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Characterization of Knee Joint Diseases Using Medical Ultrasound and Magnetic Resonance Imaging

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Abstract: ***Background: Ultrasound (US) has been advocated for the assessment of soft tissue supporting structures of the knee joint, because it's a simple, rapid, cheap, accurate method and well accepted by patient in comparison to Magnetic Resonance Imaging (MRI). This study was aimed to determine the characterization of incidence of knee joint diseases, with US compared to MRI, in Radiological Center, College of Applied Medical Sciences, King Khalid University (KKU), Saudi Arabia, in patients with knee joint symptoms. Method: A cross sectional descriptive study on the sonographic pattern of knee joint diseases was performed to assess characterization of knee joint diseases at Radiological Center, College of Applied Medical Sciences, King Khalid University(KKU), Saudi Arabia, of 124 patients from October 2011 to August 2014. US technique has been carried out according to the protocol of American Institute of Ultrasound in Medicine (AIUM), using a linear probe transducer with high frequency 7.5 to 12MHz. Result: A total of 124 patients with knee joint disorders were evaluated with US and MRI. The age range was from 12 to 80 years. The mean age was 38 years and median 36 years. The commonest presenting symptom was painful swelling of the knee joint. US revealed characterization frequency per individual, was: hyper echoic 4 (3.2%), hypo echoic 6 (4.8%) an echoic 102 (82.3%), echogenic 2 (1.6%) and none seen of other diseases 10 (8.1%) and MRI characterization frequency individuals, was: high signal 102 (82.3%) and low signal 22 (17.7%). Conclusion and recommendations: The study suggested that Musculoskeletal (MUS) US can evaluate characterization of knee joint diseases as well as effusion, side, location, and pathology related. US can be used routinely for the diagnosis of most knee joint diseases, shortening the list of magnetic resonance imaging (MRI) indications.***

Keywords: Ultrasound, Magnetic Resonance Imaging, Knee joint disease.

1. Introduction

Sonography has been employed for over six decades with few documented cases of adverse effects (Bamett et al., 1994). It has demonstrated a long-standing record of safety and efficacy in numerous clinical applications (Dalecki, 2004). Reports' describing the physical, chemical and biologic effects of US date as far back as the early 1920's, and since then, extensive research describing its mechanisms and bio-effects has been published. Using US as a clinical investigative tool started in 1950's. However, its application in imaging of MUS remained underutilized till 1980's (Wamy GN, et al 2012 and Marnix et al., 1995). Soft tissue pathology of the knee represents one of the more common, yet perplexing, musculoskeletal disorders presenting at Radiological Center, College of Applied Medical Sciences, King Khalid University (KKU), Saudi Arabia, Knee pain and related symptoms may come as a result of damage to one or more of the soft tissue structures that stabilize and cushion the knee joint, including the ligaments, muscles, tendons, and menisci, Radiological Center records of 2011-2013 show that averages of 200 patients with knee joint disorders. In a country with a population of 21 million people, it contributes significantly to the burden of disease. The only mode of examination for these patients has been X-rays of the knee and this meant that little information was got about the soft tissue component of the knee. U/S of the knee joint has the advantage over Magnetic resonance imaging (MRI) in that it is cheaper, convenient and easier to use, is dynamic and has no contra-indications to its use(Iagnocco, 2010). U/S involves no radiation and can obtain views in multiple planes. It can also visualize soft tissue structures like the menisci and cartilage and can yield a lot more information on the bursae, tendons, muscles, ligaments menisci and joint space pathologies (Grassi, Lamanna, & Cervini, 1999).

2. Materials and Methods

A total of 200 patients with knee joint symptom participated in this study, which has taken place between September 2011- June 2014, at Radiological Center, College of Applied Medical Sciences, King Khalid University (KKU), Saudi Arabia.

1.1 Ultrasound Examination

The knee joint ultrasound examination has performed with GE-USA Medical System Logic 3 Expert 2007, using linear probes with high frequency of 7.5 to 12MHz. The technique protocol meets the standard by American Institute of Ultrasound in Medicine (AIUM) (Ian et al 2012).

1.2 MRI Examination

The MRI machine was a GE 1.5 Tesla, field of view (FOV) 14 cm, using 4/0.2 mm thickness/gap and about20 minutes total time (without Gradient Echo (GRE)). 5 or 6 sequences were used: (1) Axial fast spin echo (FSE) T2-Weighted Fat saturation, (2) Coronal FSE T1W, (3) Coronal FSE proton density weighted (PDW) Fatsat, (4) Sagittal spin echo (SE) PDW, (5) Sagittal FSE T2W Fatsat, (6) +/- Sagittal T2*

1.3 Data Collection and Analysis

Data will be collected in the tabulated database sheet and will be analyzed by SPSS. The data included the age, gender, weight, height, mass index, US findings, MRI findings, US and MRI characterizations.

3. Results

A total of 124 patients with knee joints complains were recruited in the study. Males constituted 101 individuals (81.5%), and females 23 individuals (18.5%). The age range was from 12 years to 80 years. Commonest presenting symptoms were painful, swelling of the knee joint, and inability to move. The sonographic features and MRI revealed variable types of diseases. Ultrasound characterization frequency was: Hyperechoic 4 (3.2%), Hypoechoic 6 (4.8%) anechoic 102(82.3), echogenic 2 (1.6%) and non seen of other diseases 10 (8.1%) and MRI characterization frequency was high signal 102 (82.3) and low signal 22 (17.7%), effusion, bursitis, synovial cysts, arthritis, Quadriceps rupture and baker cyst characterized as an echoic structures in US and giving high signal in MRI, DVT and tumor giving hyper echoic feature in ultrasound and low signal in MRI, Meniscus tear appear as hypo echoic feature in ultrasound and giving low signal in MRI, loose body appear as echogenic structure in ultrasound and low signal feature in MRI, ACL and PCL tear giving high signal in MRI and not seen in ultrasound but in Doppler ultrasound giving high vascularity. effusion was the most frequent 81 (64.8), loose body 2 (1.6), synovial cyst 4 (3.2 %), quadriceps tendon rupture 1 (0.8), meniscus tear 6 (4.8%), tumor 1 (0.8%) and bursitis 8 (6.4%), arthritis 5 (4 %), baker cyst 4 (3.2%) and DVT 3 (2.4%) also seen in both ultrasound and MRI and ACL tear 6 (4.8%), PCL tear 4 (3.2%) seen in MRI only.

Table 1: Shows Frequency Distribution

Gender	Frequency	Percent
Male	101	81.5
Female	23	18.5
Total	124	100.0

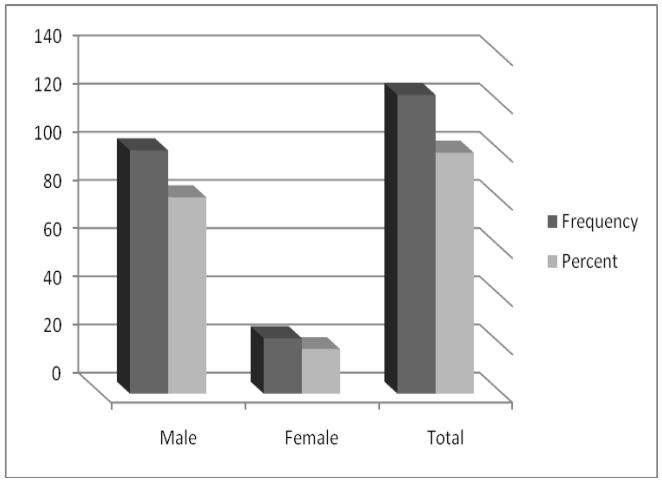

Figure 1: Shows Frequency Distribution

Table 2: Shows Ultrasound Incidence

US status	Frequency	Percent
Not seen	10	8.1
seen	114	91.9
Total	124	100.0

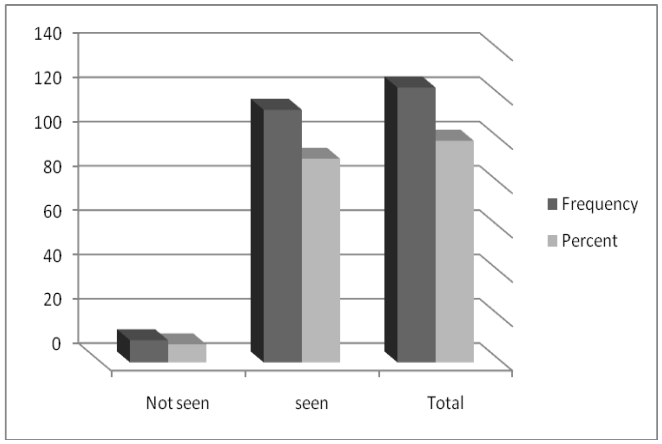

Figure 2: Shows Ultrasound Incidence
US*= Ultrasound

Table 3: Shows Ultrasound Characterization Frequency

US*	Frequency	Percent
Non	10	8.1
Hyperechoic	4	3.2
Hypoechoic	6	4.8
echogenic	2	1.6
anechoic	102	82.3
Total	124	100.0

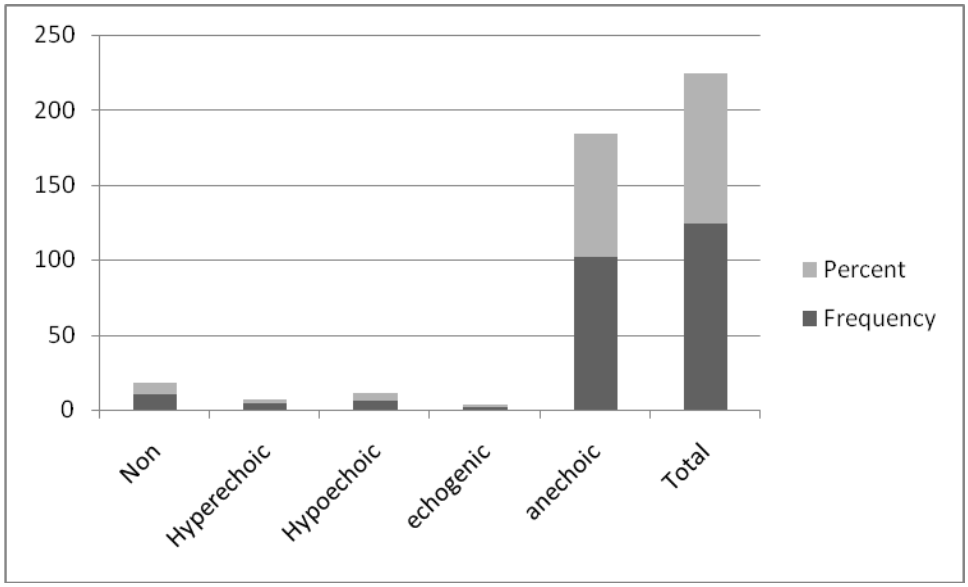

Figure 3: Shows Ultrasound Characterization Frequency

US*= Ultrasound

Table 4: Shows MRI Characterization Frequency

MRI*	Frequency	Percent
High signal	102	82.3
Low signal	22	17.7
Total	124	100.0

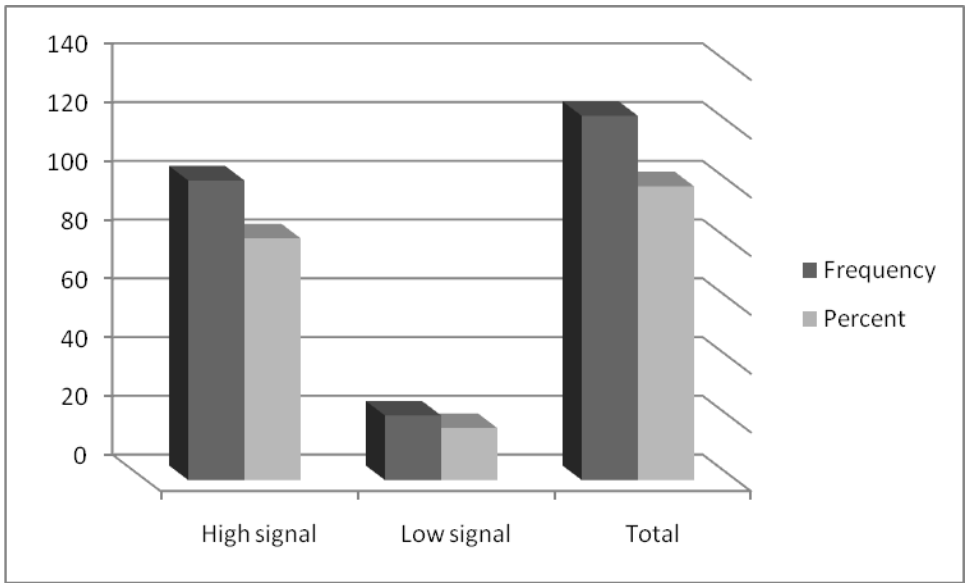

Figure 4: Shows MRI Characterization Frequency

MRI*= Magnetic Resonance Imaging

Table 5: Shows Cross-tabulation between diseases and US characterization

Diseases	US* characterization					Total
	Non	Hyperechoic	Hypoechoic	Echogenic	Anechoic	
Effusion	0	0	0	0	80	80
Bursitis	0	0	0	0	8	8
Meniscus tear	0	0	6	0	0	6
Loose body	0	0	0	2	0	2
Baker cyst	0	0	0	0	4	4
Synovial cyst	0	0	0	0	4	4
Quadriceps tendon rupture	0	0	0	0	1	1
Arthritis	0	0	0	0	5	5
DVT**	0	3	0	0	0	3
Tumor	0	1	0	0	0	1
ACL*** tear	6	0	0	0	0	6
PCL**** tear	4	0	0	0	0	4
Total	10	4	6	2	102	124

Table 6: Shows relationship between diseases and MRI characterization

Diseases	MRI***** characterization		Total
	High signal	Low signal	
Effusion	80	0	80
Bursitis	8	0	8
Meniscus tear	0	6	6
Loose body	0	2	2
Baker cyst	4	0	4
Synovial cyst	4	0	4
Quadriceps tendon rupture	1	0	1
Arthritis	5	0	5
DVT**	0	3	3
Tumor	0	1	1
ACL*** tear	0	6	6
PCL**** tear	0	4	4
Total	102	22	124

DVT** = Deep vein thrombosis; ACL*** = Anterior cruciate ligament;
PCL**** = Posterior cruciate ligament, US* = Ultrasound, MRI*****= Magnetic Resonance Imaging

Table 7: Shows cross tabulation between US &MRI characterization

US** characterization	MRI* characterization		Total
	High signal	Low signal	
Non	0	10	10
Hyperechoic	0	4	4
Hypoechoic	0	6	6
Echogenic	0	2	2
Anechoic	102	0	102
Total	102	22	124

US** = Ultrasound, MRI*= Magnetic Resonance Imaging

4. Discussion

In this study, out of 124 patients with knee joint complains who had US and MRI examinations; more males were incorporated in the study than females. Males were 101(81.5%) and females 23 (18.5%), (table 4-1); though males were higher in this study which has been carried out where males are more active in Kingdom of Saudi Arabia (KSA) than female, all disorders seen by MRI (100%) and 114 disorders (91.9%) seen by ultrasound and 10 disorders not seen by it (8.1%), (table 4-2). This distribution was shared by many previous studies (Court-Payen M. 2004). Ultrasound characterization frequency was: hyper echoic 4 (3.2%), hypo echoic 6 (4.8%) and echoic 102 (82.3%), echogenic 2 (1.6%) and non seen of other diseases 10 (8.1%) and MRI characterization frequency was high signal in 102 (82.3%) and low signal 22 (17.7%), effusion, bursitis, synovial cysts, arthritis, Quadriceps rupture and baker cyst characterized as an echoic structures in US and giving high signal in MRI, DVT and tumor giving hyper echoic feature in ultrasound and low signal in MRI, Meniscus tear appear as hypo echoic feature in ultrasound and giving low signal in MRI, loose body appear as echogenic structure in ultrasound and low signal feature in MRI, ACL and PCL tear giving high signal in MRI and not seen in ultrasound but in Doppler ultrasound giving high vascularity. Age group frequency commonest was 39 to 47 years about 32 (25.8%) individuals, 36 (29%) individuals had 27-29 body mass index (BMI). We observed that effusion was the commonest 80 (64.5%), the commonest clinical complains were found to be knee joint pain and swelling (effusion), This was similar to what was observed by (Verena & Sarah, 2001).for that specific radiological examination should be done, there for we used U/S and MRI to evaluate characterization of knee joint diseases, Bursitis where 8(6.5%) this is the same to what (Di Minno MN, et al 2013) observed, meniscal injury(6) is associated with sporting activities especially foot ball which is commonest sport in Saudi Arabia, A percentage of (4.8%) of meniscal degeneration and tear was detected in patients. Reports reveal that majority of cases developed knee joint meniscal tears because the meniscus has such important functions in load bearing and stability of the knee, loss of this structure in the young is associated with significant degenerative changes which may be depicted on U/S and MRI in addition to meniscal pathology (Leahy M. et al 2013).Such justification exactly matches our findings in this study observations at U/S and MRI and patient clinical history about tendon tear, Quadriceps tendon Rupture 1 (0.8%) (loose body 2 (1.6%) were similar to results obtained by (Rasmussen, 1999), the major causative factors of such condition was due to traumatic origin resulting in avulsion of fragments of cartilage and bone from the tibial tuberosity, also we found incidence frequency of other diseases like: arthritis5 4%, synovial cysts 4 3.2%, DVT3 2.4%, Tumor1 0.8%, ACL tear 6 4.8% and PCL tear4 3.2%.

Study done by (Eric, E. et al 2001) had shown that identification of fluid between the semimembranosus and medial gastrocnemius tendons in communication with a posterior knee cyst indicates Baker's cyst with 100% accuracy, these features were demonstrated in all cases where the Baker's cysts werefound. also we found that female 3(75 % more than male1 25%) because female stand more than male in the kitchen and more obese. this was the same what (Ward EE, et al 2001) and (Naredo et al., 2005) reported and.(Guermazi A, et al 2008), Although we found degenerative osteoarthrosis occurred in patients of above 50 years, this is the same to(Harry & Joseph et al 1999) who reported that it is usually uncommon in the age group 41-50 (Eşen S, et al 2013).

5. Limitations of this Study

It is recognized that ultrasound offers little or no diagnostic information for internal structures such as the cruciate ligaments. Ultrasound is complementary to MRI.

6. Conclusion and Recommendations

Ultrasound can be able to evaluate the knee joint diseases especially cystic masses, menisci, ligaments, tendons and muscles tear. Most of the knee joint disorders were as a result of the degenerative diseases. Doppler ultrasound is very important in case of differentiation of baker's cysts from DVT and aneurysm in vessel. MRI is not widely available and is expensive; for that I recommend that ultrasound can contribute to the diagnoses of knee joint pathology in the low resourced countries. When ACL or PCL rupture is suspected, MRI is inevitable.

Acknowledgements

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Figures (1- 8) show Ultrasound and MRI* Characterization

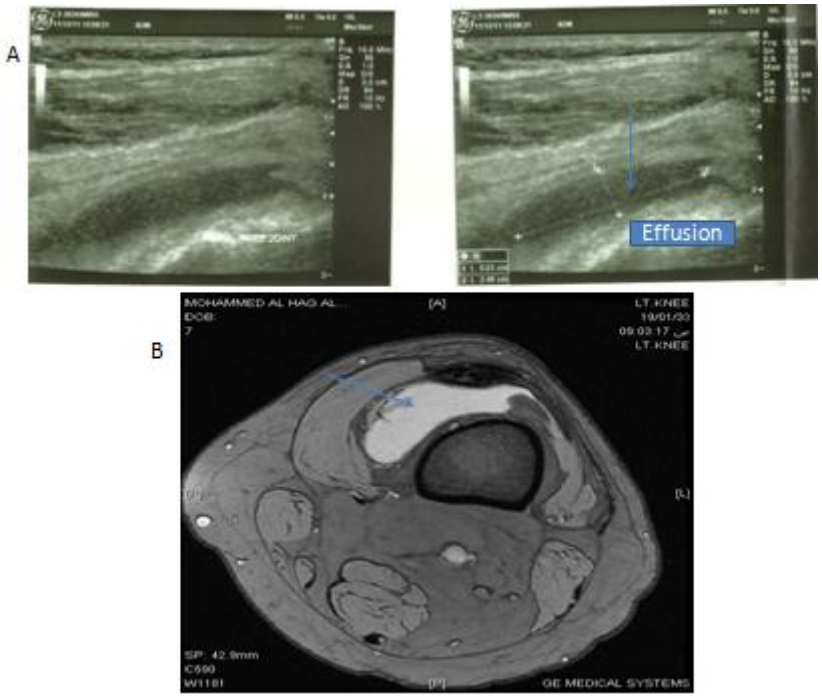

Figure 1: Knee joint Effusion, Ultrasound: A, MRI: B

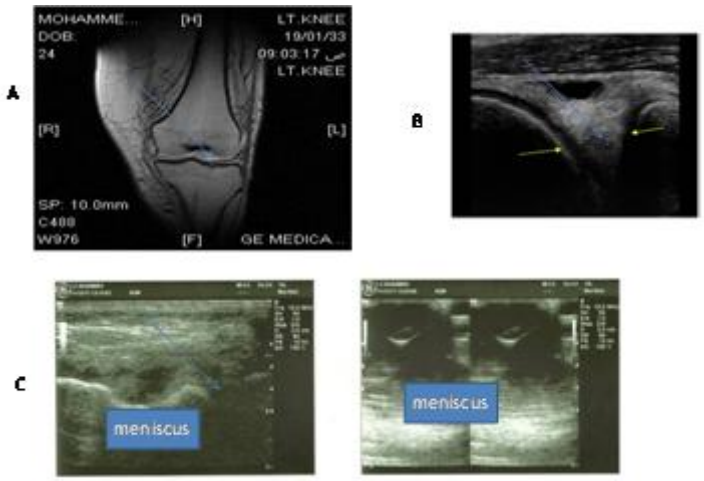

Figure 2: Knee joint Meniscus tear, MRI: A, Ultrasound: B &C

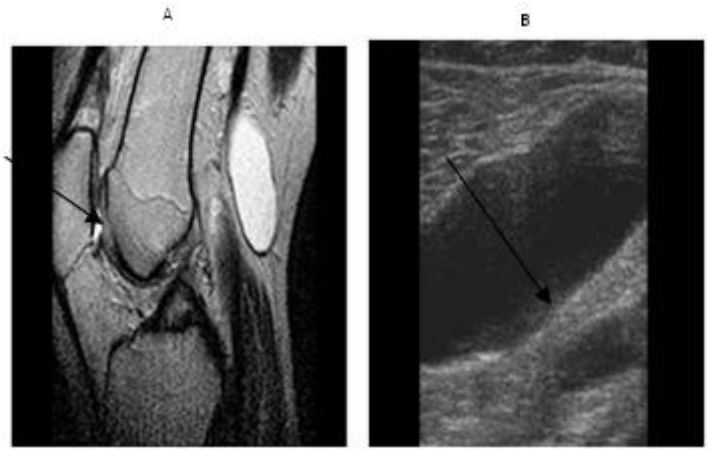

Figure 3: Knee joint, Arthrosynovial cyst, coronal T2 weighted Magnetic Resonance Imaging (MRI):A, longitudinal view Ultrasound: B

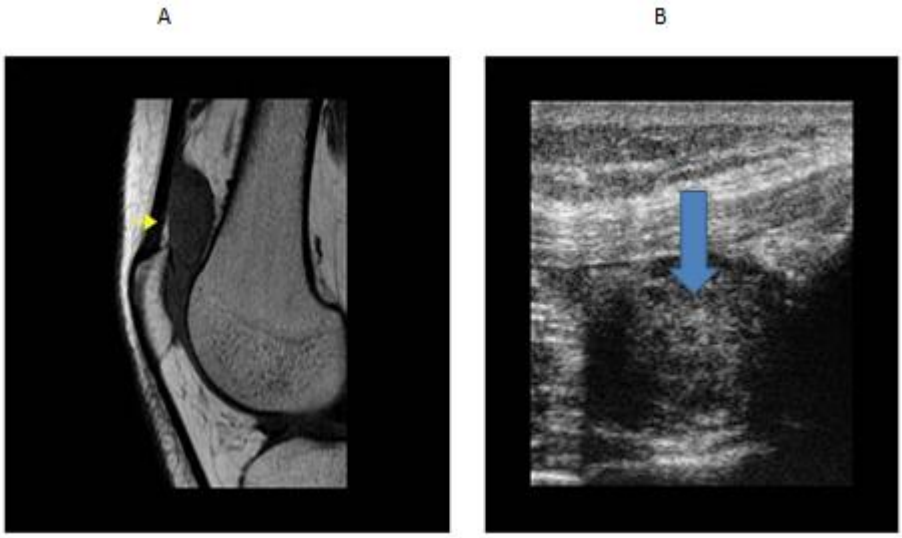

Figure 4: Knee joint Soft tissue mass in continuation with the suprapatellar recess, Sagittal T1 weighted Magnetic Resonance Imaging (MRI):A, without effusion and synovial thickening in Ultrasound B

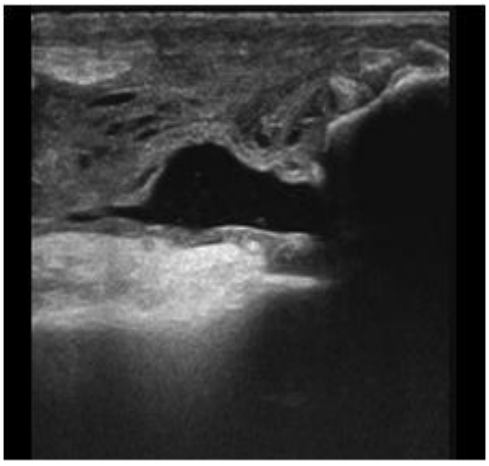

Figure 5: Knee joint Quadriceps tendon rupture, Ultrasound longitudinal view

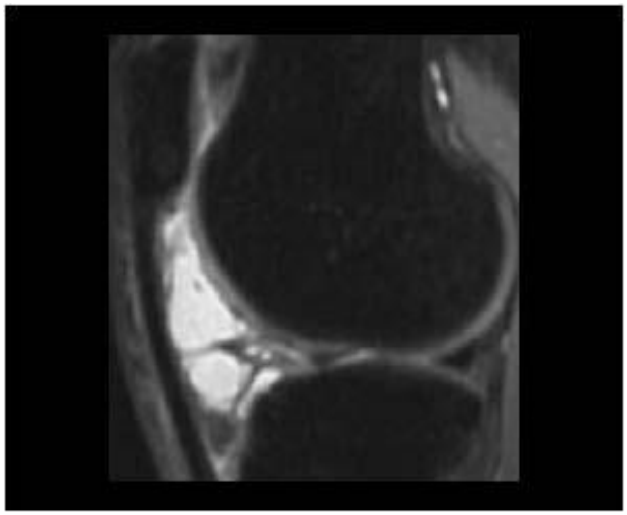

Figure 6: Knee joint Synovial cyst, Sagittal T2 weighted Magnetic Resonance Imaging (MRI)

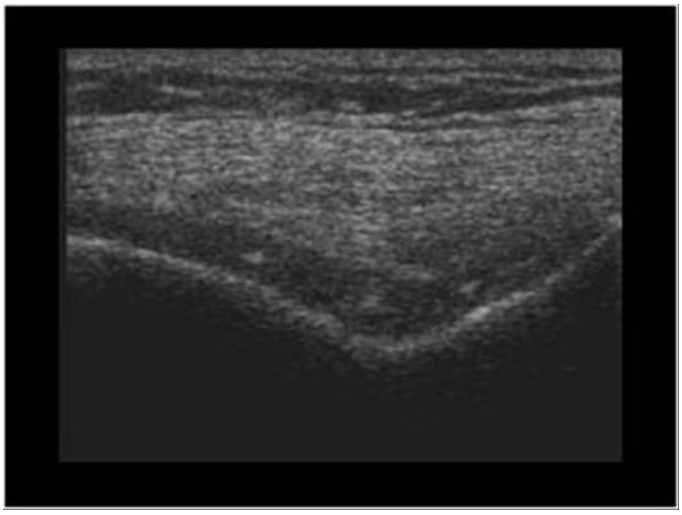

Figure 7: Knee joint Cartilage calcifications Ultrasound

Figure 8: Show Knee joint Baker's cyst, Ultrasound Transverse view