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Research Article

ROLE OF HIGH RESOLUTION USG (HRUSG) IN THE EVALUATION OF PAINFUL SHOULDER JOINTS – A PROSPECTIVE STUDY

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ABSTRACT

This prospective study was carried out in the department of Radio-diagnosis, in a tertiary care hospital from a period of April 2017 to September 2017 to evaluate the role of high resolution USG in cases of painful shoulder joints. Total of 50 patients (29 male and 21 female) were evaluated by USG using 7.5 to 12 MHz linear array transducer with colour power Doppler facility and 3.5 to 5 MHz convex transducer with proper patient positioning and optimum techniques. In all cases proper history taking, clinical examination and supportive investigations were performed. Conventional radiographs were taken in all cases. Follow up study was divided according to clinical problems and their magnitude, consent of the patients, clinical course and treatment plan. Cases were planned for other imaging modalities like CT scan and MRI as confirmatory imaging modalities. Dynamic sonography was highly sensitive (100%) and specific (100%) for rotator cuff pathologies and most importantly it excluded other pathologies like occult fracture of humeral head, adhesive capsulitis, labral tear, infective collections which simulated rotator cuff pathologies. Hypervascularity around the affected shoulder joint in infective and inflammatory conditions was picked up by colour Doppler.

INTRODUCTION

The shoulder joint is distinguished by an extreme range of motion. This ball and socket synovial joint is structurally a weak joint because the glenoid cavity is too small and shallow to hold the head of humerus in place thereby compromising stability for mobility. However stability of the joint is maintained by the coracoacromial anchor secondary socket for the head of the humerus, the musculotendinous cuff of the shoulder and the muscles attaching the humerus to pectoral girdle. Pain or restricted movement of shoulder joint of varying severity account for the most common musculoskeletal problems in our daily life. X-ray is the first imaging modality in investigation of a patient but it does not allow visualization of tendons, bursal components or soft tissue structures and thus remain normal most of the time.

With the introduction of high frequency linear array probes, USG has emerged as a primary diagnostic modality for investigating the rotator cuff diseases. It has the added advantage of offering a dynamic examination enabling an assessment of both range of motion and muscular coordination about the joint. Tissue harmonic imaging, 2D matrix probe technology, extended field of view images, colour Doppler sonography have extended the diagnostic accuracy of Musculoskeletal USG.

With these views in mind this study was undertaken to evaluate the usefulness of USG over X-Ray in detecting the lesions of painful shoulder joints enabling the clinician to arrive at a correct diagnosis rapidly.

Aims and Objectives

Evaluation of the patient of painful shoulder joint by X-ray, High resolution ultrasonography and colour Doppler.

Correlation of the X-ray and USG findings of these patients.

Comparative evaluation of these two modalities in revealing the findings.

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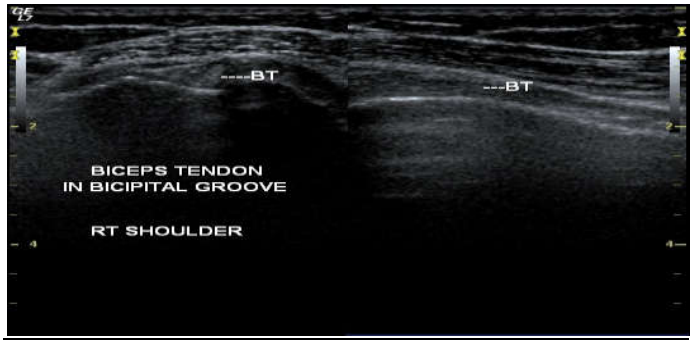


Image 1 Normal View of Biceps Tendon in Transverse and Longitudinal View

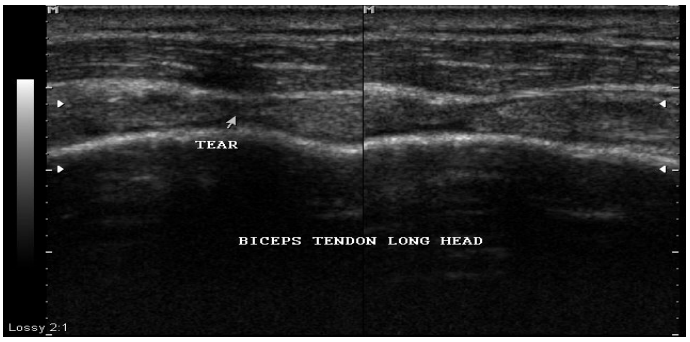


Image 2 USG Picture Showing Tear of Long Head of Biceps of Right Shoulder

Image 3 Transverse section USG image showing dislocated biceps tendon from biceps groove during active flexion during medial rotation. Note the shallow bicipital groove

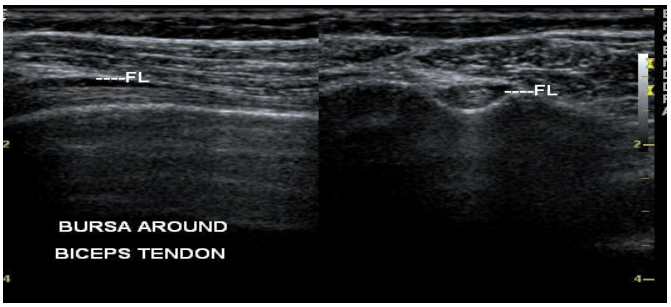
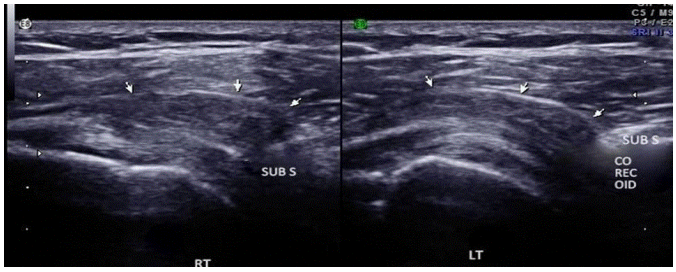


Image 4 Fluid around Biceps Tendon in Biceps Groove and Also In Ls Distenction of Biceps Tendon Sheath

Image 5 Normal View of Subscapularis



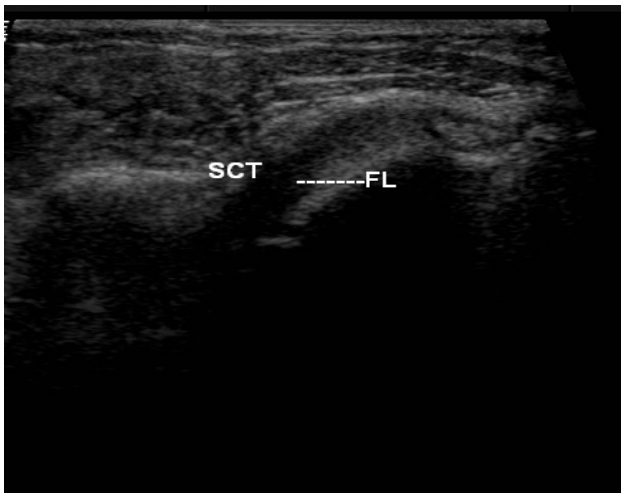


Image 6 USG Showing Thickened and Hetrogenous Appearance of RT Subscapularis Tendon Compared With Lt Side Suggestive of Tendinitis

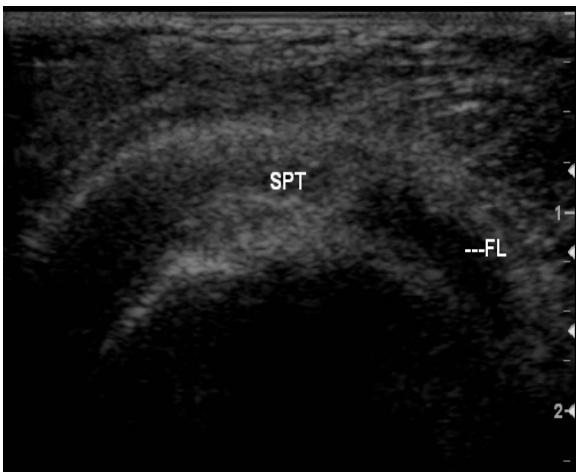


Image 7 USG Showing Fluid In Subscapularis And Supraspinatus Tendon In A Patient Suspected To Have Frozen Shoulder. Diagnosis of Rotator Cuff Tendinopathy Was Made (Left Shoulder)

Image 8 Normal View of Supraspinatus

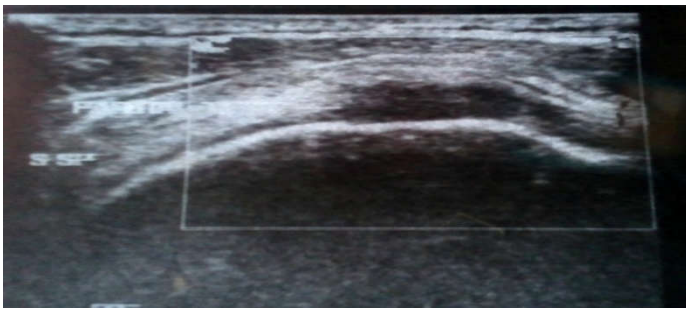


Image 9 Partial Thickness Tear of Supraspinatus Tendon (Right Side)

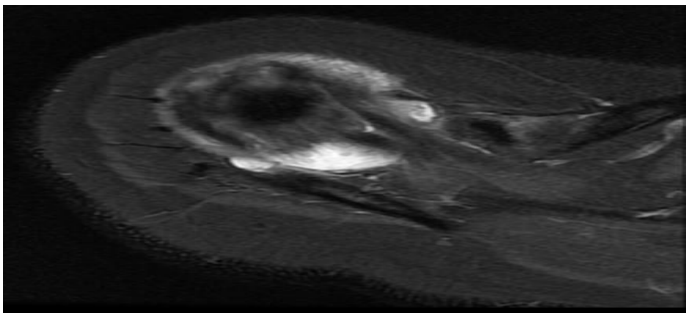


Image 10 Axial Fat Suppressed T2 WTD Image of The Same Patient Demonstrating Partial Thickness Supraspinatus Tear

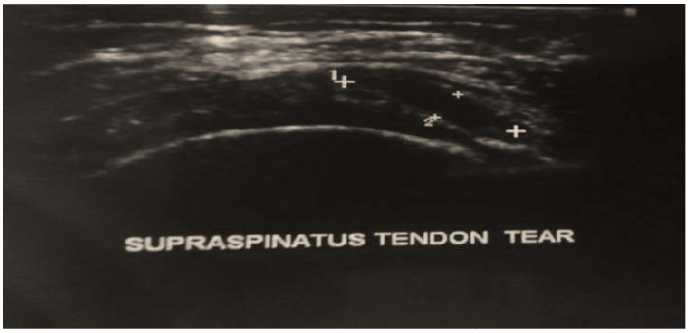


Image 11 Full Thickness Supraspinatus Tear Rt SIDE

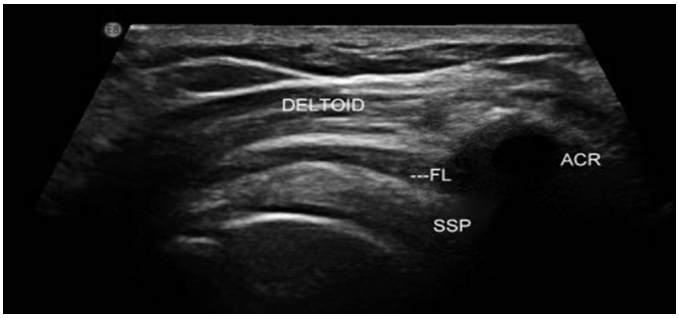


Image 12 Free Fluid in Sub Acromial Sub Deltoid Bursa Rt Side

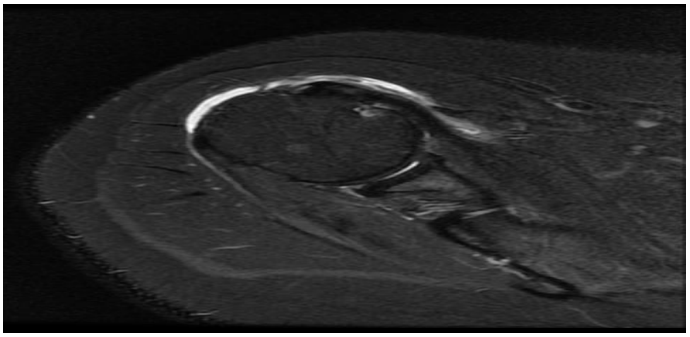


Image 13 Axial Fat Suppressed T2 Wtd Image of The Same Patient Demonstrating Fluid In Subdeltoid Bursa

Image 14 Normal View of Infraspinatus

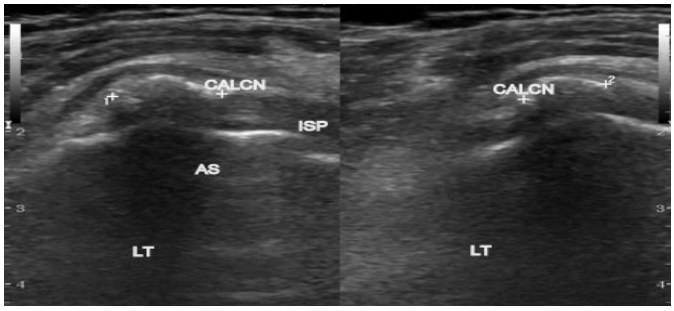


Image 15 USG Confirming Soft Tissue Calcification of the Infraspinatus Muscle

Image 16 Normal Appearance of Posterior Glenoid Labrum

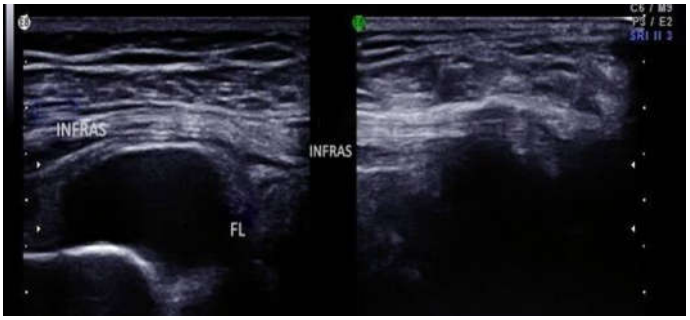


Image 17 Fluid Due To Shoulder Joint Effusion Separating the Infraspinatus and Posterior Labrum

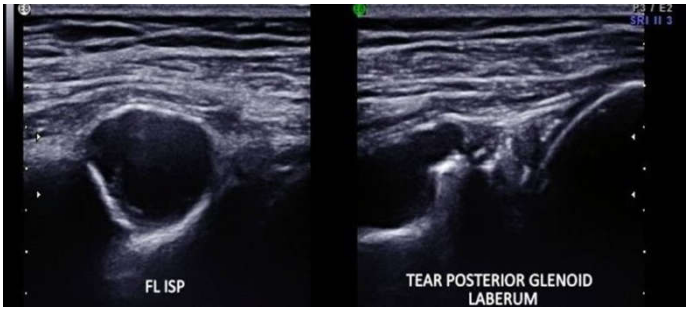


Image 18 SAME patient as above showing the posterior labrum better delineated due to fluid in the joint space. Note the tear in the posterior labrum

Image 19 Huge Inflamatory Collection in the Subdeltiod Region (Lt Side) Communicating With Left Shoulder Joint

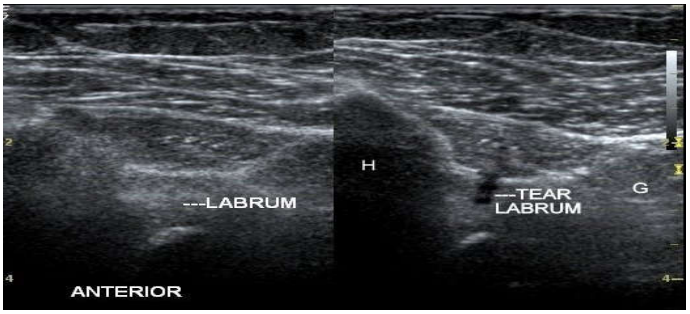


Image 20 USG Showing Tear Anterior Glenoid Labrum Right Side And Compared With the Normal Glenoid Labrum on the Left Side

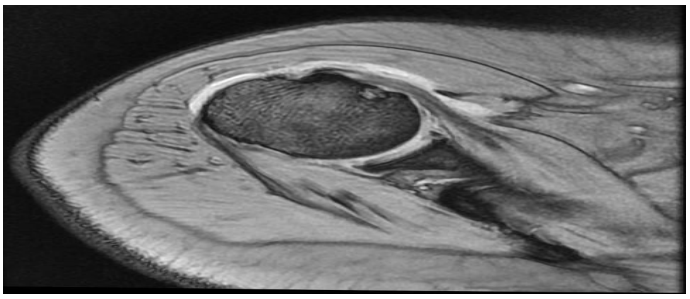


Image 21 Axial Merge Sequence Demonstrating Tear Anterior Labrum of the Same Patient

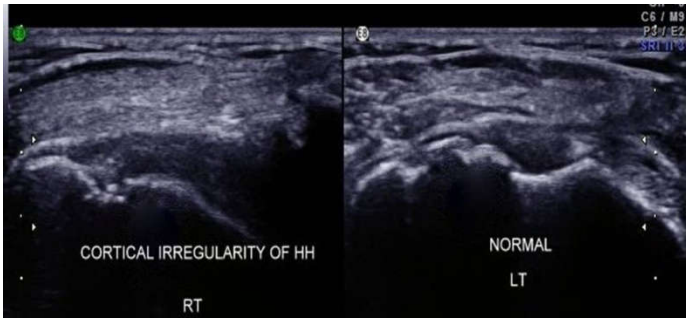


Image 22 Bony Irregularity of the Humeral Head Which Was Occult On Radiograph

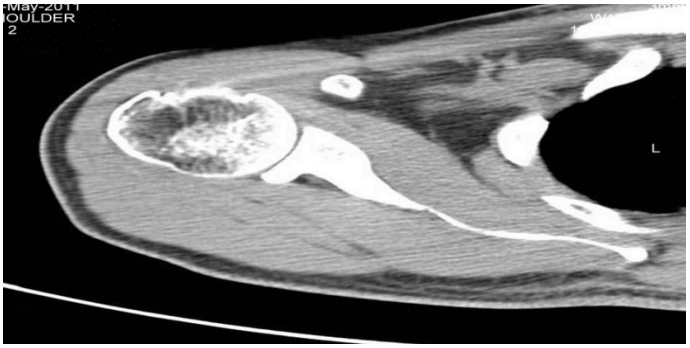


Image 23 CT Scan of The Same Patient Confirming The Fracture

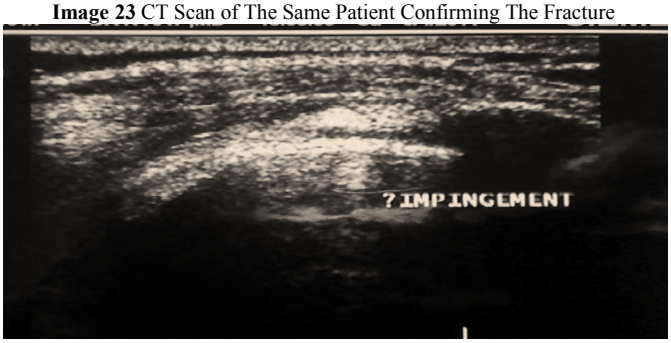


Image 24 Impingement of the Suppraspinatus Tendon Under The Coracoacromial Arch Rt Side

Image 25 Dynamic Study of Rt Shoulder Joint In Abduction In A Case of Adhesive Capsulitis

RESULTS AND ANALYSIS

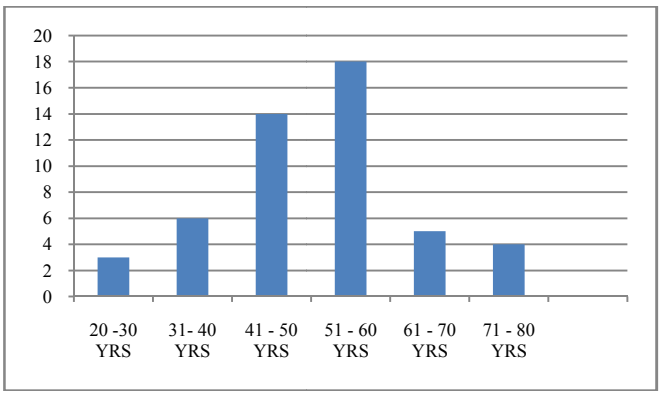
Clinical Status

Age

Table 1 Age Incidence of Patients Having Shoulder Joint Related Complaints

Sl.No	Age Range (Year)	No. of cases	Percentage
1	20 – 30	3	6.0 %
2	31 – 40	6	12.0%
3	41 – 50	14	24.0%
4	51 – 60	18	36.0%
5	61 – 70	5	10.0%
6	71 – 80	4	8.0%

Table: 1 Most patients who present with shoulder joint related complaints were between 40 -70 years. However those with associated previous history of trauma presented at younger age



Bar Diagram 1 The Age Incidence of The Patients

Table 2

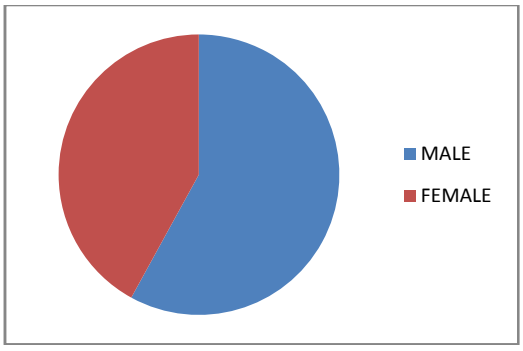
LESIONS	20-30 yrs	31-40 YRS	41-50 yrs	51-60 yrs	61-70 yrs	71-80 yrs	Total	%
	---	---	---	---				
Tears of Rotator cuff	1	4	9	4	3	14	35	70.0%
Adhesive capsulitis	---	1	1	3	---	---	5	10.0%
Impingement Syndrome	---	---	1	---	1	---	2	4.0%
Inflamatory Collection and Abscesses	---	---	1	---	---	---	1	2.0%
Osteoarthritis and Degenerative Condtions solely	---	---	---	---	---	1	1	2.0%
Laberal tears and others	---	---	---	1	1	---	2	4.0%
Rotator cuff tendinopathy	---	---	1	---	---	1	2	4.0%
Fracture	1	---	---	---	1	---	2	4.0%
Total	2	5	13	8	6	15	50	100.0%

1 patient who had come with dislocated biceps tendon has been included in Rotator cuff tears age group between 20-30 years.

Sex Distribution of Patient with Shoulder Pain

Table 3

Total number of pateints	Male	Female
50	29	21



Pie Chart 1 Showing Sex Distribution of Shoulder Joint Related Complaints

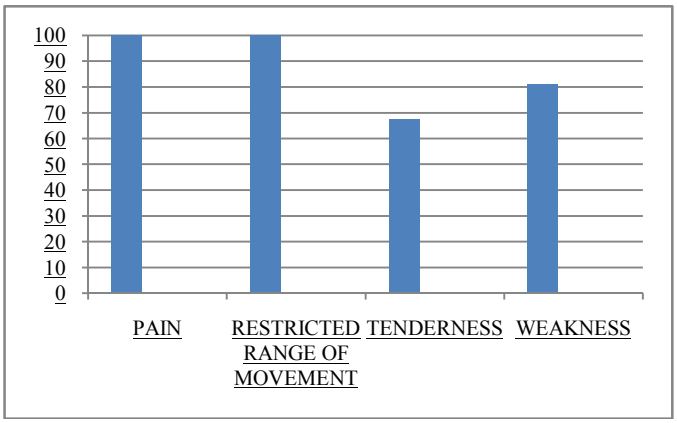
Associated Histories of Pateints with Shoulder Pain (of 15 Pateints)

Table 5 Frequancy of Symptoms in Rotator Cuff Pathologies

History	No of Pateints
Diabetes	4
Previous Surgery	2
Neuropathies	1
Previous trauma	8

Table 6

Sl.no	Symptoms / sign	No. of Cases	Percentage
1	PAIN	37	100.0%
2	Limitation of Movement of Shoulder Especially Abduction & External Rotation	37	100.0%
3	Localise Tenderness	25	67.5%
4	Weakness	30	81.0%



Bar Diagram 2 Trends of Various Signs And Symptoms of Patients with Shoulder Complains

X-Ray and USG Correlation

Out of the 50 patients who had presented to us, X-Ray revealed gross osteoarthritic changes in only one. In another patient who also had an associated fracture humeral head, conventional radiography could not detect it. It was detected on USG and confirmed on CT. In one patient with calcifying tendonitis the infraspinatus calcification was not appreciated in AP view likely due to superimposition of the scapula. In all the other 48 cases the X-Ray was normal USG showed the following:

Limitation of sliding movement of supraspinatus under acromian during abduction	35 cases
Fluid distention of biceps tendon sheath	35 cases
Hypoechoic cleft /defect in the tendon of rotator cuff	36 cases
Herniation of deltoid muscle or subdeltoid bursa in the cuff	5 cases
Bursal & Joint space Collection	3 cases
Loss of fibrillary pattern of tendon	3 cases
Fluid in the rotator cuff muscles	1 case

In The One Patient with Associated Osteoarthritis

X-Ray showed	1. Osteophytes from inferior lip of glenoid labrum. 2. Narrowing of gleno humeral joint space. 3. Subcondral sclerosis of glenoid.
USG showed	1. Fluid in the biceps tendon around bicipital groove.. 2. Limitation of sliding of supraspinatus tendon under acromian. 3. Increased vascularity of rotator cuff muscles

The osteophytic liping since it was located in the inferior lip of glenoid labrum could not be appreciated well on the USG and nor could the subcondral sclerosis be well appreciated on USG

In The One Patient with Associated Fracture Humeral Head

X-Ray	Occult
USG	1. Showed the fracture humeral head confirmed by CT. 2. Limitation of sliding movement of supraspinatus under acromian during abduction. 3. Fluid distention of biceps tendon sheath. 4. Increased vascularity of the muscles of rotator interval

Rotator CUFF Pathologies

Clinical diagnosis = 50
Sonographic diagnosis = 37
Final diagnosis = 37 (1 case of osteoarthritis where USG appeared normal except for limitation of overhead abduction but failed to visualise the inferior osteophytic lippig)
Sonographic sensitivity, specificity, PPV and NPV were 100%, 100%,100% and 98% respectively

DISCUSSION

Correlation of Hypo Echoic or Anechoic Cleft in The Cuff, Focal Tendon Defect, Herniation of Deltoid Muscle or Subdeltoid Bursa In The Cuff And Rotator Cuff Tear

During USG examination of the 37 patient with rotator cuff pathologies 34 of them who had rotator cuff tear had hypo echoic or anechoic cleft in the cuff. 1 patient among the 35 patients included in rotator cuff tear had dislocated biceps tendon from bicipital groove the diagnosis of which was clinchéd during dynamic examination only possible during sonography 5 patients who had full thickness rotator cuff tear had focal tendon defect and herniation of deltoid muscle or subdeltoid bursa in the cuff.
So in a nut shell.

Rotator Cuff Tear

Clinical diagnosis = 50
Sonographic diagnosis =35
Final diagnosis = 35 (1 Associated osteoarthritis, 1 associated fracture humeral head)
Sonographic sensitivity, specificity, PPV and NPV were 100%, 100%, 100% and 98% respectively.

Rotator Cuff Tears

Sensitivity and specificity 93 % for diagnosis of full thickness rotator cuff tears were reported by Brennek and Morgan in 1992[1] where as Holsbeeck *et al* [2] supported sensitivity and specificity of 94 %. In diagnosing partial thickness tears present study shows sensitivity and specificity of 100% and 100% respectively in valuating rotator cuff pathologies.

Most rotator cuff tears occur at the level of the insertion of the supraspinatus tendon on the greater tuberosity. Partial thickness tear may involve the bursal or the articular surface of the tendon. Full thickness tears may be very extensive. Essential information for the orthopedic surgeon includes size and location of the tear, the amount of tendon retraction on the longitudinal view and the muscle status (fatty infiltration of the muscle being a contradiction to surgery). US criteria of rotator cuff tears have largely been described [3] and evaluated.

The direct signs are the followings

1. Non visualization of the cuff,
2. Focal tendon defect,
3. Hypo echoic or anechoic cleft in the cuff,
4. Direct joint communication through a tendon gap with a distended subacromial – subdeltoid bursa,
5. Naked tuberosity(focal apposition of deltoid muscle on greater tuberosity),
6. Compression of tendon,
7. Herniation of deltoid muscle or subdeltoid bursa in the cuff.

The indirect signs are

1. Cortical irregularity of the greater tuberosity,
2. Thinning of the cuff,
3. The cartilage interface sign,
4. Joint effusion,
5. Effusion of the subacromial - subdeltoid bursa,
6. Glenohumeral joint effusion.

Tendon non-visualization is the US finding that best predicts a full thickness tear. Abnormal or hypoechoic zone within the tendon are of limited value in the prediction of a partial-thickness tear. In the diagnosis of a full-thickness tear the most helpful secondary signs are cortical irregularity of the greater tuberosity and the presence of joint fluid. Cortical irregularity of the greater tuberosity is a very important sign, having the highest sensitivity and negative predictive value in the diagnosis of a tear. The cartilage interface sign is a thin echogenic line at the interface of the hyaline cartilage of the humeral head and the adjacent tendon. This sign has 100% specificity and positive predictive value in the diagnosis of a full-thickness tear. (B. Daenen, et, al 2007)[4]

Partial Thickness Tear

Partial thickness tear can be of following types

1. Bursal surface tear,
2. Articular surface tear,
3. Intra substances tear.

They occur at a slightly younger age group (40 -60 years). They occur most commonly along the deep capsular side of the cuff, but it can occur on the bursal side also.

Articular surface partial tear adjacent to the insertion of the rotator cuff into the greater tuberosity is termed as a rim-rent-tear and this type tends to occur in younger patients which are in contrast to the medially located tears in the critical zone of the supraspinatus tendon that occurs in the older patients (Jacobson, 2002)[5].

The following criteria can help to diagnose partial thickness tear

1. A mixed (Hypo and hyperechoic) focus in the crucial zone of supraspinatus tendon,
2. A hypoechoic lesion visualized into orthogonal imaging planes with either articular or bursal extension (Holsbeeck M T ,et ,al 1995),[6]

Impiengement Syndrome

Shoulder impingement is a syndrome where active arm abduction or elevation creates pain as the supraspinatus tendon slides beneath the coracoacromial arch. This can occur when the space containing the supraspinatus tendon is bounded by the scapula and the coracoacromial arch is decreased. This feature almost overlaps with one finding in his adhesive capsulitis where there are also limitations of sliding movements of the supraspinatus tendon underneath the acromian during arm abduction; however the other findings will serve to differentiate the two conditions.

Neer and Welsh[7] have proposed three clinical and surgical stages of impingement as follow:

Stage 1 Corresponds to edema and hemorrhage in the bursa,
Stage 2 To widening and fibrosis of the bursa with tendinosis,
Stage 3 To tendon rupture.

During dynamic examination, soft tissue impingement is considered when there is pooling of fluid in the lateral aspect of the subacromial subdeltoid bursa or when there is deformation of the bursa and the tendon

Calcifying Tendonitis

Calcifying tendonitis is related to deposition of calcium, predominantly hydroxyapatite, in the rotator cuff tendons. In the cuff, the lower third of the infraspinatus, the critical zone of the supraspinatus and the preinsertional fibers of the subscapularis are the most commonly involved but deposits may occur in other locations, such as the myotendinous junction of the long head of the biceps. Four stages are described: precalcific, calcific, resorptive, and postcalcific. This condition becomes extremely painful at the resorptive stage.

On ultrasound, 3 types of calcifications are described

Type I calcifications are well defined highly echoic foci followed by an acoustic shadow. They correspond to the formative phase.
Type II and **Type III** calcifications are more blurred, ill defined on plain films, and look like hyperechoic foci with a **faint (type II) or absent (type III)** acoustic shadow are associated with the resorptive phase, when the calcifications are nearly liquid and may be aspirated.

Role of USG in Excluding Other Pathologies Which Mimic Rotator Cuff Pathologies Clinically

Pathologies	No. of Patients	X – RAY	USG Findings
Adhesive Capsulitis	5	N	Fluid around biceps tendon sheath Limitation in dynamic overhead abduction . Thickening of coracohumeral ligament
Anterior glenoid Labral Tear	1	Inconclusive/ N	Increased vascularity of the muscles of rotator interval I USG demonstrated Anterior Glenoid labral tear with the torn labrum.
Posterior glenoid Labral Tear	1	N	Demonstrated the hypoechoic cleft in the triangular Posterior Labrum.
Fluid Collection in Infraspinatus	The same patient with Posterior Labral tear.	N	Fluid in infraspinatus.
Fracture	1	Occult	Cortical irregularity Demonstrated.
Inflammatory collection	1	Osteoporosis around humeral head. Slight widening of glenohumeral joint space.	Demonstrated the inflammatory collection under the deltoid muscle communicating with the right glenohumeral joint and increased vascularity in the tissue surrounding the collection on color Doppler.

Thus the above table supports the following studies

1. USG has a sensitivity of 91 %, specificity of 100 % and an accuracy of 92% for detecting adhesive capsulitis making dynamic sonography a reliable technique for the diagnosis of the condition (K N Ryu et ,al in 1993).[8]
2. Pattern *et al* in their study showed that 42 fractures detected sonographically were not detected in initial radiographs.[9]
3. Study by Azzoni R, Cabitza P *et al* with 200 consecutive patients sonography proved to be safe, accurate and useful in measuring the subacromial space and comparable to what is obtained when radiography is used alone (Azzoni R *et al* 2004).[10]
4. Study by Ronnie Ptasznik 2001 which stated that powered doppler is more sensitive to changes in perfusion at micro vascular level and can depict soft tissue hyperemia presented in rotator cuff tendinitis.[11]
5. Jon A Jacobson 2002 who stated that posterior labrum is more easily identified appearing hyperechoic and triangular. The anterior labrum is more difficult to visualize and may require and arm abduction and Axillary screening approach.[12]
6. Cardinal *et al* 2001 who stated the diagnosis of septic bursitis can be suspected when the bursa become distended by complex effusion containing debris and separation. And almost any joint can be aspirated under USG guidance for gram staim, culture and sensitivity.(Cardinal *et al* 1998[13], Joseph G Craig 1999[14])

SUMMARY & CONCLUSION

High resolution USG is also highly sensitive and specific for diagnosing rotator cuff pathologies.

Color Doppler is very useful in detecting increased vascularity in the muscles of the rotator cuff which is seen in patients of AC.

USG is a highly and specific tool for diagnosing fluid distention of the biceps tendon sheath, thickening of coracohumeral ligament and diminished excursion of supraspinatus muscles which occur in Adhesive Capsulitis.

Rotator cuff pathologies is more common than non Rotator cuff lesion. In shoulder joint related problems among rotator cuff pathologies partial thickness tear is more common than full thickness tear. Incidence of Rotator Cuff pathologies increases with increasing age of patients attributed to degenerative process.

Sonography can detect many occult fracture and joint effusion not detected by plain radiography.

Though it is less sensitive it is highly specific for diagnosis of labral tear.

Though High-resolution Ultrasoud is a very efficient modality in detecting shoulder joint lesion it has some limitation like operator dependencie, long learning and patient cooperation. Also technical factors like anisotropy should be take care of during USG.

Radiographs can better demonstrate bony lesion, lysis and sclerosis of bone, narrowing of joins space, osteophytes, subcondralsclerosis, and subcondral cysts.

However where most of the findings are in soft tissue USG is a more sensitive and specific method for diagnosing rotator cuff pathologies.

Thus in summary it can be said that X-ray ,high resolution Ultrasonography and Doppler can be regarded as effective primary modalities of imaging for most of the shoulder pathologies to expedite patient care.

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