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Original Article

Radiology Section

Role of Ultrasonography in Detecting Meniscal Tear and its Correlation with Magnetic Resonance Imaging: An Observational Study

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ABSTRACT

Introduction: A meniscal tear is the most common injury to the knee, and commonly occurring from both athletic events and activities of daily living. The diagnosis of a meniscal tear may require Magnetic Resonance Imaging (MRI), which is costly. In remote and rural parts of our country, MRI is not available so ultrasonographic examination of knee can be used as diagnostic tool to overcome financial burden to such population groups.

Aim: To correlate the accuracy of Ultrasonography (USG) and MRI for diagnosing meniscal tears and also to correlate the specificity, sensitivity, and predictive values of USG for meniscal tears in comparison with MRI.

Materials and Methods: It was an observational study. It included 50 patients who presented to our institute with complain of acute or chronic knee pain and restriction of movement with clinical signs and symptoms of meniscal tear with history of trauma. All patients underwent ultrasonographic examination of knee along with MRI and arthroscopy. The statistical analysis was done by using Statistical Package for Social Sciences (SPSS) 22.0 software. Accuracy, sensitivity, specificity, Positive Predictive Value (PPV) and Negative Predictive Value (NPV) were calculated based on detection of meniscal tear.

Results: This study comprised of 50 patients: 45 were males and 5 were females whose median age was 29 years. Upon combining both medial and lateral menisci, USG showed mean accuracy of 72%, mean sensitivity of 48.6% and mean specificity of 85.7%. MRI showed mean accuracy of 76%, mean sensitivity of 50% and the mean specificity of 90.6%.

Conclusion: According to this study, USG has shown reasonable accuracy, sensitivity, specificity, PPV and NPV in comparison to MRI in detecting meniscal lesions.This study has proved that USG can be a good negative test for meniscal tear as we can exclude normal meniscus from abnormal, thus patient with normal meniscus could be prevented from undergoing costly MRI as their initial investigation. So, it can be used as an effective diagnostic screening tool.

Keywords: Knee MRI, Meniscus, Ultrasound

INTRODUCTION

Knee joint is amongst the most commonly injured joint, especially during sports activity. Injuries to tissues like ligaments, meniscus and tendons are most common, though damage to the bones is also possible [1]. The most common cause of knee pain and disability is tear in menisci.

Meniscal tears occurring in isolation or in association with ligamentous injury can result in marked physical impairment [2]. To adequately evaluate and treat such injuries, we should be aware of type of tear so that we can plan our management preoperatively. The presence of clinical symptoms of pain, swelling, locking, catching, and loss of motion often require surgical intervention. Clinical evaluation of the knee alone cannot define the extent and morphology of the meniscal lesion [3].

Knee arthroscopy is gold standard for diagnosing and treating any intraarticular knee pathology, but preoperative evaluation of any lesion is of utmost importance before putting patient to any kind of surgical trauma so, various radiological modalities have been developed to affirm the clinical findings and to ascertain lesion. MRI is often considered the “gold standard” diagnostic imaging modality for detection of meniscal abnormalities but due to its high cost it is not readily available to a large number of patients in developing nations for either financial or logistic reasons [4,5]. USG is a viable imaging modality for the assessment of the musculoskeletal system. High frequency USG includes easy availability and multiplanar capability, as well as economic advantages. It can demonstrate the fibrillar microanatomy of tendons, ligaments and muscles, enhancing its diagnostic capability. The ability to compress, dynamically assess structures and comparison with the contralateral side is advantageous [6].

Ultrasound can demonstrate different types of injury in the meniscus [7]. Indirect or dynamic techniques are generally applied in conjunction with sonography to diagnose Anterior Cruciate Ligament (ACL) and Posterior Cruciate Ligament (PCL) tears [8].

However, while MRI is gaining its ascendancy, USG is an important complementary tool, and there is now a large body of literature documenting the effectiveness of musculoskeletal sonography [9]. In a developing nation major proportion of the rural population is economically a weaker section. So, if USG can predict symptomatic patient without meniscal tear then he/she could be saved from costly MRI investigation. Hence with foregoing the present study was conducted with an aim to correlate the accuracy of USG and MRI for diagnosing meniscal tears.

MATERIALS AND METHODS

It was an observational study. It included 50 patients (50 knees with 100 menisci) with significant history and clinical evaluation suggestive of meniscal lesion of the knee joint coming to Orthopaedic Department and referred to the Department of Radiodiagnosis for investigation over a period of 14 months (December 2018 to February 2020). This study was carried out in Tertiary Care Hospital in Uttar Pradesh, India.

Inclusion Certeria

All the patients of age more than 16 years who presented to the institute with complain of acute or chronic knee pain with restriction of movement, history of trauma and with positive McMurray test who further carried out MRI and arthroscopy and gave informed consent were included in the study.

Exclusion Criteria

Patient with metallic implants, claustrophobia, having major knee trauma and previous history of knee surgery were excluded from the study.

Study Procedure

All the 50 patients underwent USG and MRI prior to arthroscopy. All patients included in the study, completed the study protocol in a single hospital admission, since no follow-up was required. There were no complications in the study.

Medial menisci and lateral menisci were analysed separately. Grade 1 and grade 2 lesions detected on MRI and ultrasound were considered as negative scans. The higher grade of the reported tear was taken into consideration when a range of grades was reported. The most widely accepted MRI scales for the intrameniscal signal abnormalities are classified into three grades (Grade 1- globular signal not extending to the surface of the meniscus, Grade 2- linear signal not extending to the surface of the meniscus, Grade 3- Linear or globular signal intensity extending to the surface of the meniscus) [10].

Sonography was performed using PHILIPS EPIQ 7G machine by using high frequency probe of frequency 7-10 MHz. Patients were examined in prone and supine position. MRI Examination was performed using PHILIPS ACHIEVA 3T machine MRI system and imaging sequences were obtained in all three planes: Sagittal (T1, PD fat sat, T2), Coronal (T1, PD fat sat, stir), and Axial (T1, T2 fat saturation). Arthroscopic examination was performed under spinal anaesthesia with complete sterile precautions. Arthroscopy were done using standard anteromedial and anterolateral portals and visualised with a 4 mm diameter, 30-degree oblique arthroscope.

STATISTICAL ANALYSIS

The statistical analysis was done by using SPSS 22.0 software. All data were systemically collected and patients were categorised as True Positives (TP), False Positives (FP), False Negatives (FN) and True Negatives (TN). Accuracy, sensitivity, specificity, PPV and NPV were calculated based on detection of meniscal tear.

Grade 1 and grade 2 tears on MRI and USG were considered as 'No tear' and hence, were included as a negative test result.

RESULTS

In this study out of the 50 patients, 45 were males and 5 were females whose median age was 29 years.

The most common mode of injury was from other causes which included road traffic accident, occupational injuries etc., as compared to sport injuries [Table/Fig-1].

Mode	Medial (n)	Lateral (n)	Combined (n)
Sport	8	3	2
Other (RTA, Occupational)	11	6	1
Degenerative	2	1	0

[Table/Fig-1]: Mode of meniscal Injury.

The medial and lateral meniscus was taken into consideration separately, so a total of 50 knees were evaluated in 50 patients. After final arthroscopic confirmation, 34 patients had 37 meniscal tears of which 3 were degenerative tears. Two patients had meniscal cysts in association with meniscal tear. Rest 16 patients had no meniscal lesion.

Out of the 37 meniscal tears majority of the tears i.e., 24 tears (65%) were those involving the medial meniscus and 13 tears (35%) involving the lateral meniscus. Out of total meniscal tears majority of the tears were those involving the posterior horn of medial meniscus [Table/Fig-2]. All the tears were seen in both MRI and USG. Grade 3 tear of MRI were taken as positive cases.

Portion	Medial (n)	Lateral (n)
Posterior Horn	17	10
Body	6	1
Anterior Horn	1	2

[Table/Fig-2]: Portion of meniscus Involved.
Data represented as number of meniscal tears

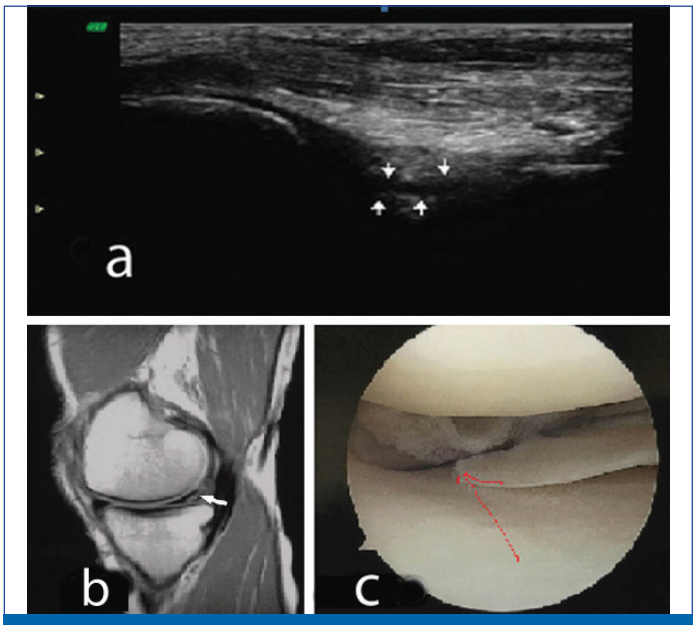
Comparing the sensitivity, specificity, PPV, NPV and accuracy of USG with MRI was done taking the findings at arthroscopy as a positive finding and grade 3 tears on MRI and USG as positive.

For medial and lateral meniscus ultrasound showed mean accuracy of 72%, mean sensitivity 48.6% and the mean specificity 85.7% as compared to MRI which showed mean accuracy of 76%, mean sensitivity 50% and the mean specificity 90.6%. The ultrasound showed PPV 66.6% and the NPV 73.9% as compared to MRI which showed PPV 75% and the NPV 76.3%. The ultrasound showed Likelihood Ratio (LR) (+) of 3.40, and LR(-) of 0.60 as compared to MRI which showed LR(+) of 5.30 and LR(-) of 0.55 [Table/Fig-3].

Investigation	Accuracy	Sensitivity	Specificity	PPV	NPV	LR(+)	LR(-)
USG	72	48.6	85.7	66.6	73.9	3.40	0.60
MRI	76	50	90.6	75	76.3	5.30	0.55

[Table/Fig-3]: Total medial and lateral meniscus comparison of USG and MRI.

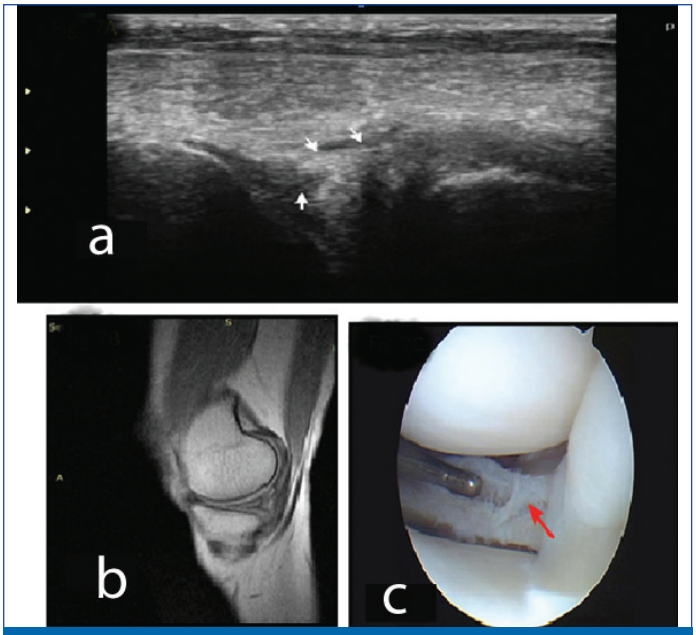
In this study, it was difficult to differentiate between meniscal degeneration and meniscal tear on USG. On arthroscopy most common meniscal tears were 12 flap tears (32.4%) followed by 12 longitudinal tears (32.4%), 6 bucket handle tears (16.2%), 4 complex tears (10.8%), 2 horizontal (5.4%) and 1 radial tear (2.7%). There were no oblique tears. USG, MRI and arthroscopic images of the patient depicted in the [Table/Fig-4,5].



[Table/Fig-4]: a) Sagittal sonogram shows hypoechoic areas within the posterior horn of the medial meniscus (PHMM). b)Saggital PDWI shows abnormal signal intensity in the posterior horn of the medial meniscus (white arrow) reaching the articular surface-grade 3 tear posterior horn medial meniscus tear. c) Arthroscopy showing tear of medial meniscus (red arrow).

DISCUSSION

This comparative study investigated the accuracy, sensitivity, specificity, PPV and NPV of USG in comparison with MRI; the final outcome confirmed with arthroscopy.



[Table/Fig-5]: a) Sagittal sonogram shows hypoechoic cleft within the posterior horn of the lateral meniscus (PHLM). b) Sagittal T1 WI show abnormal signal intensity in the posterior horn of the lateral meniscus reaching the articular surface (horizontal tear). c) Arthroscopic view of a horizontal meniscal tear (red arrow).

Ultrasound has also been widely used as a screening imaging tool for decades. The advantages of USG include low cost, no radiation exposure, direct visualisation of soft tissues, and a readily available dynamic study [11].

The study included 50 patients. The average age in this study was 29 years, which was similar to study by EL-Monem SA and Enaba MM, whose average age was 28.4 years [12]. Our study showed males predominance i.e., 45 males (90%) and 5 females, similar to the study of Nasir AI [13]. This could be explained by the fact that the males are the one who were physically active, engaged in increased various outdoor activities and sports events while females are more vulnerable to meniscal degeneration resulting from weight bearing due to obesity and less involvement in outdoor activities [14].

The common cause for the mode of injury was either due to a road traffic accident, occupational injury or other non sporting causes. So, in this study the common mechanism was an indirect injury due to twisting forces similar to the study by Drososab GI and Pozo JL, on the cause and mechanism of injury on 392 patients excluding professional athletes [15], showed that in the common population, two thirds of meniscal tears occurred in the non existence of sporting activities, often within the range of everyday activities and in the absence of the classic injury mechanism.

Majority of the meniscal tears were those involving the posterior horn of medial meniscus akin to study done by Mostafa HAM et al., followed by the posterior horn of the lateral meniscus, body of medial meniscus [14], anterior horn of lateral meniscus, anterior horn of medial meniscus.

In this study, it was difficult to differentiate between meniscal degeneration and meniscal tear similar to study by Chiang YP et al., [11]. Although, the Ritcher J et al., described the different vertical meniscal tear as sharp bright line echo and the degeneration as hypoechoic areas but they also confirmed that different types of meniscal tears could not be differentiated by ultrasound alone [16].

There was no significant difference in comparison of accuracy, specificity, PPV and NPV of USG and MRI evaluation of medial and lateral meniscus when compared separately. However, sensitivity of lateral meniscus was lower than the medial meniscus in USG. In contrast to Maeseneer MD et al., study that USG is capable to detect normal meniscus by 100% accuracy but has no role in diagnosis of pathological meniscus, we were able to detect the normal as well as the injured meniscus [17].

According to a prospective study done by Shetty AA et al., performed on 35 patients on comparison of USG and MRI in meniscal tears [18], there was a sensitivity of 86.4%, specificity of 69.2%, PPV of 82.6% and NPV of 75% for USG and sensitivity of 86.4%, specificity of 100.0%, PPV of 100.0% and NPV of 81.3% for MRI in their study. Compared to the study by Shetty AA et al., this study has got a relatively lower sensitivity (48.6%) but a better specificity (85.7) [18]. This low specificity in their study could be because of either low sample size or poor technique and less experience with the method.

In comparison to the studies done by Shanbhogue AKP et al., and Forouzmehr A, this study shows relatively lower sensitivity (48.6%) and almost equivalent specificity (85.7%) [19,20]. The sensitivity and specificity of Shanbhogue AKP et al., was 83.3% and 87.5%, respectively and that of Forouzmehr A was 75% and 88%, respectively [19,20]. This difference could be because of the difference in sample size and different technique.

Hence, It can be said from the results of this study that the higher specificity and lower sensitivity reflect the power of high-resolution ultrasound to confirm that the meniscus is normal rather than to diagnose the pathology, thus it is a good negative test. Thus, this study shows how USG can be a boon for rural population as it can diagnose normal meniscus with good accuracy and specificity.

The cause for false negative and false positive MRI were reviewed with the radiologists and in all the cases the same reporting was done and the cause has been attributed to the slice thickness of MRI which when increased there is a higher chance to miss the tears. But in all cases the same report was given again and the false reports has been attributed to the grade 3 tears which were reported as grade 2 in few cases because of the doubtful extension to surface.

Limitation(s)

Drawback of the study is that besides smaller sample size, USG is an operator dependent tool so accuracy of ruling out the tear depends on skill and knowledge of operator so it is important to have trained radiologist to report on USG of meniscus. Although USG can pick up subtle changes in meniscus, it cannot describe the type of tear because ultrasound of meniscus can be performed only in longitudinal plane.

CONCLUSION(S)

According to this study, USG has shown reasonable accuracy, sensitivity, specificity, PPV and NPV in comparison to MRI in detecting meniscal tears except for sensitivity of lateral meniscus which was lower than the medial side.

This study has proved that USG is a useful adjuvant diagnostic tool. It provides supportive evidence about meniscal tear and helps in taking a decision regarding management of a meniscal tear as the patient can avoid performing the high cost MRI unless the patient was proved to be injured and needing MRI.

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