Diagnostic Value of Ultrasonography in Determination of Knee Joint Pathologies with Comparison to MRI

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Knee pain is a common musculoskeletal symptom in the general population and results in significant disability, reducing the quality of life and inducing financial burden to the health care system. This cross-sectional, descriptive type of observational study was conducted with a total 52 patients having symptomatic knee joint disease in the Department of Radiology and Imaging, Mymensingh Medical College Hospital, Bangladesh from April 2019 to September 2020. This study was performed to find out the effectiveness of ultrasonography as a modality of investigation in the determination of knee joint pathologies with comparison to MRI, considering MRI as the gold standard. The majority of the patients 13(25.0%) were in the age group of 15-25 years with mean age was 39.88 ± 15.308 years. In detecting synovial effusion, bursal collection, baker's cyst, tendinopathy and tumor pathologies ultrasound had 100.0% sensitivity, specificity and accuracy for each whether bursitis has 100.0%, 96.4% and 98.07% respectively. MCL tear had 100.0%, 97.8%, 98.07%. LCL tear detection showed 100.0%, 97.8%, 98.07%. PCL tear had 66.7%, 95.9%, 94.2%. ACL tear had 50.0%, 97.6%, 88.4% sensitivity, specificity and accuracy. Meniscal tear showed 66.7%, 97.8%, 88.4% sensitivity and accuracy. In all cases difference was statistically significant with a p value <0.0001 which strongly supported against null hypothesis. From this study, it is concluded that high-resolution USG showed high sensitivity, specificity and accuracy compared to MRI in detecting common knee abnormalities, and could be considered as the first-line imaging modality in the evaluation of knee pain.

Introduction

Knee pain is a common presenting complaint. It may be the result of an injury, such as a ruptured ligament or torn cartilage and several medical conditions including arthritis, gout, tumor, and infections also cause knee pain[1]. Musculoskeletal imaging is an important diagnostic tool for the spectrum of healthcare providers who treat musculoskeletal conditions[2]. Among the noninvasive investigations for knee pain Magnetic resonance imaging (MRI) is the gold standard. As it has a high negative predictive value and helps in the avoidance of unnecessary knee arthroscopy[3]. The most common investigation to be performed for knee pathologies are plain X-rays, but soft tissue details are very minimal. Ultrasonography is used for the assessment of the musculoskeletal system. The advantages are low cost, portability, real-time assessment, and facilitated side-by-side comparisons[4]. This study aims to evaluate the common knee pathologies with USG as the initial line of imaging technique as well as diagnostic tool compared to MRI, taking MRI as a Gold standard[3,4,5,6].

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And establishment of the efficacy of this modality that has a widespread demographic coverage so that it will help clinicians that in the absence of MRI, USG can also help to direct the further course of management in a suspected patient with knee joint pathologies.

Methods
This cross-sectional descriptive type of observational study was conducted among purposively selected 52 adult patients with knee pain in the Department of Radiology and Imaging, Mymensingh Medical College Hospital, Mymensingh, Bangladesh from April 2019 to September 2020. The research protocol was approved by the institutional ethical committee (Memo no: MMC/IRB/2019/154 Date: 18/06/2019). After fulfilling the inclusion & exclusion criteria, patients were enrolled. USG of the knee was performed using ultrasound machines SAMSUNG SONOACE X8 with 5-12 MHz linear-array transducer using musculoskeletal settings. Then all patients underwent undergone MRI within 1-7 days following the USG examination. MRI of the knee was done with a Siemens MAGNETOM Avanto 1.5 T scanner using T1, T2, Proton density, and STIR sequences in axial, oblique coronal, and oblique sagittal planes.

Inclusion criteria: All clinically suspected cases with symptoms of knee disease.

Exclusion criteria: Non-cooperative, Gross fracture, Contraindication for MRI: pacemaker, metallic implant, claustrophobia.

All the data were recorded and analyzed with the help of SPSS (Statistical Package for Social Science) Windows version-25.0 software programs. Quantitative variables were expressed as range, mean, and standard deviation. Qualitative variables were expressed as frequency and percentage. Considering MRI as the reference standard, the Chi-square test (x^2) was done to find the significance of USG findings. The p value <0.01 was considered statistically significant. The results of sensitivity, specificity, accuracy and PPV, NPV were computed to find the correlation of USG findings with MRI.

Results

Table I: Distribution of respondents by age (n= 52)

Age (year)	Frequency (n)	Percentage (%)	Mean±SD (years)
15-25	13	25.0	
26-35	10	19.2	
36-45	11	21.2	39.88±15.308
46-55	09	17.3	
56-65	09	17.3	
Total	52	100.0	

Table II: Distribution of respondents by history (n=52)

History of	Frequency (n)	Percentage (%)
Trauma	27	51.9
Non-trauma	25	48.1
Total	52	100.0

Table III: Distribution of different pathologies according to age group (n=52)

| All common pathologies in ultrasonography	Ages (years)					
	15-25	26-35	36-45	46-55	56-65	Total
Synovial effusion	13	08	08	09	08	46
Bursal collection	09	08	07	09	07	40
Bursitis	03	06	04	08	04	25
Baker's cyst	01	02	04	03	04	14
Tendinopathy	00	01	02	06	03	12
ACL tear	05	01	00	00	00	06
PCL tear	02	01	00	01	00	04
MCL tear	04	02	01	00	01	08
LCL tear	02	02	01	01	00	06
Meniscal tear	02	02	01	05	01	11
tumor around the knee	01	00	02	00	00	03
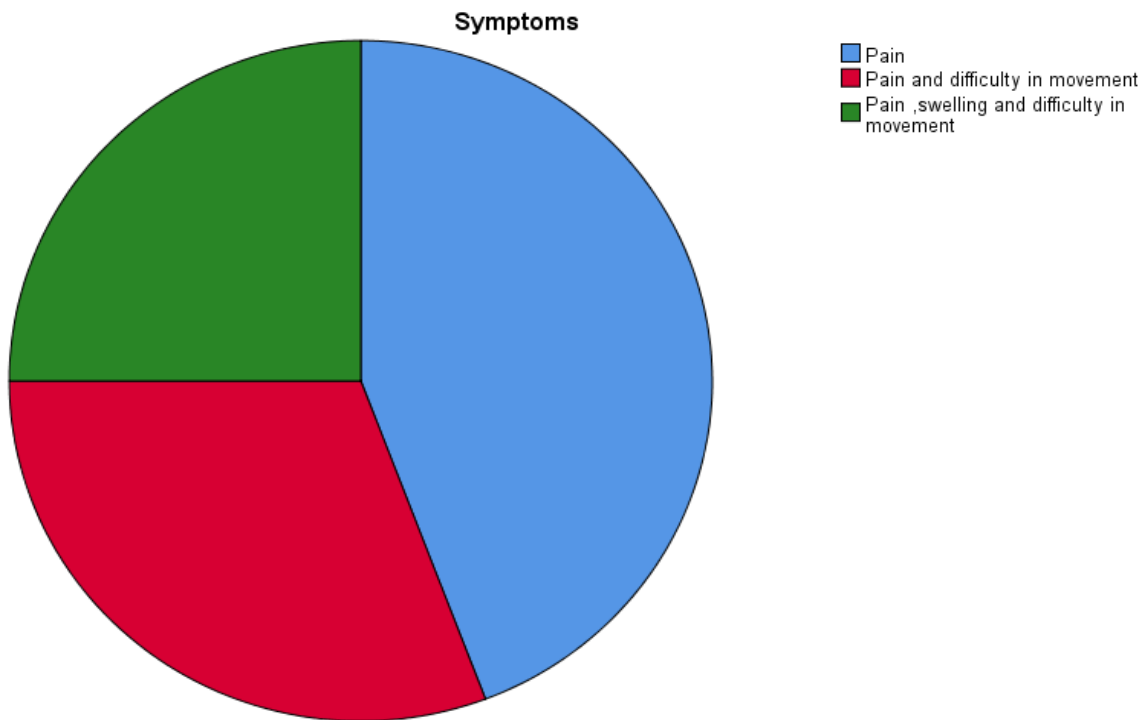
Figure 1: Pie diagram about the distribution of symptoms

Table IV: Results of Test of diagnostic performance, Hypothesis testing, and Inter test agreement of each knee pathology

Pathologies	Statistical measures						
	Sensitivity	Specificity	PPV	NPV	Accuracy	χ^2 test	p value
Synovial effusion	100	100	100	100	100	52.00	0.00001
Bursal collection	100	100	100	100	100	52.00	0.00001
Bursitis	100	96.4	96	100	98.07	48.137	0.00001
Baker's Cyst	100	100	100	100	100	52.00	0.00001
Tendinopathy	100	100	100	100	100	52.00	0.00001
ACL tear	50	97.6	83.3	89.1	88.4	17.943	0.000023
PCL tear	66.7	95.9	50	97.9	94.2	15.594	0.000079
MCL tear	100	97.8	87.5	100	98.07	44.489	0.00001
LCL tear	100	97.9	83.3	100	98.07	42.411	0.00001
Meniscal tear	66.7	97.3	90.9	87.8	88.4	26.181	0.00001
Tumour	100	100	100	100	100	52.00	0.00001

Discussion

In this study, the ages of the patients ranged from 16 to 65 years and mean±SD was 39.88±15.308 years. Hawana et al. found an age range from 22 to 62 years (average 42 years)[8] and Ahmed et al. found an age range from 12 to 80 years[9]. In this study, a total of 52 patients were taken. Among them 32(61.5%) were male and 20(38.5%) were female. A male-to-female ratio of 1.59:1 was noted. Yousif et al. found male (83.0%) and female 34(17.0%)[10]. In this study, among total of 52 patients, 27(51.9%) had a history of trauma and 25(48.1%) had a history of osteoarthritis. Out of 27 cases with trauma 13 cases were 15 to 25 age group, and out of 25 patients, 18 cases with osteoarthritis had the 45-65 age range. It showed that trauma was more common in the younger age group and osteoarthritis was more common in the older age group. Though Singh et al found trauma in patients in the age group 26-65 years[6]. In this study, 23(44.2%) cases had pain only, 16(30.8%) had pain with difficulty in movement, and 13(25.0%) had symptoms of pain with swelling and difficulty of movement. Ahmed et al found knee joint pain and swelling as the commonest clinical complaints[9]. In this study, all common pathologies detected by ultrasonography according to their age distribution showed that among 52 cases,46 cases had synovial effusion with the highest number of 13 cases of synovial effusion in 15-25 years. Among 40 bursal collections highest 9 was on 15-25 years. Twenty five (25) cases had bursitis and the highest 6 were at 26-35 years. A total of 14 cases had Baker's cyst and the highest number 4 was at 36-45 years and 56-65 years respectively. Fourteen (14) cases of tendinopathy with the highest 6 cases were on 46-55 years. Among 6 cases of ACL, 4 cases of PCL tear, 8 cases of MCL tear and 6 LCL tear cases highest 4 cases, 2 cases, 4 cases, 2 cases respectively were in the 15-25 years age group. Among 11 meniscal tear cases, highest 5 cases were in 46-55 age group. Among 3 cases of tumours around the knee highest 2 cases were in 36-45 age group. In the study of Yousif et al. found that among 200 cases, 81 cases had synovial effusion with the highest number 33 was on 41 to 50 years, 8 cases had bursitis and the highest 2 were on 31 to 50 years. A total 4 cases had Baker's cyst and the highest number 3 was on 51 to 60 years. Among 6 cases of ACL and 4 cases of PCL tear, all were in younger age group[10]. In this study, among 52 symptomatic patient ultrasonography detected 46(88.5%) having synovial effusion, 40(76.9%) having bursal collection, Baker's cyst 14(26.9%) tendinopathy 12(23.1%) and tumour 3(5.8%). All synovial effusion, bursal collection, Baker's cyst and tendinopathy detected by ultrasonography are also seen to be present on MRI. Total 25(48.1%)

having bursitis detected by ultrasonography shows 24(46.2%) in MRI. Ultrasonography shows ACL tear 6(11.5%), PCL tear 4(7.7%), MCL tear 8(15.4%), LCL tear 6(11.5%), meniscal tear 11(21.2%) among them MRI shows bursitis 24(46.2%), ACL tear 10(19.2%, PCL tear 3(5.8%), MCL tear 7(13.5%), LCL tear 5(9.6%) and tumour 3(5.8%) respectively. Singh et al. found among 50 symptomatic patient ultrasonography detected 44(88.5%) having synovial effusion, Baker's cyst 7(14.0%) tumour 1(2.0%)[11]. All synovial effusion, bursal collection and Baker's cyst detected by ultrasonography are also seen to be present on MRI. Ultrasonography shows ACL tear 16(32.0%), PCL tear 6(12.0%), MCL tear 6(12.0%), LCL tear 5(10.0%), meniscal tear 32(64.0%), among them MRI shows ACL tear 17(34.0%), PCL tear 4(8.0%), MCL tear 5(10.0%), LCL tear 6(12.0%) and Tumour 1(2.0%) respectively[11]. Like us, Ahmed et al. found effusion was the commonest 80(64.5%) and we found 46(88.5%) having synovial effusion[9].

In this study, among 27 cases with a history of trauma, 23 cases have synovial effusion on ultrasonography and among 25 cases with a history of osteoarthritis, 23 cases had synovial effusion on ultrasonography. 23(25) cases of bursitis, also had synovial effusion. D'Agostino et al. found 85(14.2%) cases with synovial effusion had both synovitis and effusion[12]. Gaafar et al. found knee effusion in 21(70.0%)[13]. Among them, two had Baker's cyst and marked effusion and we found all cases of Baker's cyst are associated with synovial effusion too. The sensitivity, specificity, positive and negative predictive values and overall accuracy values of USG regarding joint effusion in this study are all equal 100.0%. Hawana et al.[8], Yousif et al.[10] and Singh et al.[11] found the same. But Draghi et al.[14] found that USG correctly identified 78 of 96 patients with joint effusion, showing a sensitivity of 81.3% and a specificity of 100.0%, with a positive predictive value (PPV) of 100.0% and a negative predictive value (NPV) of 77.5% (p value = 0.001). In this study 25(48.1%) having bursitis detected by ultrasonography shows 24(46.2%) in MRI. Yousif et al.[10] had bursitis 8(6.4%), Gaafar et al.[13] had (10.0%). Draghi et al.[14] found that 15 had bursitis, while 143 had no bursitis. In their study of knee bursitis with the USG compared to MRI, correctly identified 13 out of 15 cases of bursitis, showing a sensitivity of 86.67%, specificity of 100.0% and *K* index of

0.92. Ultrasound showed bursitis in 5 cases versus 7 by MRI (sensitivity of 71.4%, specificity of 100.0%, in the suprapatellar bursa and we found the sensitivity, specificity, positive/negative predictive values and overall accuracy values of USG regarding bursitis 100.0%, 96.4%, 96.0% and 98.07% respectively. In this study, 14 Baker's cysts are correctly diagnosed both on MRI and on ultrasonography. Gaafar[13], Yousif[10], Wang[15] and Hawana[8] found sensitivity, specificity, positive or negative predictive values and overall accuracy values of USG regarding joint effusion, synovial proliferation and Baker's cyst all equal to 100.0%. In this study, sensitivity, specificity, positive, negative predictive values, and overall accuracy values of US regarding tendinopathy are 100.0%, Warden[16] also said that the accuracy of grayscale USG was superior to that of MRI in confirming clinical diagnosis of tendinopathy. In this study sensitivity, specificity, positive or negative predictive values and overall accuracy values of USG regarding ACL tear is 50.0%, 97.6%, 89.1% and 88.4%. Singh[6] found a sensitivity of 78.2%, specificity of 78.2% and accuracy of 78.3% for PCL detection on ultrasonography. Grzelak[5] found their sensitivity- 97.3%, specificity- 84.8%, PPV- 83.7% and NPV- 97.5%. Attya[17] conducted a study in which he recorded an accuracy of 83.3%, the sensitivity of 81.2% and specificity of 84.2% of ultrasonography in the diagnosis of ACL injury. Current study for PCL tear sensitivity- 66.7%, specificity- 95.9%, PPV- 50.0%, NPV- 94.2% and accuracy- 94.2%. According to Singh[6] sensitivity is 33.3%, specificity is 95.9% and accuracy- 83.3% for PCL detection on ultrasonography. Wang[15] showed sonographic examination had a sensitivity of 83.3%, a specificity of 87.0% and an accuracy of 85.7% in detecting PCL tears. In this study, for ultrasonography detection of MCL tear sensitivity- 100.0%, specificity- 97.8%, PPV- 87.5%, NPV- 100.0% and accuracy- 98.07% which is close to the findings of Singh[6]. According to a study done by Singh[6] accuracy, sensitivity and specificity of USG in diagnosing medial collateral ligament tears were 96.6%, 100.0% and 84.6% respectively. Again, according to a study done by Singh[11] accuracy, sensitivity and specificity of USG in diagnosing medial collateral ligament tears were 96.0%, 83.0% and 97.0% respectively. In this study for ultrasonography detection of LCL tear sensitivity- 100.0%, specificity- 97.8%, PPV- 83.3%, NPV-

100.0% and accuracy- 98.07% which is close to the findings of Singh[6]. According to his study for diagnosing lateral collateral tears accuracy, sensitivity and specificity were 95.0%, 84.6% and 97.8% respectively Again, in the study done by Singh[11] for diagnosing lateral collateral tears accuracy, sensitivity and specificity were 96.0%, 80.0% and 97.0% respectively. In this study, for ultrasonography detection of overall meniscal tear sensitivity- 66.7%, specificity- 97.8%, PPV- 90.9%, NPV- 87.4% and accuracy- 88.4%. The sensitivity of sonography in detecting meniscal lesions ranged from 82.2% to 93.3% in previous studies of Wang[15]. In the study of Singh[6], the sensitivity and specificity of MRI in diagnosing medial meniscus tears is 58.0% and 88.0% and for lateral meniscus is 33.0% and 92.0% respectively. In this study, the sensitivity, specificity, positive and negative predictive values and overall accuracy values of tumour around the knee is 100.0% for each. We found three cases of tumour around the knee, two of which are soft tissue tumour and one is intraosseous tumour. Palanisamy[18] found that USG is 100.0% sensitive to demonstrate cortical thinning, break, fracture, soft tissue component, Neurovascular Bundle (NVB) involvement, a cystic component with fluid-fluid level and joint effusion but less informative in intra-osseous and sclerotic lesions, In this study performance test for tumor detection were 100.0% but it would be less if we had took much more cases of tumor of different types. In this study all cases difference was statistically significant with a p-value <0.0001 which strongly assumed against the null hypothesis.

Conclusion
This study is significant in today's perspective as it analyzes the role of USG which is cheap and easily available in our country against MRI which still has limited availability and has cost constraints. Therefore, analyzing the efficacy of a modality that has a wide spread demographic coverage is essential so that it is known to clinicians that in absence of MRI, USG can also help direct the further course of management in a suspected patient with knee joint pathologies. It is thereby concluded that due to its availability, accuracy and cost effectiveness, USG should be made the first-line modality for detecting knee pathologies and MRI should be preserved for

detecting complex cases where USG does not satisfy the serving of clinical purpose.

Limitation
Knee USG was performed by a short-experienced operator. In this study, MRI had been considered as the reference standard to compare USG findings; not MR arthrography, arthroscopy, or surgery. However MRI itself is not 100.0% accurate in the detection of knee pathology.

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