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THESIS

"COMPARISON OF HIGH RESOLUTION AND DYNAMIC SONOGRAPHY WITH MAGNETIC RESONANCE IMAGING IN EVALUATION OF MUSCULOTENDINOUS PATHOLOGIES OF SHOULDER JOINT, IN A TERTIARY CARE HOSPITAL IN MALABAR REGION"

By

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Dissertation submitted to the
Kerala University of Health Sciences, Thrissur
In Partial fulfillment of the requirements for the degree of

MD Degree
in RADIODIAGNOSIS

Under the Guidance of

Dr. V R RAJENDRAN
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DEPARTMENT OF RADIODIAGNOSIS,
KMCT MEDICAL COLLEGE, MANASSERY, CALICUT

2021 - 2024

DEPARTMENT OF RADIODIAGNOSIS
KMCT MEDICAL COLLEGE HOSPITAL, MANASSERY

DECLARATION BY THE CANDIDATE

*I hereby declare that this **DISSERTATION** entitled **"COMPARISON OF HIGH RESOLUTION AND DYNAMIC SONOGRAPHY WITH MAGNETIC RESONANCE IMAGING IN EVALUATION OF MUSCULOTENDINOUS PATHOLOGIES OF SHOULDER JOINT, IN A TERTIARY CARE HOSPITAL IN MALABAR REGION"***

was undertaken by me at KMCT Medical College, Manassery, Calicut under the guidance of Dr. V R RAJENDRAN , **Professor and HOD, Department of Radiodiagnosis, KMCT Medical College, ,Manassery in partial fulfillment of rules and regulations for the award of degree of M.D in Radiodiagnosis. I also declare that no modifications have been done after the manuscript checking for plagiarism as per University regulations.**

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LIST OF ABBREVATIONS

USG	Ultrasound
MRI	Magnetic Resonance Imaging
CT	Computed Tomography
MRA	Magnetic Resonance Angiography
FOV	Field Of View
FS	Fat-Saturated
GRE	Gradient Echo
PD	Proton Density
FTT	Full-Thickness Tear
PTT	Partial-Thickness Tear
S SP	Supraspinatus
I SP	Infraspinatus
S SC	Subscapularis
TM	Teres Minor
SASD BE	Sabacrmial Subdeltoid Bursa Effusion
JE	Joint Effusion
BT	Biceps Tendionsis
ACJ	Acromioclavicular joint Arthropathy
ABER	Abduction-External Rotation
TP	True positive
TN	True negative
FP	False positive
FN	False negative
MHz	Megahertz

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STRUCTURED ABSTRACT

BACKGROUND AND OBJECTIVE

Clinical examination, radiography, ultrasonography (USG), Computed Tomographic (CT), magnetic resonance imaging (MRI), arthrography, and arthroscopy are all popular diagnostic procedures used to evaluate shoulder pain. Rotator cuff pathology, which is not always easily identified clinically in shoulder injuries, might be difficult to detect. The gold standard for diagnosing rotator cuff problems is MRI, which may be more accurate than high-resolution ultrasonography. The purpose of this study was to assess the diagnostic accuracy of high-resolution USG and MRI in diagnosing musculotendinous pathologies of the shoulder joint.

METHOD

This observational study comprised 100 patients who reported shoulder pain and met the inclusion and exclusion criteria. Patients above the age of 18 who were referred by the orthopaedic department for an MRI were enrolled after obtaining written consent. All subjects underwent MRI and USG scans, with a focus on the rotator cuff muscles: supraspinatus, infraspinatus, teres minor, and subscapularis. Diagnostic accuracy was

determined by comparing the USG results with MRI, and the sensitivity, specificity, PPV, and NPV were calculated for each condition.

RESULTS

Of the 100 participants, 42 were women and 58 were men, with the majority over the age of 40. The USG has a high sensitivity (87%) for detecting full-thickness tears in the rotator cuff muscles, as well as a 100% specificity. However, in partial-thickness tears, USG exhibited a sensitivity of 50%, demonstrating that partial tears are less detectable than full-thickness tears. For non-rotator cuff problems, USG had a sensitivity of 81%, specificity of 80%, PPV of 0.88, and NPV of 0.71, indicating reasonable reliability. Additionally, USG showed inconsistent sensitivity among the various rotator cuff muscles, with the supraspinatus showing the highest accuracy.

CONCLUSION

This study indicates that USG is an effective diagnostic tool for detecting full- thickness rotator cuff injuries, with high specificity and great predictive value. But its sensitivity was reduced for partial-thickness tears and other tendinopathies, which emphasises the necessity of additional imaging methods like MRI in these situations. The combination of MRI and USG increases diagnostic accuracy, particularly in complex cases.

INTRODUCTION

The global prevalence of shoulder pain ranges between 16% and 26%[1,2]. Rotator cuff illness (defined as tendinosis and/or tear) is the leading cause of shoulder pain, followed by frozen shoulder, instability, and osteoarthritis. Rotator cuff disease is the most common cause of shoulder pain, affecting roughly 65%-70% of individuals[3]. Rotator cuff disease becomes more common as people age, and it is anticipated that by the age of 70, more than half of the population will have a full- or partial-thickness rotator cuff tear, which is not necessarily symptomatic[4]. Rotator cuff tears must be diagnosed early since untreated tears can worsen, cause pain, and result in irreversible fatty degeneration and atrophy of the shoulder musculature[5,6]. Once these muscle changes occur, the chance of a recurrent tear after surgical repair is significant, with reports ranging as high as 94%[7,8]. Furthermore, bigger and retracted tears can be technically challenging to heal, and inherent changes in tendon characteristics may prevent an anatomic repair to the footprint[9,10].

The preferred imaging modalities for evaluating shoulder discomfort are ultrasonography (USG) with dynamic manoeuvres and magnetic resonance imaging (MRI), both of which have their own set of advantages and disadvantages. The best acceptable imaging modality is determined by factors such as availability, cost-effectiveness, accuracy, and competence. Many musculoskeletal diseases that were previously identified only by medical expertise are now more reliably examined using modern imaging technologies such as ultrasonography and MRI.

Because of its multiplanar capabilities, high soft tissue resolution, and lack of ionising radiation, MRI is now widely recognised as the preferred modality for shoulder imaging. MRI provides a thorough image of sonographically unreachable areas such as the labrum, deep ligaments, capsule, and bone-obscured regions. MRI is also frequently employed as the primary diagnostic technique for problems such as recurrent dislocations, labral lesions, articular cartilage damage, synovial diseases, tumors, and infections. It efficiently emphasises accompanying muscular anomalies and detects surgically curable conditions. However, despite its advantages, MRI has drawbacks such as high costs, restrictions for individuals with implanted medical devices, claustrophobia, and restricted availability. Furthermore, MRI remains more expensive than other modalities such as ultrasonography, making it less accessible for routine examinations in some situations.

There is a growing corpus of studies comparing the efficacy of ultrasonography and MRI in diagnosing rotator cuff tears and other shoulder joint disorders. Historically, research typically assessed the accuracy of each modality separately, with fewer studies providing direct comparisons. Advances in high-resolution sonography, sophisticated procedures, and a better understanding of shoulder diseases have resulted in higher diagnosis accuracy with ultrasound. High-resolution ultrasound, when conducted by skilled sonologists, is now thought to be nearly as accurate as MRI in diagnosing full-thickness rotator cuff injuries, and may even outperform MRI in detecting partial-thickness tears. In this study, we plan to assess the accuracy of high-resolution sonography for musculotendinous diseases of the shoulder joint and compare its sensitivity and specificity with MRI.

AIM AND OBJECTIVES

AIM OF STUDY

To evaluate accuracy of high-resolution sonography when compared to MRI for musculotendinous pathologies of shoulder joint.

OBJECTIVES OF STUDY

To evaluate the sensitivity, specificity, positive predictive value, and negative predictive value of high resolution and dynamic sonography in the diagnosis of shoulder joint pathologies in patients with shoulder pain, using MRI as the reference standard, and to compare their findings.

REVIEW OF LITERATURE

INTRODUCTION

Shoulder pain is one of the most common musculoskeletal symptoms seen in healthcare facilities[11]. This could be related to a variety of factors, with one main cause being rotator cuff tendinopathy or tears[12]. According to Park et al[13], the shoulder joint is vulnerable to damage due to its wide range of motion. Although there are 26 muscle groups that regulate the rotator cuff which serves as the primary stabiliser of the glenohumeral joint, is hence essential for upper limb function.

ANATOMY OF SHOULDER JOINT AND ASSOCIATED TENDONS

The glenoid cavity and humeral head are synovially articulated to form the shoulder joint, which is a ball and socket. It consists of joints, muscles, ligaments, bursa, capsules, and bones. The articular surfaces of the shoulder joint are coated with articular cartilage, and the glenoid rim is fortified by a fibrocartilaginous labrum. The very complex and dynamic structure of this joint contributes significantly to a wide range of motion, making it prone to instability. The three primary bones linked with the shoulder joint are the humerus, clavicle, and scapula, with the flat imprints or facets of the larger tuberosity of the humerus serving as attachment points for the rotator cuff tendons[14].

Furthermore, an integral element of the shoulder complex is the acromioclavicular joint (AC joint), as well as the subacromial subdeltoid bursa, a sac located below the acromion process and coracoacromial ligament, extending over the rotator cuff tendons.

ROTATOR INTERVAL

The rotator interval is a triangular gap that is bordered superiorly by the anterior margin of the supraspinatus muscle and inferiorly by the superior margin of the subscapularis muscle. The intertubercular grove forms the apex of the triangle, while the coracoid process forms the base. The triangle includes the coracohumeral ligament and the superior glenohumeral ligament.

ROTATOR CUFF

Rotator cuff consists of four muscles: supraspinatus, infraspinatus, teres minor, and subscapularis. The former three muscles attach on the greater tuberosity of the humerus, whereas the subscapularis inserts on the smaller tuberosity. Because of its common tendinous attachment onto the humerus, the rotator cuff functions as a single functional anatomical unit.

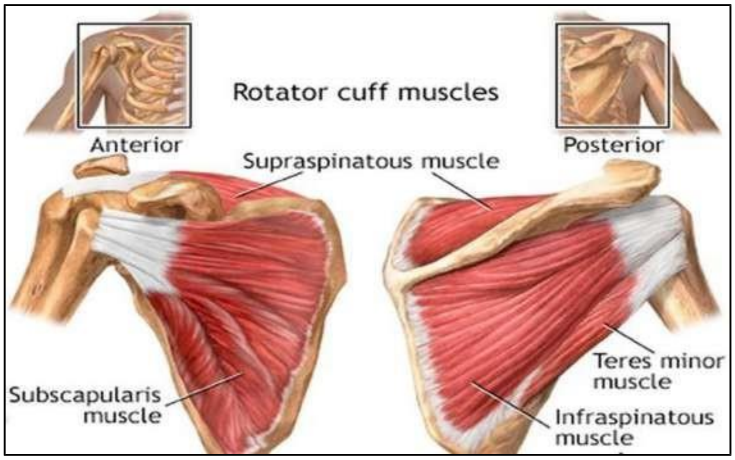


Figure 1:Anterior and posterior view of healthy rotator cuff anatomy

PHYSIOLOGICAL FEATURES OF ROTATOR CUFF TENDONS

Tendons connect muscles to bones, providing stability and movement by transmitting contractile force[15]. Collagen fibres in tendons are organised into fascicles and sub-fascicles within endotenon sheaths, which alter stiffness during movement; consequently, tendon tensile characteristics are affected by loading rates[16,17]. The rotator cuff tendons, which connect to the shoulder joint capsule, stabilise the humeral head inside the glenoid fossa and allow for movement[18,19]. The subscapularis tendon joins to the humerus's smaller tuberosity and allows for internal arm rotation. The supraspinatus tendon attaches to the larger tuberosity's "footprint" and aids in arm elevation and abduction[20]. Meanwhile, the infraspinatus and teres minor tendons provide for external humerus rotation, with the latter distinguishable by its trapezoid shape and insertion into the greater tuberosity's inferior facet[21].

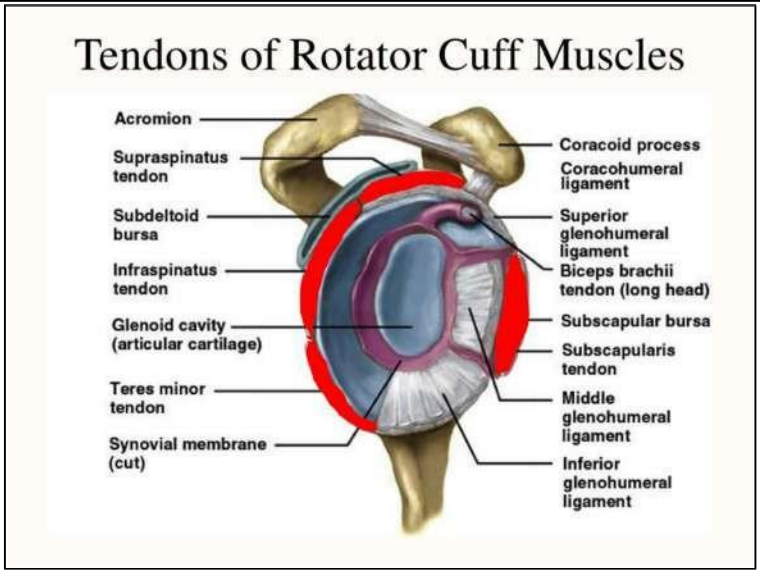


Figure 2:Tendons of the rotator cuff

PATHOLOGY ASSOCIATED WITH THE SHOULDER JOINT

The shoulder joint is prone to a variety of conditions, including rotator cuff tendinopathy and shoulder impingement problems[21].

SHOULDER IMPINGEMENT

Shoulder impingements are utilised in clinical settings to assess the extent of tissue injury in the shoulder joint. Shoulder impingement can be subacromial or posterior. Subacromial impingement is a clinical ailment that results from interaction between the rotator cuff tendons and the larger tuberosity of the humerus. It is related with a variety of conditions, including subacromial bursitis, partial rotator cuff tears, and biceps tendinitis. Internal impingement is caused by movement-induced exertion of the posterior labrum and inferior part of the supraspinatus and infraspinatus tendons, and is associated with a stiff posterior shoulder capsule[23].

NON-ROTATOR CUFF PATHOLOGIES

Non-rotator cuff conditions include glenohumeral joint effusion, subacromial- subdeltoid bursa effusion, acromio-clavicular joint arthropathies, calcifying bursitis, dislocation, and synovitis[24]. Similarly, enthesis, or the insertion of ligaments, fascia, muscles, and tendons into bone, can cause inflammations such enthesitis as a result of recurrent biomechanical stress[25]. USG is sensitive enough to detect glenohumeral joint effusion and subacromial subdeltoid bursal effusion, even in small numbers. Fluid aspiration under US guidance enables precise diagnosis. A painful acute microcrystaline bursitis occurs when calcific deposits in the tendon penetrate the bursa. Subluxation or dislocation of the acromioclavicular joint causes enlargement of the joint cavity and bulging of the superior capsule and ligaments. Rupture of the long head of the biceps brachii tendon usually causes a bump in the anterior arm, known as the "Popeye sign". Tendon disruption commonly occurs at the intrarticular level, resulting in distal retraction and an empty groove. In acute tears, the tendon stump is surrounded by fluid. Transverse USG scans, which show the bicipital sulcus and the tendon covering the smaller tuberosity, are used to identify medial biceps tendon dislocation.

ROTATOR CUFF PATHOLOGY

Rotator cuff disease is a degenerative condition of the rotator cuff tendons that has multiple causes[19,26]. Biochemical changes in tissue weaken collagen fibres and impair tendon flexibility, making the tendon prone to tear[27]. Early detection of rotator cuff tears is therefore critical, as untreated tears may gradually increase, resulting in fatty degeneration and weakening of the shoulder muscle[28].

Tendinosis or Tendinopathy

Tendinosis or tendinopathy is caused by degenerative or exhausted tendons, which gradually soften the afflicted tendons[29,30]. The supraspinatus tendon was found to be the most commonly afflicted tendon throughout the impingement process, with decreasing blood flow and old age being the main causes[18]. Chronic tendinopathy is typically caused by repetitive micro trauma and vascular alterations that promote collagen fibre breakdown, whereas calcific tendonitis is associated with thyroid gland and oestrogen metabolism abnormalities, as well as alcohol misuse and obesity3[1,32]. Calcific tendinopathy of the rotator cuff tendons results from calcium deposits (mostly carbonate apatite) within the tendons[33]. However, calcific tendinitis should be distinguished from the degenerative calcification that occurs within a damaged tendon.

Rotator Cuff Tears

Rotator cuff tears are characterised based on the degree of change in fibre structure[24]. Furthermore, tendon tears are classified as small (<1cm), medium (1-3 cm), large (3-5 cm), or >5 cm[34].

Rotator cuff tears can also be characterised as full thickness tears that extend from the articular surface to the bursal surface of the tendon[17]. Partial thickness tears can occur on the articular, bursal, or intratendinous surface of rotator cuff tendons and may coexist with tendinosis[35].

Full Thickness Tears

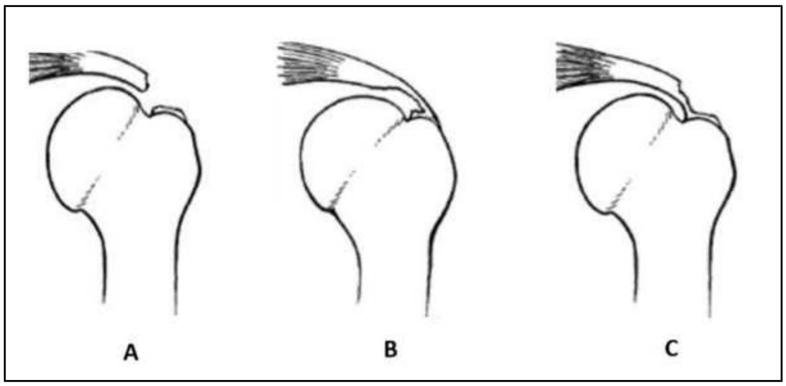
According to studies, the majority of full thickness tears occur at the footprint of the larger tuberosity at the insertion of the supraspinatus tendon, which is frequently validated by B-Mode ultrasonography[36]. Full thickness tears are represented as hypoechoic or anechoic tendon abnormalities extending from the articular to the bursal surface. The use of B- Mode ultrasound to identify full thickness rips can thus be limited due to the presence of echogenic debris, tissue scarring, or deltoid muscle herniation in the tear site. Studies have demonstrated that these tears frequently impact the supraspinatus tendon in the hypovascular zone near its insertion, as well as the anterior attachment to the larger tuberosity of the humerus.

A full-thickness tear of the rotator cuff tendon can cause medial tendon retraction because it affects all of the width of the tendon. As a result, tendon retraction under the acromion frequently causes the rotator cuff to become infilled with fluid or the deltoid muscle to herniate in the defect area. Furthermore, such tears may affect the infraspinatus tendon, subscapularis tendon, and longhead of the biceps tendon, with fluid in the subdeltoid bursa and biceps tendon sheath serving as a secondary signal.

Partial Thickness Tears

Partial thickness tears are characterised according to their location, with the tear communicating with either the articular or bursal surface of the tendon, whereas intrasubstance tears occur within the tendon[35]. Rotator cuff tears vary in width, even with small tears. A few millimetres in width can affect a single tear, as opposed to big tears that exceed 5mm in width and may include multiple tendons. Tendon tears decrease tendon structure and are typically found in areas of degenerative change. As a result, repairing tendons containing scar tissue, particularly at the margins of damaged rotator cuff tendons, are biomechanically inferior to intact tendons, limiting their capacity to withstand strain or tensile strength[37].

Although infraspinatus tendon tears are infrequent, they are common among athletes who engage in over-arm throwing sports. These people typically exhibit internal (postero-superior) impingement. In addition, joint effusion in the gleno- humeral joint area may occur[23].



A *Full thickness tear extending from the articular to bursal surface of tendon*
B *Partial thickness tear on the articular surface of the tendon*
C *Partial thickness tear on the bursal surface of the tendon*

Figure 3:Classification of rotator cuff tears

IMAGING OF THE SHOULDER

Radiography is commonly employed in the examination of the rotator cuff because imaging results may indirectly indicate rotator cuff disease or provide extra information useful in clinical therapy. Cortical irregularity of the larger tuberosity at the supraspinatus attachment point has a sensitivity of 90% and a negative predictive value of 96% in detecting a rotator cuff tear[38]. Other radiographic findings include the presence of a subacromial enthesophyte or acromioclavicular osteophyte, which can induce cuff impingement. Calcification of the rotator cuff and potentially the surrounding bursa can also be seen. Superior humeral head migration with narrowing of the acromiohumeral distance is a significant radiographic finding that indicates the existence of a big or massive rotator cuff injury that has disturbed the glenohumeral joint's force coupling. According to Goutallier et al[39], an acromiohumeral distance of less than 6 mm is usually often linked with a full-thickness chronic infraspinatus tear, and hence surgical repair is not always possible due to poor cuff quality and extensive fatty degeneration. In contrast, an acromiohumeral distance of 6 mm or more was not diagnostically significant. Other studies have found that cephalad displacement of the humeral head indicates a chronic rotator cuff injury that cannot be cured surgically[40]. Other radiographic abnormalities may include os acromiale, fracture, osteoarthrosis of the acromioclavicular or glenohumeral joint, and, less occasionally, cancer.

ULTRASONOGRAPHY

Ultrasound imaging assessment of the rotator cuff was developed in 1977[42] and has grown in popularity as technology, portability, and cost have dropped. With sufficient training, great accuracies in rotator cuff disease diagnosis are possible. A full-thickness rotator cuff tear can be identified with 92.3% sensitivity and 94.4% specificity with USG, whereas a partial-thickness tear has 66.7% sensitivity and 93.5% specificity[43]. USG can also detect rotator cuff muscle fatty degeneration and atrophy[6,44,45]. The benefits of USG include mobility, low cost, and a lack of contraindications, while the downsides include limited assessment of the capsule, labrum, and cartilage, as well as the inability to evaluate exclusively intraosseous abnormalities. Images acquired with US have superior spatial resolution than pictures produced with standard MR imaging[56], and patients prefer US assessment over MR imaging[47]. Image acquisition and interpretation in USG are typically dependent on the interpreting physician's ability. However, in comparison to the other imaging modalities, picture interpretation requires the most operator input. USG examination of the rotator cuff has shown little interobserver variability, although variability is larger in the diagnosis of partial-thickness tears[48,49]. Operator reliance also appears in MR imaging, where interobserver variability has been reported as minimal; nonetheless, poor agreement has been recorded for partial-thickness tears[50,51]. Defined imaging techniques and protocols are critical for reducing operator dependence, particularly with the USG.

Table 1:Shoulder ultrasound examination techniques

Structure	View	Position	Pathologies detected
Extraarticular long-head biceps tendon	Longitudinal and transverse	Neutral with supinated palm resting on the knee	Tendinosis, tear, tenosynovitis, dislocation/subluxation
Subscapularis	Longitudinal and transverse	External rotation	Tendinosis, tear, fluid in subscapularis bursa
Supraspinatus tendon	Longitudinal and transverse	Modified Crass position	Tendinosis, tear
Infraspinatus tendon	Longitudinal and transverse	Hand on contralateral shoulder	Tendinosis, tear
Subacromial bursa	Coronal plane at the lateral margin of the acromion	Neutral with arm abducted to shoulder level	Fluid in bursa and impingement with abduction
Posterior glenohumeral joint	Axial plane	Neutral	Joint effusion, hyperemia, osteoarthritis
Posterior rotator cuff muscle	Sagittal plane	Neutral	Muscle atrophy of infraspinatus or teres
bellies			minor
Spinoglenoid notch	Axial plane	Neutral	Paralabral cyst or mass
Acromioclavicular joint	Axial plane	Neutral	Osteoarthritis, capsular hypertrophy, hyperemia

Ultrasound Criteria for Rotator Cuff Pathology

- Tendinosis/Tendinopathy is characterised by a thicker tendon with loss of the typical hyperechoic fibrillary pattern. Without a tendon defect, there may be a heterogeneous, ill-defined, hypoechoic region in the tendon with varying calibre (enlarged/thinned).

Signs of Rotator Cuff Tear:

- PTT: A well-defined focal hypoechoic or anechoic anomaly that disrupts tendon fibres and is restricted to the articular or bursal surface of the tendon, or an intramuscular substance, but without transmission of the tear to the opposing tendon surface. PTT was divided into "articular side" or "bursal side" tears, as well as "high-grade" (more than 50% thickness) or "low-grade" (less than 50% thickness) tears.

Figure 4: USG of partial thickness tear of subscapularis

- FTT is characterised by a hypoechoic zone that interferes with hyperechoic tendon fibres over the entire substance of the rotator cuff muscle (s), from the articular to bursal surface. The tendon may not be seen, have a hypoechoic discontinuity, or have a retracted edge due to tearing. Classification small (<1 cm), medium (1-3 cm), large (3-5 cm) and massive (>5 cm) tears were based on their longest dimension.

Figure 5:Full-thickness tear of supraspinatus

a

Figure 6:Full-thickness tear of infraspinatus tendon

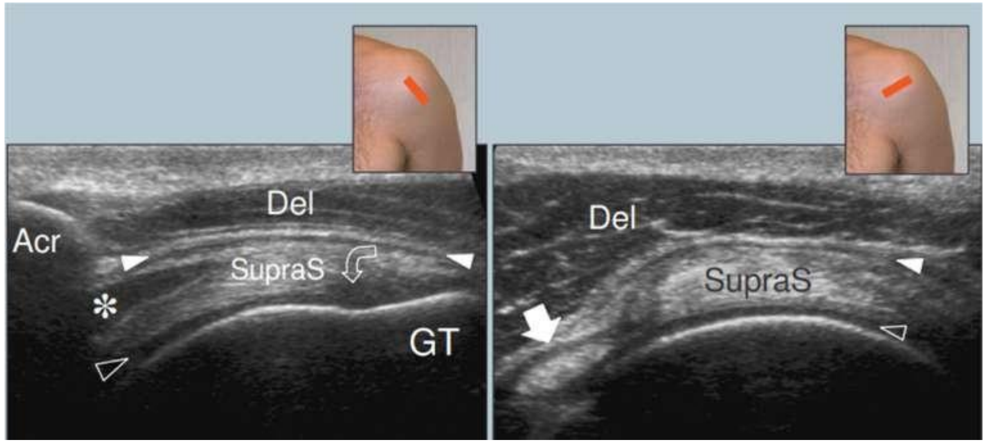


Figure 7:USG image of Supraspinatus tendon

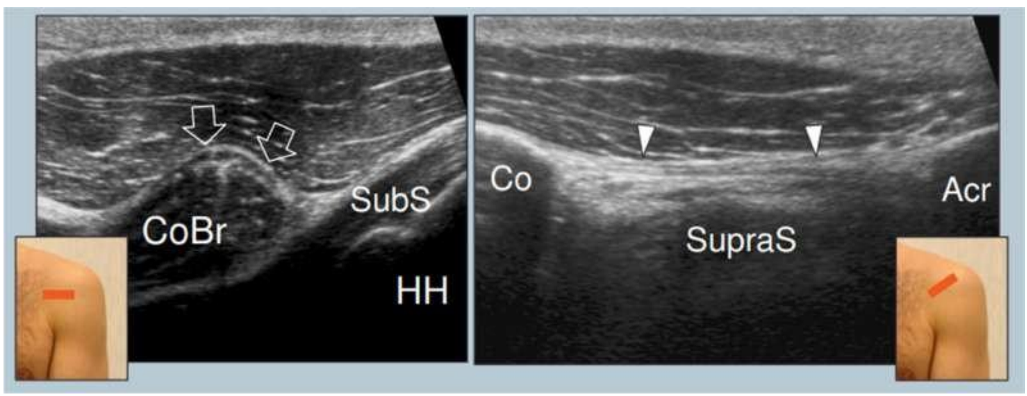


Figure 8:Anteromedial structure and coracoacromial structure

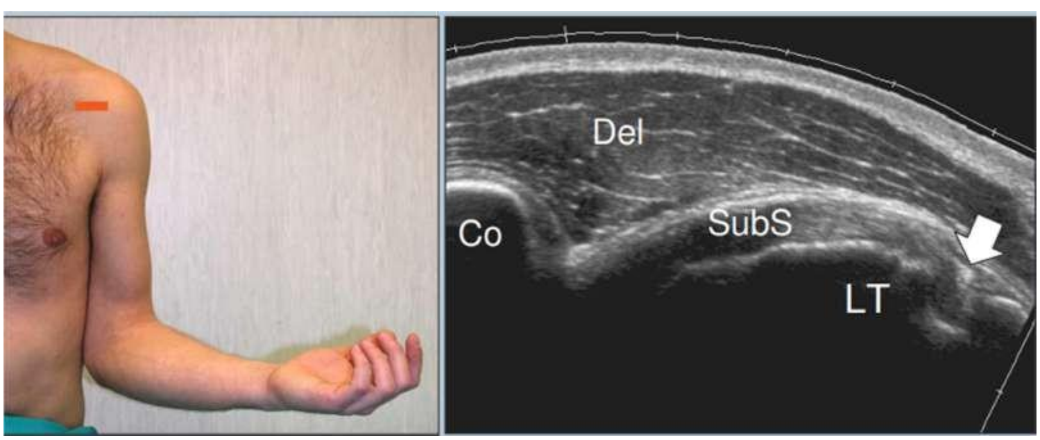


Figure 9:Subscapularis tendon

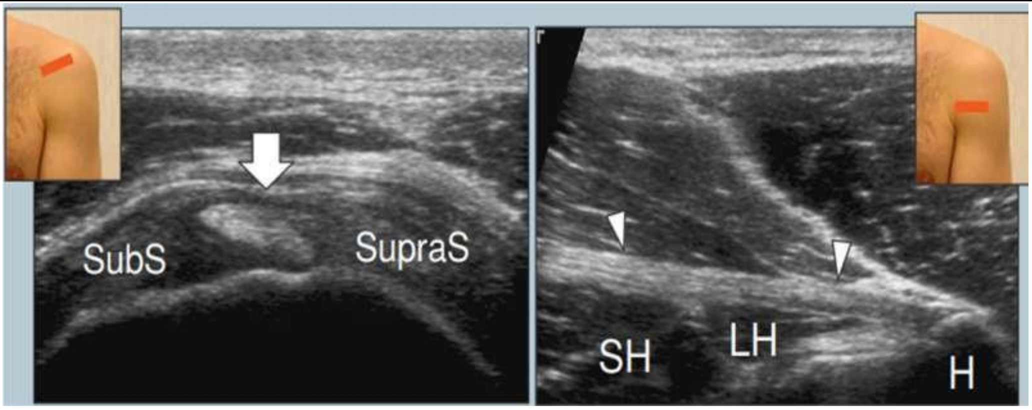


Figure 10:Long head of biceps tendon

Indirect Signs of Rotator Cuff Tear:

- Fluid is present in the SASD bursa and GHJ.
- Cartilage interface sign- In rotator cuff FTTs, the presence of fluid in the torn tendon accentuates the underlying cartilage, resulting in two hyperechoic lines indicating the cartilage and the cortex.
- Sagging or depression of hyperechoic peri-bursal fat into the tendon gap.
- Muscle atrophy- Increased echogenicity and reduced muscle mass.
- Fatty muscular atrophy, with poor definition and uneven echotexture in the muscle belly.
- Fatty infiltration of muscle:
    - Mild: effaced pennate pattern and mild elevated echogenicity
    - Moderate-severe: lack of pennate pattern and pronounced hyper echogenicity.

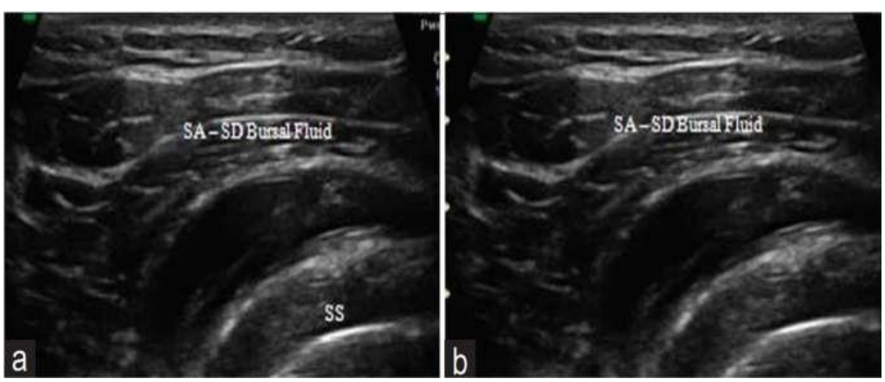


Figure 11:USG showing SA-SD bursal fluid

Secondary Signs of Rotator Cuff Tear:

- Cortical irregularity of the greater tuberosity and shoulder joint effusion, characterised by anechoic fluid in the axillary pouch, posterior recess, and sheath of the long head of the biceps tendon.

Figure 12:Subscapularis tendon tear

ULTRASOUND CRITERIA FOR NON-ROTATOR CUFF PATHOLOGY

- Acromioclavicular (AC) Joint Arthropathy and Subluxation
  - The joint gap between the acromion and distal end of the clavicle may enlarge slightly.
  - Increased soft tissue width between bone ends of the joint.
  - Irregular articular surfaces.
- Acromioclavicular (AC) Joint Dislocation:
  - A noticeable expansion of the joint space between the acromion and the lateral end of the clavicle.
- Glenohumeral Joint Effusion:
  - Fluid expands the glenohumeral joint capsule.
  - The posterior labrum is hyperechoic and located towards the glenoid margin, with synovial fluid separating it from the humerus.
  - Fluid within the joint capsule indicates effusion, which is

commonly linked to joint inflammation or injuries.

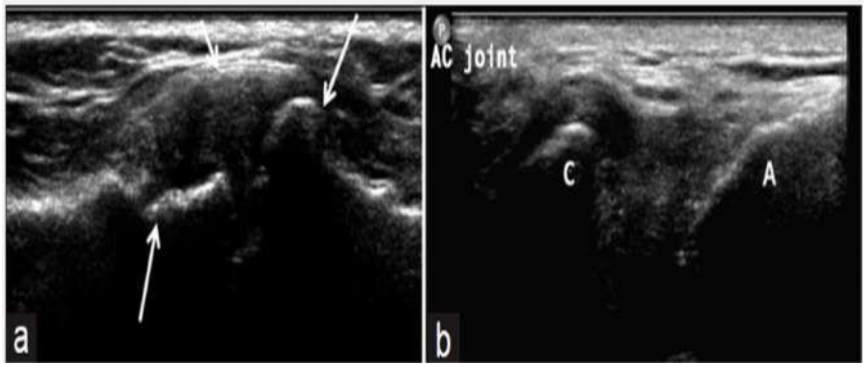


Figure 13:Acromio-clavicular joint pathology

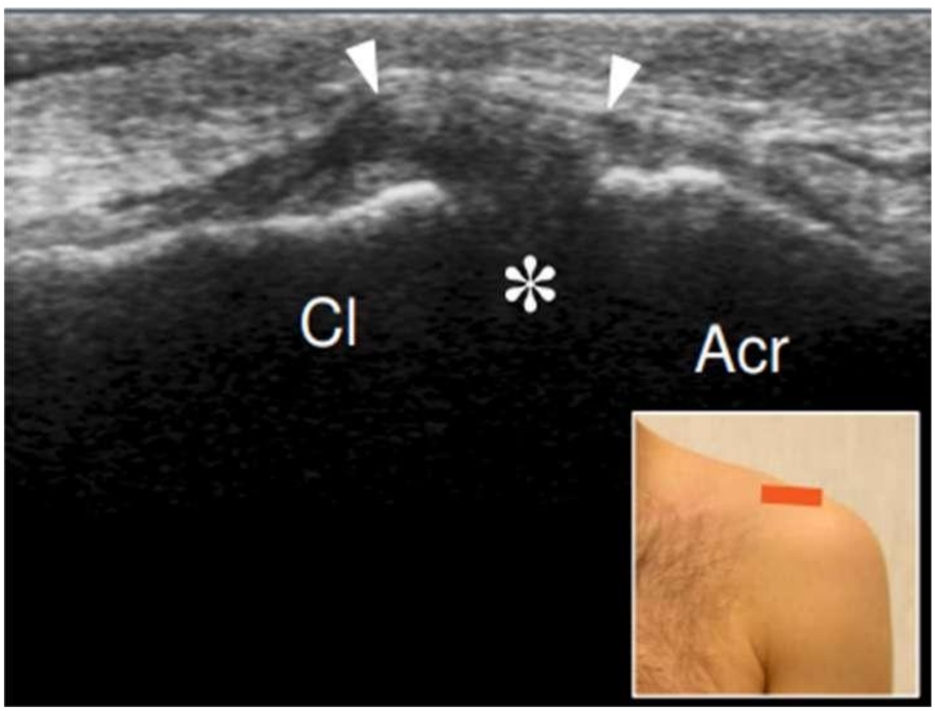


Figure 14:Acromioclavicular joint

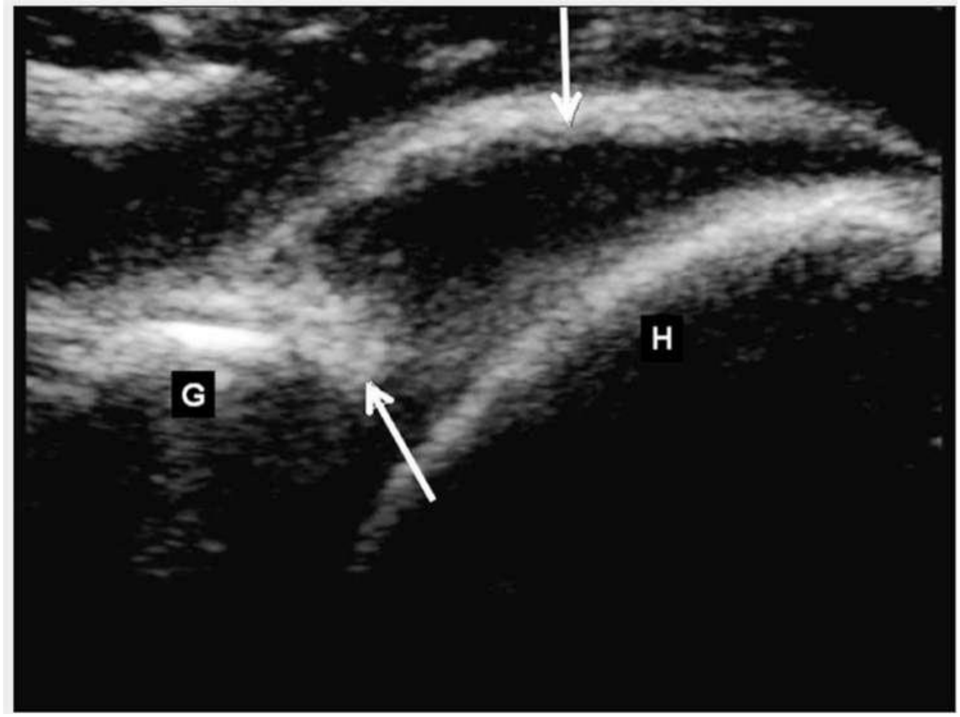


Figure 15:Gleno-humeral joint effusion

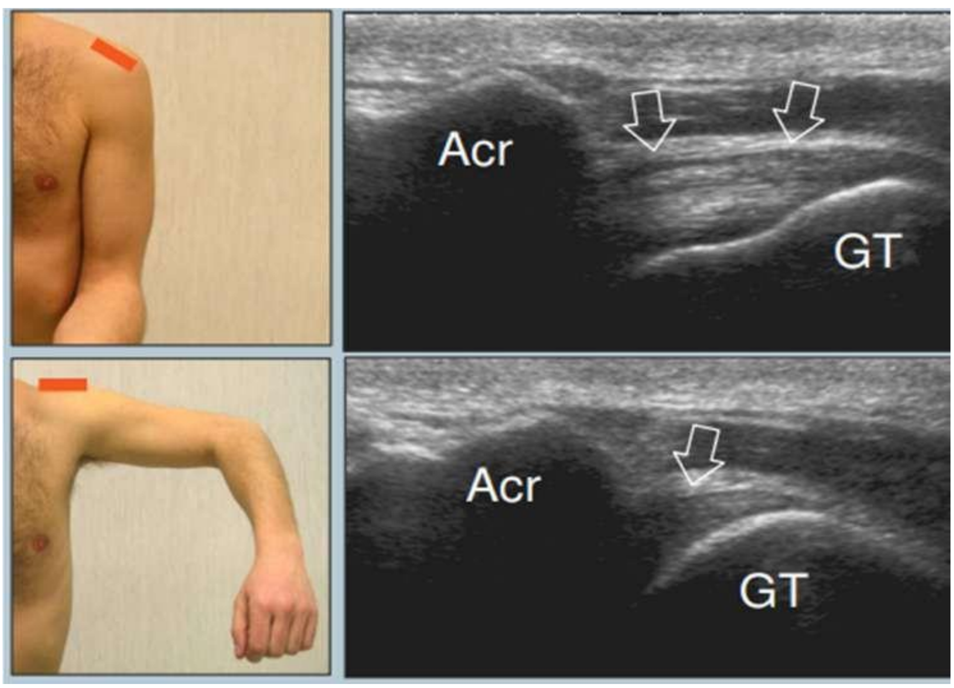


Figure 16:Subacromial impingement test

Table 2:Advantages and disadvantages of ultrasound

Advantages	Disadvantages
Portability	Operator skill dependent
No radiation risk	
Dynamic assessment and allows real time comparison with the other side	Limited assessment of deeper structures, eg: labrum and cartilage
Alternative to patients with contraindication for MRI or claustrophobia	Cannot detect intraosseous abnormality
Low cost	

MAGNETIC RESONANCE IMAGING (MRI)

Plain magnetic resonance (MR) imaging has greater soft tissue contrast and resolution, making it a valuable tool for assessing the shoulder for rotator cuff pathology. A full-thickness rotator cuff tear may be diagnosed with 92.1% sensitivity and 92.9% specificity using MR imaging, but a partial-thickness tear requires 63.6% sensitivity and 91.7% specificity[43]. Other crucial information regarding the rotator cuff obtained with MR imaging is the presence of muscle fatty degeneration and atrophy, which is associated with poor prognosis following rotator cuff surgery, although fatty degeneration grading can be inaccurate[52,53]. The benefits of using MR imaging include a comprehensive assessment of all shoulder structures, including cartilage and bone marrow, whereas the disadvantages include patient concerns (claustrophobia and contraindications due to some metallic implants and technological equipment), cost, and accessibility. MR imaging following intraarticular contrast material administration (MR arthrography) can also be used to assess the rotator cuff, with 95.4% sensitivity and 98.9% specificity for full-thickness tears and 85.9% sensitivity and 96% specificity for partial-thickness tears[43]. The use of intraarticular contrast material with MR imaging is ideal for assessing an intraarticular anomaly involving the labrum and cartilage[53].

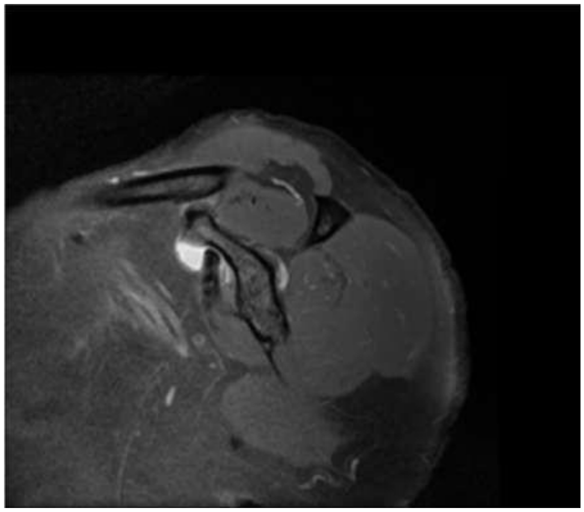


Figure 17:MRI image of Joint effusion

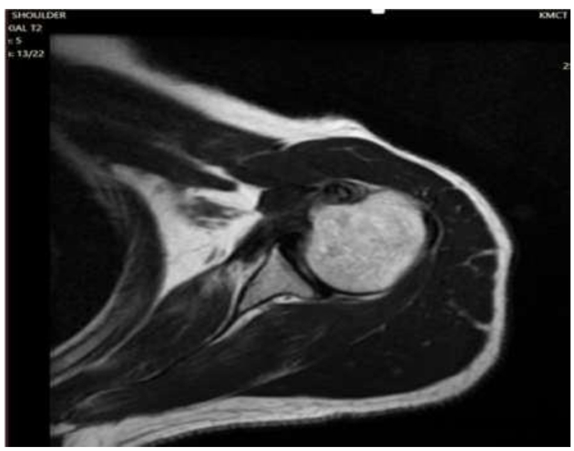


Figure 18:Long head of biceps tendinosis

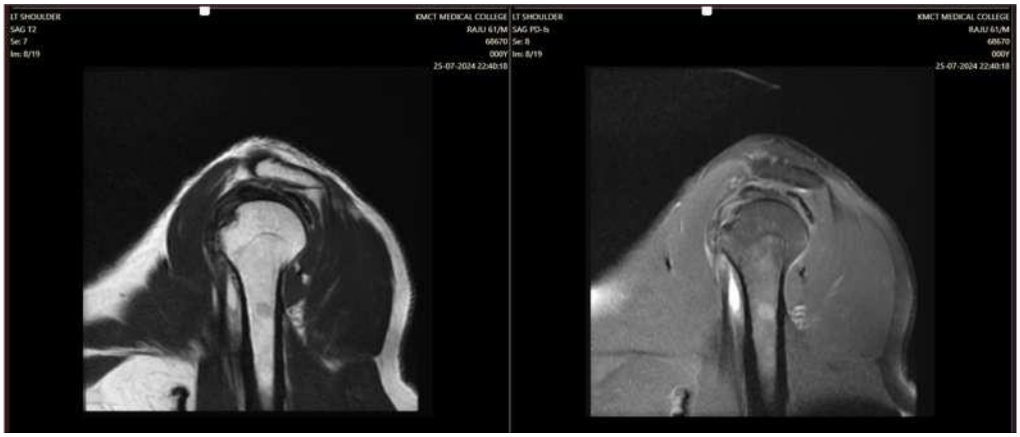


Figure 19:MRI image supraspinatus tendinosis

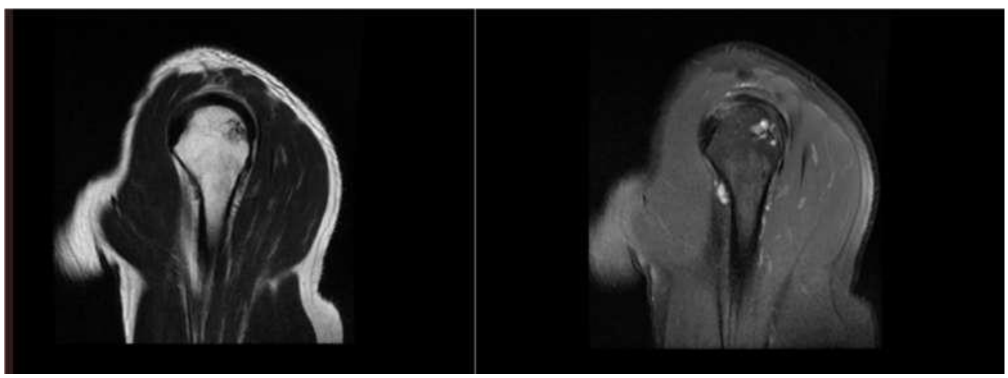


Figure 20:subscapularis tendinosis

MR Imaging Protocol

The patient is positioned supine, with the arm a bit externally rotated. High-quality images need the use of a local surface coil. MR imaging planes include the coronal oblique plane, the sagittal oblique plane, and the transaxial plane. Axial PD or gradient echo images are taken from the top of the acromioclavicular joint through the inferior glenoid border. Coronal oblique PD, T2 weighted, and intermediate TE fat- suppressed images are taken perpendicular to the glenoid cavity. T1-weighted and STIR images in the oblique sagittal plane show the body of the scapula and the larger tuberosity. Fat saturation techniques improve sensitivity for detecting full-thickness tears.

Table 3:Example protocol for a plain MR procedure endorsed by ESSR

Plane	**Sequence**	**FOV (max)**	**Slice thickness**	**TE**	**Matrix (min)**
Axial	Intermediate-FS	16 cm	3.5 mm	40–60	256 × 256
Coronal Oblique	Intermediate-FS	16 cm	3.5 mm	40–60	256 × 256
Coronal Oblique	T2	16 cm	3.5 mm	40–60	256 × 256
Sagittal Oblique	Intermediate-FS	16 cm	3.5 mm	40–60	256 × 256
Sagittal Oblique	T1	16 cm	4 mm	Min	256 × 256
∗(Optional) Axial	GRE	16 cm	3.5 mm	10–20	256 × 256

MRI Criteria for Rotator Cuff Pathology

Tendinopathy was described as increased signal intensity on Proton Density (PD) Weighted imaging that was not as bright as the fluid signal on the T2 Weighted sequence. PTT was defined as a focused increase in signal intensity or discontinuity of fibres on T1 Weighted, PD Weighted, and T2 Weighted sequences that was as bright as fluid signal on T2 Weighted sequences and affected either the bursal or articular surface or the mid substance of the tendon. The tear was evaluated complete when the focal discontinuity covered

Figure 21:MRI images in coronal show a full-thickness tear of the supraspinatus

full thickness of the tendon from bursal surface to articular surface, retraction of the torn ends, and the gap was either filled with fluid signal intensity or altered signal intensity of granulation tissue[54,55].

Computed Tomographic (CT) Imaging

CT has a limited role in the diagnosis of suspected rotator cuff disease, but it can be used to assess muscular atrophy and fatty degeneration; nevertheless, the grading of such findings is inaccurate[56,52]. CT after intraarticular injection of iodinated contrast material (CT arthrography) can be utilised to assess intraarticular structures (e.g., labrum) and rotator cuff tears that communicate with the articular surface[53]. Because MR arthrography provides greater information on interstitial and bursal- sided injuries and does not require ionising radiation, CT arthrography is rarely used in rotator cuff evaluation. CT arthrography may play a more essential role following surgery because metal anchors and accompanying artefacts can reduce the diagnostic usefulness of MR images.

REVIEW OF LITERATURE

Bhatnagar et al[57]. evaluated the diagnostic potential of USG and MRI for shoulder joint musculotendinous disorders. In their study of 75 patients, USG had a sensitivity of 95.2%, specificity of 88.8%, and a PPV of 80% for detecting FTT, and a sensitivity of 94.7%, specificity of 85.7%, and PPV of 90% for PTT. USG had an overall accuracy of 91% in diagnosing shoulder tears, demonstrating its usefulness as an initial, dynamic diagnostic modality. However, MRI proved useful in providing a thorough view of joint components, particularly when measuring the labrum and glenohumeral ligaments, which are frequently beyond the scope of sonographic imaging. The study shows that, while USG is useful for initial screening, MRI is still required for a comprehensive assessment of shoulder disease.

Varma S. et al[58]. investigated the diagnostic accuracy of USG and MRI for shoulder joint pain. The study, which included 35 patients, investigated shoulder diseases such as tendon injuries, bursitis, degenerative changes, calcifications, and impingement by comparing results from both imaging techniques. MRI was found to have higher sensitivity and specificity than USG, particularly for more complex shoulder issues. Although USG has advantages in terms of cost, real-time imaging, and ease of comparison with the unaffected side, its disadvantages include operator dependency and lower sensitivity for specific diseases. Thus they concluded that, MRI is a more accurate diagnostic tool, particularly when USG results are unclear. The study emphasises the complimentary functions of USG as a preliminary screening tool and MRI as a confirmatory modality for a thorough shoulder joint evaluation.

Shrestha MS et al[59]. investigated the diagnostic capacities of high-resolution USG and MRI for diagnosing rotator cuff injuries in the shoulder joint. The study examined the accuracy of both imaging modalities in 50 patients aged 15 to 80 years (mean age 41.6), with symptoms including persistent shoulder pain, restricted movement, trauma, and repeated dislocations. The findings showed that USG had a diagnostic accuracy of 57.14% for full-thickness tears and 58.33% for partial tears, whereas MRI had 100% accuracy for total supraspinatus tears. The findings support the use of high-resolution ultrasonography as a viable first-line examination for rotator cuff injuries, with MRI serving as a more conclusive tool for detecting full- thickness rips.

Barad HV et al[60]. performed a prospective, cross-sectional study to compare the effectiveness of USG as a first-line imaging modality for shoulder pain to MRI. The study, which included patients with shoulder pain who were predominantly between the ages of 40 and 59 and had a male-to-female ratio of 3.5:1, found that trauma was the most common cause, with reduced range of motion in 94% of instances. The supraspinatus tendon was most commonly damaged, followed by the subscapularis tendon. USG demonstrated great sensitivity and specificity, particularly for partial- thickness injuries in these tendons, with sensitivity values of 90.62% and 100% for the supraspinatus and subscapularis tendons, respectively. While MRI is still the most precise instrument, USG is emphasised as a quick, real-time, cost-effective primary imaging alternative for rotator cuff evaluation, despite its operator dependence.

Roy JS et al[61]. performed a meta-analysis to investigate the diagnostic accuracy of USG, MRI, and MR arthrography (MRA) in detecting rotator cuff issues. After reviewing three sets of data, they discovered high diagnostic accuracy for full- thickness rotator cuff tears across all modalities, with sensitivity and specificity values exceeding 0.90. For partial tears and tendinopathy, specificity remained high (>0.90), while sensitivity was slightly lower (0.67-0.83). Notably, USG accuracy was comparable when conducted by radiologists, sonographers, and orthopaedists, making it a versatile alternative. Given its excellent accuracy, cost-effectiveness, and safety, the study suggests USG as the best first-line imaging option for rotator cuff diseases, particularly for detecting full-thickness tears that may necessitate surgical repair.

Gupta A et al[62]. investigated the diagnostic accuracy of USG in diagnosing rotator cuff and associated non-rotator cuff diseases of the shoulder, with MRI as the gold standard. The study included 50 patients (mean age 56.0 years), with USG and MRI examinations carried out independently. While MRI revealed diseases in all patients, USG indicated abnormalities in 92% of instances, with the supraspinatus tendon being the most commonly afflicted. USG indicated great sensitivity (84%) and specificity (87.5%) for tendinosis, as well as 100%

sensitivity and specificity for full-thickness tears. However, USG was less sensitive in detecting partial thickness tears in the infraspinatus tendon, subscapularis tendinosis, and teres minor atrophy. The study concludes that, while USG is useful for identifying certain shoulder diseases, it could miss certain conditions, particularly polytendon abnormalities.

Chander R et al[63]. did a study to compare the diagnostic accuracy of USG and MRI in diagnosing rotator cuff injuries in 50 individuals with shoulder pain or impairment. USG showed a sensitivity of 83.7% and specificity of 100% for detecting partial- thickness tears, as well as 100% sensitivity and specificity for full-thickness tears, with high agreement with MRI data (k=1.0 for full-thickness tears). The results indicate that USG, when administered by an experienced radiologist, is a reliable first- line imaging tool for rotator cuff disorders. In cases when USG findings are inconclusive, MRI is indicated, hence supporting USG as a cost-effective and accessible primary modality.

Jain V et al[64]. evaluated the efficacy of USG and MRI in detecting musculotendinous disorders in the shoulder. They used a GE S8 USG equipment and a GE Signa 1.5 Tesla MRI to evaluate patients for tendinitis, partial- and full-thickness injuries. USG revealed tendinitis in 75% of cases, partial-thickness tears in 80%, and full-thickness tears in 100% of cases, indicating significant agreement with MRI findings. The study discovered that USG had high sensitivity, specificity, and predictive accuracy for shoulder diseases, but its negative predictive value was lower for supraspinatus injuries. While MRI provides a comprehensive view of shoulder disorders, USG's low cost, accessibility, and dynamic imaging characteristics make it an excellent first-line imaging tool for diagnosing musculotendinous shoulder issues.

Kurnal KK et al[65]. investigated the diagnostic accuracy of USG versus MRI for shoulder disorders. The most common diagnosis among the 54 patients was subacromial-subdeltoid bursitis. USG had a sensitivity of 63.3% and a specificity of 70.8% for partial-thickness tears, but only 80% and 91.8% for full-thickness tears, respectively. MRI exhibited superiority in detecting labral and capsular anomalies, reinforcing its position as the most sensitive and specific modality for assessing shoulder discomfort. The study supports MRI as a supplemental, confirmatory approach, particularly when USG findings are uncertain, because it can provide comprehensive tendon and joint examinations with minimum risk.

Medhat Refaat et al[66]. did a study to compare the diagnostic efficacy of USG and MRI in shoulder impingement syndrome, with MRI as the reference standard. The study included 30 patients with subacromial impingement, who were scanned using both modalities. The study found no significant difference between USG and MRI in diagnosing supraspinatus tendon and non-rotator cuff disorders. USG exhibited 100% sensitivity, specificity, PPV, NPV, and accuracy in diagnosing full-thickness supraspinatus tendon injuries. For partial-thickness rips, USG achieved 80% sensitivity, 95% specificity, 88.9% PPV, 90.5% NPV, and 90% accuracy. The study concluded that USG is equivalent to MRI in assessing shoulder impingement syndrome and rotator cuff tears, especially full-thickness tears. Additionally, the stated that, considering the low cost, availability, and dynamic real-time assessment, USG can be advised as the first line of treatment for patients presenting with shoulder pain.

MATERIALS AND METHODS

STUDY SETTING:

This study is to be conducted at the department Radiodiagnosis and Orthopaedics department of KMCT medical college, Mukkam, Kozhikode.

STUDY POPULATION:

Patients who were referred for an MRI scan due to shoulder pain.

STUDY DESIGN:

A hospital based observational study.

SAMPLE SIZE WITH JUSTIFICATION:

$$n = \frac{{z\alpha/_2}^2 \times pq}{d^2}$$

A previous study by Bhatnagar S et al[57] showed a prevalence of 94% therefore prevalence for the sample size calculation is considered as 94%.

Therefore,

prevalence from previous study (p) =

94%, 100-p (q) = 6%,

absolute precision (d) = 5%,

critical value at 5% level of significance ($z\alpha/_2$) = 1.96.

$$n = \frac{1.96^2 \times 0.94 \times 0.06}{0.05^2} = 86.66$$

The sample size was expanded from 86.66 to 100 to improve statistical power and adjust for any dropouts.

DURATION OF STUDY:

12 Months.

INCLUSION CRITERIA:

- Males and females aged 18 years and older and in whom ultrasound and MRI done in KMCT medical college hospital, Calicut.
- History of pain in either of shoulder.
- History of restricted movements in either shoulder.
- Clinically suspected to have rotator cuff tear, biceps tendon injury, calcific tendinitis etc.

EXCLUSION CRITERIA:

- Patients with previous history of surgery or prosthesis in shoulder.
- Patients with known or diagnosed fracture/dislocation involving the shoulder in plain radiograph.
- Patients with pacemaker, metal implants, cochlear implants.
- Patients with claustrophobia.
- Patients not willing to participate in the study.

METHODOLOGY:

Informed consent forms in the local language were given to patients, and their signatures were acquired in order to participate. Data was collected using a proforma, which included age, gender, occupation, symptoms such as pain, and any associated injuries. After getting the written consent from the individuals aged more than 18 years with shoulder pain who were referred from the orthopaedic department to the radiology department were included in the study. MRI and ultrasound scans were taken for all the individuals included in the study.

A high-resolution, real-time sonographic evaluation of the shoulder was performed utilising a Samsung HS 70 ultrasound scanner equipped with a 5-12 MHz linear transducer, following ESSR guidelines. An expert radiologist conducted the examination while the patients was sitting in a revolving chair. Depending on the situation, the examiner was positioned behind or in front of the patient, or the patient was placed supine on an examination table with the upper extremity hanging off the side for better visibility. MRI scans were performed supine, with the shoulder and arm alongside the body in a neutral or minimally externally rotated position. To stabilise the shoulder, the patient's hand was frequently tucked beneath the hip. A four-channel flex coil was used, and an abduction-external rotation (ABER) approach was performed to detect suspected labral pathology or articular surface rotator cuff tears.

Both ultrasound and MRI results were compared to determine the accuracy of ultrasound in diagnosing shoulder joint pathologies. The evaluation focused primarily on four muscles—the supraspinatus, infraspinatus, teres minor, and subscapularis-and their associated conditions.

STATISTICAL METHODS:

Categorical data were reported as a proportion of the total number of instances. Qualitative variables were compared using Chi square test. A p-value less than 0.05 was considered significant. The data was analysed with SPSS

25.0, and graphical representations were created using either Microsoft Excel or SPSS.

ETHICAL CLEARANCE:

Study was conducted after getting clearance from Institutional Research Committee and Institutional Ethics Committee. The information collected was used only for the purpose of study and strict confidentiality was maintained throughout the study.

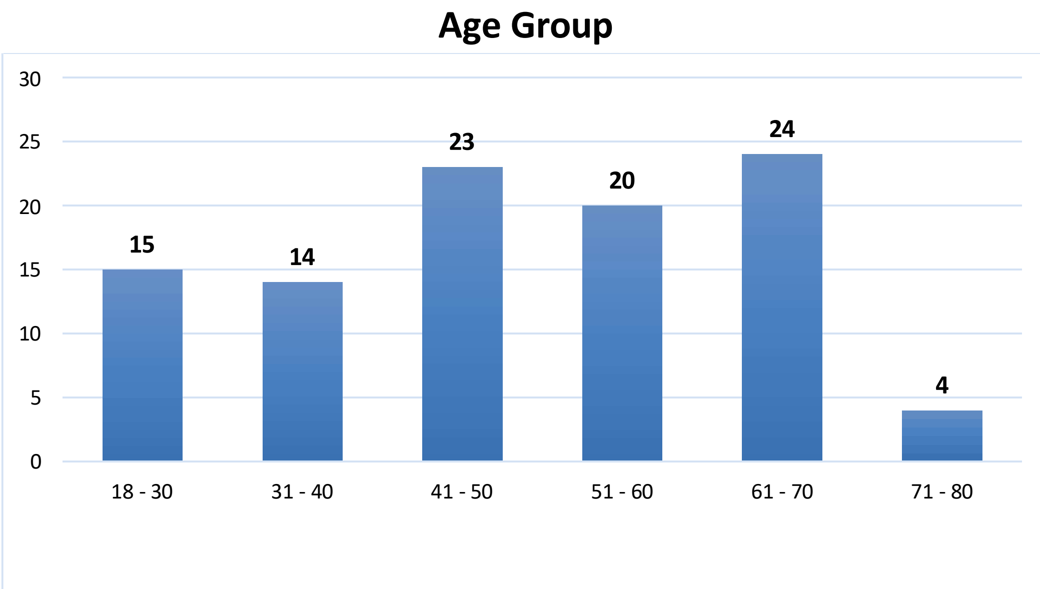
INFORMED CONSENT:

Patients who met the criteria for selection were informed about the purpose of study and signed informed consent was obtained.

RESULTS AND OBSERVATIONS

Table 4:Distribution of age group of study sample

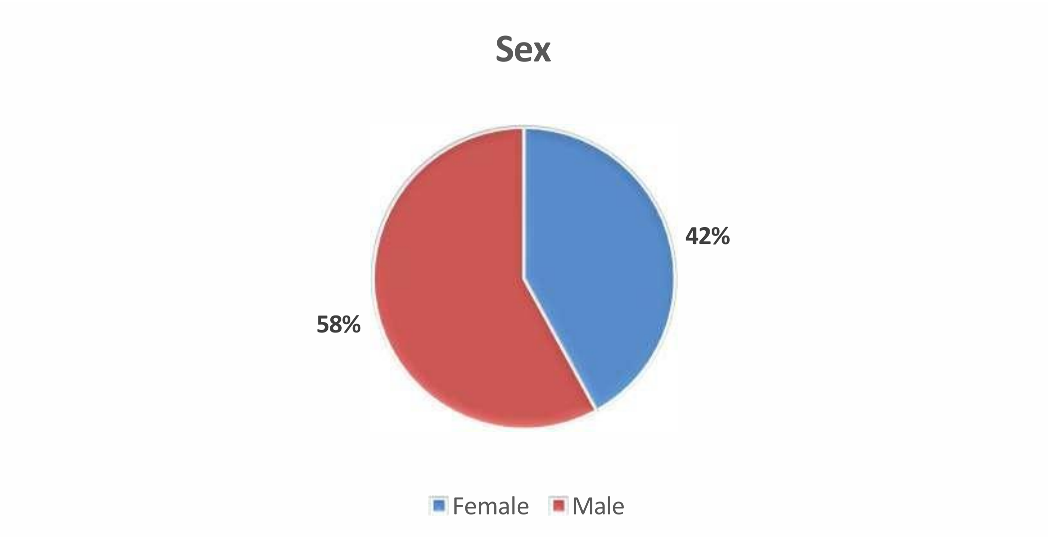
		No. of patients
Age Group	18 - 30	15
	31 - 40	14
	41 - 50	23
	51 - 60	20
	61 - 70	24
	71 - 80	4
	Total	100



Most patients are between the ages of 41 and 70, with 23 patients between the ages of 41 and 50, 20 patients between the ages of 51 and 60, and 24 patients between the ages of 61 and 70. The younger age groups comprise 15 patients aged 18-30 and 14 patients aged 31-40, while the oldest group contains only 4 patients aged 71-80.

Table 5:Distribution of sex of study sample

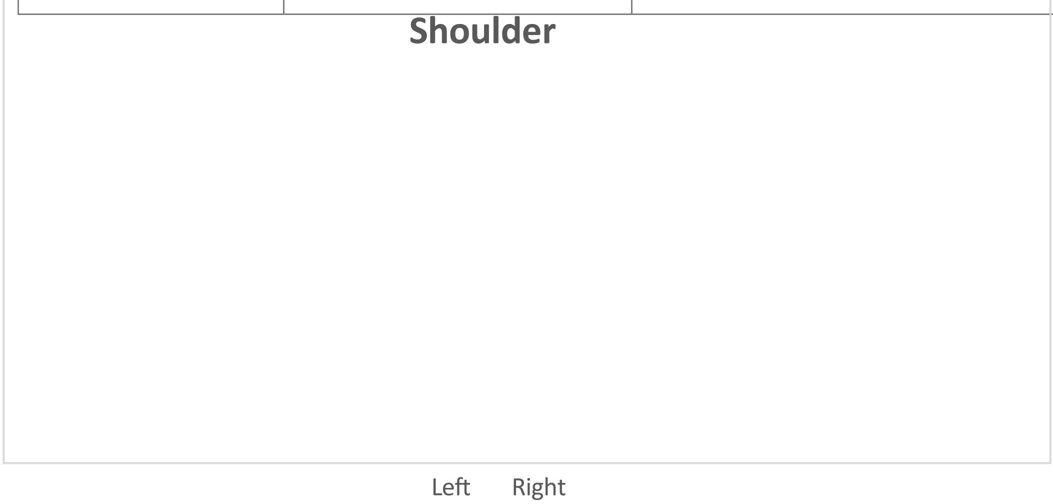
		No. of patients
Sex	Female	42
	Male	58
	Total	100

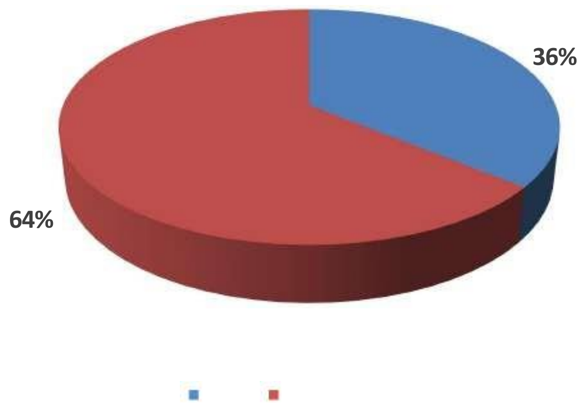


Out of 100 patients, 42 patients were females and 58 patients were males.

Table 6:Distribution of affected shoulder of(Left/Right) study sample

		No. of patients
Shoulder	Left	36
	Right	64
	Total	100





Out of 100 patients, 36 have complications with their left shoulder and 64 with their right.

		Full thickness tear	TP	FP	TN	FN	Sensitivity	Specificity	PPV	NPV
Subscapularis	USG	1	1	0	97	2	0.33	1	1	0.97
	MRI	3								
Infraspinatus	USG	11	11	0	88	1	0.91	1	1	0.98
	MRI	12								
Supraspinatus	USG	31	31	0	64	5	0.86	1	1	0.92
	MRI	36								

Table 7:Rotator cuff pathology (FTT): USG v/s MRI

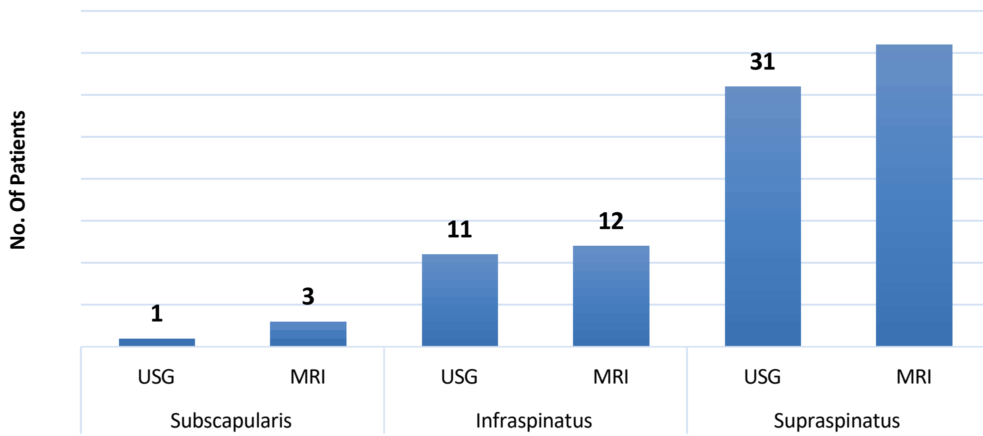


Figure 22:Rotator cuff pathology (FTT): USG v/s MRI

The above table compares the diagnostic accuracy of USG and MRI for detecting full- thickness tears in the subscapularis, infraspinatus, and supraspinatus muscles. True positive (TP), false positive (FP), true negative (TN), and false negative (FN) counts are used to calculate sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

Subscapularis: USG found 1 TP, 0 FP, and 2 FN, with 98 TN. This resulted in a sensitivity of 0.33, which means USG successfully identified 33% of MRI-confirmed tears, and a specificity of 1. The PPV was 1, while the NPV was 0.97, indicating that USG's results were highly reliable but had limited sensitivity.
Infraspinatus: USG detected 11 TPs, 1 FN, and 88 TNs, resulting in a sensitivity of
0.91 and specificity of 1. The PPV and NPV were both high, at 1 and 0.98, demonstrating USG's remarkable agreement with MRI-confirmed infraspinatus tears. Supraspinatus: USG was precisely aligned with MRI-confirmed cases, resulting in 31 TPs with 5 FNs and a specificity of 1 with 64 TNs.

Table 8:Rotator cuff pathology (PTT): USG v/s MRI

		Partial thickness tear	TP	FP	TN	FN	Sensitivity	Specificity	PPV	NPV
Subscapularis	USG	2	2	0	90	8	0.2	1	1	0.91
	MRI	10								
Infraspinatus	USG	4	4	0	91	5	0.44	1	1	0.94
	MRI	9								
Supraspinatus	USG	13	12	1	79	8	0.6	0.98	0.92	0.90
	MRI	20								

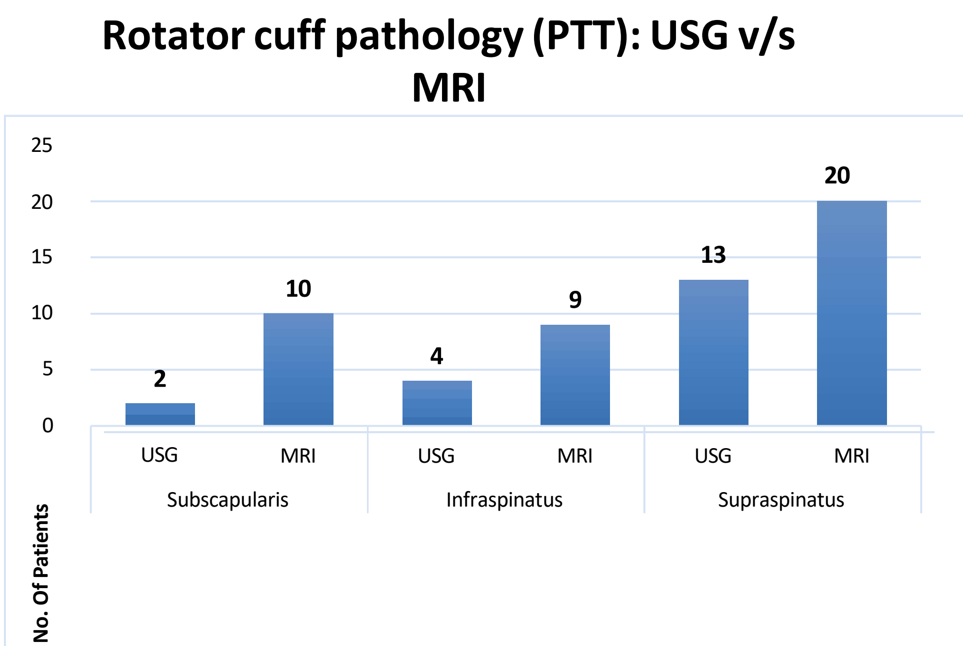


Figure 23:Rotator cuff pathology (PTT): USG v/s MRI

Subscapularis: USG found 2 TPs, 8 FNs, and 90 TNs. This leads to a specificity of 1, which indicates perfect accuracy in recognizing non-tear instances, and a sensitivity of 0.2, which indicates limited identification of MRI-confirmed tears.

Infraspinatus: USG found 4 TPs, 5 FNs, and 91 TNs. Sensitivity is 0.44, which indicates modest detection capabilities, and specificity is 1. Despite missing some real positives, USG is very accurate for negative instances, as shown by its high PPV and NPV of 1 and 0.94, respectively.

Supraspinatus: Of the 13 cases identified by USG, 12 were TPs, 8 FNs, 1 FPs, and 79 TNs. This results in a sensitivity of 0.6 and a specificity of 0.98, indicating that supraspinatus tears outperform the other muscles. The PPV is 0.92, while the NPV is 0.90, demonstrating a well-balanced reliability for both positive and negative outcomes.

Table 9:Rotator cuff pathology (Tendinosis): USG v/s MRI

		Tendinosis	TP	FP	TN	FN	Sensitivity	Specificity	PPV	NPV
Subscapularis	USG	37	37	0	43	20	0.64	1	1	0.68
	MRI	57								
Infraspinatus	USG	17	17	0	67	16	0.51	1	1	0.80
	MRI	33								
Supraspinatus	USG	38	37	1	51	11	0.77	0.98	0.97	0.82
	MRI	48								
Teres minor	USG	2	2	0	96	2	0.5	1	1	0.97
	MRI	4								

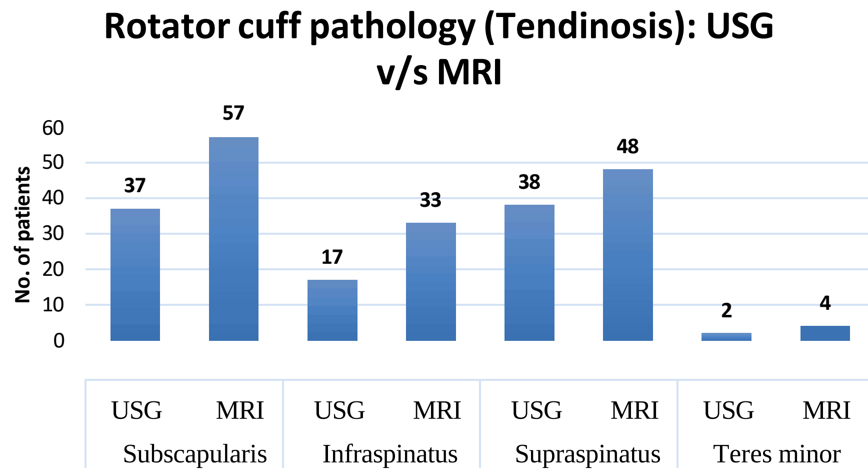


Figure 24:Rotator cuff pathology (Tendinosis): USG v/s MRI

Subscapularis: USG found 37 TP, 43 TN, and 43 FN, with a sensitivity of 0.64. The specificity was 1, demonstrating complete accuracy in identifying people without tendinosis. The PPV was 1, and the NPV was 0.68, indicating that while USG was useful for determining the absence of tendinosis, it was less reliable in detecting instances that exist.

Infraspinatus: USG found 17 TPs and 16 FNs, yielding a sensitivity of 0.51, indicating moderate detection ability. The specificity is 100%, and the PPV and NPV are 1 and 0.80, respectively. This means that USG excelled at determining the absence of tendinosis but lacks to identify actual cases.

Supraspinatus: USG identified 38 case with 37 TPs, 1 FP, and 51 TNs, with a sensitivity of 0.77 and specificity of 0.98. The PPV was 0.97, while the NPV was 0.82, indicating good performance in confirming and ruling out tendinosis.

Teres Minor: The USG identified 2 cases with 2TPs with 2FNs and 96 TNs, resulting in a sensitivity of 0.5, suggesting a modest detection ability. The specificity was perfect at 1, and the PPV and NPV were 1 and 0.97, respectively, indicating excellent reliability in excluding tendinosis.

Table 10:Non rotator cuff pathology: USG v/s MRI

		Present	TP	FP	TN	FN	Sensitivity	Specificity	PPV	NPV
Joint effusion	USG	31	24	7	63	6	0.8	0.9	0.77	0.91
	MRI	30								
Biceps tendinosis	USG	10	6	4	82	8	0.42	0.95	0.6	0.91
	MRI	14								
ACJ Arthropathy	USG	17	16	1	76	7	0.69	0.98	0.94	0.91
	MRI	23								
SASD BE	USG	20	14	6	69	11	0.56	0.92	0.7	0.86
	MRI	25								

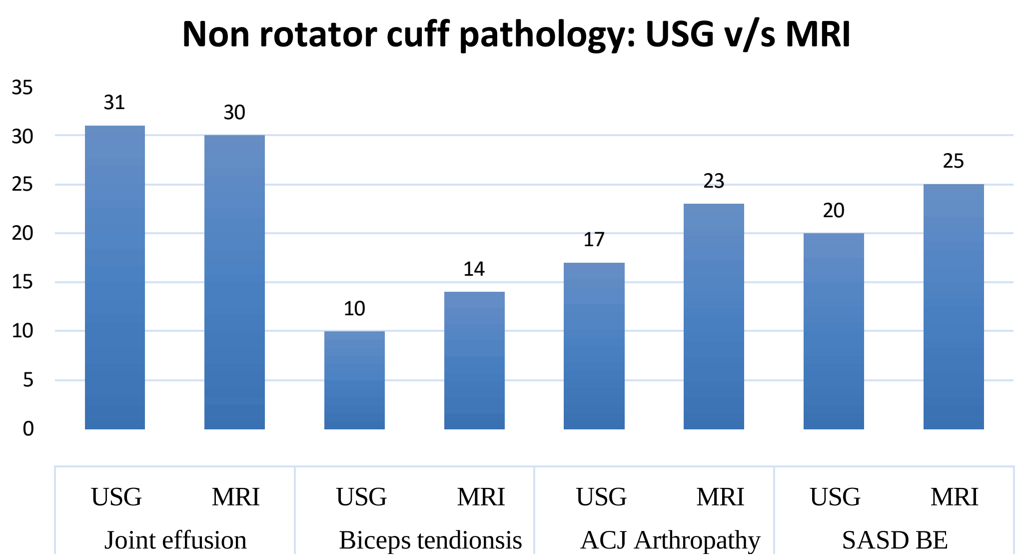


Figure 25:Non rotator cuff pathology: USG v/s MRI

Joint Effusion: USG detected 24 TP, 7 FP, and 6 FN, yielding a sensitivity of 0.8, showing a relatively strong ability to detect actual cases. The specificity was 0.9, indicating good accuracy in identifying those without joint effusion. The PPV was 0.77, indicating that when USG revealed the existence of joint effusion, there was a good chance that it was correct, while the NPV was 0.91, indicating excellent reliability in ruling out the condition.

Biceps Tendinosis: USG identified 6 TPs with 4 FPs and 82 FNs, yielding a sensitivity of 0.42, indicating moderate detection capabilities. The specificity was high (0.95), indicating strong accuracy in identifying those without biceps tendinosis. The PPV was 0.6, indicating a moderate likelihood that a positive result indicated the presence of the condition, whereas the NPV was 0.91, demonstrating a consistent capacity to rule it out when the test was negative.

ACJ Arthropathy: USG observed 16 TPs, 1 FPs, and 7 FNs, with a sensitivity of 0.69 and specificity of 0.98. The PPV was 0.94, indicating a high likelihood that a positive test result accurately indicated ACJ arthropathy, and the NPV was 0.91, indicating excellent reliability in ruling out the condition.

SASD BE: USG found 20 positive cases, consisting 14 TPs and 6 FPs, with a sensitivity of 0.56 and specificity of 0.92. The PPV was 0.7, indicating a reasonable likelihood of correctly diagnosing SASD BE when positive, while the NPV was 0.86, demonstrating strong reliability in ruling out the condition.

Table 11:USG and MRI Diagnosis

				TP	FP	TN	FN	Sensitivity	Specificity	PPV	NPV
Rotator Cuff	FTT	USG	32	32	0	63	5	0.86	1	1	0.93
		MRI	37								
	PTT	USG	17	17	0	66	17	0.5	1	1	0.8
		MRI	34								
	Tendinopathy	USG	53	52	1	27	20	0.72	0.96	0.98	0.57
		MRI	72								
Non-Rotator Cuff		USG	59	52	7	29	12	0.81	0.80	0.88	0.71
		MRI	64								

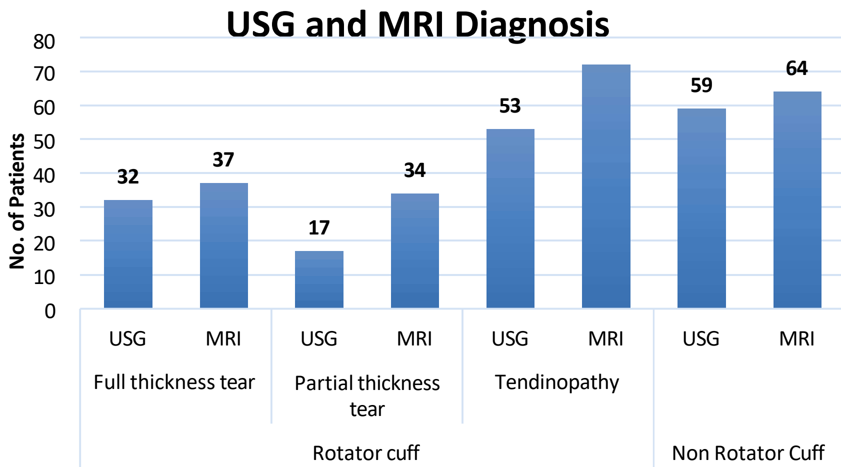


Figure 26:USG and MRI Diagnosis

For full-thickness tears, USG found 32 true positives and 63 true negatives, with 5 false negatives and 0 false positives (FP). This results in a sensitivity of 0.87, indicating that USG correctly identified 87% of MRI-confirmed full-thickness tears. The specificity was 1, indicating perfect accuracy in identifying patients without tears, and the positive predictive value (PPV) and negative predictive value (NPV) were both high, at 1 and 0.93, respectively, demonstrating great reliability for positive and negative outcomes.

USG detected 17 TPs, 66 TNs, 17 FNs, and no FPs in partial-thickness tears. This resulted in a sensitivity of 0.5, indicating that USG detected 50% of MRI-confirmed partial tears. The specificity was again 1, and the PPV and NPV were 1 and 0.80, respectively, demonstrating great accuracy in ruling out tears when none were found but limited sensitivity in detecting all positive cases.

In terms of tendinopathy, USG detected 53 TPs out of 72 MRI-confirmed cases, with 20 FNs, 1 FP, and 27 true negatives. Sensitivity was 0.72, specificity was 0.96, PPV was 0.98, and NPV was 0.57, demonstrating reliable identification of tendinopathy cases with some limits in excluding non-cases.

For Non-Rotator Cuff conditions, USG identified 59 true positives, 7 true negatives, 52 false positives, and 29 false negatives. Its sensitivity was 81 (good enough to identifying actual cases), and its specificity was 0.80 (properly identifying non-cases in 80% of cases). The PPV of 0.88 and NPV of 0.71 indicate that the results are relatively reliable, while there is some uncertainty in excluding normal cases.

DISCUSSION

Patients with shoulder pain are assessed utilising a variety of techniques, including clinical examination, radiography, USG, CT, MRI, arthrography, and arthroscopy. Because diagnostic procedures have limitations, rotator cuff pathology cannot always be diagnosed clinically in the setting of a shoulder injury. Some of the abnormalities found by high-resolution ultrasound during clinical examination that resemble rotator cuff tears include subacromial-subdeltoid bursitis, tenosynovitis, greater tuberosity fracture, calcific tendinosis, and tendinitis.

Magnetic resonance imaging is the gold standard for diagnosing rotator cuff injury of the shoulder joint. It is non-invasive and has multiplanar capabilities, demonstrating good soft tissue results without the use of ionising radiation. MRI provides on-site data, including the extent of the lesion and surrounding structures, as well as secondary alterations. MRI is a diagnostic tool that can accurately indicate which patients would benefit from surgery. Although MRI is an expensive procedure, it has established as the gold standard for evaluating rotator cuff disorders. The availability of modern imaging modality is a barrier in developing nations such as India, where the majority of the population lives in rural areas. Ultrasound is regarded as the most cost-effective and accessible initial imaging technique for assessing rotator cuff disorders. Although ultrasound is operator dependent and may not be as accurate as MRI, it does provide a quick, non-invasive, real-time cross-sectional image of the joint.

In this hospital-based observational study, we intended to assess the accuracy of high-resolution sonography in comparison to MRI for musculotendinous disorders of the shoulder joint. Furthermore, we tried to assess the sensitivity, specificity, positive predictive value, and negative predictive value of high resolution and dynamic sonography in the diagnosis of shoulder joint pathologies in patients with shoulder pain, using MRI as the reference standard, and to compare their findings. The study included 100 patients with shoulder pain who had been referred for an MRI scan and met the inclusion and exclusion criteria. Individuals over the age of 18 with shoulder pain who were referred from the orthopaedic department to the radiology department were included in the study after they were provided with written consent. All research participants underwent MRI and ultrasonography scans. The accuracy of ultrasonography in identifying shoulder joint disorders was determined by comparing its results to those of an MRI. The evaluation concentrated on four muscles—the supraspinatus, infraspinatus, teres minor, and subscapularis—and their corresponding conditions.

In this study of 100 individuals with shoulder pathology, 42 were women and 58 were men. 36 people have troubles with their left shoulder and 64 with their right. A total of 68% of the patients were above the age of 40. Demographic data of the study group were similar in the study by Yazigi et al[67]. In their study, there were 63.75% male and mean age of study group was 48 years.

For Non-Rotator Cuff pathologies, USG found 59 true positives, 7 true negatives, 52 false positives, and 29 false negatives. It had a sensitivity of 81 (enough to identify genuine cases) and a specificity of 0.80. The PPV of 0.88 and NPV of 0.71 suggest that the results are rather reliable, although there is considerable uncertainty in excluding normal cases.

For rotator cuff pathology in the subscapularis, USG found one positive case out of three MRI-confirmed full-thickness tears, demonstrating not sufficient sensitivity in diagnosing subscapularis full-thickness tears. In the infraspinatus tendon, USG found 11 true positives out of 12 MRI-confirmed cases, indicating good agreement with MRI. In the supraspinatus tendon, USG identified 31 true positives out of 36 cases verified by MRI, exhibiting high accuracy in detecting full-thickness tears. When full-thickness tears were examined across all tendon groups, USG discovered 32 true positives and 63 true negatives, with 5 false negatives and 0 false positives. This yields a sensitivity of 0.87, indicating that USG accurately identified 87% of MRI-confirmed full-thickness tears. The specificity was 1, indicating complete accuracy in identifying patients without tears, and the positive predictive value and negative predictive value were both high, at 1 and 0.93, indicating excellent reliability for both positive and negative outcomes.

Iannotti et al[68]. showed a similar sensitivity of 88%. At the same time, Iannotti et al reported a specificity of 82%, which is lower than in the present study. Martín- Hervás C et al[69] found 100% specificity for USG diagnosis of full- thickness tears when compared to arthroscopy or open surgery results. However, published data on the sensitivity of ultrasound in diagnosing full-thickness rotator cuff injuries vary extensively. Cowling et al[70]., using arthroscopy as the standard, discovered that USG had good sensitivity and specificity for diagnosing full-thickness rotator cuff injuries (92.3% and 93.0%, respectively). In contrast, Paavolainen et al[71] reported an overall sensitivity of 74% and specificity of 95% of USG in diagnosing 20 full-thickness rotator cuff injuries.

In the subscapularis tendon, USG detected 2 PTTs out of ten MRI-confirmed cases, demonstrating a limited detection capability. USG identified 4 PTTs out of nine MRI-confirmed instances in the infraspinatus tendon, indicating slightly greater performance than in the subscapularis. USG detected 13 positives cases out of 20 MRI-confirmed partial-thickness tears in the supraspinatus tendon, the tendon group with the highest true positive count, however a number of instances were missed. USG detected 17 TPs, 66 TNs, 17 FNs, and no FPs in partial-thickness tears irrespective of tendon groups. This resulted in a sensitivity of 0.5, indicating that USG detected 50% of MRI-confirmed partial tears. The specificity was again 1 which is similar to full-thickness tears, and the PPV and NPV were 1 and 0.80, respectively, demonstrating excellent accuracy in ruling out tears when no tear, but limited sensitivity in detecting all positive cases.

The sensitivity and specificity of USG for identifying partial-thickness Rotator cuff tears were discovered to be lower than for full-thickness Rotator cuff tears. Lenza et al[72]. did a meta-analysis to assess the diagnostic test accuracy of MRI, MRA, and USG for detecting any rotator cuff tears in persons who have suspected rotator cuff tears and are considering surgery. Lenza et al reported that USG had a low sensitivity for detecting partial thickness tears. In their studies, the USG had a significantly lower sensitivity (52%) but a higher specificity (93%). These results were consistent with the current study.

Cowling et al[66]. observed that the sensitivity and specificity of ultrasound in diagnosing partial-thickness tears were 65.0% and 94.0%, respectively. Elmorsy et al[73]. conducted a retrospective analysis to compare preoperative MRI and USG imaging findings to surgical results of 255 patients who had shoulder arthroscopy. They discovered that USG was less sensitive than MRI for detecting partial- thickness tears, although not by a statistically significant amount (23% vs. 54.1%; $p = 0.333$). Furthermore, they found USG to be more specific than MRI for diagnosing partial-thickness Rotator cuff tears (90.1% vs. 72.6%, respectively; $p < 0.001$) and so suggested US as the preferred diagnostic modality for Rotator cuff tears at their institution. Martin-Hervas et al[65]. found that USG had an adequate specificity of 67.9% for partial tears but an extremely poor sensitivity (12.5%), and hence recommended the use of MRI in addition to US for identifying PTT in patients with clinical symptoms of shoulder disease. Similarly, Sipola et al[74]. suggested that MRI should be used to confirm negative USG findings in patients with rotator cuff tear indications and symptoms who did not achieve symptom improvement after three months of conservative treatment. These studies indicate that USG has limited sensitivity and specificity for identifying partial-thickness rotator cuff injuries. If the USG is used alone, it may miss the diagnosis because of its low sensitivity for partial-thickness rotator cuff injuries. The combination of MRI imaging and US in individuals suspected of having partial-thickness tears improves the likelihood of diagnosing the tear.

USG indicated varying true positives across tendon groups, showing differing accuracy in diagnosing tendinopathy in each tendon. In the subscapularis, USG found
37 TPs out of 57 MRI-confirmed instances, indicating intermediate detection capabilities. In the infraspinatus, USG revealed 17 TPs out of 33 MRI confirmed cases. In the supraspinatus, USG detected 38 TPs out of 48 confirmed by MRI, indicating a relatively high agreement with MRI. For the teres minor, USG revealed two TPs out of four verified by MRI, indicating intermediate sensitivity in detecting tendinopathy in this tendon. Across all tendons of rotator cuff, USG detected 53 TPs, 27 TNs, 20 FNs, and 1 FP in tendinopathy. Sensitivity was 0.72, specificity was 0.96, PPV was 0.98, and NPV was 0.57, demonstrating reliable identification of tendinopathy cases with some limits in excluding non-cases. Yazigi et al[63] found a lower sensitivity (53.3%) and specificity (58%) than the current study. The low sensitivity in their study could be related to the typical practice of looking for scenarios in which, for example, an ultrasound examination may show tendinopathy but magnetic resonance imaging on the same patient may show a rotator cuff tear. Such scenarios can be explained by the low sensitivity reported in their study.

Overall, USG revealed high specificity across all situations, with the best efficacy for detecting full-thickness tears. The sensitivity was maximum for full- thickness tears, moderate for tendinopathy, and lowest for partial-thickness tears. Similarly, USG had strong specificity and predictive values across all tendons, although sensitivity varied, especially for the subscapularis.

LIMITATION OF STUDY

The primary limitation of this study was the small sample size. Despite these limitations, the study successfully identified the causes of acute shoulder joint pain, as evidenced by an MRI. False-positive findings in sonographic assessments of rotator cuff tears can be caused by technical factors (such as transducer positioning, anisotropy, and acoustic shadowing by the deltoid septum), anatomical features (such as the rotator cuff interval, supraspinatus-infraspinatus interface, and musculotendinous junction), or disease characteristics (such as tendon inhomogeneity, scar tissue, calcification, and rotator cuff thinning). Similarly, false-negative sonographic findings can be caused by technical limitations (such as transducer frequency, suboptimal focussing, imaging protocol, and transducer handling), anatomical factors (such as non-diastasis of ruptured tendon fibres), disease-related aspects (such as tendinosis, calcifications, synovial proliferation, scar tissue, and bursal thickening), or patient-specific factors (such as obesity, muscularity, and limited shoulder mobility).

SUMMARY AND CONCLUSION

This study compared the diagnostic accuracy of high-resolution USG to MRI for detecting musculotendinous diseases of the shoulder joint. The evaluation focused on the rotator cuff's four major muscles: supraspinatus, infraspinatus, teres minor, and subscapularis.

Key findings:

- Full-Thickness Tears: Ultrasound had a high sensitivity (87%) and specificity (100%) for diagnosing full-thickness rotator cuff tears. It correctly diagnosed tears with a strong PPV and NPV, yielding consistent findings for full- thickness tears.
- Partial-Thickness Tears: Ultrasound has low sensitivity (50%) for diagnosing partial-thickness tears, but good specificity (100%) and PPV (100%). This suggests that, while ultrasound was effective in excluding normal cases, it was less sensitive in detecting all positive cases, particularly partial-thickness tears.
- Tendinopathy Diagnosis: Ultrasound had intermediate sensitivity for identifying tendinopathy in the rotator cuff muscles, with the supraspinatus muscle exhibiting the best agreement with an MRI. However, sensitivity differed between muscle groups.
- For non-rotator cuff conditions, sensitivity of USG was 81%, making it good at identifying actual cases, while the specificity was 80%, indicating it accurately identified non-cases in 80% of cases.

Ultrasound is a cost-effective, and dynamic imaging tool for identifying rotator cuff disorders, particularly full-thickness tears, due to its excellent specificity and real-time evaluation capability. However, it has limits, particularly in recognising partial thickness tears and some tendinopathies. MRI is the gold standard for complete evaluation and

should be performed in conjunction with ultrasonography to provide more accurate diagnosis, especially in situations with complicated or confusing findings. Combining both imaging modalities improves diagnosis accuracy for patients with shoulder pain.

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ANNEXURES

PROFORMA

Name	**Age:**	**Sex:**
Inpatient No:	**Unit/ward:**	**Occupation**

Socioeconomic status:

Address:

Date of admission:

Shoulder pain	**Yes/no**
History of trauma	**Yes/no**
Any h/o previous surgeries	**Yes/no**
Any implants	**Yes/no**
Any significant cardiac/renal or hepatic diseases	**Yes/no**
History of fear/ anxiety when in a confined space	**Yes/no**

PATIENT INFORMATION SHEET

Title of the project- "COMPARISON OF HIGH RESOLUTION AND DYNAMIC SONOGRAPHYWITH MAGNETIC RESONANCE IMAGING IN EVALUATION OF MUSCULOTENDINOUS PATHOLOGIES OF SHOULDER JOINT,IN ATERTIARY CARE HOSPITAL IN MALABAR REGION."

- Purpose of this project/study- this study is done to assess the accuracy of ultrasound with dynamic manoeuvres when compared to MRI in the diagnosis of shoulder joint pathologies in patients with shoulder pain.
- Procedure/methods of the study including withdrawal criteria-your participation in the study is voluntary. You are free to choose not to take part in the study or stop taking part at any time.
- Expected duration of the subject participation-for one year
- The benefits to be expected from the research to the participant or to others. We do not guarantee that you will benefit from taking part in this study.
- Any risks expected from the study to the participant: Do not take part in this study if you are - Pregnant, Patients with pacemaker or metal implants, Claustrophobic patients, Patients with known or diagnosed fractures/dislocations of shoulder, Patients with previous history of surgery or Prosthesis in shoulder.
- Maintenance of confidentiality of records: Every detail about you given in this study will be kept confidential, and even if we publish the results of the study, your identity will not be revealed.
- Provision of free treatment for research related injury: You will not have research related injury. If you are injured as a result of this study, your injury will be treated.
- Compensation to the participants for foreseeable risks and unforeseeable risks related to research study leading to disability or death: There will not be any disability or death as a result of taking part in this study. If any injury occurs to you, appropriate compensation will be given.
- You have the freedom to withdraw from the study at any time during the study period without the loss of benefits that the participant would otherwise be entitled.
- Possible current and future uses of the data to be generated from the research: If new information is available from this study, that will be utilised for patients in the future. If you need the information, it will be provided to you. The newly available information will be published in a suitable journal.
- Address and mobile number of the principal investigator (PI): For more information, you may contact the investigator.

Signature/thumb impression of the participant:

Dr. Apoorva Ganesh
Junior Resident
Department of the Radiodiagnosis
KMCT Medical College, Calicut.
Phone No :

Place:
Date:

േരാഗിയുെട വിവര ഷീ*്

പMതിയുെട ശീർഷകം- മലബാർ േമഖലയിെല ഒരു െടർഷ്റി െകയർ േഹാസ്പി*ലിൽ േതാളിൽ േവദനയു് േരാഗികളിൽ േതാളിൽ സM്ിയുെട മസ്േലാെടൻഡിനസ് പാേഥാളജികളിൽ എംആർഐയുമായി ഉയർ് െറസല്ൂഷനും ൈഡനാമിക് േസാേണാ‡ഗാഫിയും താരതമ്ം െചു്ു

ഈ േ‡പാജക്*ിന്െറ/പഠന്ിന്െറ ഉേദ്ശ്ം- േതാൾ േവദനയു് േരാഗികളിൽ സM്ി പാേഥാളജികളുെട േരാഗനിർAയ്ിൽ എംആർഐയുമായി താരതമ്െ¶ടു്ുേ്ാൾ ചലനാ-കമായ ത‡@ൾ ഉപേയാഗി@് അൾ‡ടാസൗ6ിന്െറ കൃത്ത് വീലയിരു്ുതിനാണ് ഈ പഠനം നട്ുത്.

പിൻവലി്ൽ മാനദ്ഢം ഉൾെ¶െട പഠന്ിന്െറ നടപടി‡കമം/രീതികൾ- പഠന്ിെല നി്ളുെട പ്ാളി്ം സ്േമധയാ ഉ്താണ് പഠന്ിൽ പെ്ടു്ാതിരി്ാേനാ ഏത് സമയ്ും പെ്ടു്ുത് നിർ്ാേനാ നി്ൾ്് സ്ാത‡@്മു6്.

പഠനപ്ാളി പ്ാളി്ിന്െറ ‡പതീ്ി്ു് ൈദർഘ്ം ഒരു വർഷേ്്

- ഗേവഷണ്ിൽ നി് പ്ാളിേ്ാമ*ു്വർേ്ാ ‡പതീ്ിേ്6 ‡പേയാജന്ൾ- ഈ പഠന്ിൽ പെ്ടു്ുതിൽ നി് നി്ൾ്് ‡പേയാജന ലഭി്ുെമ്ഞ്ൾ ഉറ¶ുനൽകു്ിA.
- പഠന്ിൽ നി് പ്ാളി്് ‡പതീ്ി്ു് എെ@്ിലും അപകടസാധ്തകൾ- ഗർഭിണി, േപസ് േമ്ർ ഒെA്ിൽ െമ*ൽ ഇം്ാന്റുകൾ ഉ് േരാഗികൾ േ്ാസ്േ‡ടാേഫാബിക് േരാഗികൾ,അറിയാവു്േതാ േരാഗനിർAയം െചെ¶േതാ ആയ േതാളിെല ഒടിവുകൾ/ @ാന‡ഭംശം ഉ് േരാഗികൾ, ശസ്‡ത‡കിയയുെട മുൻ ചരി‡തമു് േരാഗികൾ നി്ളാെണ്ിൽ ഈ പഠന്ിൽപെ്ടു്രുത്.
- േരഖകളുെട രഹസ്സ്ഭാവം പരിപാലി്ൽ: ഈ പഠന്ിൽ നൽകിയിടു് നി്െള കുറി@ു് എA്ാ എA്ാ വിശദാംശ്ളും രഹസ്സ്ഭാവേ്ാെട സൂ്ി്െ¶ടും, പഠന്ിന്െറ ഫല്ൾ ഞ്ൾ ‡പസിM്ീകരി@ാലും, നി്ളുെട ഐഡന്റി*ി െവളിെ¶ടു്ിA.
- ഗേവഷണവുമായി ബMെ¶ട പരി്ിന് സൗജന് ചികിš ലഭ്മാ്ൽ: ഗേവഷണവുമായി ബMെ¶ട പരി്് നി്ൾ്് ഉ6ാകിA ഈ പഠന്ിന്െറ ഫലമായി നി്ൾ്് പരിേ്ൽ്ുകയാെണ്ിൽ നി്ളുെട ്ർ ചികിšി്െ¶ടും.
- ൈവകല്ിേലേ്ാ മരണ്ിേലേ്ാ നയി്ു് ഗേവഷണ പഠനവുമായി ബMെ¶ട മുൻകൂട്ി കാണാവു് അപകടസാധ്തകൾ്ും മുൻകൂട്ി കാണാനാവാ് അപകടസാധ്തകൾ്ും പ്ാളികൾ്ു് നടപരിഹാരം- ഈ പഠന്ിൽ പെ്ടു്ുതിന്െറ ഫലമായി എെ@്ിലും ൈവകല്േമാ മരണേമാ ഉ6ാകിA. നി്ൾ്് എെ@്ിലും പരി്് സംഭവി്ുകയാെണ്ിൽ ഉചിതമായ നടപരിഹാരം നൽകും.
- പ്ാളി്് േമ*െത്ിലും തര്ിൽ അർഹതയു് ആനുകൂല്ൾ

നടെ¶ടാെത, പഠന കാലയളവിൽ ഏത് സമയ½ും ം പഠന½ിൽ നി് പിൻവാ□ാനു് സ്ാത‡@്ം നി□ൾ□ു6്.

- ഗേവഷണ½ിൽ നി് ജനേറ*ുെചേ!6 ഡാ*യുെട സാധ്മായ നിലവിെലയും ഭാവിയിെലയും ലഭ്മാെണ□ിൽ വിവര□ൾ ഉപവിയഗ□ൾ േരാഗികൾ□ായി ഉപേയാഗി□െ¶ടും നി് നി□ൾ□് വിവര□ൾ ആവശ്മുെ6□ിൽ ആ് നി□ൾ□് നൽകും പുതുതായി ലഭ്മായ വിവര□ൾ അനുേയാജ്മായ ജ്ര േജണലിൽ‡പസിMീകരി□ും.
- ‡പിൻസി¶ൽ അേന്ഷകന്െറ (PI) വിലാസവും െമാൈെബൽ ന്റും കൂടുതൽ വിവര□ൾ□്. നി□ൾ□് അേന്ഷകെന ബMെ¶ടാവുതാണ് ഡോക്ടർ ഗേണശ്. ജൂനിയർ െറസിഡന്റ്, േറഡിേയാ ഡയേ□ാസിസ് വകു¶്ജന□ൂട്ം:

INFORMED CONSENT FORM

*Title of the project- "**Comparison of high resolution and dynamic sonography with magnetic resonance imaging in evaluation of musculotendinous pathologies of shoulder joint, in a tertiary care hospital in Malabar region**."*

The details of the study have been provided to me in writing and explained to me in my own language. I confirm that I have understood the above study and had the opportunity to ask questions. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason, without the medical care that will normally be provided by the hospital being affected. I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s). I have been given an information sheet giving details of the study. Risk and benefit of this project has been explained to me. I fully consent to participate in the above study.

(I also consent / do not consent to use my stored biological samples for future scientific purposes: Yes/ No – if applicable)

Signature/thumb impression of the participant: Signature of investigator:

Signature of the witness: Dr. Apoorva Ganesh

Junior Resident Department of the Radiodiagnosis

KMCT Medical College, Calicut.

Phone No :

Name and address of the witness:

Place:

Date:

KMCT MEDICAL COLLEGE
Institutional Ethics Committee

Registered under Rule 122 DD of the Drug and Cosmetic Rules 1945
Reg.No.ECR/859/Inst/KL/2016

Ref. No.KMCT/RP 2022/IEC/33

APPROVAL OF RESEARCH PROJECT

The Institutional Ethics Committee, KMCT Medical College, Kozhikode has evaluated the protocol of the research project entitled.

"COMPARISON OF HIGH RESOLUTION AND DYNAMIC SONOGRAPHY WITH MAGNETIC RESONANCE IMAGING IN EVALUATION OF MUSCULOTENDINOUS PATHOLOGIES OF SHOULDER JOINT, IN A TERTIARY CARE HOSPITAL IN MALABAR REGION "

Submitted by Dr.Apoorva Ganesh, Junior Resident (PG), Dept. of Radiodiagnosis, KMCT Medical College, Kozhikode.

Guide: Dr. V R Rajendran, Professor & HOD, Dept. of Radiodiagnosis, KMCT Medical College, Kozhikode.

Co-Guide: Dr. Rajesh O P, Assistant Professor, Dept. of Orthopaedics, KMCT Medical College, Kozhikode.

The Committee has approved the same/ rejected/ returned for further clarification.

The investigator shall submit a copy of the completed research project to the Institutional Ethics Committee (IEC) immediately after the completion of the study.

SECRETARY

Dated : 01/12/2022

Manassery P.O, Mukkam - 673 602, Kozhikode, Kerala, India
Phone: 0495 2295087, 2293040, **Fax:** 0495-2294753
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IEC APROVAL CERTIFICATE

IRC APPROVAL CERTIFICATE

KMCT Medical College
Institutional Research Committee

Ref. No. KMCT/MC/IRC/ 121 17092022 Date- 10/11/2022

APPROVAL OF RESEARCH PROJECT

Followings are details of research protocol received, reviewed by members of Institutional Research committee after suggested corrections.

Title of study- COMPARISON OF HIGH RESOLUTION AND DYNAMIC SONOGRAPHY WITH MAGNETIC RESONANCE IMAGING IN EVALUATION OF MUSCULOTENDINOUS PATHOLOGIES OF SHOULDER JOINT,IN A TERTIARY CARE HOSPITAL IN MALABAR REGION.

Name of principal investigator and department-
Dr.Apoorva Ganesh,
Junior Resident,
Department of Radiodiagnosis,
KMCT Medical College.

Name of the guide and department-
Dr.V R Rajendran,
Professor & HOD,
Department of Radiodiagnosis,
KMCT Medical College.

Name of co-guide
Dr.Rajesh O P,
Assistant Professor,
Department of Orthopaedics,
KMCT Medical College.

Members of Institutional Research Committee have reviewed the research protocol.

Members of institutional research committee has given the approval to the proposed research protocol after appropriate review with suggested corrections.

Hence this research protocol is approved by Institutional Research committee.

Chairman,
Institutional research committee.

Member secretary,
Institutional research committee

MEMBER SECRETARY
INSTITUTIONAL RESEARCH COMMITTEE
KMCT MEDICAL COLLEGE

KMCT
MEDICAL COLLEGE

INSTITUTIONAL ETHICS COMMITTEE

DHR Registration Number: EC/NEW/INST/2024/KL/0467

THESIS COMPLETION CERTIFICATE

Name of PG student: Dr. Apoorva Ganesh

Department: Radiodiagnosis

Year of admission: 2021

Title of thesis: COMPARISON OF HIGH RESOLUTION AND DYNAMIC SONOGRAPHY WITH MAGNETIC RESONANCE IMAGING IN EVOLUTION OF MUSCLUOTENDINOUS PATHOLOGIES OF SHOULDER JOINT IN A TERTIARY CARE HOSPITAL IN MALABAR REGION.

Name of guide: Dr. V R Rajendran

Status of completion: Completed

This is to certify that the above student has successfully completed their thesis submitted in partial fulfilment of the requirements for their postgraduate degree.

Date: 18.11.24

18/11/24

Member Secretary
MEMBER SECRETARY
INSTITUTIONAL ETHICS COMMITTEE
KMCT MEDICAL COLLEGE

Chairman
CHAIRPERSON
INSTITUTIONAL ETHICS COMMITTEE
KMCT MEDICAL COLLEGE.

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Date: 25 - 11- 2024
Place: Calicut

Dr Apoorva Ganesh

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PLAGIARISM VERIFICATION CERTIFICATE

PART A

1. NAME OF THE RESEARCHER: DR APOORVA GANESH
2. TITLE OF THE THESIS: COMPARISON OF HIGH RESOLUTION AND DYNAMIC SONOGRAPHY WITH MAGNETIC RESONANCE IMAGING IN EVALUATION OF MUSCULOTENDINOUS PATHOLOGIES OF SHOULDER JOINT, IN A TERTIARY CARE HOSPITAL IN MALABAR REGION
3. COURSE :MD RADIODIAGNOSIS
4. KUHS REG NO:212130078
5. NAME OF GUIDE : DR V R RAJENDRAN
6. OFFICIAL DESIGNATION OF THE GUIDE &ADDRESS :PROFESSOR AND HOD ,DEPARTMENT OF RADIODIAGNOSIS ,KMCT MEDICAL COLLEGE, MANASSERY, CALICUT

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DR APOORVA GANESH

PART B

THE PLAGIARISM REPORT OF THE ABOVE THESIS HAS BEEN REVIEWED BY THE UNDERSIGNED.

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Dr. V.R RAJENDRAN, DMRD, MD
PROFESSOR & HOD of Radio Diagnosis
KMCT MEDICAL COLLEGE
Manassery, Mukkom, Kozhikode - 673 602

SIGNATURE OF THE RESEARCHER:	SIGNATURE OF THE GUIDE WITH SEAL
NAME OF THE RESEARCHER	NAMEANDDESIGNATION
DR APOORVA GANESH	DR V R RAJENDRAN DEPARTMENTOFADIODIAGNOSIS KMCT MEDICAL COLLEGE, MANASSERY, CALICUT

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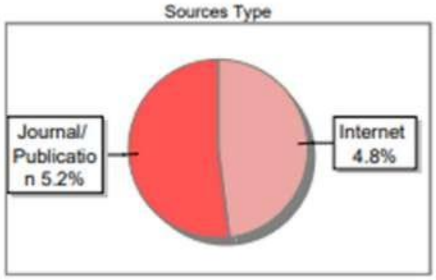

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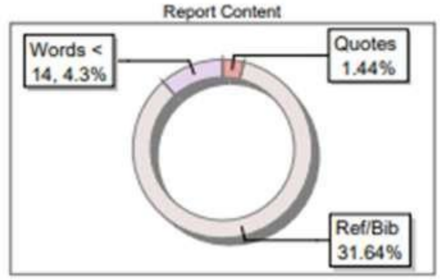

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Language	English
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KEY TO MASTERCHART

SL.NO.	SERIAL NUMBER
M	MALE
F	FEMALE
L	LEFT
R	RIGHT
USG	ULTRASOUND
MRI	MAGNETIC RESONANCE IMAGING
FTT	FULL THICKNESS TEAR
PTT	PARTIAL THICKNESS TEAR
TEND	TENDINOSIS
S SP	SUPRASPINATUS
I SP	INFRASPINATUS
S SC	SUBSCAPULARIS
TM	TERES MINOR
SASD BE	SUBAROMIAL SUBDELTOID
BURSITIS JE	JOINT EFFUSION
BT	BICEPS TENDINOSIS
ACJ ARTHRO	ACRMIOCLAVICULAR JOINT
ARTHROPATHY	
P	PRESENT

MASTER CHART

SL NO:	AGE	SEX	SHOULDER	ROTATORCUFFPATHOLOGY						NON ROTATORCUFFPATHOLOGY							
				USG			MRI			USG				MRI			
				FTT	PTT	TEND	FTT	PTT	TEND	SASDBE	JE	BT	ACJARTHRO	SASDBE	JE	BT	ACJARTHRO
1	39	M	L			SSp,I Sp,SSc		SSp	SSp,I Sp,SSc								
2	27	M	R			SSp		SSp									
3	61	F	R	SSp	I Sp		SSp	I Sp,SS C			P			P			
4	48	F	R		SSp,I Sp			SSp,I Sp			P			P			
5	64	M	R	SSp		I Sp,SSc	SSp		I Sp,SSc	P							
6	47	M	L	SSp, I Sp		SSc	SSp,I Sp	SSc	SSc		P			P			
7	50	F	R	SSp, I Sp		SSc	SSp,I Sp		SSc				P			P	P
8	53	F	R	SSp, SSc	I Sp		SSp,SSc	I Sp			P			P	P		
9	55	F	R	SSp			SSp	I Sp			P			P			
10	63	M	L		SSp	SSp,SSc		SSp,I Sp	SSp, SSc							P	
11	50	F	L			SSp,SSc			SSp, SSc								
12	70	F	R	SSp		I Sp,SSc	SSp		I Sp,SSc	P							
13	54	F	L			SSp,SSc			SSP,SS c								
14	50	M	R			SSp		SSp	SSp	P							
15	45	M	L			SSp			SSp	P			P				P
16	64	M	L			SSp,I Sp,SSc, TM			SSp,I Sp,SSc, TM	P	P		P	P			P
17	27	M	L														
18	56	M	R			SSp,I Sp,SSc		SSp, SSc	SSp,I Sp,SSc			P			P		
19	37	M	R				SSp										
20	46	M	L			SSp, SSc			SSp, SSc			P			P		
21	35	M	L						SSP,SS c	P							

22	47	M	L	SSp			SSp,I Sp,SSc					P			P		
23	45	F	R	SSp		SSc	SSp	I Sp	SSc,TM		P			P			
24	69	M	R		SSp	SSp, SSc		SSp	SSp, SSc				P	P			P
25	65	F	R	SSp		I Sp,SSc	SSp		I Sp,SSc		P						
26	58	M	R	SSp,I Sp			SSp,I Sp				P	P			P	P	P
27	44	F	L						SSp, SSc								
28	50	F	R	SSp,I Sp	SSc		SSp,I Sp	SSc	SSc								
29	52	M	R		SSp	SSp,I Sp,SSc		SSp	SSp,I Sp,SSc	P				P			
30	47	F	L			SSp, SSc			SSp,I Sp,SSc								
31	47	M	R		SSp			SSp	I Sp,SSc								
32	43	F	R		SSp	SSp,I Sp,SSc		SSp	SSp,I Sp,SSc	P				P			
33	26	M	R	I Sp			I Sp										
34	74	M	R			SSp, SSc			SSp,I Sp,SSc				P				P
35	60	F	R	SSp		SSc	SSp		SSc		P				P		
36	61	M	L	SSp		SSp,I Sp,SSc	SSp		SSp,I Sp,SSc		P				P		P
37	40	M	R			SSp			SSp								P
38	60	F	L			SSp			SSp	P		P		P		P	
39	34	M	R					SSp									
40	62	F	R	SSp,I Sp			SSp,I Sp				P				P		
41	57	M	R					SSc		P				P			
42	75	M	R		SSp	SSp, SSc		SSp	SSp, SSc			P	P			P	P
43	65	M	R						SSp, SSc				P				P
44	22	M	L														

45	19	F	R							P				P			
46	38	F	R			SSp		SSc	SSp,I Sp,SSc								
47	56	F	R	SSp,I Sp		SSp,I Sp,SSc	SSp,I Sp		SSp,I Sp,SSc	P				P			
48	64	M	R	SSp,I Sp		SSc	SSp,I Sp		SSc	P		P	P	P		P	P
49	59	M	R			SSp,I Sp,SSc, TM		I Sp	SSp,I Sp,SSc, TM	P	P		P	P	P		P
50	32	F	R			SSp,I Sp			SSp,I Sp		P				P		
51	67	M	R			SSp,I Sp			SSp,I Sp		P				P		
52	46	M	L						SSp, SSc								
53	45	F	R	SSp		I Sp	SSp		I Sp		P				P		
54	39	M	R			SSc			SSc				P				P
55	64	M	R	SSp,I Sp			SSp,I Sp		SSc, TM		P		P		P		P
56	47	F	R			SSp, SSc		SSp	SSp, SSc		P				P		
57	46	F	R			SSp,I Sp,SSc			SSp,I Sp,SSc	P	P			P	P		
58	30	M	L	SSp			SSp										
59	74	M	L			SSp, SSc			SSp, SSc	P		P					
60	58	M	L						SSp, SSc				P				
61	54	F	R		SSp	SSp, SSc		SSp	SSp, SSc		P		P		P		P
62	23	F	L					SSp									
63	58	F	R				SSp		I Sp,SSc					P	P	P	P
64	70	M	R		SSp, SSc	SSp,I Sp,SSc		SSp, SSc	SSp,I Sp,SSc	P	P	P	P	P	P	P	P
65	37	M	R						SSp, SSc								
66	70	M	L						SSp								
67	58	M	R	SSp			SSp	SSc	I Sp							P	

68	21	M	R		SSp			SSp									
69	47	F	R			SSp	SSp		SSp,I Sp,SSc					P	P		P
70	62	F	R	SSp		I Sp	SSp	SSc	I Sp								
71	37	M	R														P
72	19	M	R							P				P			
73	40	M	R	SSp			SSp										
74	47	F	L			SSp			SSp		P				P		
75	32	F	R						SSc							P	
76	64	F	L	SSp		SSp,I Sp,SSc	SSp		SSp,I Sp,SSc				P				P
77	23	M	L			SSp			SSp	P				P			
78	24	F	L												P	P	
79	62	M	R	SSp,I Sp		SSc	SSp,I Sp		SSc								
80	44	F	R						SSp, SSc					P			
81	22	M	R											P			
82	27	M	L			SSp			SSp								
83	65	F	R	SSp			SSp		SSp,I Sp,SSc		P				P		
84	23	M	L								P				P		
85	61	M	L		SSp	SSp, SSc		SSp	SSp, SSc		P	P			P	P	
86	55	F	L						SSp,I Sp,SSc								
87	54	F	L	SSp			SSp		I Sp,SSc								
88	51	M	R		SSp	I Sp,SSc	SSp	I Sp	I Sp,SSc		P				P		
89	55	F	R						SSp,I Sp,SSc								P
90	26	M	R								P				P		

91	52	F	R	SSp		I Sp,SSc	SSp		I Sp,SSc							P	
92	67	M	R			SSp			SSp				P				P
93	48	F	L			SSp,I Sp,SSc		SSc	SSp,I Sp,SSc	P				P			
94	32	M	L					SSp									
95	65	F	R	SSp	I Sp		SSp	I Sp	SSc		P				P		
96	65	F	L			SSp, SSc			SSp, SSc								
97	63	M	R			I Sp	SSp, SSc		I Sp		P				P	P	
98	72	M	R	SSp,I Sp			SSp,I Sp		SSc		P		P		P		P
99	43	M	L	SSp			SSp				P				P		
100	32	M	L		SSp			SSp									