International Journal of Medical Research Professionals
P-ISSN: 2454-6356; E-ISSN: 2454-6364
DOI: 10.21276/ijmrp

Original Research Article.

Sonographic Evaluation of Pathologies of Knee Joint with MRI Correlation

Veerendra K Sharma[1], Trishdeep Singh Grewal[2*]

[1]Associate Professor, [2*]Senior Resident,
Department of Radiodiagnosis, SGRRIMHS, Dehradun, Uttarakhand, India.

ABSTRACT

Introduction: Musculoskeletal imaging has rapidly expanded in last few years and ultrasound has become popular modality for evaluation of various joints. Magnetic resonance imaging is accepted as the gold standard technique for evaluation of various knee pathologies. However, ultrasound being inexpensive, widely available and non-invasive technique which also allows dynamic imaging can be used for assessment of knee joint as an alternative to MRI.

Aim: To evaluate role of ultrasound for assessing various knee pathologies and to assess the accuracy of ultrasound in comparison to MRI.

Materials and Methods: This prospective study included 100 patients whose symptoms were suggestive of knee disease and were undergoing both ultrasound and MRI. Ultrasound examination of the involved knee was done together with an ultrasound examination of the contralateral normal knee for comparison followed by MRI of the symptomatic knee in all 100 patients. MRI was regarded as gold standard. Comparison was made between ultrasound and MRI using KAPPA coefficient. Sensitivity, specificity, PPV, NPV and accuracy were calculated to assess diagnostic accuracy of ultrasound as compared to MRI and ultrasound.

Results: Most common ultrasound finding in present study was knee effusion followed by osteophytes. Almost perfect agreement was noted between ultrasound and MRI for detecting medial meniscus tear, meniscal cyst, medial meniscal extrusion, MCL tear, Bakers cyst and osteophytes. Only slight agreement was noted between ultrasound and MRI for detecting lateral meniscal degeneration and ACL tear. Among various pathologies ultrasound showed accuracy of 100 for detecting baker's cyst and accuracy of 99 for detecting MCL tear and patellar tendinopathy.

Conclusion: Ultrasound is a good imaging modality for extra-articular lesions such as patellar tendinopathy, medial and lateral collateral ligaments. Ultrasound can also be an effective imaging modality for evaluating patients with medial meniscal tears, baker's cyst and knee effusion. For detection of meniscal degeneration ultrasound performs poorly as compared to MRI. Both anterior and posterior cruciate ligaments are not clearly visualized on ultrasound, thus it is poor modality for evaluating both.

Keywords: Cruciate Ligament, Collateral Ligament, Meniscus, Osteoarthritis.

***Correspondence to:**

Dr. Trishdeep Singh Grewal,
Senior Resident,
Department of Radiodiagnosis,
SGRRIMHS, Dehradun, Uttarakhand, India.

Article History:

Received: 24-01-2020, **Revised:** 21-02-2020, **Accepted:** 18-03-2020

Access this article online	
Website: www.ijmrp.com	Quick Response code
DOI: 10.21276/ijmrp.2020.6.2.008	

INTRODUCTION

The knee joint is one of the most vulnerable joint of the body. Wide range of pathological conditions involving tendons, ligaments, muscles, synovial space and articular cartilage affect knee joint and they constitute a major cause of pain and instability.[1,2] While bony changes can be immediately recognized in an x-ray image, the soft tissue structures cannot be appreciated. Magnetic resonance imaging (MRI) has overcome limitations of other imaging modalities with multiplanar imaging capabilities, non-invasive nature and lack of radiation.[3,4]

But is expensive and is not readily available at many hospitals with limitations to claustrophobic patients and patients with implants. Knee arthroscopy is a valuable diagnostic and therapeutic procedure but is invasive and associated with complications such as joint infection, deep vein thrombosis and pulmonary embolism.[5-7] Ultrasound (USG) can reliably assess tendon injuries, ligament injury, muscle trauma, synovial lesions and bursitis. Nerves and vessels around knee joint can also be reliably assessed.[8] It can be performed readily, quickly and both knees can be assessed at the same appointment. It is inexpensive, portable and provides real-time dynamic examination and thus help in diagnosis in the community or even on the sports field.[9]

Ultrasound can be done even in patients with metallic implants, which is a limitation in magnetic resonance imaging. The other advantage is clinical assessment by radiologist at time of examination.[9]

As there is little literature available regarding ultrasound as diagnostic tool to evaluate knee joint especially in India. This study is planned to evaluate the role of ultrasound and compare ultrasound findings with those of MRI or arthroscopy.

MATERIALS & METHODS

This study was a prospective study comprising 100 patients and was conducted in the Department Of Radiodiagnosis and Orthopedics, Shri Guru Ram Rai Institute of Medical & Health Sciences, Patel Nagar, Dehradun. All measurements were done using linear probe of frequency ranging from 5-13 Hz on one of the mentioned machines Philips IU22 ultrasound machine or Samsung Accuvix XG.

Patients whose symptoms were suggestive of knee disease and were undergoing both ultrasound and MRI as per clinical requirement were recruited in the study. After informed written consent, patients were recruited into the study. Ultrasound examination of the involved knee was done together with an ultrasound examination of the contralateral normal knee for comparison in all patients followed by MRI of the symptomatic knee in all patients. The ultrasound and MRI examination were done by two consultant radiologists, one doing the ultrasound and the other consultant radiologist doing the MRI image analysis with both having enough experience in the field of musculoskeletal system and both were blinded to each other's' findings.

Sonographic Technique of Examination

Ultrasound of knee joint was performed in supine and prone position. Anterior, posterior, medial and lateral approaches to the knee were performed by placing the ultrasound probe in the longitudinal and transverse planes.[2,9,10]

Anterior knee was examined with patient supine with knee flexion of 20 -30 degrees by placing a small pillow beneath popliteal space. Suprapatellar, juxtrapatellar and infrapatellar regions were examined in succession. Structures that were evaluated were quadriceps tendon, suprapatellar synovial recess, prepatellar bursa, patellar tendon and anterior cruciate ligament (ACL).[2,9,10]

In anterior approach knee was maximally flexed with patient in supine position and probe was placed in sagittal plane over patellar tendon to visualize anterior cruciate ligament. In same position probe was placed in transverse plane in suprapatellar region to visualize cartilage.[2,9,10]

The medial aspect of knee was examined with leg externally rotated. Relevant anatomic structures that were examined were: the medial collateral ligament (MCL), medial femorotibial joint space, medial meniscus and pes anserinus complex.[2,9,10]

The lateral aspect of knee was examined with leg internally rotated. From anterior to posterior aspect, the structures that were evaluated are femorotibial joint space, the lateral meniscus, the lateral collateral ligament (LCL), and superior tibiofibular joint.[2,9,10]

The posterior region of the knee was examined with patient in prone position with knee extended. Main structures that were examined were semimembranosus bursae, posterior cruciate ligament (PCL), posterior horns of menisci and neurovascular structures.[2,9,10]

Statistical Analysis

Data was subjected to standard statistical analysis and all statistical tests were conducted using Statistical Package for the Social Sciences (SPSS) for Windows version 21.0 (SPSS Inc., Chicago, IL).

MRI was regarded as the gold standard exam for various knee pathologies as arthroscopy was not done for all patients.

The agreement between studies including US vs. MRI was calculated using the Kappa (k) coefficient. Kappa (k) coefficients were interpreted using the guidelines outlined by Landis and Koch, where strength of the kappa coefficients is interpreted in the following manner: 0.01-0.20 slight; 0.21-0.40 fair; 0.41-0.60 moderate; 0.61-0.80 substantial; 0.81-1.00 almost perfect.[11-13]

Sensitivity, specificity, PPV, NPV and accuracy were calculated to assess diagnostic accuracy of ultrasound as compared to MRI and ultrasound.

Table 1: Knee pathologies on ultrasound and MRI

PATHOLOGIES	ULTRASOUND	MRI
EFFUSION	72	76
QUADRICEPS TENDINOPATHY	0	0
PATELLAR FRACTURE	1	1
PATELLAR TENDINOPATHY	3	2
BURSITIS	0	1
ACL TEAR	3	23
PARTIAL ACL TEAR	0	15
PCL TEAR	3	7
MCL TEAR/SPRAIN	5	5
MEDIAL MENISCUS TEAR	22	26
MEDIAL DEGENERATION	7	25
MEDIAL MENISCAL CYST	1	1
MEDIAL MENISCAL EXTRUSION	1	1
LATERAL MENISCAL TEAR	13	10
LATERAL MENISCAL DEGENERATION	3	7
LCL TEAR/SPRAIN	3	3
OSTEOPHYTES	30	28
CARTILAGE THINNING	11	20
BAKERS CYST	7	7

Table 2: Agreement level between ultrasound and MRI for detecting various knee pathologies.

PATHOLOGIES	KAPPA VALUE	SIG	AGRREMENT
EFFUSION	.74	<.001	SUBSTANTIAL
PATELLAR TENDINOPATHY	.79	<.001	SUBSTANTIAL
MEDIAL MENISCUS TEAR	.83	<.001	ALMOST PERFECT
LATERAL MENISCAL TEAR	.59	<.001	MODERATE
MEDIAL MENISCUS DEGENRATION	.23	.003	FAIR
LATERAL MENISCAL DEGENERATION	.16	.070	SLIGHT
MENISCAL CYST	1	<.001	ALMOST PERFECT
MEDIAL MENISCAL EXTRUSION	1	.000	ALMOST PERFECT
ACL TEAR	.02	.666	SLIGHT
PCL TEAR	.58	<.001	MODERATE
MCL TEAR	.90	<.001	ALMOST PERFECT
LCL TEAR	.65	<.001	SUBSTANTIAL
BAKERS CYST	1.00	<.001	ALMOST PERFECT
OSTEOPHYTES	.95	<.001	ALMOST PERFECT
CARTILAGE THINNING	.58	.<.001	MODERATE

Table 3: Diagnostic accuracy of ultrasound compared to MRI for detecting various knee pathologies.

PATHOLOGIES	SENSTIVITY	SPECIFICITY	PPV	NPV	ACCURACY
EFFUSION	90.7	87.5	95.8	75.0	90.0
PATELLAR TENDINOPATHY	100	98.98	66.67	100	99.00
MEDIAL MENISCUS TEAR	80.77	98.65	95.45	93.59	94.00
LATERAL MENISCAL TEAR	70.00	93.33	53.85	96.55	91.00
MEDIAL MENISCUS DEGENERATION	20.00	97.33	71.43	78.49	78
LATERAL MENISCAL DEGENERATION	14.29	97.85	33.33	93.81	92.00
MEDIAL MENISCAL CYST	100.0	100.0	100.0	100.0	100.0
MEDIAL MENISCAL EXTRUSION	100.0	100.0	100.0	100.0	100.0
MCLTEAR	100.0	98.98	83.33	100.0	99.00
LCL TEAR	100.0	98.97	66.67	98.97	98.00
BAKERS CYST	100.0	100.0	100.0	100.0	100.0
OSTEOPHYTES	100.0	97.22	03.33	100.00	98.00
CARTILAGE THINNING	50.00	98.75	90.91	88.76	89.00

RESULTS

Patients included in the study ranged in age from 9 to 70 years with a mean age of 37.1 years. The majority of patients belonged to the age group between 20 and 30 years, comprising 32% of all patients. Males constituted 65 % and females constituted 35% of patients. The most common clinical complaint among study population was knee pain, seen in 87% of patients.

Most common ultrasound finding in our study was knee effusion (72%), followed by osteophytes (30%), medial meniscal tear (22%) and lateral meniscal tear (13%) as shown in table 1.

Agreement between ultrasound and MRI for detecting various knee pathologies is shown in table 2. Almost perfect agreement was noted between ultrasound and MRI for detecting medial meniscus tear, meniscal cyst, medial meniscal extrusion, MCL tear, Bakers cyst and osteophytes. Only slight agreement was noted between ultrasound and MRI for detecting lateral meniscal degeneration and ACL tear.

Sensitivity, specificity and accuracy of USG in detecting various knee pathologies with MRI as gold standard are shown in table 3.

Among various pathologies ultrasound showed accuracy of 100 for detecting baker's cyst, accuracy of 99 for detecting MCL tear and patellar tendinopathy and accuracy of 98 for detecting LCL tear and osteophytes.

DISCUSSION

In the last decade, musculoskeletal imaging has rapidly expanded due to the imaging capabilities of magnetic resonance imaging and ultrasound. Musculoskeletal ultrasound has shown considerable expansion in the last few years.

MRI is accepted as the gold standard technique for evaluation of various knee pathologies.3,4 However in India MRI is not always available on demand especially in small hospitals. It also does not allow dynamic testing and is a rather lengthy and expensive imaging modality. Ultrasound (US) on the other hand is an inexpensive, widely available and non-invasive technique which also allows dynamic imaging but there are concerns regarding the diagnostic accuracy.[9]

Most common ultrasound finding in our study was knee effusion (72%), followed by osteophytes (30%) and medial meniscal tear (22%). Effusion was also seen as most common ultrasound finding in other studies by Singh B et al and Yousif et al.[14,15]

Knee effusion is commonly seen in various knee pathologies and can be detected by ultrasound. In our study substantial agreement was noted between ultrasound and MRI in detection of effusion. Ultrasound also demonstrated sensitivity of 90.7, specificity of 87.5, and accuracy of 90.0. Similar sensitivity and specificity of ultrasound was also seen in study by Draghi F et al.[16] In recent study Singh B et al ultrasound showed sensitivity, specificity and accuracy of 100 for detecting knee effusion.[14] Anterior tendons of knee consist of quadriceps and patellar tendons and are involved in acute inflammation or more chronic degenerative processes. In a study by Khan KM et al 24 athletes with patellar tendinosis who underwent tenotomy, ultrasonographic findings were proven to be consistent with those of both MRI and histopathologic results.[17] In our study substantial agreement (k= 0.79, sig<0.001) was noted between ultrasound and MRI for detection of patellar tendinopathy [Fig 1]. Ultrasound also demonstrated high sensitivity, specificity and accuracy in detecting patellar tendinopathy. The quadriceps tendon is less commonly affected by tendinopathic change than the patellar tendon and when seen it usually relates to persistent strenuous overuse. In our study also, no case of quadriceps tendinopathy was seen. Meniscal lesions are a major cause of knee pain and have adverse effects on the proper functioning of the knee joint. Tears and degenerations constitute the majority of meniscal lesions. In our study almost, perfect agreement was noted between US and MRI in detection of medial meniscus tears [Fig 2, 3]. Unlu EN et al in their study showed moderate agreement between US and MRI (κ = 0.5−0.75, sig = 0.005) in detection of tears.[18]

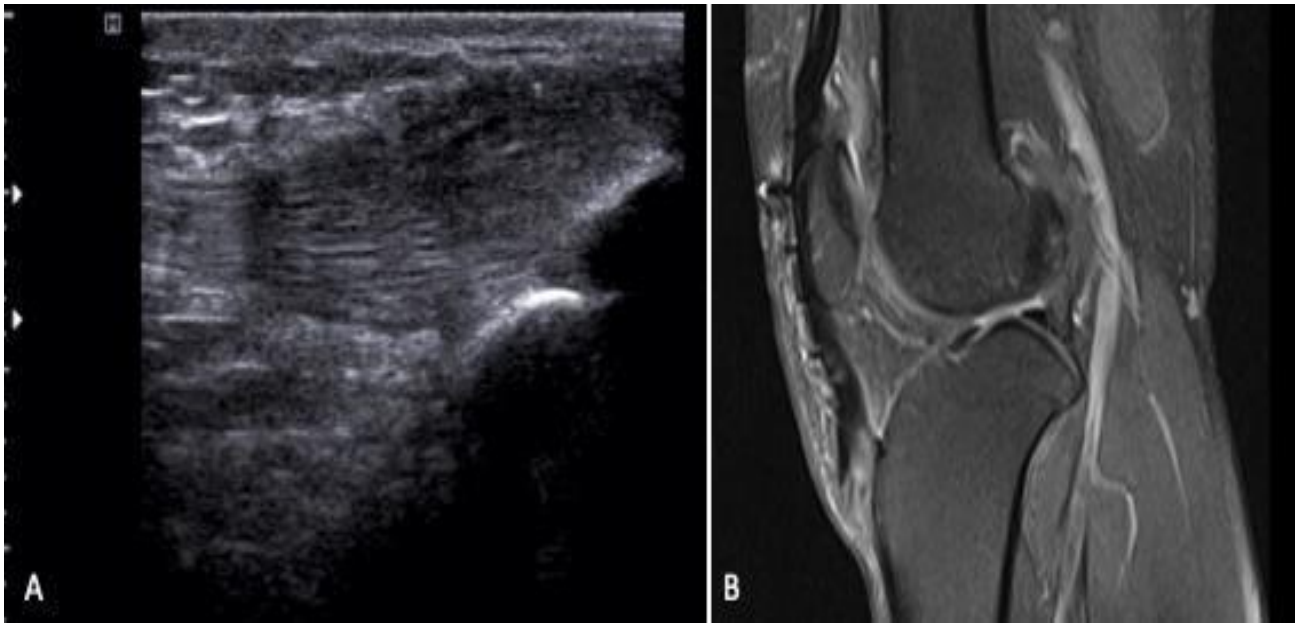

Fig 1: (a) USG image depicts thickened and hypoechoic patellar tendon at its tibial attachment suggestive of tear (b) MRI PDFS sagittal image shows patellar tendon tear at its tibial attachment.

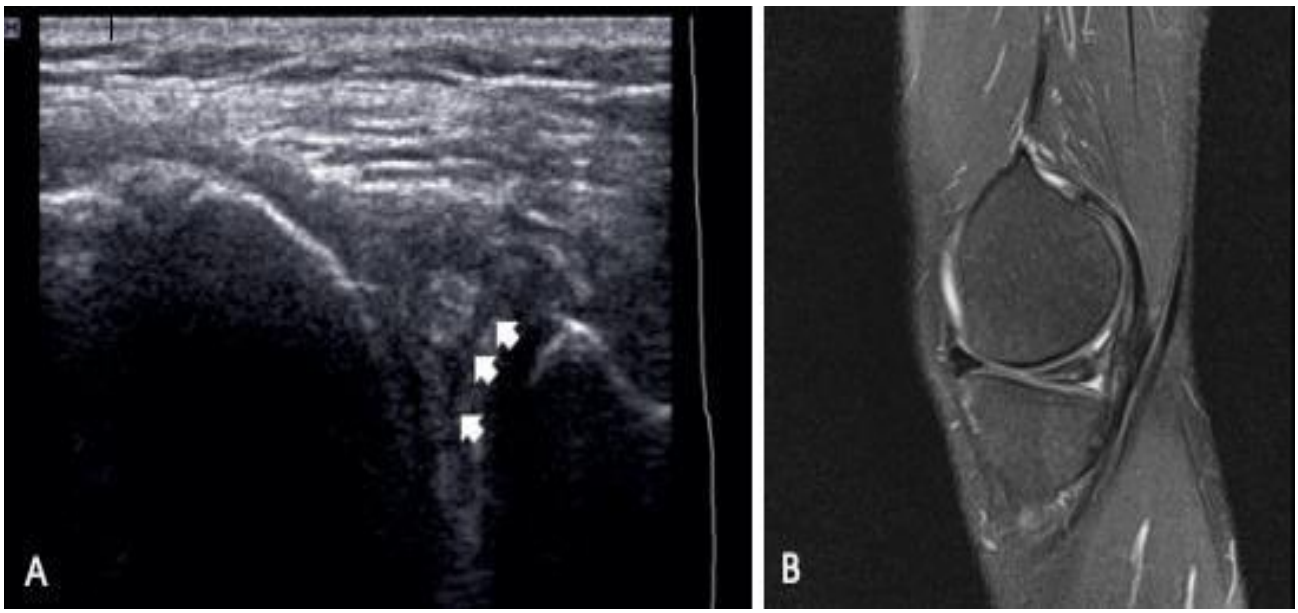

Fig 2: (a) USG image depicts linear hypoechoic area in medial meniscus suggestive of tear (b) MRU PDFS sagittal image shows tear in posterior horn of medial meniscus.

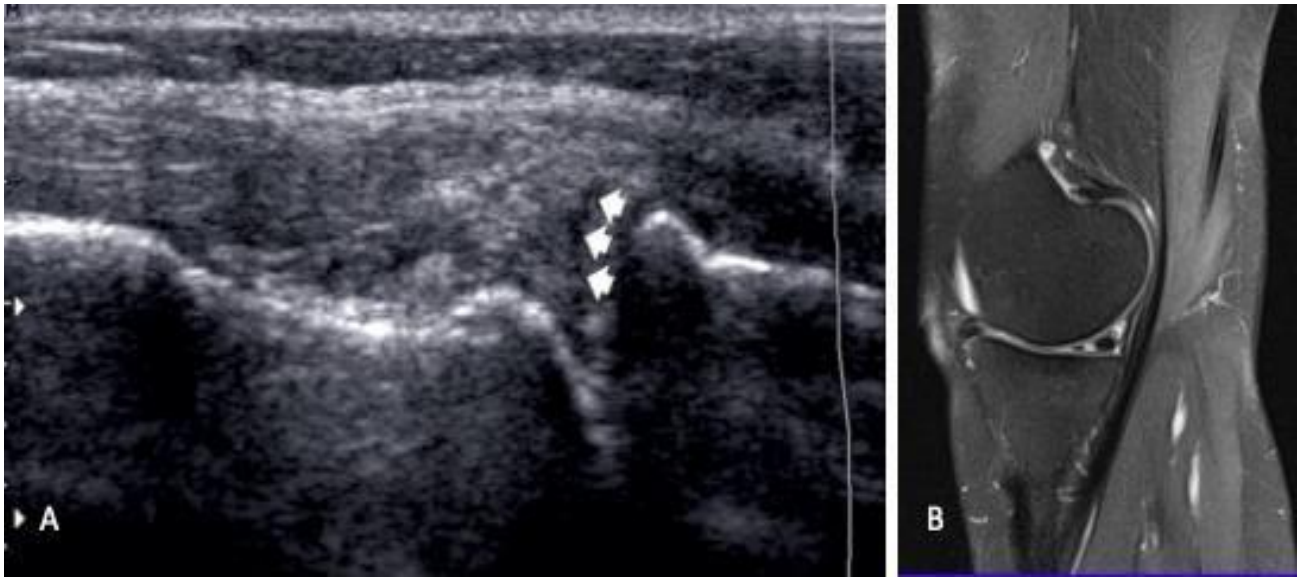

Fig 3: (A) USG image depicts linear hypoechoic area in medial meniscus suggestive of tear (b) MRI PDFS sagittal image shows tear in medial meniscus.

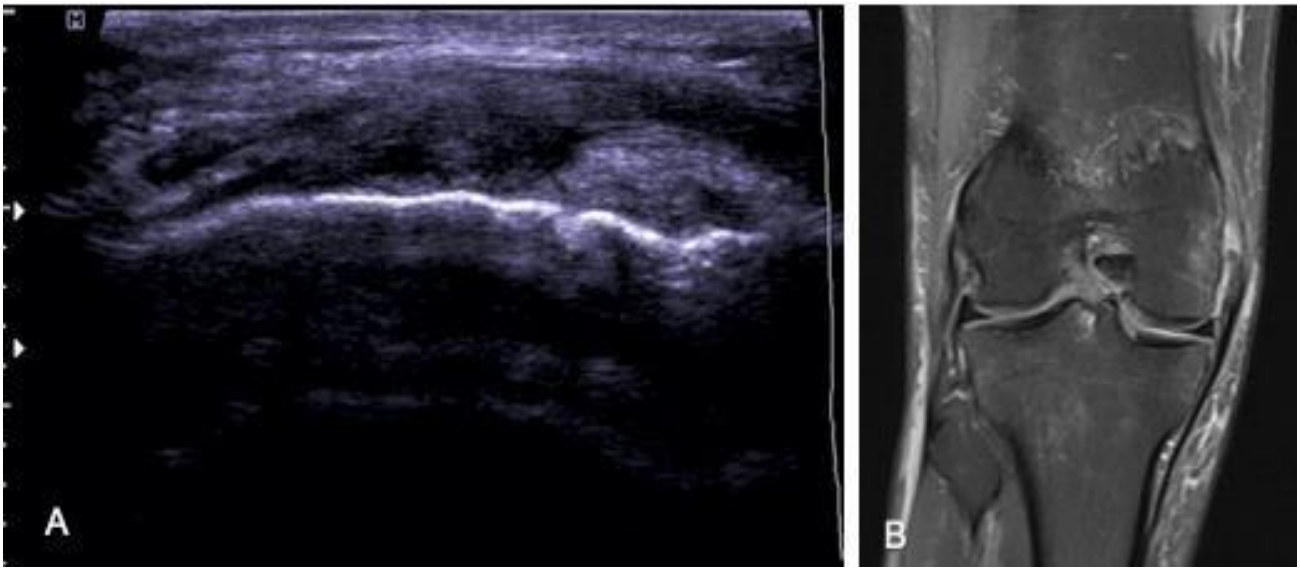

Fig 4: (A) USG image depicts hypoechoic and bulky medial collateral ligament at its femoral attachment suggestive of tear (B) MRI PDFS coronal image shows medial collateral ligament tear at its femoral attachment.

Ultrasound in comparison to MRI in our study showed a sensitivity of 80.7, specificity of 98.6 and accuracy of 94. Similarly, in study by Singh A et al sensitivity of ultrasound in detecting medial meniscal tears was 77.7, specificity was 90.4 and accuracy was 86.6 with MRI as gold standard.[19] In study by Singh B et al also ultrasound showed high sensitivity, specificity and accuracy in detecting medial meniscal tears with MRI as gold standard.14 However, in study by Ghosh N et al ultrasound showed sensitivity of 100 but lower specificity of 40 as compared to our study.[20] Sample size in this study was small and bedside ultrasound was performed by sports medicine specialist for diagnosing the lesions.

For detecting lateral meniscus tears moderate agreement was noted between ultrasound and MRI in our study and in study by by Unlu EN et al.[18] In our study the sensitivity, specificity and accuracy of ultrasound in detection of lateral meniscal tears were 70.0, 93.3 and 91.0 respectively. Similar results were seen in studies by Singh B et al and Singh A et al who evaluated various knee pathologies on ultrasound and used MRI as gold standard.[14,19] Unlu EN et al and Wareluck et al used arthroscopy as gold standard in evaluating lateral meniscus tears on ultrasound and also showed sensitivity and specificity similar to our study.[18,21] Meniscus degeneration occurs with aging resulting in pain and knee dysfunction. MRI is regarded as the gold standard in the evaluation of degeneration. However it can be identified on ultrasound also.[9]

The agreement for detection of medial meniscus degeneration using ultrasound in our study was fair. Unlu EN et al in their study also showed poor agreement ($\kappa < 0.5$, $P = 0.123$) for both lateral and medial meniscal degeneration and more degenerative lesions were detected by MR than USG.[18] Thus ultrasound is not a suitable test for detection of meniscal degeneration and performs poorly in differentiation of tears from degeneration.

Collateral ligaments are also commonly injured during sports or traffic injuries. In our study almost perfect agreement was noted between ultrasound and MRI in detection of medial collateral ligament tear [Fig 4]. Ultrasound also demonstrated sensitivity of 100.0, specificity of 98.9 and accuracy of 99.0.

Compared to our study Singh B et al and Singh A et al showed slightly lower sensitivity (83.3 and 84.6) but similar specificity (97.7 and 100) and accuracy (96 and 96.6) of ultrasound for detecting medial collateral ligaments tears.[14,19] Ghosh N et al showed lower sensitivity of 67.0 and specificity of 83.0 for ultrasound in their study. However in their study bedside ultrasound was performed by sports medicine specialist for diagnosing the lesions.[20]

For detecting lateral collateral ligament tear substantial agreement was noted between ultrasound and MRI in our study. Ultrasound also demonstrated sensitivity of 100, specificity of 98.97 and accuracy of 98.0 in our study. In study done by Singh B et al sensitivity, specificity and accuracy of USG in diagnosing lateral collateral ligament tears were 84.6 , 97.8 and 95.0 respectively.[14] Thus ultrasound can be an effective imaging modality for evaluating patients with collateral ligament injuries.

Currently, MRI and arthroscopy are the reference standards for diagnosing an ACL injury. Due to its deep location and oblique orientation, the anterior cruciate ligament is barely visible with ultrasound, thus it is still not possible to directly visualize the ACL using sonography.[2] Various direct and indirect methods are described in various studies to look at anterior cruciate ligament. Ultrasound had shown high sensitivity and specificity in diagnosing ACL tear in these studies.[19,22-24]

We used both anterior and posterior approaches to look for anterior cruciate ligament tear. In anterior approach knee was maximally flexed with patient in supine position and probe was placed in sagittal plane over patellar tendon and Hoffa pad was used as acoustic window. In posterior approach probe was placed on posterior aspect of knee (posterior fossa) in midline.

In our study ACL was only partially visible with both these approaches. We were unable to visualize normal ACL's in most of patients. Anterior cruciate ligament tears were seen in only 3 patients on ultrasound compared to 23 patients on MRI in our study. Only slight agreement was seen between ultrasound and MRI in detecting anterior cruciate ligament tears with k=.02, sig =0.66.

Posterior cruciate ligament can also depicted on ultrasound by posterior approach. The intermediate and distal portion of posterior cruciate ligament is demonstrated by ultrasound. The proximal portion of this ligament and its insertion into femur cannot be demonstrated.[2,9] We used posterior approach to look at PCL injuries and were able to identify PCL tears [Fig 5] in 3 patients in contrast to 7 patients identified on MRI. In our study moderate agreement was noted between US and MRI (κ = 0.58, sig< 0.001). In our study ultrasound showed high specificity of 100 which is consistent with other studies done Singh B et al, Singh A et al and Lalitha P et al.[13,19,29] However, ultrasound showed low sensitivity of 42.86 in our study which is consistent with study done by Singh A et al who showed sensitivity of 33.3 in their study. However other studies by Wang C et al and Lalitha P et al and Wang C et al showed higher sensitivity of 83.3 and 83.3 and 75.[16,25]

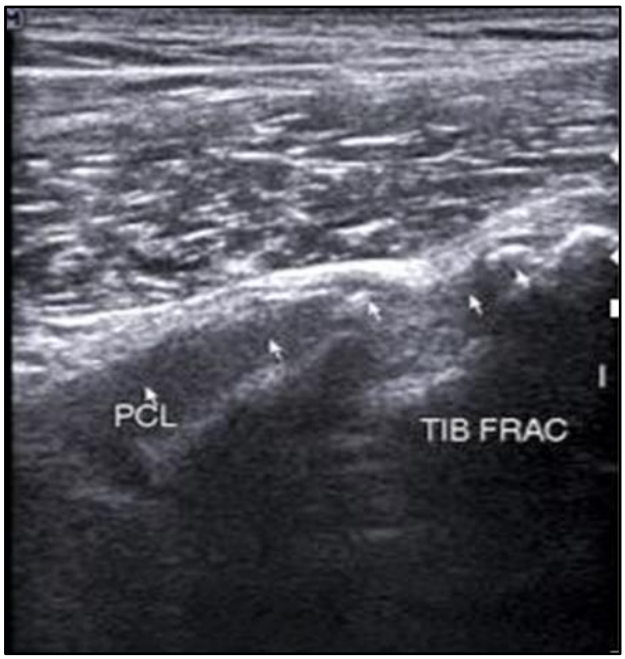

Fig 5: Ultrasound image with linear probe depicts thickened and hypoechoic right posterior collateral ligament with echogenic? bony fragments at its tibial insertion suggestive PCL tear with avulsion fracture

Fig 6: (A) Ultrasound image depicts osteophytes along medial aspect of tibio-femoral joint (B) MRI T1W1 image shows tibio-femoral osteophytes.

For detecting Baker's cyst ultrasound in our study showed sensitivity, specificity and accuracy of 100. In study by Singh B et all and Ward EE et al ultrasound showed similar sensitivity, specificity and accuracy of 100 in detecting baker's cyst.[14,27]

Osteoarthritic changes including osteophytes, medial meniscal extrusion and morphological articular cartilage changes in the femoral condyle of the knee joint can also be reliably identified by ultrasound.[28-30]

For detecting osteophytes [Fig 6] almost perfect agreement was noted between ultrasound and MRI in detection of osteophytes. Ultrasound also showed high sensitivity of 100, specificity of 97.2 and accuracy of 98.0 for detecting osteophytes compared to MRI as gold standard. Nearly similar results were seen in study by Podlipská, J. et al.[31]

In our study for detecting cartilage thinning ultrasound showed moderate agreement with MRI. Sensitivity of ultrasound was 50, specificity was 98.7 and accuracy was 89 compared to MRI as gold standard. Podlipská, J. et al determined the site-specific diagnostic performance of semi-quantitative ultrasound grading of knee femoral articular cartilage using MRI as a reference. For medial femoral cartilage ultrasound showed sensitivity ranging from 97.4 – 74.5, specificity ranging from 54.2 – 70.2 and accuracy ranging from 64.8 – 73.0. Findings were lower for lateral femoral cartilage.[31] Saarakkala, S. et al in their study showed that positive findings in ultrasound are a strong indicator of arthroscopic cartilage changes but negative findings do not rule out degeneration.[32]

Thus ultrasound has good sensitivity and specificity for detecting osteophytes but sensitivity and specificity is somewhat variable for cartilage thinning. It is not an alternative to MRI. But due to its low cost it can be used to look for progression of disease.

LIMITATIONS

The present study has a limitation of sample size. We recommend that the study should be done on large number of patients as well as at multiple centres.

CONCLUSION

The knee joint is one of the most important joints in the human body responsible for weight-bearing and a group of complex movements during ordinary life activities and even in vigorous sports making it susceptible to different knee conditions. Ultrasound is inexpensive and rapidly available modality which can be used for evaluation of various knee pathologies.

Ultrasound is a good imaging modality for extra-articular lesions such as patellar tendinopathy, medial and lateral collateral ligaments with good sensitivity, specificity and accuracy compared to MRI.

Ultrasound can be an effective imaging modality for evaluating patients with medial meniscal tears especially those who cannot afford MRI or have various contraindications to MRI. However, for evaluating lateral meniscal tears it has low sensitivity even though its specificity is good. Thus, in selected patients with trivial trauma or those with contraindication to MRI it can be used to rule out lateral meniscal injury. For detection of meniscal degeneration ultrasound is not a suitable test and performs poorly as compared to MRI.

Both anterior and posterior cruciate ligaments are not clearly visualized on ultrasound, thus it is poor modality for evaluating both. However, it performs better for posterior cruciate ligament tears as compared to anterior cruciate ligament tears and can be used in when MRI is not available.

Ultrasound is a good imaging modality for evaluation of baker's cyst and knee effusion and shows good accuracy for detecting both of them. It can also be used for evaluation of osteoarthritis as a complementary imaging technique to X-rays to clarify tissue-specific structural osteoarthritic changes, especially when MRI is not justified.

ETHICAL CONSIDERATIONS

Approval was taken from institutional ethical committee. Patient's confidentiality was protected during data collection.

REFERENCES

1. Razek AA, Fouda NS, Elmetwaley N, Elbogdady E. Sonography of the knee joint. J Ultrasound 2009;12:53–60.

2. Bianchi S, Martinoli C, Bianchi S. Knee. In: Baert AL, editor. Ultrasound of the musculoskeletal system. Berlin Heidelberg: Springer-Verlag; 2007. pp. 637–744.

3. Yaqoob J, Alam MS, Khalid N. Diagnostic accuracy of Magnetic Resonance Imaging in assessment of Meniscal and ACL tear: Correlation with arthroscopy. Pak J Med Sci. 2015;31:263-8.

4. Navali AM, Bazavar M, Mohseni MA, Safari B, Tabrizi A. Arthroscopic evaluation of the accuracy of clinical examination versus MRI in diagnosing meniscus tears and cruciate ligament ruptures. Arch Iran Med. 2013;16:229-32.

5. Ward BD, Lubowitz JH. Basic knee arthroscopy part 3: diagnostic arthroscopy. Arthrosc Tech. 2013;2:503-5.

6. Friberger Pajalic K, Turkiewicz A, Englund M. Update on the risks of complications after knee arthroscopy. BMC Musculoskelet Disord. 2018;19:179.

7. Salzler MJ, Lin A, Miller CD, Herold S, Irrgang JJ, Harner CD. Complications after arthroscopic knee surgery. Am J Sports Med. 2014;42:292-6.

8. Jacobson JA. Knee ultrasound. In: Jacobson JA, editor. Fundamentals of musculoskeletal ultrasound, 2nd edition. Philadelphia, PA: Elsevier Saunders; 2013; 212-56.

9. Patil P, Dasgupta B. Role of diagnostic ultrasound in the assessment of musculoskeletal diseases. Ther Adv Musculoskelet Dis. 2012;4:341–55.

10. Ives TI, Girish G, Kalume Brigido M, Jacobson JA. US of the Knee: Scanning Techniques, Pitfalls, and Pathologic Conditions. Radiographics. 2016;36:1759-75.

11. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977;33:159-74.

12. Viera AJ, Garrett JM. Understanding interobserver agreement: the kappa statistic. Fam Med. 2005;37:360-3.

13. Crewson PE. Reader agreement studies. AJR Am J Roentgenol.2005;184:1391-7.

14. Singh B, Pawar K, Kachewar S, Ghule S. Evaluation of knee joint by ultrasound and MRI. IOSR Journal of Dental and Medical Sciences. 2016;15:122-31.

15. Yousif EA, Ahmed BH, Abdella AA, Ali QM. Knee joint diseases diagnosed by ultrasound and magnetic resonance imaging. Sudan Med Monit. 2014;9:1-4.

16. Draghi F, Urciuoli L, Alessandrino F, Corti R, Scudeller L, Grassi R. Joint effusion of the knee: potentialities and limitations of ultrasonography. J Ultrasound. 2015;18:361-71.

17. Khan KM, Bonar F, Desmond PM, Cook JL, Young DA, Visentini PJ et al,. Patellar tendinosis (jumper's knee): findings at histopathologic examination, US, and MR imaging. Victorian Institute of Sport Tendon Study Group. Radiology.1996;200:821-7.
18. Unlu EN, Üstüner E, Şaylısoy S, Yılmaz Ö, Özcan H, Erden I. The role of ultrasound in the diagnosis of meniscal tears and degeneration compared to MRI and arthroscopy. Acta Med Anatol 2014;2:80-87.
19. Singh A, Mangat I, Thukral C, Gupta K. Ultrasonography in evaluation of knee injuries with magnetic resonance imaging correlation. International Journal of anatomy, radiology and surgery. 2018;7:50-5.
20. Ghosh N, Kruse D, Subeh M, Lahham S, Fox JC. Comparing Point-of-care- ultrasound (POCUS) to MRI for the Diagnosis of Medial Compartment Knee Injuries. J Med Ultrasound. 2017;25:167-72.
21. Wareluk P, Szopinski KT. Value of modern sonography in the assessment of meniscal lesions. Eur J Radiol. 2012 Sep;81(9):2366-9.
22. Khan Z, Faruqui Z, Ogyunbiyi O, Rosset G, Iqbal J. Ultrasound assessment of internal derangement of the knee. Acta Orthop Belg. 2006;72:72-6.
23. Grzelak P, Podgórski MT, Stefańczyk L, Domlalski M. Ultrasonographic test for complete anterior cruciate ligament injury. Indian J Orthop 2015;49:143-9.
24. Skovgaard Larsen LP, Rasmussen OS. Diagnosis of acute rupture of the anterior cruciate ligament of the knee by sonography. Eur J Ultrasound 2000;12:163-7.
25. Lalitha P, Reddy B.H, Reddy K.J, Kumari, V.S. Ultrasound evaluation of normal and abnormal posterior cruciate ligament- a prospective study materials. Pak J. Radiol.2010;20:125-9.
26. Wang C, Shih T, Wang H, Chiu Y, Wang T. The accuracy of ultrasonographic examination of injured posterior cruciate ligament. J Med Ultrasound. 2009;17:187-92.
27. Ward EE, Jacobson JA, Fessell DP, Hayes CW, van Holsbeeck M. Sonographic detection of Baker's cysts: comparison with MR imaging. AJR Am J Roentgenol. 2001;176:373-80.
28. Koski JM , Kamel A, Waris P, Waris V, Tarkiainen I, Karvanen E et al. Atlas- based knee osteophyte assessment with ultrasonography and radiography: relationship to arthroscopic degeneration of articular cartilage. Scand J Rheumatol. 2016;45:158-64.
29. Riecke BF, Christensen R, Torp-Pedersen S, Boesen M, Gudbergsen H, Bliddal H.An ultrasound score for knee osteoarthritis: a cross-sectional validation study.Osteoarthritis Cartilage. 2014;22:1675-91.
30. Nogueira-Barbosa MH, Gregio-Junior E, Lorenzato MM, Guermazi A, Roemer FW, Chagas-Neto FA, et al. Ultrasound assessment of medial meniscal extrusion: a validation study using MRI as reference standard. AJR Am J Roentgenol. 2015;204:584–8.
31. Podlipská J, Guermazi A, Lehenkari P, Niinimäki J, Roemer FW, Arokoski JP, et al. Comparison of diagnostic performance of semi-quantitative knee ultrasound and knee radiography with MRI: oulu knee osteoarthritis study. Sci Rep. 2016;6:22365.
32. Saarakkala S, Waris P, Waris V, Tarkiainen I, Karvanen E, Aarnio J et al. Diagnostic performance of knee ultrasonography for detecting degenerative changes of articular cartilage. Osteoarthritis Cartilage. 2012;20:376-81.

Source of Support: Nil. **Conflict of Interest:** None Declared.

Cite this article as: Veerendra K Sharma, Trishdeep Singh Grewal. Sonographic Evaluation of Pathologies of Knee Joint with MRI Correlation. Int J Med Res Prof. 2020 Mar; 6(2): 26-33. DOI:10.21276/ijmrp.2020.6.2.008