
Bony contusion in form of STIR hyperintensity noted in the posterior-lateral aspect of humeral head.

Acromioclavicular joint is normal. No joint effusion.

No bursal fluid collection.



CORONAL T1W IMAGES SHOWING LOW LYING ACROMION



THE SUPRASPINATOUS TENDON – S/O TENDINOSIS BONY CONTUSION IN THE POSTERIOR ASPECT OF HUMERAL HEAD

CASE NO.3

AGE: 52yrs

GENDER: Male

PRESENTING COMPLAINT: Pain and weakness of right shoulder for 4 months.

FINDINGS:

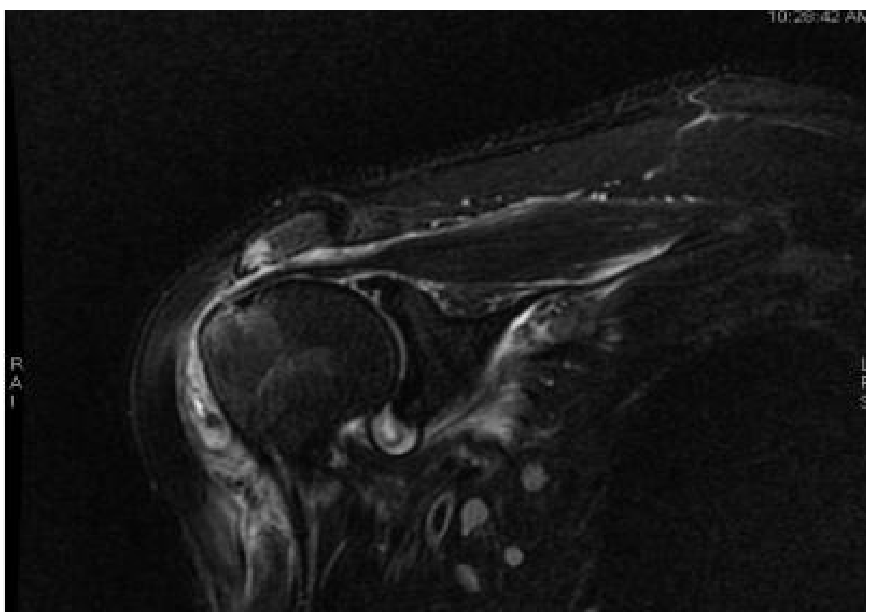
Loss of continuity of subscapularis tendon fibres at the humeral attachment site with fluid around it – complete tear

Medial dislocation of biceps tendon

Fluid around supra and infraspinatus with no signal abnormality within. Mild Joint effusion is noted.

Cortical erosion and edema of humeral head in the posterior and superior aspects. Edema of lateral aspect of acromion.

AXIAL STIR IMAGES SHOWING COMPLETE TEAR OF SUBSCAPULARIS CEPS TENDON IN THE BICIPITAL GROOVE, FLUID AROUND THE SUPRASPINATOUS TENDON, JOINT EFFUSION



CORONAL T2 FS SHOWING EDEMA OF LATERAL ACROMION

CASE NO.4

AGE: 48 years

GENDER: Male.

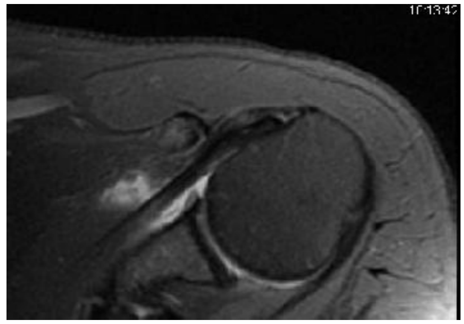
PRESENTING COMPLAINT: Left shoulder pain and weakness for 8 months.

FINDINGS:

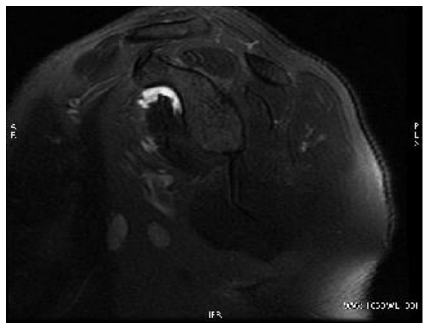
Subcoracoid Impingement of subscapularis tendon noted in form of reduced coracohumeral distance (7.7mm), with fluid around the subscapularis tendon. Supraspinatus, Infraspinatus and Teres minor tendons appear normal. Minimal fluid noted around the biceps tendon.

Hypertrophy of acromioclavicular joint is noted. No evidence of joint effusion.

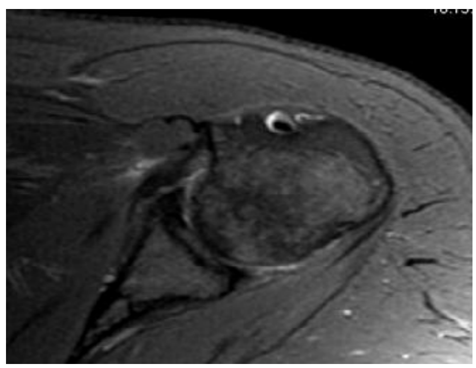
Labrum appears normal.



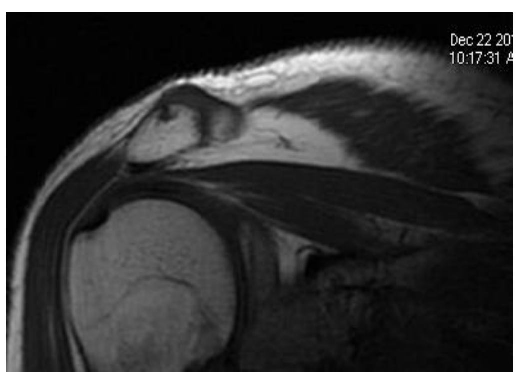
AXIAL STIR IMAGE SHOWING REDUCED CORACOHUMERAL DISTANCE WITH FLUID AROUND SUBSCAPULARIS TENDON



SAGITTAL T2 FS IMAGES DEPICTING FLUID AROUND THE SUBSCAPULARIS TENDON



AXIAL STIR IMAGE SHOWING FLUID AROUND THE BICEPS TENDON



CORONAL T1W IMAGE SHOWING HYPERTROPHY OF ACROMIOCLAVICULAR

CASE NO.5

AGE: 68 Years

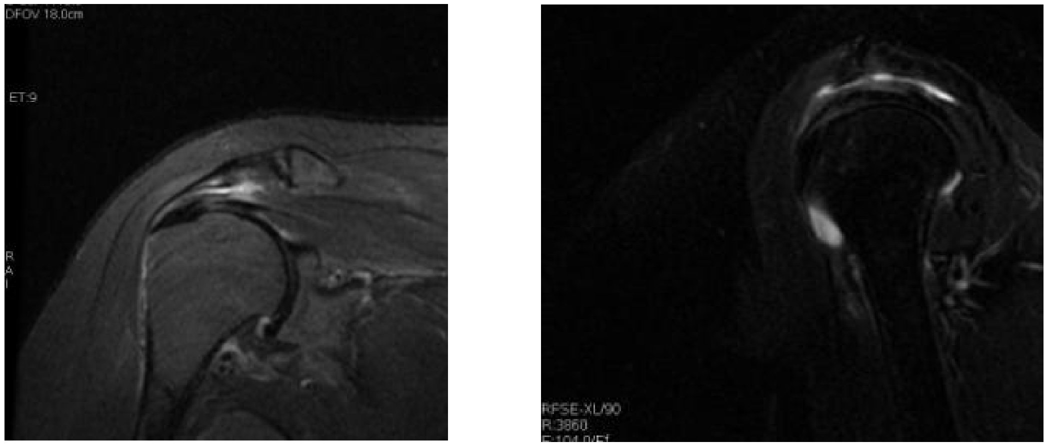
GENDER: Female

PRESENTING COMPLAINT: Reduced movement and stiffness of the right shoulder joint for 7months

FINDINGS:

Abnormal hyperintensity and minimal discontinuity of fibres in the acromial surface of supraspinatus muscle with minimal adjacent fluid, loss of fat plane between theacromion and the tendon – partial thickness bursal surface supraspinatus tear. Rest of the cuff tendons are normal.

Joint effusion.



CORONAL & SAGTTIAL T2FS IMAGES SHOWING BURSAL SURFACE PARTIAL THICKNESS TEAR OF SUPRASPINATUS TENDON AND MINIMAL JOINT EFFUSION.

CASE NO.6

AGE: 60 years

GENDER: Female

PRESENTING COMPLAINT: Weakness of the right shoulder for 10 months

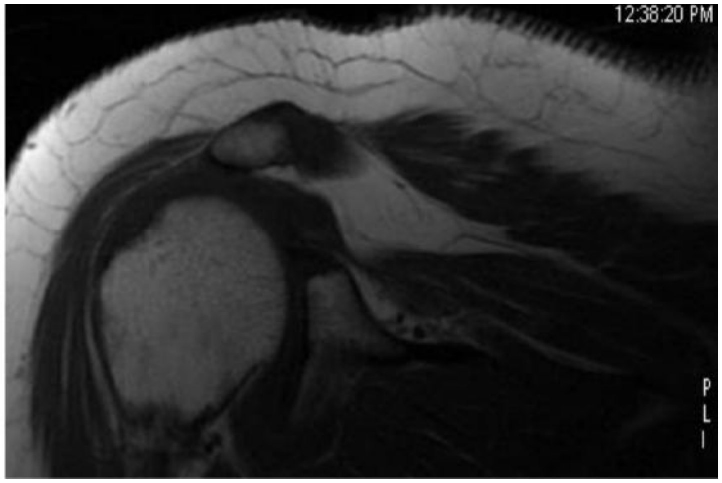
FINDINGS:

Anterior downsloping acromion notedMarkedly reduced acromiohumeral distance (4mm).

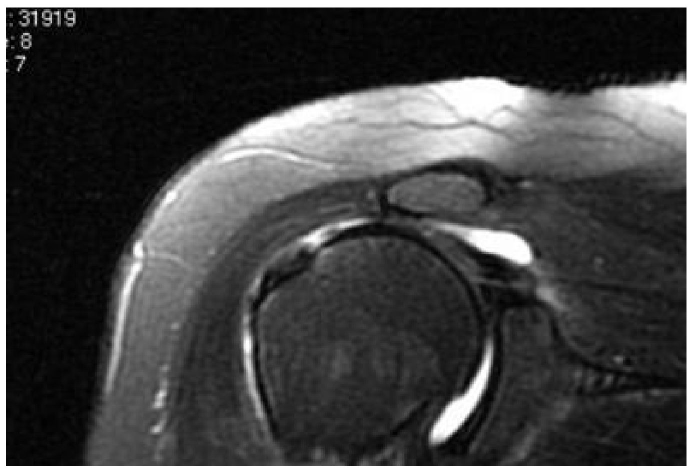
T2 hyperintensity noted in the supraspinatus tendon close to its insertion with complete disruption of tendon signal,fluid adjacent to the tendon and retraction of the muscle – S/O full thickness tear.

T2 hyperintensity in the subscapularis tendon with no disruption of fibres – tendinosis of subscapularis tendon.

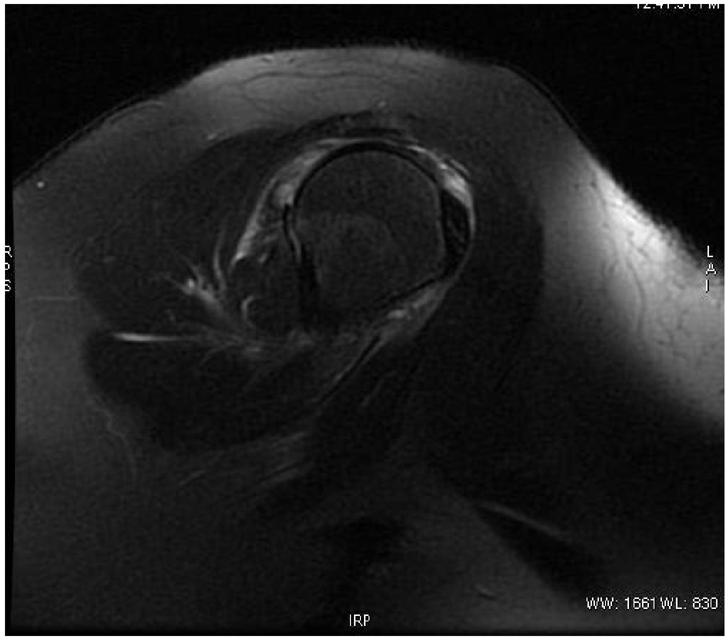
Minimal fluid around bicipital tendon Infraspinatus and Teres minor tendons are normal. Labrum is intact.



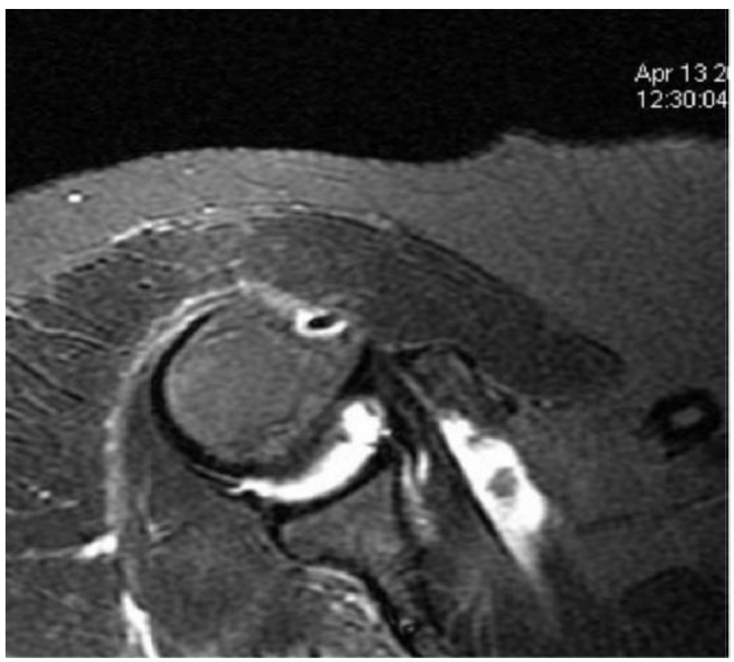
CORONAL T1 IMAGES SHOWS ANTERIOR DOWNSLOPING ACROMION WITH REDUCED ACH



CORONAL STIR SHOWING COMPLETE DISRUPTION OF SUPRASPINATUS TENDON CLOSE TO ITS INSERTION WITH RETRACTION OF FIBRES &SURROUNDING FLUID – FULLTHICKNESS SUPRASPINATUS TEAR.



SAGITTAL T2 FS SHOWING LOSS OF SUPRASPINATUS TENDON SIGNAL CONSISTENT WITH FULL THICKNESS TEAR.



AXIAL STIR IMAGES SHOWING HYPERINTENSITY IN SUBSCAPULAR TENDON WITH NO DISRUPTION OF FIBRES, FLUID AROUND THE BICEPS TENDON.

CASE NO 7

AGE: 65 years

GENDER: female

PRESENTING COMPLAINT: Pain and difficulty in abducting the right arm over the head for 3 months

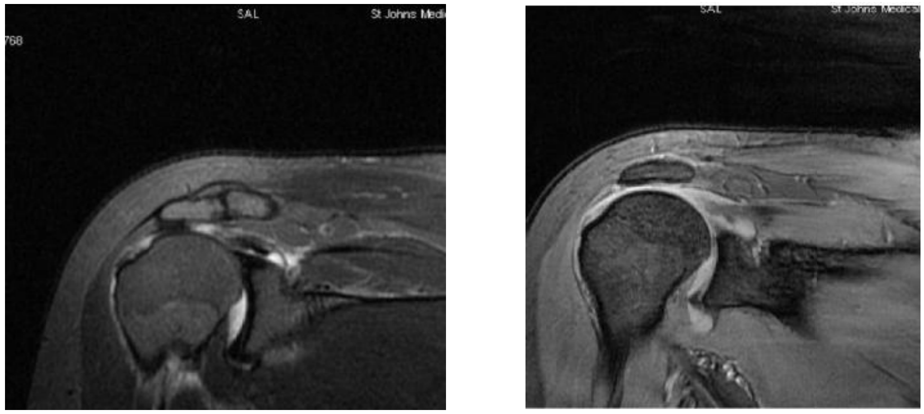
FINDINGS:

Discontinuity of supraspinatus and infraspinatus tendon fibers with retraction of musculotendinous junction and adjacent fluid – complete tear of the supraspinatus and the infraspinatus tendon.

Edema noted involving supraspinatus and infraspinatus muscle. Fluid noted in the subscapularis tendon sheath.

Fluid noted around the biceps tendon. Moderate joint effusion is noted.

Type I acromion is noted. Acromioclavicular joint are normal.



CORONAL T2 FS & PD FS IMAGES SHOWING TYPE I ACROMION < COMPLETE TEAR OF SUPRASPINATOUS TENDON WITH RETRACTION OF FIBER

AXIAL STIR IMAGES SHOWING FULL THICKNESS INFRASPINATOUS TENDON TEAR WITH RETRACTION OF THE END JOINT EFFUSION < FLUID AROUND THE BICEPS AND SUNSCAPULARIS TENDON.

CASE NO 8

AGE: 70 years

GENDER: female

PRESENTING COMPLAINT: weakness of right shoulder for 2years

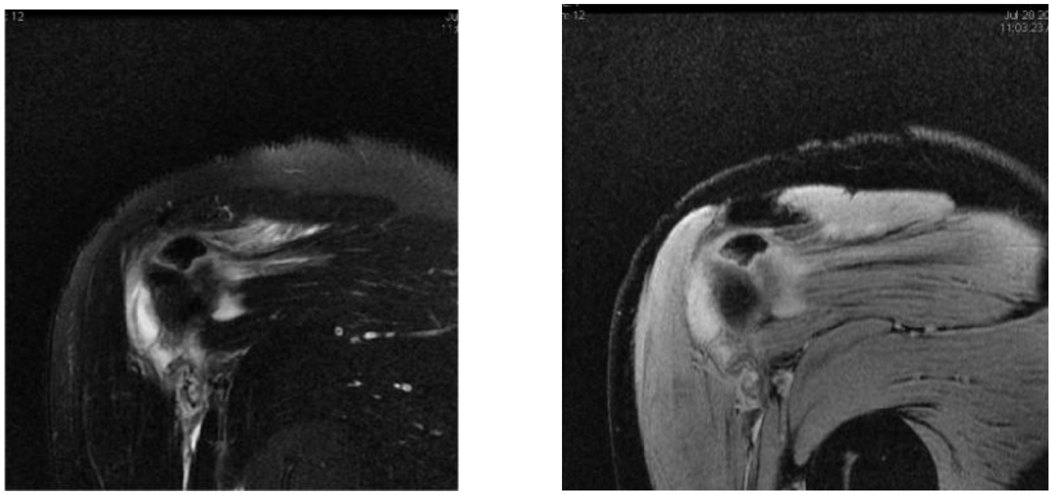
FINDINGS:

Intrasubstance STIR hyperintensities with sparing of the surfaces in the posterior fibres of supraspinatus tendon –intrasubstance partial tear.

A blooming focus noted in the supraspinatus tendon – calcification in the tendon. Rest of the rotator cuff tendons are normal.

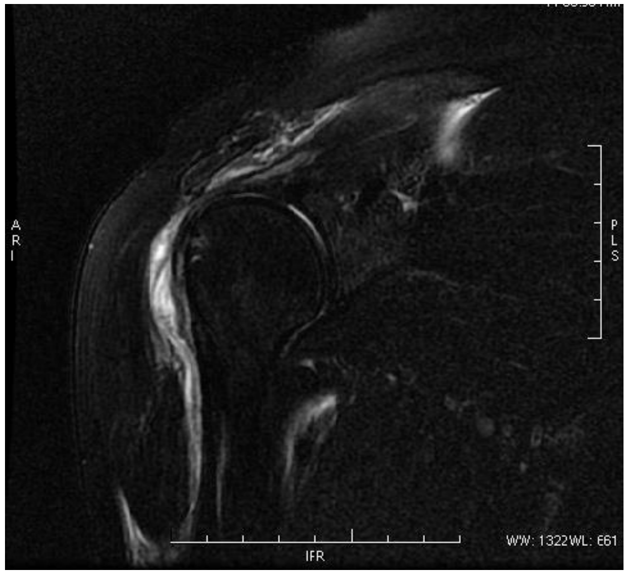
Mild to moderate joint effusion noted. Fluid noted around biceps tendon. Lateral downsloping acromion noted.

Subdeltoid & subacromial bursal fluid noted. Labrum is normal.

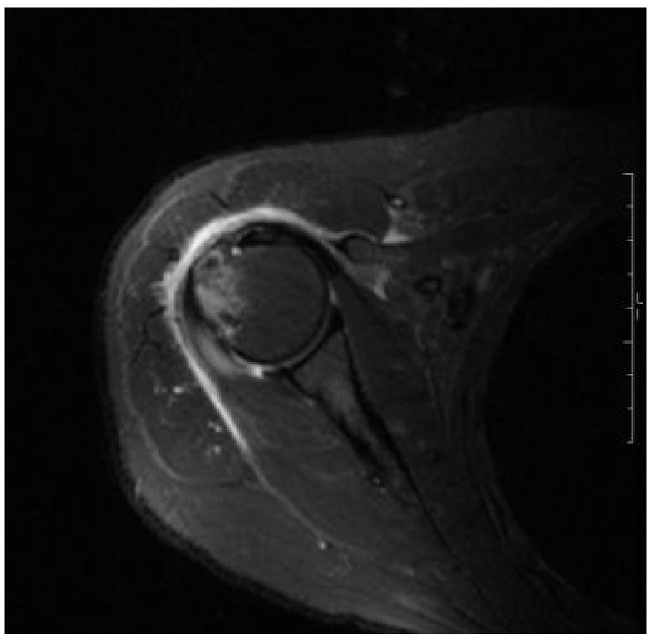


CORONAL T2 FS & GRE SHOWING HYPOINTENSE FOCUS WITH BLOOMING ON GRE – CALCIFICATION IN THE SUPRASPINATUS TENDON

CORONAL T1 IMAGE SHOWING LATERAL DOWNSLOPING ACROMION.



CORONAL T2 FS IMAGE SHOWING INTRASUBSTANCE PARTIAL TEAR OF SUPRASPINATUS, JOINT EFFUSION, SUBDELTOID BURSAL FLUID.



AXIAL STIR IMAGE SHOWING INTRASUBSTANCE PARTIAL TEAR OF SUPRASPINATUS, JOINT EFFUSION, SUBDELTOID BURSAL FLUID, HUMERAL HEAD CONTUSION

CASE NO 9

AGE: 47Years

GENDER: Male

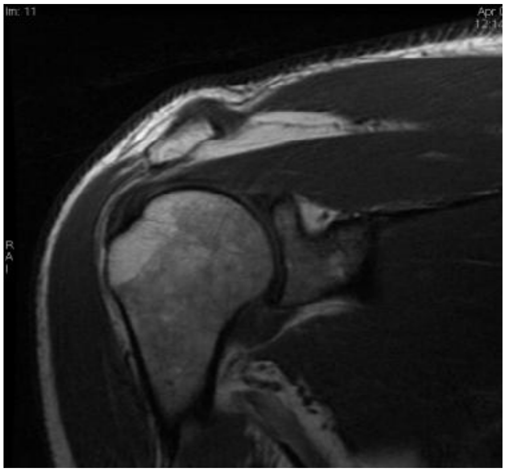
PRESENTING COMPLAINT: Pain in the right arm and upper limb for 1 year, increasesd for 1 month

FINDINGS:

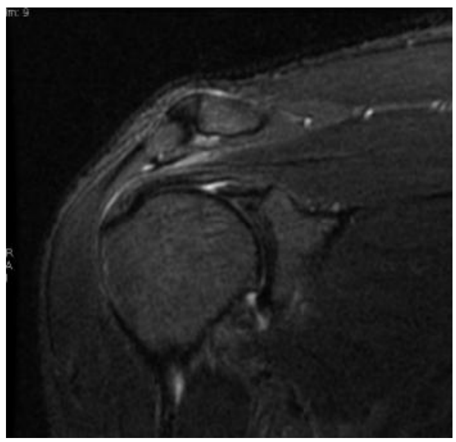
The lateral portion of the acromion is tilted inferiorly relative to the clavicle suggestive of inferolateral tilt of acromion, causing impingement of supraspinatus tendon ,seen as hyper intensity within the tendon.

Hyper intensity in the subscapularis tendon at its insertion with fluid around it –partial tear.

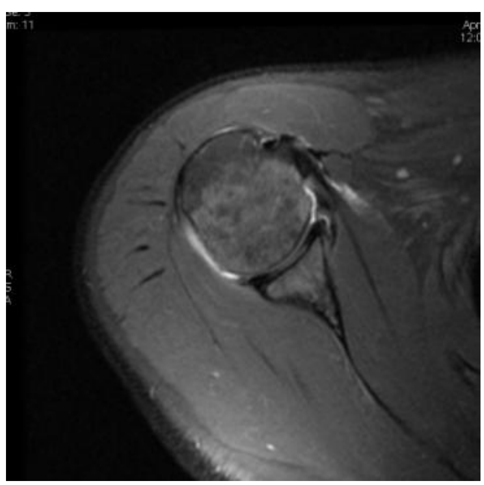
Marrow edema in the posterosuperior humeral head. Acromioclavicular joint hypertrophy. Minimal joint effusion.

CORONAL T1W IMAGES SHOWING INFEROLATERAL TILT OF ACROMION



CORONAL T2FS IMAGE SHOWING IMPINGEMENT OF SUPRESPINATOUS AND SUBSCAPULARIS TENDON.



IMAGES SHOWS PARTIAL TEAR OF SUBSCAPULARIS TENDON

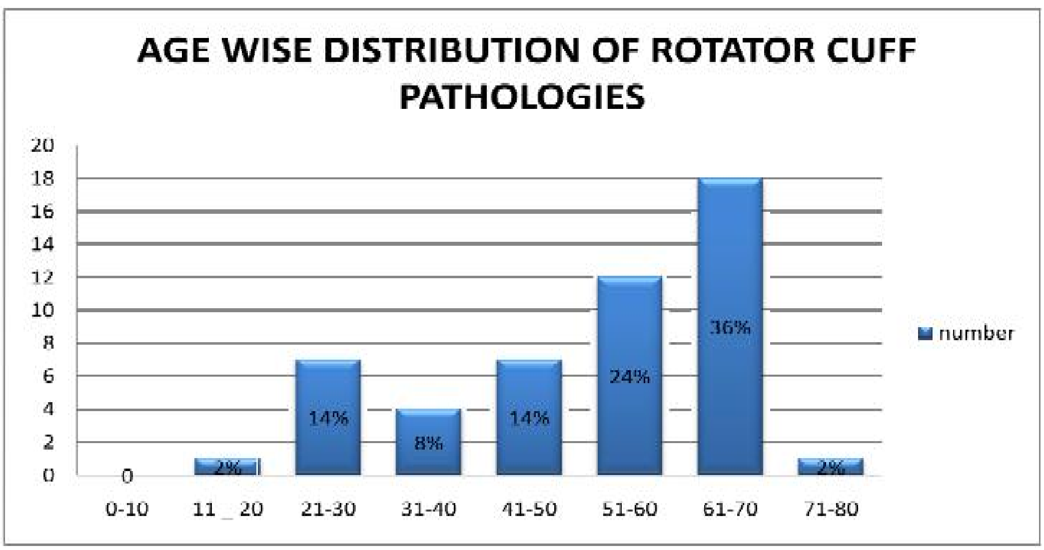
5.2 DATA ANALYSIS.

Fifty cases of rotator cuff disease as per the inclusion and exclusion criteria were included in the study. The observations of these 50 patients were compiled and analyzed.

5.2.1 Age wise distribution of rotator cuff pathologies:

The age of the patients with rotator cuff pathologies studied ranged from 19 to 78 years, with a mean of 52.10 $\pm$ 2.08.

The patients involved in the study were divided into 7 age groups viz. 11-20 years, 21-30 years, 31-40 years, 41-50 years, 51-60 years ,61-70 years and 71- 80 years. There was one (2%) in 11-20 year age group, seven (14%) in 21-30 year age group, four (8%) in 31-40 year age group, seven(14%) in 41-50 year age group, twelve (24%) in 51-60 year age group, eighteen (36%) in 61-70 year age group, one (2%) in 71-80 year age group as given in chart below.



In patients with age more than 50 yrs, 17 (34%) patients show tears as compared to less than 50 years where 7 (14%) show tear in supraspinatus tendon. In patients more than 50yrs of age, 12(24%) showed tendinosis and in less than 50 years 7(14%)

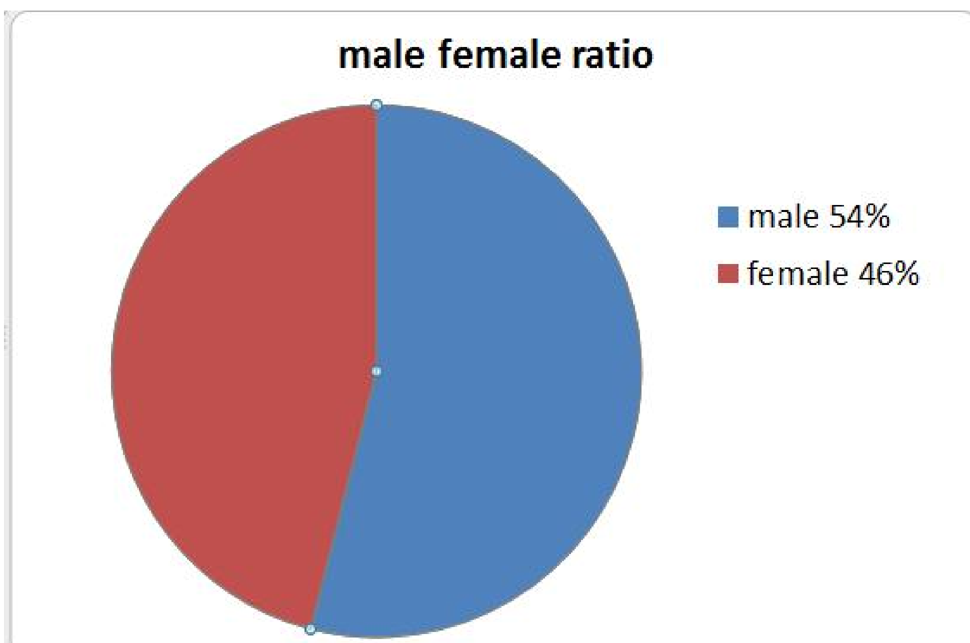
showed tendinosis. Thus in this study tears and tendinosis appear to be common in older age groups than in younger patients, with tears being more common than tendinosis in older age groups.

In this study, 50% patients had type II acromion or type III acromion or associated

spurs / osteophytes in the acromion. Of these 25 patients, 9 (36%) were in the 61-70 age group, 7(28%) in the 51-60 age group, 4(16%) in the 41-50 age group, 3 (12%) in the 21-30 age group and one (4%) each in 31-40 and 71-80 age groups.

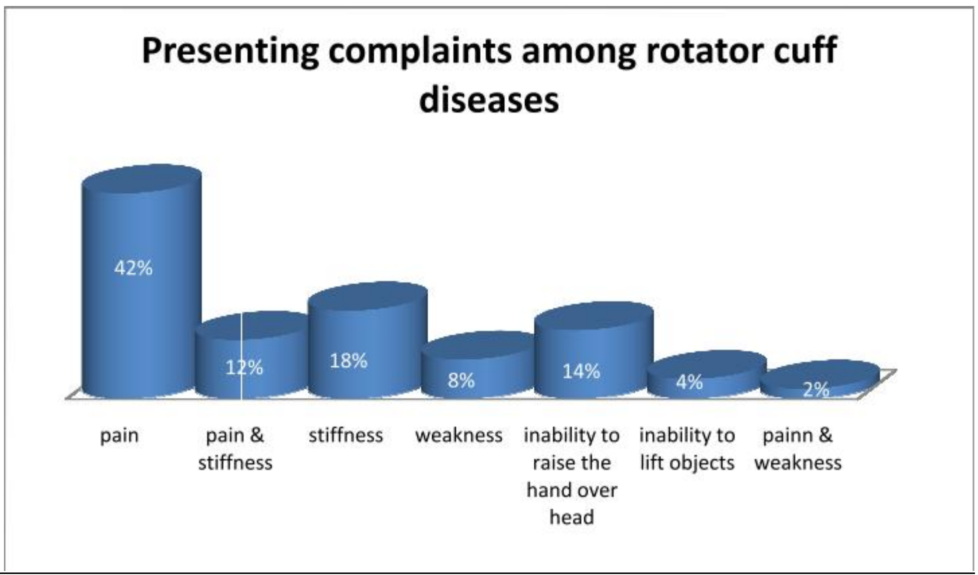
5.2.2 Sex wise distribution of rotator cuff diseases

Of the 50 patients studied, 23(46%) were females and 27 (54%) were males. The mean age among females was 62.8 + 1.98 and the mean age among males was 47.19+ 2.2.



5.2.3 Clinical presentation of rotator cuff pathologies

Patients with rotator cuff diseases presented with pain, stiffness or reduced range of movement, weakness of the shoulder joint, inability to raise the hand over the shoulder (like in combing hair the table etc) difficulty to lifting objected (like a glass from the table) and combinations of more than one complaints. The most frequent complaint being pain among 21 subjects accounting for 42 % in descending order of frequency other complaints are stiffness of joint among 9 (18%) difficulty in raising the upper limb among 7 (14%) combination of pain and stiffness among 6 (12%) weakness among 4(8%),difficulty in lifting objects in 2 (4%) and pain with weakness in 1 (2%).



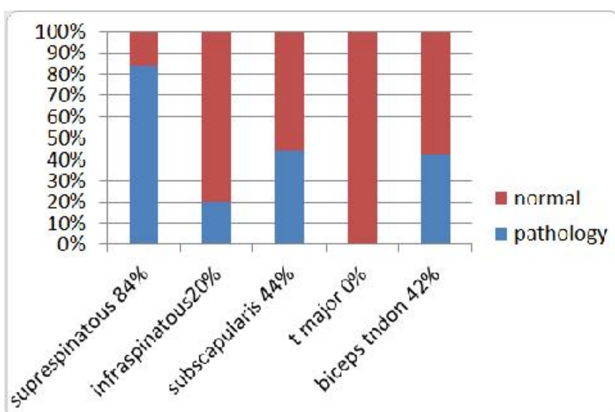
Of the 50 patient , 27 presented with symptoms in the right side accounting for 54% and 23 (46%) patients had disease in the left side.

5.2.4 Spectrum of rotator cuff pathologies

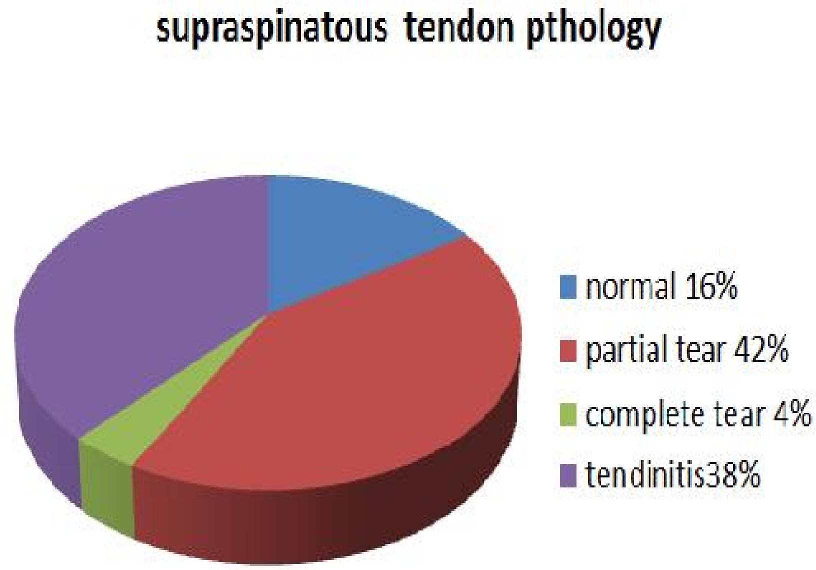
Of the patients with shoulder complaints referred to our department magnetic resonance imaging 50 patients with rotator cuff disorders during the study period are included in the study. The pathologies of the rotator cuff tendons comprised of impingement resulting in tendinosis or tendenopathy and tendon tears – partial and full thickness tear thickness tears. Associated and precipitating factors like acromion shape & slope, acromio- clavicular joint hypertrophy, labral tears, joint effusion, tendon calcifications and bursal fluid were noted.

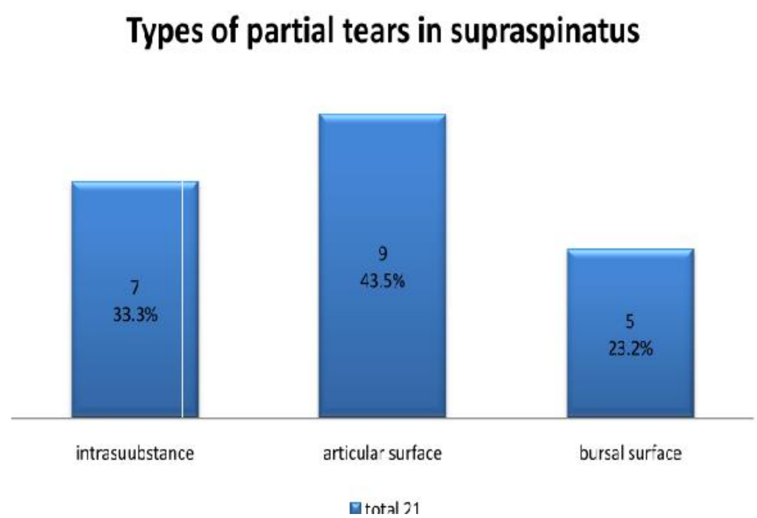
The most frequently affected tendon being supraspinatus and the least affected being teres minor.

In the decreasing order of frequency the other tendons involved are subscapularis, biceps and the infraspinatus. Of the 50 patients 42 (84%) abnormal supraspinatus tendons and 8 (16 %) normal supraspinatus were noted. Of the subscapularis tendon 22(44%) were pathological and 28(56%) were normal. Among the infraspinatous tendon 40(20%) were normal and 10(20%) were abnormal. Abnormal bicipital tendons were seen in 21 (42%) and normal bicipital tendons seen in 29(58%).All the Teres minor tendons were normal accounting for the least commonly affected rotator cuff tendon.



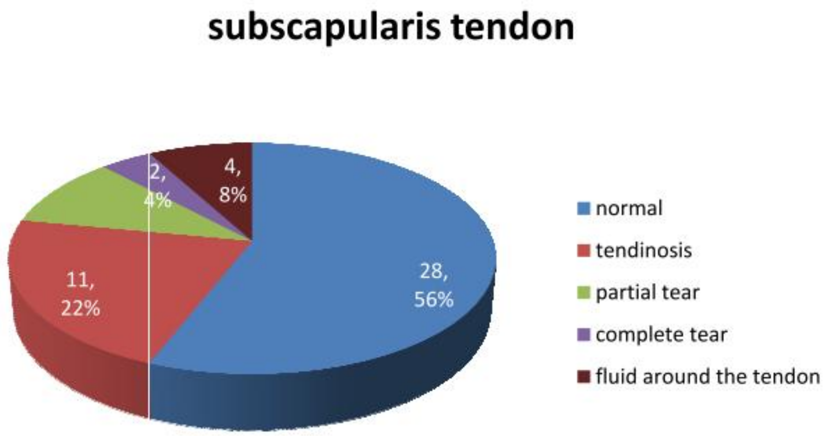
Of the pathologies of the supraspinatus tendon, tendinosis was seen in 19 patients (45%) partial tear in 21 (50%) and complete tear in 2 (4.7%). Thus partial tear and tendinopathies are the most commonly encountered abnormality in the supraspinatustendons in this study population accounting for 42% and 38% respectively.



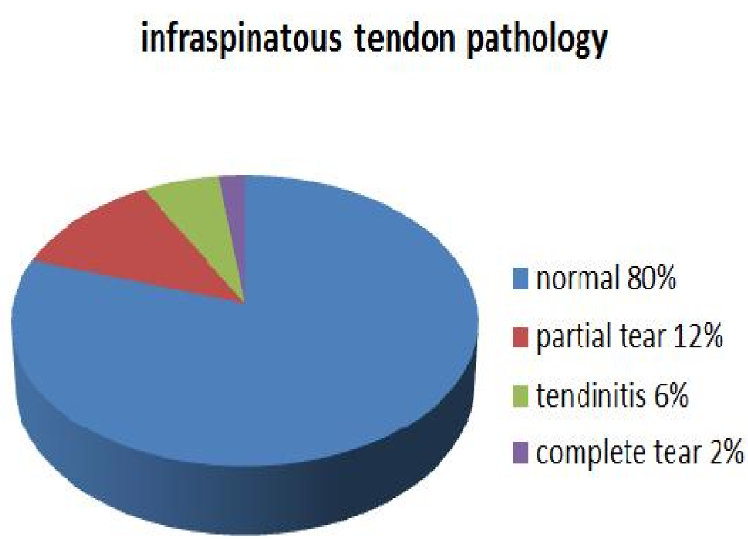


Partial tears can be further classified as intrasubstance tear when it does not involve the surfaces, articular surface partial tear when the humeral side of the tendon is involved and bursal surface partial tear when the acromial side is involved. There were 21 patients with partial tear of supraspinatus of these the common type was the articular surface tear in 9(43.5%), followed by intrasubstance tear in 7(33.3%) and the least common was the bursal surface tear in 5 (23.2%).

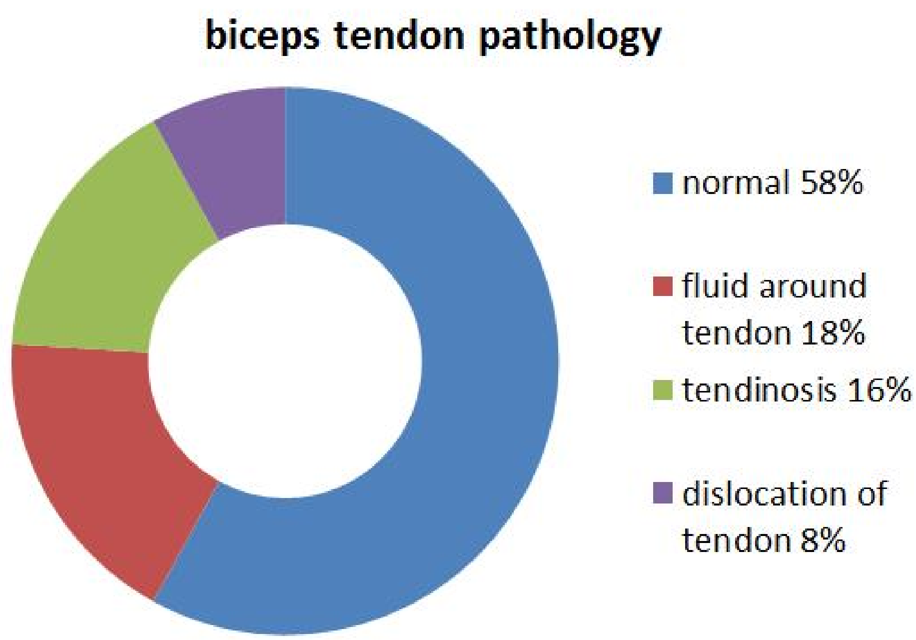
Among the abnormalities of subscapularis, tendinosis with no evidence of tear was noted in 11 (22 %), tear noted in 7 (14 %) partial in 5 (10%) & complete in 2 (4%) and the fluid around the tendon with no signal abnormality in the tendon was noted in 4 (8%)Normal subscapularis tendon noted in 28 (56%).Tendinosis or tendinopathy is the frequently encountered pathology in the subscapularis tendons.



Tendinosis was found in 3(6%), partial tear in 6 (12%) and complete tear in 1(2%) of the infraspinatus tendon rest of the tendons 40 (80%) were normal. Thus the frequent abnormality in the infraspinatus in this study group was partial tear.

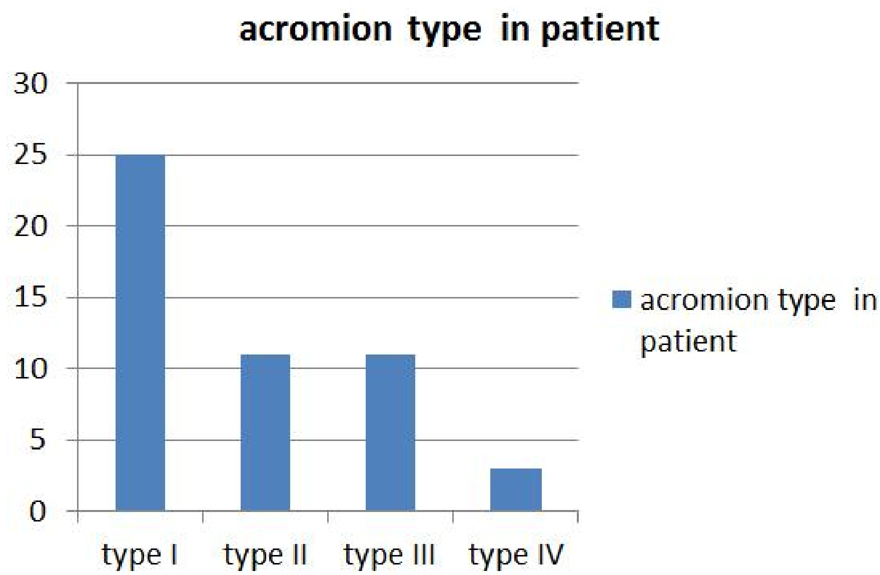


Associated abnormalities in bicipital tendons were noted in 21 (42%) patients. The abnormalities seen in the tendon included tendinosis in 8(16%), fluid around the tendon with no signal abnormality in the tendon in9 (18%) and dislocation of the tendon in 4 (8%). Thus the common abnormal finding seen in relation to the biceps tendon in a rotator cuff disease in our study group is fluid around the tendon.

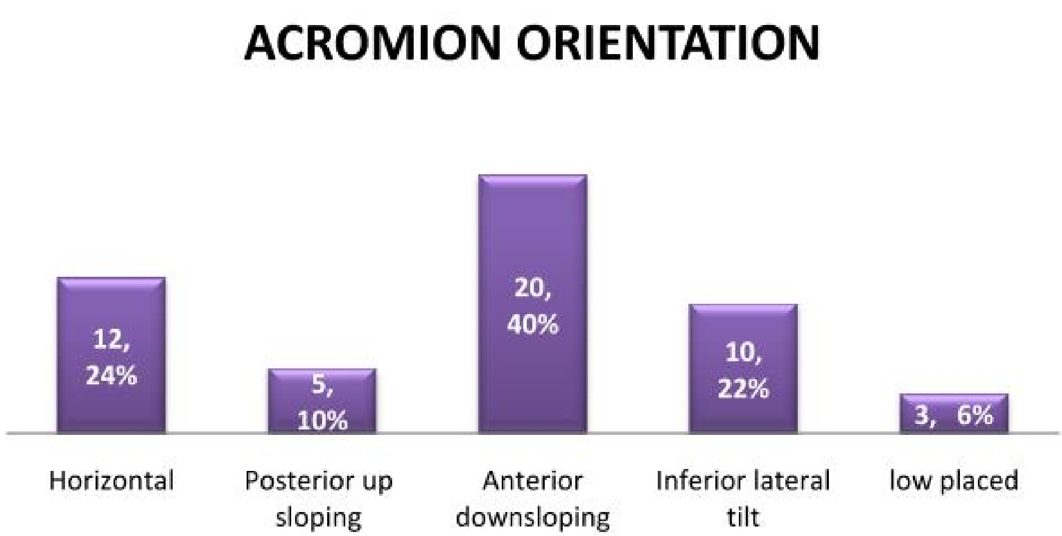


5.2.5 Other related/ predisposing findings:

Of the 50 patients, type I acromion was seen in 25 (50%) ,type II and III acromion was seen in 11(22%) each. Three of the patients (6%) had type IV. In this study the common type of acromion is the type I or flat acromion.

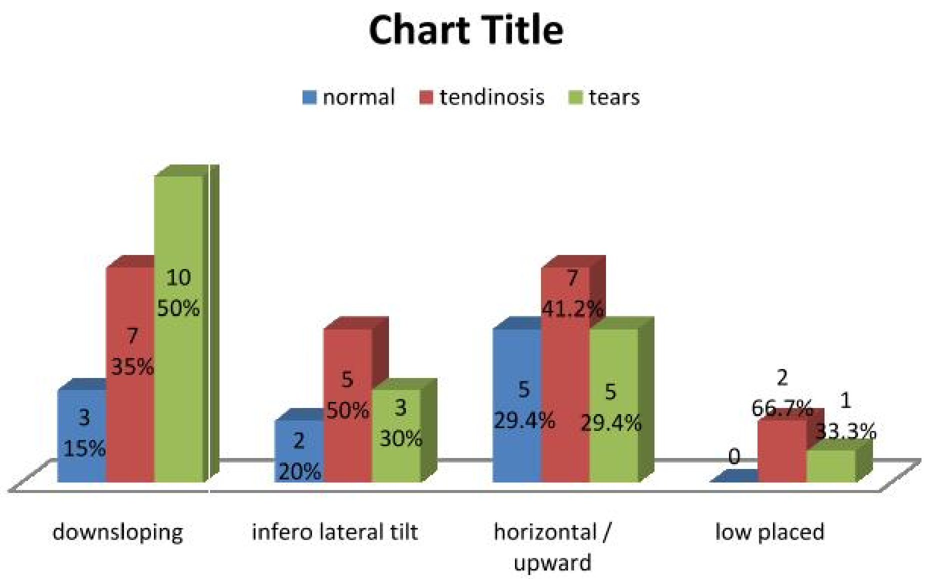


The orientation and the sloping of the acromion is described as horizontal, posterior up-sloping, anterior down sloping, inferolateral tilt or low placed. The most frequent being anterior downsloping in this study, in 20 (40%), next being horizontal orientation in 12 (24%), inferolateral tilt in 10(20%), posterior upward sloping in 5(10%) and low placed in 3 (6%).

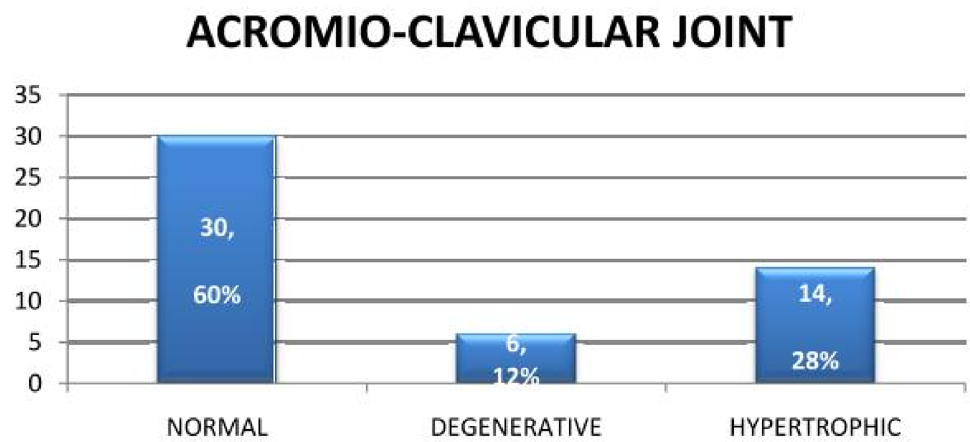


Of 20 patients with downsloping acromion 3 (15%) had normal tendon, 7(35%) had tendinosis and 10(50%) had tears Of the 10 patients with- lateral tilt, 2

(20%) had normal tendon , 5(50%) had tendinosis 3(30%) had tears. Of the 17 patients with horizontal or upward acromion, 5(29.4%) had normal tendons, 7(41.2%) had tendinosis and 5(29.4%) had tears. Of the 3 patients with low placed acromion, none had normal tendon, 2(66.7%) had tendinosis and 1(33.3%) had tear.

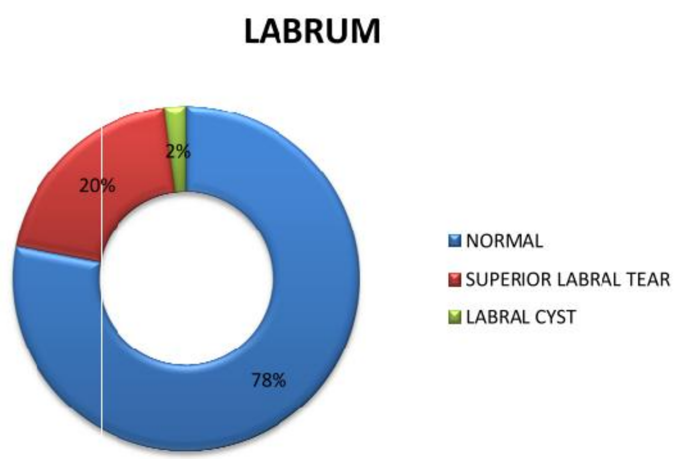


Acromio- clavicular joint was assessed in terms of being normal, degenerative while showing osteophytosis or hypertrophic when there is hypertrophy and callus formation which appears as rounded mass of medium signal intensity surrounding the joint. In our study AC joint was found to be normal in 30 out of 50 (60%), degenerative in 6 (12%) and hypertrophy in 14(28%).

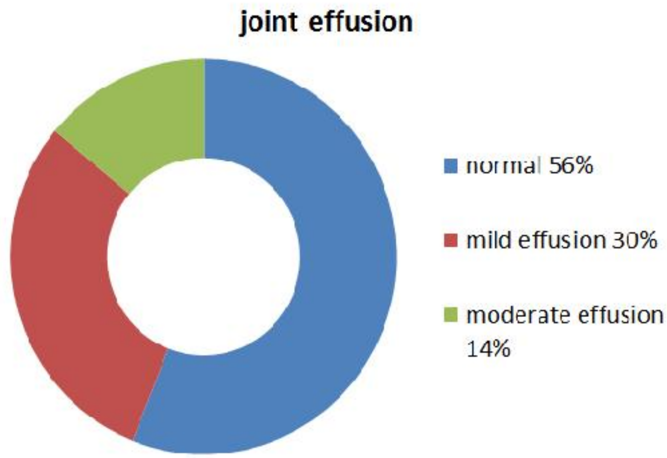


Of these 20 patients with acromioclavicular arthropathy, 11(55%) had tear,8 (40%) had tendinosis and 1 (5%) had normal tendon.

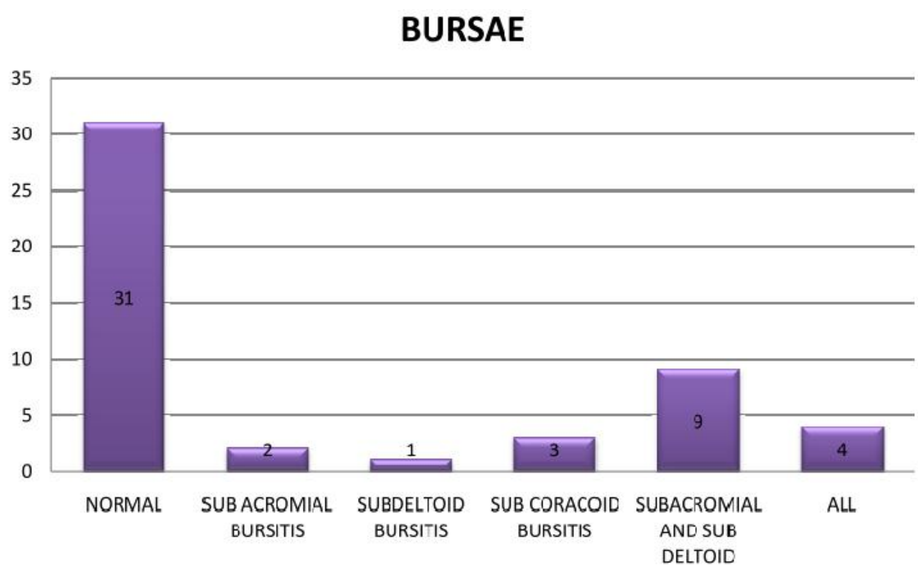
Of the 50 patients with rotator cuff pathologies, 10 patients (20%) had associated superior labral tear and one (2%) had labral cyst. Rest of the patient showed no labral abnormality.



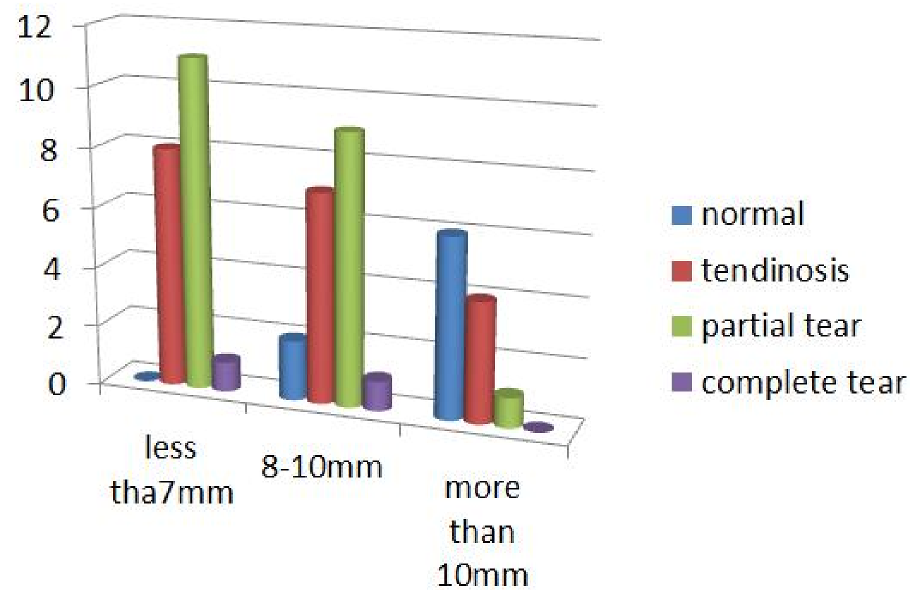
Joint effusion was noted in 22 out of 50 patients (44%). No effusion was seen in 28 (56%). Joint effusion was mild or minimal in 15 (30%) and moderate in 7(14%).



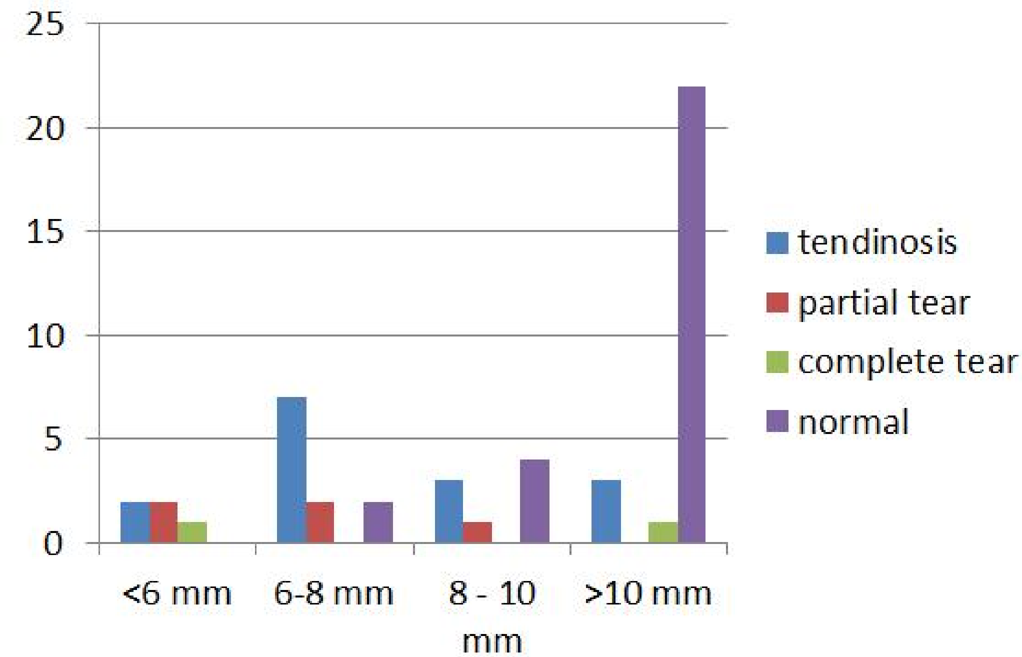
Bursal fluid / bursitis can be seen in patients with rotator cuff disorders. In our study bursae around the shoulder joint was normal in 31 (62%). Isolated sub acromial, sub deltoid and sub coracoid bursitis was noted in 2(4%),1(2%) and 3(6%) respectively. Combination of subacromial and sub deltoid bursitis was seen in 9 (18 %), being the most frequent in our study. Involvement of all three was noted in 4 (8%).



The acromiohumeral distance (AHD) is measured between the superior articular surface of the humeral head and the under-surface of the acromion. The patients were grouped as more than 10mm, 8-10mm and less than 7 mm. 20patients (40%) had AHD less than 7mm and all 20 (i.e 100%) patients had abnormal supraspinatus tendon, no patient had normal supraspinatus tendon in this group. There were 19patients (38%) in the 8-10mm group of this 2 (10.52%) had normal tendon and 17(89%) had abnormal tendons. Eleven patients (22%) had AHD more than 10mm, of this 5 (45%) had abnormal tendons and 6(55%) had normal supraspinatus tendon.



The coracohumeral distance is measured between the tip of the coracoid process and the lesser tuberosity. Normally it is more than 11mm. In our study patients were classified into groups according to coracohumeral distance as less than 6mm, 6-8mm, 8-10mm and more than 10 mm. 26 patients (52%) had coracohumeral distance more than 10mm, of these 22(84%) had normal tendon and 4(15.4%) had abnormal tendons. Five (10%) had coracohumeral distance less than 6 mm, of these all (100%) had abnormal subscapularis tendon. 11 (22%) had coracohumeral distance between 6 and 8 mm, of these 2(18%) had normal tendons and 8(72%) has abnormal tendons. In the coracohumeral distance between 8 -10 mm group there were 8 (16%) of them 4(50%) each has normal tendon and abnormal tendon.



6. DISSCUSION

Magnetic resonance imaging, with the advent of surface coils has become a valuable approach in demonstrating the musculoskeletal abnormalities. Imaging of the shoulder using MRI has various advantages over conventional techniques. The soft tissue structures supporting the shoulder are arranged in multiple planes, hence the direct multiplanar imaging capability of MRI is superior to the single plane capability of computed tomography. The rotator cuff is well visualized in magnetic resonance imaging and the individual central tendons of the four rotator cuff muscles can be separately identified. Thus allowing precise localization and quantification of rotator cuff abnormalities. MRI can demonstrate the rotator cuff excellently including the subacromial portion, which is hidden from view on ultrasonography. Rotator cuff muscles provide major support to the shoulder joint in stabilizing it and thus is frequently affected.

In our study 50 patients with rotator cuff disorders were included and magnetic resonance imaging characteristics of the abnormality were described. Age and gender distribution among the study population were also described. All the imaging was done using a 1.5 Tesla machine **in the Department Of Radio Diagnosis, Shri B.M Patil Medical College And Research Center, Bijapur.**

6.1 Age wise distribution of rotator cuff diseases:

In the current study the age of the patients with rotator cuff disorders ranged from 19 to 78 years with the mean of 52.10 + 2.08 The peak incidence was found in the sixth and the seventh decade of life. Various literatures have pointed out that the incidence of rotator cuff tendon degeneration and injury increases with the age. Rotator cuff diseases is multi factorial both extrinsic and intrinsic factors have been implicated. Intrinsic factors like poor vascularity, alteration in the material composition & properities with aging have been studied [82,83,84].

Ozaki et al ,in Tears Of The Rotator Cuff Of the Shoulder Associated With Pathological Changes In The Acromio believed that the pathogenesis of rotator cuff disorders is an intrinsinc process [83,84,85] and the risk of rotator cuff disorder increases with aging. Microvascular studies have shown diminished vascularity in the cuff tissue with increased age which appears consistent with the pattern of degeneration observed in age related degenerative tendinopathies[86,87,88,89].

Study conducted **by Needell et al, in Imaging Of The Rotator cuff: Peritendinous and Bone Abnormalities in Asymptomatic Population[90]** 100 asymptomatic shoulders, a higher incidence of tendinosis was found among younger population against more tears in the older age group in the fifth and sixth decade of life.

Tendinosis or tendinopathies were characterized by moderately hyper intense signal within the tendon on short TR/TE (eg) T1 weighted image and proton density images.

These signal intensities are oriented along the long axis of the tendon. They can be homogeneous (focal, diffuse, or bandlike)[98] or inhomogeneous. This hyperintensities usually fades or disappears on long TR/TE (T2-weighted images), whether obtained with conventional[99, 100, 101] or fast spin echo imaging sequences without fat suppression. On Fat-suppressed sequences, or STIR imaging sequences these signal are more conspicuous and should be distinguished from true fluid signal as seen in a rotator cuff tear[102]. Tendon thickening may be present, and increased and more diffuse thickening may be associated with more advanced tendinosis[103].

In our study tears to be more common in the age groups more than 50 years 34% compared to 14% in patients less than 50%.But higher frequency of tendinosis in younger patients compared to older patients was not found in our study. The extrinsic factors like impingement secondary to spurs, osteophytosis, downsloping acromion, type II & III of acromion also increases with age [90] .

6.2 Gender distribution of rotator cuff disease:

Equivocal distribution of rotator cuff disease has been described in most of the literature. Some shown slight female predominance in case of tendinosis and slight male predominance among patients with tears[91.]

Study done among 90 patients by **Milgrom et al, in the Rotator –Cuff Changes In Asymptomatic Adult,** showed no statistically significant differences in the incidence of rotator-cuff lesions related to gender[92].

In our study rotator cuff diseases was seen in 27 male patients (54%) and 23female patients (46%), thus showing no significant difference in the gender distribution among the study population.

6.3 Clinical complaints and rotator cuff disease:

Study done among 150 patients by **Zlatkin et al, in Diagnostic Performance Of MR Imaging: Comparison With Arthrography And Correlation With Surgery** shows pain is the most frequently associated complaint with rotator cuff pathology. It is usually located over the anterior, superior, and lateral aspects of the shoulder[93]. Pain usually is minimal at rest in a neutral and supported position of the arm. The pain is typically exacerbated with overhead raising or abduction of arm as in combing hair,especially when lifting against resistance[94].

Weakness may be a manifestation of either pain inhibition or muscular fatigue. True weakness often presents as an inability to raise the arm above the shoulder level. Stiffness or decreased range of motion may be secondary to pain or weakness of the rotator cuff [92,93].

Our study showed pain as the most common presenting complaint of rotator cuff disorders, which is consistent with the literature[91,94].

6.4 Rotator cuff diseases:

Rotator cuff disorders include impingement causing tendinosis and partial and full thickness rotator cuff tears, calcific tendinitis, and coracoid impingement involving the subscapularis tendon. The patho morphological changes of the rotator cuff are probably multifactorial, including intrinsic and extrinsic factors. Most of these extrinsic factors are assessed using the magnetic resonance imaging .These associated factors like type of acromion, acromial orientation, acromioclavicular joint arthropathy etc, are analyzed in this study.

In our study the most commonly affected tendon being supraspinatus followed by subscapularis and infraspinatus. Teres minor was not involved in any of the patients in

this study. This is consistent with the study conducted **by Jerosch et al, In The Incidence Of Rotator Cuff Rupture.** It was a study conducted on the dissected specimen of shoulder joints of 122 patients; it was found that isolated supraspinatus occurred in 78% cases[96].It was also noted no tear occurred without the involvement of supraspinatus tendon. **Depalma et al, in Surgery Of The Shoulder** examined 96 cadaver shoulder and showed similar finding of supraspinatus as the commonly affected tendon and the incidence and degree of tear increased with age[97].

Partial tears of tendon can be intratendinous/ intra substance without involvement of the surface, either on the bursal or the articular surface of the tendon. On MRI partial tears appears as focal areas of hyperintensity on both short and long TE sequences[104].

This hyperintense signal does not extend through the entire thickness of the tendon.

In our study in 50 patients with shoulder complaints showed hyperintense signal in T1 weighed images with corresponding increased signal intensity in T2 weighed images with defects or discontinuity in the tendon fibers which is not extending through the thickness of the tendon were termed as partial tears. Among this 50 patients totally 32patients had partial tear(64%) of which 21(42%) patients had tear in the supraspinatus tendon, 5(10%) in the infraspinatus tendon and 6 (12%)subscapularis tendons.

Traughber PD et al, in Arthroscopic Correlation With Emphasis On The Partial Tear study conducted in 50 patients with surgical correlation found partial tears of the articular surface in 70%, Fluid in the subdeltoid bursa may commonly be identified in bursal-side partial- thickness tears and may make it easier to assess the size and depth of bursal-side partial tears[105]. Articular surface tear are found more common than the bursal surface tears[106].

In our study 21 patients had partial tear of the supraspinatus tendon of these partial tears was most commonly seen in the articular surface in 43.5% followed by intrasubstance tears in 33.3% and bursal tears in 23.2%,which was found to be least common.

The articular surface of the cuff is hypo vascular compared to the bursal surface, resulting in a higher incidence of partial-thickness rotator cuff tears on the articular surface of the cuff [93,107]. **Clark et al, In Tendons ,Ligament And Capsule Of The Rotator Cuff** show that a thinner, less uniform arrangement of collagen bundles near the articular surface leads to an ultimate strength that is half that of the bursal portion of the tendon. This may also predispose the tendon to a higher incidence of articular surface partial thickness tears[110].

Full thickness tears are ones in which the signal abnormalities appear to traverse through the whole thickness, extending through from surface to surface on at least one image[104].This bright signal intensity is related to the presence of fluid secondary to tear. Presence of fluid in the subacromial –subdeltoid bursa is a common finding. **Davidson et al, in Rotator Cuff And Posterio-Superior Glenoid Labrum Injury Associated With Increased Glenohumaral Motion Showed in** 100 patients that complete or full thickness tear is more frequent in supraspinatus[50].

In our study full thickness tear was seen in 5 out of 50 patients (10%), of which 2(4%) occurred in the supraspinatus tendon.

Teres minor is an important external rotator of the shoulder, contributing up to 45% of the power of external rotation. An intact or even hypertrophied, teres minor can provide enough power to external rotation and can maintain the ability to perform the activities of daily living, such as eating and drinking, and reduce the symptoms of the other cuff tendon tear.**Gilles et al, in The 'dropping' and 'Hornblower's' Signs In Evaluation Of Rotator Cuff Tears** conducted study on 2,436 shoulder MRI examinations for a period of 67-months period from September 1996 to April 2002. MRI findings of teres minor abnormality was seen in 0.8% only among the study population[112].**In our study** none of the Teres minor showed any abnormality.

6.5 type of acromion and associated rotator cuff diseases:

Bigliani and colleagues in the Morphology Of Acromion And Its Relation to Rotator Cuff classified acromion as type I to IV , namely flat, curved inferior surface, hooked and convex near the distal end , respectively . According to **Iannotti et al** Type II & III are commonly associated with shoulder impingement[93].

Bigilalni et al, In The Relationship Of Acromial Architecture To Rotator Cuff Disease study in 140 cadavers showed significant increase in full thickness tear with type II acromion. **Morrision and Bigilani** in another study found 80% correlation between type II and type III acromion with rotator cuff disease[114].**Ellman et al, in The Rotator Cuff End Result Study Of Factor Affecting Reconstruction** found association of rotator cuff tears with type II & III acromions[115].

In our study done in 50 patients with rotator cuff pathologies, type I was noted in 25 (50%) and type II & III in 11 each (22%) .In this study it was found 50% of patients (25 out of 50) had either type II or III acromion or spurs/osteophytes in the acromion. Of these patients 13 (52%) had tears (partial and complete), 9(36%) had tendinosis and 3 (12%) had normal supraspinatus tendon. **Thus in our study** abnormal tendons were common with type II /III acromion.

Variation in acromion configuration and slope drastically affect the space available for supraspinatus tendon especially during abduction and rotational movements. The slope of the acromion is best appreciated on sagittal and coronal oblique images. Usually the lateral aspect of the acromion is oriented nearly horizontal or slopes downward posteriorly, best appreciated on sagittal oblique images. An anteriorly downsloping acromion is termed when the inferior cortex of the anterior acromion is located more caudally than the inferior cortex of the posterior aspect of the acromion. An inferolateral tilt or slope is one where the most lateral portion of the acromion is tilted inferiorly relative to the clavicle which can be detected on coronal oblique images. Sloping of the acromion in either direction increases the risk for impingement from mechanical trauma to the underlying distal supraspinatus tendon[48]. Normally, the inferior cortex of the acromion is in line with the inferior cortex of the clavicle on coronal oblique views. A low-lying acromion exists when its inferior cortex is positioned below the inferior cortex of the clavicle[48]. This positioning causes narrowing of the acromiohumeral space, which may predispose to impingement

In our study anterior down sloping acromion was noted in 20 (40%) and inferolateral tilt of acromion was noted in 10 (20%). Three (6%) had low placed acromion. Of 20 patients with downsloping acromion, 3(15%) had normal tendon, 7(35%) had tendinosis and 10(50%) had tears. Of the 10 patients with inferolateral tilt , 2(20%) had normal tendon, 5(50%) had tendinosis, 3(30%) had tears. Of the 17 patients with horizontal or upward acromion, 5(29.4%) had normal tendons, 7(41.2%) had tendinosis and 5(29.4%) had tears. Of the 3 patients with low placed acromion, none had normal tendon, 2(66.7%) had tendinosis and 1(33.3%) had tear.

In a study by Needel et al in 100 patients acromioclavicular joint changes increased with age. More than 80% patients with partial tear and all the patient with full thickness showed had acromioclavicular joint arthrosis[90].

In our study Acromio- clavicular joint degeneration/ hypertrophy has been noted in 20 (40%) patients. Of these 20 patients in our study with acromioclavicular arthropathy, 11(55%) had tear, 8 (40%) had tendinosis and one(5%) had normal tendon. Thus abnormal tendon was common in patient with AC joint arthropathy and tear being more frequent.

6.6Bicipital tendon abnormality and rotator cuff diseases:

Scott J E et al, in Long Bicipital Tendon of the Shoulder: Normal Anatomy and Pathologic Findings on MR Imaging study showed bicipital tendinitis / tenosynovitis was frequently accompanied rotator cuff diseases[119].

Rotator cuff disorders, especially in complete tears, the long bicipital tendon can get impinged between the humeral head and the coracoacromial arch. This can result in flattening of biceps tendon, tendinitis, partial tears and overt rupture.

Neer, in Cuff Tears, Biceps Lesions, And Impingement found that biceps tendon ruptures are extremely uncommon without coexisting rotator cuff abnormality[76].

Beall et al in a study done in 111 patients with shoulder pain who underwent both MR and surgery, found 23 patients with bicipital tendon abnormality. They concluded tears of the long head of the biceps tendon had a statistically significant association with tears of the supraspinatus and subscapularis components of the rotator cuff. It was also found relationship between acromiohumeral impingement and the adverse effects on both the biceps tendon and superior rotator cuff[120].

Similar finding were seen in our study, 50 patients with rotator cuff disease, 21 (42%) had abnormal biceps tendon. Of these abnormal bicipital tendons, tendinosis was seen in 8(16%), tendinitis / fluid around the tendon was seen in 9(18%) and dislocated biceps tendon seen in 4(8%).

6.7 Labrum and rotator cuff diseases:

An overlap of symptoms exists among patients with a glenoid labral lesion and those with a rotator cuff disorder or glenohumeral instability[121].A labral tear can result as a result of trauma like in patients who engage in overhead throwing athletic sport activities, or secondary to degenerative changes in the labrum leading on to tear. Rotator cuff tears and long head of the biceps tendinopathy may accompany a superior labral tear. Both chronic overuse tears of the posterosuperior labrum and articular-side partial tears of the supraspinatus and infraspinatus tendons may result from internal impingement in the overhead position.

In a study conducted by Glenn et al, in High- Field and Low –Field MR Imaging of Superior Glenoid Labral Tears and Associated Tendon Injuries on 41 patients with arthroscopy proven labral tear , it was found 68% patients had both labral and rotator cuff tears.

In our study out of the 50 patients, 11 patients showed abnormal glenoid labrum. This smaller number may be because of the limitation of magnetic resonance imaging without arthrogram in detecting labral tears[122].

6.8Joint effusion, bursal fluid and rotator cuff disease:

Study by Hollister et al in Association of Sonographically Detected Subacrommial/Subdeltoid Bursal Effusion And Intraarticular Fluid with Rotator Cuff Tear done on 97 patients with surgery proven rotator cuff tear52% had fluid in the joint, bursa or both. It was concluded in this study that fluid in the bursa (subacromial / subdeltoid), joint effusion had strong association with rotator cuff tears.The specificity for rotator cuff tears increases when both bursal and joint fluid were present, and careful evaluation of cuff tendons is a warranted to rule out tears in presence of joint effusion or bursal effusion[123].

Similar results were also found in the study by **Grainger et al**, who reviewed 1831 MRI over 2 years. They suggested subcoracoid bursa effusions is not an incidental finding but may be associated with the rotator cuff and rotator interval tears.

In our study joint effusion was found in 22(44%) and bursal fluid noted in 19(38%) Of the 22 patients with effusion 14(63.4%) had tears and 8 (34.6%) had tendinosis. Of the 19 patients with bursal fluid, 11(57.9%) showed tear in the cuff tendon and 8 (42.1%) showed tendinosis in the cuff tendon. Thus presence of joint effusion or bursal effusion is a marker of abnormal cuff tendon especially tears.

6.9Acromio-humeral distance and supraspinatus tendon:

The acromiohumeral distance is measured between the superior articular surface of the humeral head and the under-surface of the acromion .This is occupied only by the rotator cuff and easily compressible subacromial bursa.A reduction in this distance is implicated in abnormal functioning of the rotator cuff. Decrease in this space can cause impingement on the cuff tendons especially supraspinatus leading to degeneration/ tendinosis and tears.

Saupe et al, in Association Between Rotator Cuff Abnormalities and Reduced Acromiohumeral Distance showed reduced acromiohumeral distance was associated with rotator cuff tears and rotator cuff muscle degeneration. In that study 63 patients were divided in to three groups according to the acromiohumeral distance with age and gender matched controls – group I less than 7 mm, group II 8-10mm and group III more than 10mm.It was showed that the incidence of supraspinatus pathology was less in group III, AHD > 10mm, and AHD< 7mm is almost always seen with complete tear[124].

In our study only 3(6%) showed normal supraspinatus tendon in patients with less than 10mm AHD.In patients with AHD less than 7mm, no normal supraspinatus tendon was noted which is similar to the **Saupe et al study**. Abnormal supraspinatus were seen 20(40%) with partial tears in 11(22%) in patients with AHD less than 7mm.In patients with AHD between 8-10mm,17(34%) had abnormal tendon of which 9(18%) had partial tear .

6.10 Coracohumeral distance and subscapularis tendon :

The coracohumeral distance assesses the space between the tip of the coracoid process and the lesser tuberosity and ideally is measured with the humerus in maximal internal rotation, which may not be possible in the presence of a subscapularis tendon tear.The average CHD is 11mm[125].

D.P. Stephen et al, in Relation Between Narrowed Coracohumeral Distance And Subscapularis Tears study done on 36 shoulders with corresponding controls,showed coracohumeral distance in the patients with subscapularis impingement or tear was 5mm as compared to 10mm in the control group. He concluded there is a significant relationship between tears of the subscapularis and a decreased coracohumeral distance. Narrowed coracohumeral distance may be one of the possible causes of torn subscapularis[126].

Study by Nove-Josserand et al , found a strong correlation between a narrowed coracohumeral distance and large rotator cuff tears[127].

Friedman et al, in Magnetic Resonance Imaging Of The Subcoracoid Region showed in their series that patients with subcoracoid impingement had a coracohumeral distance of 5.5 mm as compared with 11 mm in their asymptomatic control[128].

In our study, patients with coracohumeral distance more than 10 mm the frequent finding was normal subscapularis tendon in 22(44%). And in patients with coracohumeral distance less than 6mm, no patient with normal subscapularis was found. An abnormal subscapularis tendon was seen among 15 (30%) of patients in group with coracohumeral distance less than 8 mm as compared to 5(10%) in group with coracohumeral distance more than 10mm.

7. CONCLUSION

Magnetic resonance imaging is relatively a newer modality for the imaging of the shoulder joint and is currently the modality to clearly delineate the soft tissue structure of the shoulder joints. our study comprises of 50 patients with rotator cuff lesions, who were imaged in the department of Radio Diagnosis, shri B.M patil medical college and research center Bijapur. All the patients were imaged using 1.5tesla scanner (Philips achiva).The magnetic resonance imaging characteristics of various rotator cuff abnormalities were studied.

1. The age distribution found in our study is in the range of 19 and 78 years with a mean of 52.10 $\pm$ 2.08 . In our study the rotator cuff abnormalities were common in sixth and the seventh decade of life. The incidence of predisposing factors for rotator cuff tears also found to increase with age as seen in our study, type II &III acromions, acromioclavicular joint arthropathies , osteophytosis/spurs are common in the sixth and seventh decade of life.
2. The most frequent presenting complaint in our study in patients with rotator cuff disease is pain followed by stiffness resulting in reduced range of movement across the shoulder joint.MRI imaging has useful in effectively ruling out the other causes of shoulder pain.
3. In our study in patients with rotator cuff disorders 54% are male and 46 % are females, showing almost equal distribution. Thus this study shows that rotator cuff disorders occur both in male and female with no gender predisposition.
4. The most commonly affected tendon in our study is the supraspinatus tendon as seen in most of the current literature, followed by subscapularis and

infraspinatus. The least frequent being the Teres minor.

5. Among the rotator cuff abnormalities the frequently encountered finding being partial tear and tendinosis of supraspinatus in 42% & 38% respectively. Full thickness tears were relatively rare in our study.

   Among the partial tears articular surface tears were more common, as compared to bursal and intrasubstance tears.

6. About 42% of the patients showed abnormalities in the biceps tendon, which is one of the frequent findings along with rotator cuff diseases seen in this study. The common bicipital abnormality found being the fluid around the tendon.

7. Difference in shape and orientation of acromion has been implicated in predisposing to rotator cuff disease. In this study anterior downsloping of acromion was frequently associated with abnormal rotator cuff tendons. The occurrence of abnormal rotator cuff tendons especially supraspinatus was frequent with type II , type III or acromial spurs / osteophytes .

8. It was noted in our study that the frequency of normal subscapularis tendon were more in patients with coracohumeral distance more than 10 mm and no normal subscapularis were seen when coracohumeral distance was less than 6mm.

9. Reduction acromioclavicular distance has been described in impingement of supraspinatus tendon. It is noted that normal supraspinatus tendon is common when the acromioclavicular distance is more than 10mm and abnormal supraspinatus is common when the acromioclavicular distance is less than 7 mm. It was also noted no patient with acromioclavicular distance less than 7mm had normal supraspinatus tendon.

10. Various other findings like joint effusion , bursal fluid , labral tears has also been noted along with rotator cuff disease. The frequently found finding was abnormal bicipital tendon and acromioclavicular arthropathy is bursal fluid , joint effusion, and labral tears

Thus magnetic resonance imaging is very useful in depicting rotator cuff disease for prompt diagnosis along with the predisposing factors like the acromion type & orientation, reduction in coracohumeral distance, reduced acromioclavicular distance and other associated features like effusion and bursitis . Further research with a larger sample size for a longer study period is suggested to draw broader conclusions and to strengthen the findings of the present study.

8. SUMMARY

The purpose of the study was to describe the magnetic resonance imaging features of the rotator cuff diseases and to examine the age, gender, symptoms among the study group. MRI examination of 50 patients who were clinically suspected with rotator cuff disorder and referred to department of Radiology ,shri B.M patil medical college vijyapur were studied. All patients were imaged using a 1.5 tesla MRI scanner (Philips achiva 1.3).

The age distribution found in the study is between 19 and 78 years with mean being 52.10 $\pm$ 2.08.The peak incidence was found in the sixth and seventh decade of life. The frequency of cuff pathologies among males being 52% and in females being 48% in this study. The common presenting common among the patients with rotator cuff disease is pain in this study. The second common complaint being stiffness of the joint. The other complaints being weakness of arm, difficulty in lifting objects and difficulty in abduction arm over the head.

Among the 50 patients in the study 86% abnormal supraspinatus tendon was noted making it the commonly affected cuff tendon. Other less commonly affected tendons are subscapularis followed by and the infraspinatus. None of the Teres minor tendon was affected in this study. The common abnormality noted was partial tears accounting for 42% in the supraspinatus and tendinosis accounting for 38% in the supraspinatus in this study.

Among the types of partial tears like intrasubstance tears, articular surface tears and bursal surface tears, articular surface tears were more common.

Among the variations in the acromion, in this study on 50 patients, 40% patients had anterior downsloping acromion, making it the frequently encountered orientation of acromion with rotator cuff abnormality. About 50% patients had type II or type III acromion(22% each) or spur in the acromion , thus resulting in supraspinatus tendon impingement.

Coracohumeral distance reflects the space between the coracoid process and the humeral head occupied by the subscapularis tendon. In this study 81.5 %(22 out of 27) had normal subscapularis tendon and 18.5 %(5 out of 27) had abnormal tendon when the coracohumeral distance was more than 10mm. When the distance was less than 6mm no normal (0%)tendon was noted.

Acromiohumeral distance is the space between the acromion and the humeral head which is occupied by the supraspinatus tendon. A reduction in this space can cause supraspinatus impingement. About 60 % (12 out of 20) showed supraspinatus tendon tears when the acromiohumeral distance was less than 7mm as compared to 9 % (1 out of 11)when more than 10mm. No (0%) normal supraspinatus tendon was noted in patient with this distance less than 7mm.

The frequent finding noted along with rotator cuff abnormality was abnormality in the biceps tendon in 40% and Acromioclavicular joint arthropathy in 40% .Other finding along with cuff disorders are bursal fluid in 38%, joint effusion in 36%, changes in the adjacent bones 36% labral tears in 22%,

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ANNEXURE-I

ETHICAL CLEARANCE

Institutional Ethical Committee
BIJAPUR-586 103.
OUTWARD
No. 52/13
Date 14-11-13
B.L.D.E.U's Shri B.M. Patil Medical College

B.L.D.E. UNIVERSITY'S

SHRI.B.M.PATIL MEDICAL COLLEGE, BIJAPUR-586 103

INSTITUTIONAL ETHICAL COMMITTEE

INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 13-11-2013 *at* 3-30pm *to scrutinize the Synopsis of Postgraduate Students of this college from Ethical Clearance point of view. After scrutiny the following original/corrected & revised version synopsis of the Thesis has been accorded Ethical Clearance.*

Title "Evaluation of rotator cuff - pathologies with MRI"

— x — x —

Name of P.G. student Dr Shivendra Chaudhary Department of Radiology.

Name of Guide/Co-investigator Dr B.R. Dhamanagaonkar professor of Radiology.

DR.TEJASWINI. VALLABHA
CHAIRMAN
INSTITUTIONAL ETHICAL COMMITTEE
BLDEU'S, SHRI.B.M.PATIL
MEDICAL COLLEGE, BIJAPUR.

Following documents were placed before E.C. for Scrutinization

1) Copy of Synopsis/Research project.
2) Copy of informed consent form
3) Any other relevant documents.

ANNEXURE-II

PROFORMA

NAME AGE SEX SIDE

HOSPITAL NO. CLINICAL DATA **IMAGING FINDINGS**

1. **ROTATOR CUFF TENDONS:**

SUPRASPINATUS – Normal /Tendinosis/ Partial Tear/ Complete Tear / Others

INFRASPINATUS– Normal /Tendinosis/ Partial Tear/ Complete Tear / Others

SUBSCAPULARIS– Normal /Tendinosis/ Partial Tear/ Complete Tear / Others

TERES MINOR– Normal /Tendinosis/ Partial Tear/ Complete Tear / Others

2. ACROMION: TYPE – I / II/ III

ORIENTATION– Downsloping / Inferolateral tilt/ Posterioupward/ Horizontal/

Lowplaced / others

SPURS / OSTEOPHYTES

3. ACROMIO-CLAVICULAR JOINT – Normal / Hypertrophy/ Degenerative /others
4. CORACOHUMERAL DISTANCE - mm
5. ACROMIO HUMERAL DISTANCE- mm
6. JOINT EFFUSION – nil / mild / moderate/ gross
7. BURSA

   SUBDELTOID

   SUBACROMION

   SUBCORACOID
8. LABRUM
9. ADJACENT BONE
10. LIGAMENTS

ANNEXURE – III

SAMPLE INFORMED CONSENT FORM

B.L.D.E.U.'s SHRI B.M. PATIL MEDICAL COLLEGE HOSPITAL AND RESEARCH CENTRE, VIJAYAPUR – 586103, KARNATAKA

TITLE OF THE PROJECT:	Evaluation of Rotator Cuff Pathologies With MRI
PRINCIPAL INVESTEGATOR:	**Dr. Shivendra kumar chaudhary** DEPARTMENT OF RADIO DIAGNOSIS *Email: shivenchoudhary007@gmail.com*
PG GUIDE:	DR. B.R Dhamangoankar PROFESSOR DEPARTMENT OF RADIO-DIAGNOSIS SHRI B.M. PATIL Medical College & Research Centre, Sholapur Road, VIJAYAPUR - 586103

PURPOSE OF RESEARCH:

I have been informed that this study will be to study the **Evaluation Of Rotator Cuff Pathologies With MRI**

I have been explained about the reason for doing this study and selecting me/my ward as a subject for this study. I have also been given free choice for either being included or not in the study.

PROCEDURE:

I/my ward have been explained that, I/my ward will be subjected to 1.5T MRI of brain.

RISKS AND DISCOMFORTS:

I/my ward understand that I/my ward may experience some claustrophobic sensation during the procedure. I/my ward understand that necessary measures will be taken to reduce these complications as and when they arise.

BENEFITS:

I/my ward understand that my participation in this study will help to study diffusion weighted magnetic resonance imaging features of intracranial lesions

CONFIDENTIALITY:

I/my ward understand that medical information produced by this study will become a part of this Hospital records and will be subjected to the confidentiality and privacy regulation of this hospital. Information of a sensitive, personal nature will not be a part of the medical records, but will be stored in the investigator's research file and identified only by a code number. The code key connecting name to numbers will be kept in a separate secure location.

If the data are used for publication in the medical literature or for teaching purpose, no names will be used and other identifiers such as photographs and audio or video tapes will be used only with my special written permission. I understand that I may see the photograph and videotapes and hear audiotapes before giving this permission.

REQUEST FOR MORE INFORMATION:

I understand that I may ask more questions about the study at any time. Dr. shivendra kumar chaudhary is available to answer my questions or concerns. I/my ward understand that I will be informed of any significant new findings discovered during the course of this study, which might influence my continued participation.

If during this study, or later, I wish to discuss my participation in or concerns regarding this study with a person not directly involved, I am aware that the social worker of the hospital is available to talk with me and that a copy of this consent form will be given to me for careful reading.

REFUSAL OR WITHDRAWAL OF PARTICIPATION:

I/my ward understand that my participation is voluntary and I may refuse to participate or may withdraw consent and discontinue participation in the study at any time without prejudice to my present or future care at this hospital.

I/my ward also understand that Dr. shivendra kumar chaudhary will terminate my participation in this study at any time after he has explained the reasons for doing so and has helped arrange for my continued care by my own physician or therapist, if this is appropriate.

INJURY STATEMENT:

I understand that in the unlikely event of injury to me/my ward, resulting directly to my participation in this study, if such injury were reported promptly, then medical treatment would be available to me, but no further compensation will be provided.

I understand that by my agreement to participate in this study, I am not waiving any of my legal rights.

I have explained to ____ the purpose of this research, the procedures required and the possible risks and benefits, to the best of my ability in patient's own language.

Date: Dr. B.R.Dhamangoankar (Guide) Dr. shivendra kumar chaudhary (Investigator)

MASTER CHART

Sl .No.	Name /Age/Sex	Clinical Presentation	Subscapularis/ CHD	Supraspinatous /AHD	Infra Spinatous	T.Minor	Biceps Tendon	Type of Acromion	Lebrum /Joint Effusion	Bursal Fluid
1	52/M	Stiffness	Tendinosis/6 to 8mm	Partial Tear(ART)8 to 10mm	Normal	Normal	Normal	Type I	No	No
2	55/M	Pain	Partial tear - 6 to 8mm	Tendinosis/8 to 10mm	Normal	Normal	Tendinosis	Type II	Moderate	**Subacro+deltoid**
3	21/F	weekness	Normal	Partial tear (ART) < 7mm	Normal	Normal	Normal	Type I	Mild	Subdeltoid
4	62/M	Pain	Normal	Tendinosis <7mm	Normal	Normal	Normal	Type I	No	No
5	57/F	Stiffness	Tendinosis <6mm	Partial tear (B) < 7mm	Normal	Normal	Fluid around the tendon	Type II	No	Subacro
6	19/M	Difficulty in lifting object	Normal	Tendinosis 10mm	Normal	Normal	Normal	Type I	Mild	No
7	59/M	Stiffness	Normal	Partial tear (IT) < 7mm	Normal	Normal	Tendinosis	Type I	Mild	Subacro
8	61/F	Pain	Tendinosis 6 to 8 mm	Normal	Normal	Normal	Fluid around the tendon	Type I	No	No
9	32/F	Pain+Stiffness	Normal	Tendinosis < 7 mm	Normal	Normal	Normal	Type III	Mild	No
10	60 /M	Pain	Normal	Partial tear (ART) 8 to 10 mm	Normal	Normal	Tendinosis	Type II	No	Subacro+deltoid
11	25 / M	Difficulty in raising	Partial tear < 6mm	Normal	Normal	Normal	Normal	Type I	Mild	Subcoracoidal
12	63/M	Pain	Normal	Normal	Partial tear	Normal	Normal	Type I	Mild	No
13	54/F	Stiffness	Complete Tear < 6mm	Tendinosis 8 to 10mm	Complete Tear	Normal	Dislocation of tendon	Type II	Moderate	All
14	62 / M	weekness	Normal	Tendinosis < 7mm	Normal	Normal	Normal	Type II	Mild	No
15	50 / F	Stiffness	Normal	Normal	Tendinosis	Normal	Tendinosis	Type I	Mild	No
16	52 / F	Pain	Tendinosis 6 to 8 mm	Partial tear (ART) < 7mm	Normal	Normal	Normal	Type III	Moderate	No
17	62 / M	Stiffness	Normal	Tendinosis 8 to 10 mm	Normal	Normal	Fluid around the tendon	Type II	Mild	No
18	26 / F	Pain+Stiffness	Tendinosis 8 to 10 mm	Tendinosis 10 mm	Normal	Normal	Normal	Type III	No	Subacro+deltoid
19	57 /F	Pain	Partial tear < 6mm	Partial tear (ART) < 7mm	Normal	Normal	dislocation of tendon	Type III	No	Subcoracoidal
20	65 / M	Difficulty in raising	Tendinosis < 6	Tendinosis < 7mm	Normal	Normal	Fluid around the tendon	Type III	Moderate	No
21	35/M	Pain	normal	Partial tear (B) < 7mm	Tendinosis	normal	Tendinosis	Type II	no	no
22	29/F	Pain	tendinosis	Partial tear (B) < 7mm	Normal	Normal		type iv	no	no
23	59/M	Pain+Stiffness	Normal	Normal	Partial tear	Normal	Fluid around the tendon	TYPE I	NO	NO
24	66/M	Stiffness	Normal	TENDINOSIS 10 MM	Normal	Normal	Normal	TYPE II	NO	NO
25	42/F	DIFFICULTY	Tendinosis 8 to 10 mm	Complte tear 8-10	Partial tear	Normal	Dislocation of tendon	TYPE III	MODERATE	NO
26	67/M	PAIN	Normal	Partial tear (ART) 8 To 10 mm	Normal	Normal	Normal	TYPE IV	MILD	NO
27	57/M	PAIN	TENDINOSIS 6 TO 10 MM	Normal	Normal	Normal	Normal	TYPE I	no	no

28	68/F	Difficulty in raising	Normal	PARTIAL TEAR (ART) < 7mm	Normal	Normal	Fluid around the tendon	TYPE II	no	no
29	44/M	PAIN	PT 8-10 MMTENDINOSIS <7	Normal	Normal	Normal	Normal	TYPE I	no	SUBCORACOID
30	56/M	PAIN	Normal	PT (B) 8-10 MM	Normal	Normal	Normal	TYPE I	no	SUBACROMION+DELTOID
31	47/F	Stiffness	Normal	Normal	Partial tear	Normal		TYPE II	no	no
32	70/M	PAIN	Normal	Tendinosis <7mm	Normal	Normal		TYPE I	MILD	no
33	67/M	PAIN AND STIFFNESS	Complete Tear > 10Mm	PARTIAL TEAR (ART) 8-10 MM	Normal	Normal	Fluid around the tendon	TYPE II	Moderate	ACL
34	44/F	pain	tendinosis >10	Tendinosis 10 mm	normal	normal	tendinosis	Type I	no	no
35	61/F	pain	partial tear 6-8mm	Tendinosis 8-10 mm	normal	normal	dislocation of tendon	Type I	no	no
36	72/M	PAIN AND WEEKNESS	Normal	PARTIAL TEAR (ART) <7MM	Partial tear	Normal	Normal	type IV	no	SUBACROMION+DELTOID
37	49 /F	PAIN AND STIFFNESS	Normal	Tendinosis 8-10 mm	Normal	Normal	Normal	Type I	no	no
38	62 / m	pain	tendinosis >10	Tendinosis <7mm	Normal	Normal	Normal	Type I	MILD	no
39	50 / F	WEEKNESS	Normal	Normal	Normal	Normal	fluid around the tendon	Type I	no	SUBACROMION+DELTOID
40	26 / F	difficulty in raising hand	normal	PARTIAL TEAR (ART) 8-10MM	Normal	Normal	Normal	Type I	no	no
41	48 / M	PAIN AND STIFFNESS	Tendinosis 8-10 mm	Complte tear <7 mm	Partial tear	Normal	Normal	type III	Moderate	all
42	67 /F	pain	normal	Tendinosis 8-10 mm	Normal	Normal	Normal	Type I	no	no
43	28 / F	difficulty in raising hand	Tendinosis >10 mm	PARTIAL TEAR (IT) 8-10MM	Normal	Normal	Tendinosis	type III	no	SUBACROMION+DELTOID
44	66 / F	difficulty in raising hand	Normal	PARTIAL TEAR (bursal) 10MM	Normal	Normal	fluid around the tendon	Type I	no	no
45	33 / m	pain	Tendinosis 8-10 mm	PARTIAL TEAR (IT) 8-10MM	Normal	Normal	Normal	type II	mild	SUBACROMION+DELTOID
46	62 / m	pain	Normal	PARTIAL TEAR (IT) <7MM	Normal	Normal	Normal	Type I	no	no
47	67 / m	STIFFNESS	Normal	Tendinosis <7 mm	Tendinosis	Normal	Normal	type III	no	no
48	62 / F	pain	Tendinosis 6-8 mm	PARTIAL TEAR (IT) 8-10MM	Normal	Normal	Normal	Type I	Mild	SUBACROMION+DELTOID
49	37 / F	difficulty in raising hand	Normal	PARTIAL TEAR (IT) <7MM	Normal	Normal	Normal	type III	no	no
50	22 / M	pain	Normal	Tendinosis 8-10 mm	Normal	Normal	Tendinosis	Type I	no	no