ORIGINAL RESEARCH ARTICLE

High-resolution Ultrasonography of Meniscal Pathologies: Can It Serve as First-line Imaging Modality in Comparison to Magnetic Resonance Imaging

Amandeep Singh[1], Indermeet Mangat[2], Parmeet Kaur[3], Bikramjit Singh[4]

Abstract

Purpose: The knee joint injury is very usual in our daily life and many sports activities. As the attachment site for multiple tendons, ligaments, and associated bursae, knee disorders are indeed very common. The purpose of this study is to examine the effectiveness of sonography in the diagnosis of meniscal pathologies employing magnetic resonance imaging (MRI) correlation.

Methods: In this prospective study, 50 participants with knee injuries were referred for sonography and MRI in our department. A high-resolution sonography examination was combined with an examination of the contralateral normal knee, and then MRI was used to confirm the diagnosis.

Results: The study includes 50 participants with an average age of 37 years. The majority of participants were in the age-group of 21–30 years, with a maximum of 18 (36%). In diagnosing meniscal pathologies, sonography and MRI had a high level of agreement (k value = 0.674).

Conclusion: Sonography is a valuable tool for evaluating patients with knee injuries and can be used as a primary imaging investigation because it allows for a quick, interactive, and cost-effective examination of meniscal injuries in the knee joint. MRI should be used to confirm the findings of sonography in meniscal pathologies.

Keywords: Lateral meniscus, Medial meniscus, Meniscal tears, Magnetic resonance imaging, Sonography.

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Introduction

The knee joint injury is very usual in our daily life and many sports activities. Knee pathologies are very common as it serves as the attachment site for numerous tendons, ligaments, and related bursae. In knee injuries, it is very important to diagnose which patients require treatment and which do not, as further complications can be prevented in early arthroscopically treated knees. A comprehensive noninvasive modality is required to diagnose all the pathologic conditions of the knee joint including that of the menisci, ligaments, and articular cartilages.[1] Acute or chronic injuries of knee joint constitute a major cause of pain and instability.[2] An acute knee injury should be quickly imaged for the identification of meniscal and ligamentous injury. Knee injuries may involve the disruption of the normal structure and functioning of menisci or ligaments of knee joint thereby impairing their normal mobility. History, physical examination, imaging and arthroscopy all play an important role in the diagnosis of knee injuries.[3]

Knee arthroscopy is an invasive procedure which has been in used since the 1970s and is still kept standard for diagnosing the knee pathologies. But being an invasive is a major disadvantage.[4]

MRI is a highly accurate modality which is widely used for detection of knee injuries as an alternative to arthroscopy, as it can precisely diagnose the ligament and meniscal injuries of the knee joint because of its high sensitivity and specificity in making diagnosis of meniscal pathologies.[5,6] However, MRI has the disadvantages of high cost and time required for scheduling.

Sonography is an emerging modality in the musculoskeletal system nowadays. It offers advantages in the whole musculoskeletal system like in shoulder, ankle as well as in knee pathologies. By ultrasound, we can evaluate both structures in extra-articular and intra-articular location of the knee joint. The main reason why it is emerging is because of it being an inexpensive, easily available, and dynamic examination. The patient's maximum tenderness point can also be correlated and compared to the contralateral side, thus further helping us to pinpoint the pathology.[7]

Diagnosing injury to meniscus due to trauma has always been challenging. Combination of clinical history, examination with sonography, and MRI findings would result in reduce the number of unnecessary arthroscopies in many patients.[8]

Materials and Methods

In this prospective study, 50 participants were enrolled, who referred to Radiology Department of our institute with injury to knee joint between November 2018 and June 2020. After proper explanation of procedure and content, all these participants

[1,3,4]Department of Radiodiagnosis and Imaging, SGRD Institute of Medical Sciences and Research, Amritsar, Punjab, India

[2]Department of Radiology, Punjab Scan and Intervention Centre, Doraha, Punjab, India

Corresponding Author: Amandeep Singh, Department of Radiodiagnosis and Imaging, SGRD Institute of Medical Sciences and Research, Amritsar, Punjab, India, Phone: +91 9872454954, e-mail: dr.amancs@gmail.com

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underwent sonographic examination of the knee joint that was affected by trauma; for comparison purposes, sonography of the contralateral normal knee was also done. After proper examination, all these participants underwent MRI of the symptomatic knee.

Only those participants were included in study that on clinical examination had suspicious meniscal injuries.

Participants with bony injury on X-ray, history of surgery in same knee, or any MRI contraindications were excluded from study.

Sonographic Technique

A high-frequency linear transducer with a frequency of 12 MHz was used for sonography. The deep posterior structures were assessed using a low-frequency transducer (7–9 MHz).[9]

Patient Position

After adequate explanation of the procedure to the participants, sonography of knee joint will be performed with the patient lying supine, their knees flexed at 20–30° (Fig. 1).

Medial Meniscus

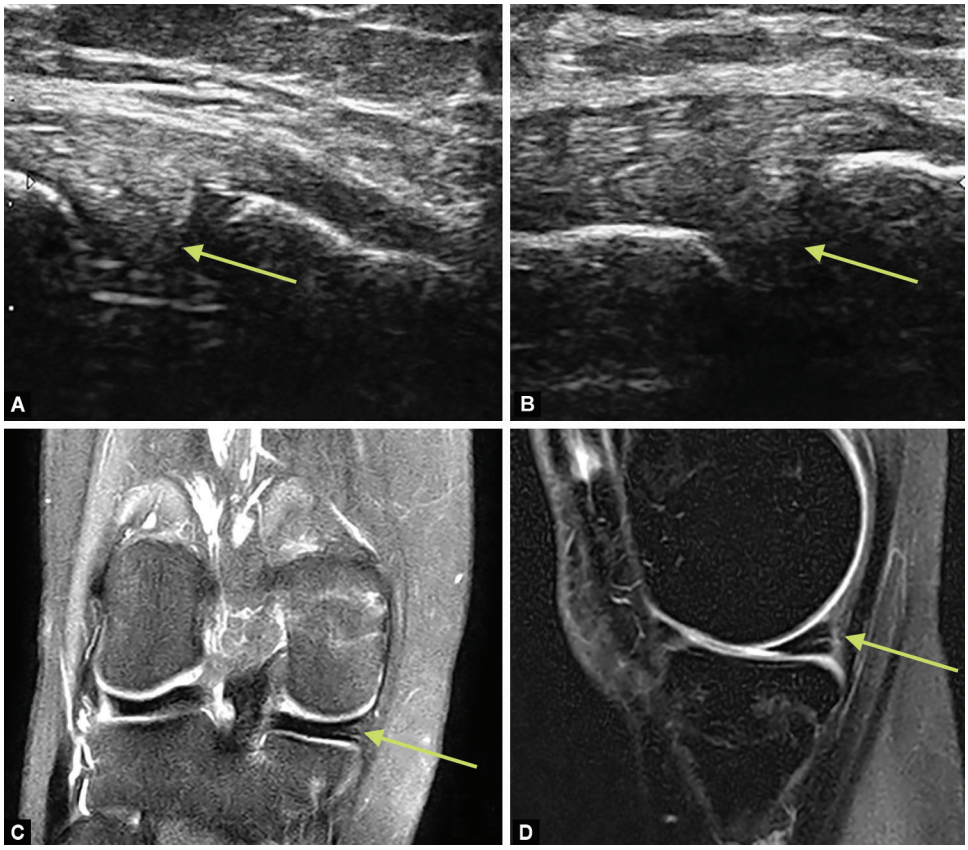
For evaluation of medial meniscus, maintaining slight (20–30°) flexion, leg of participant is externally rotated. Rest of the medial compartment of the knee can also be evaluated in this position. Between the femur and the tibia, we seen medial meniscus as a wedge-like hyperechoic structure on gray scale imaging.

Lateral Meniscus

For evaluation of lateral meniscus, with slight (20–30°) flexion, leg of participant is internally rotated. Rest of the medial compartment of the knee can also be evaluated in this position. We can evaluate anterior horn of the lateral meniscus and the anterior lateral collateral ligament from its origin on lateral epicondyle of femur to its insertion on fibular head.

Normal menisci appear as a homogeneous hyperechoic triangle-shaped structure on sonography with its tip pointing into the joint (Fig. 2A). Anterior and posterior horns of the lateral meniscus are equally wide, whereas posterior horn of medial meniscus is far much wider than its anterior horn.

Fig. 1: Position of transducer onto lateral aspect of knee with 20–30 degree flexion of the knee joint with patient lying in supine position



Figs 2A to D: Medial meniscus grade II signal. (A) USG image depicts normal homogeneous echogenicity in the medial meniscus on normal side; (B) USG image shows loss of homogeneous internal echogenicity with in a meniscus on injured side; (C,D) Coronal and sagittal PD SPAIR images show a linear hyperintensity not extending upto the articular surface in posterior horn of medial meniscus-grade II signal

MR Technique and Protocol

The magnetic resonance scan was performed on a Philips Achieva 1.5 Tesla unit. T1W axial, sagittal, PD SPAIR coronal, PD SPAIR sagittal, and PD SPAIR Axial MRI sequences were used (Table 1).

Results

There were 50 participants in the study with a mean age of 37 years. Most of the participants were in the age-group of 21–30 years accounting 18 participants (36%) (Table 2).

In the current study, 23 (46%) of the participants (left knee) and 27 (54%) of the participants (right knee) were injured. There were 35 male participants in our study and only 15 females participants (Table 3).

In the existing study, 16 participants had a tear of medial meniscus detected on sonography. However, MRI diagnosed the tear of the medial meniscus in eight other participants. We found that 12 participants were tested positive for lateral meniscus tear on sonography. MRI showed five additional participants had a tear of lateral meniscus. There was a strong agreement between sonography and MRI for the diagnosis of the medial meniscus and lateral meniscus tears with a kappa value of 0.674 and 0.682, respectively (Table 4).

The current study found that ultrasound has a sensitivity and specificity of 66.67 and 92.30% in diagnosing tears of the medial meniscus, respectively. The positive predictive value (PPV) and negative predictive value (NPV) of sonography in diagnosing tears of the medial meniscus are 88.89 and 76.47%, respectively. Sonography has sensitivity and specificity of 70.59 and 96.97% in diagnosing lateral meniscus tears, respectively. The PPV and NPV of sonography in diagnosing lateral meniscus tears are 92.30 and 86.49%, respectively.

Table 1: MRI imaging protocol

Sequences	*TR*	*TE*	*THK*	*FOV*	*RFOV*	*NSA*
T1W TSE SAG	450–500	15–25	3.0/0.7	210	80%	2
T1W TSE COR	450–500	15–25	3.0/0.7	210	100%	2
PD SPAIR COR	1,500–3,000	12–18	3.0/0.7	210	100%	3
PD SPAIR TRA	1,500–3,000	12–18	3.0/0.7	210	100%	3
PD SPAIR SAG	1,500–3,000	12–18	3.0/0.7	210	100%	3

Table 2: Age-wise distribution of the subjects

Age-group (in years)	*Frequency*	*Percentage*
11–20	9	18
21–30	18	36
31–40	12	24
41–50	7	14
51–60	4	8
Total	50	100.0

Table 3: Distribution of subjects according to sex and side involved

Gender	*Right*	*Left*	*Total*
Male	20	15	35
Female	7	8	15
Total	27	23	50

Table 4: Correlation of USG and MRI

Structures	*Kappa value*	*p value*
Medial meniscus	0.674	<0.001
Lateral meniscus	0.682	<0.001

Discussion

Pathological conditions of the knee joint include both musculoskeletal structures (bones and joints) and soft tissues. There are many different diseases, conditions, and injuries affecting the knee joint that can be benefitted from diagnostic imaging and medical treatment.

Meniscal lesions are one of the important causes of knee pain after knee injuries. By imaging, we have to detect the meniscal tears early so that arthroscopy or surgery could be done early and prevent further complications. We have to differentiate the tears from the degenerative diseases of the knee.[10]

Advances in hardware and software of ultrasonography have made it a valuable, inexpensive, accessible, cost-effective, and dynamic technique for musculoskeletal evaluation. In recent years, the use of sonography in the diagnosis of orthopedic conditions has evolved. For proper diagnosis of knee injuries, attempts by various studies have made with varying degrees of success.[11] So in this study, we tried to determine whether the USG can be used as an alternative to MRI in the diagnosis of meniscal tears or not.[12]

Diagnostic Criteria for Meniscal Pathologies Tears on Sonography and MRI

On Sonography

Partial tear of meniscus: Clefts of lower echopattern seen within the structure (Fig. 2B).

Complete tear of meniscus: A part separate from meniscus was recognized or clefts of lower echopattern extending outside the free margin of the meniscus[13] (Fig. 3A).

On MRI

Two criteria are commonly used for making MRI diagnosis of a meniscal tear:

An abnormal meniscal morphology.

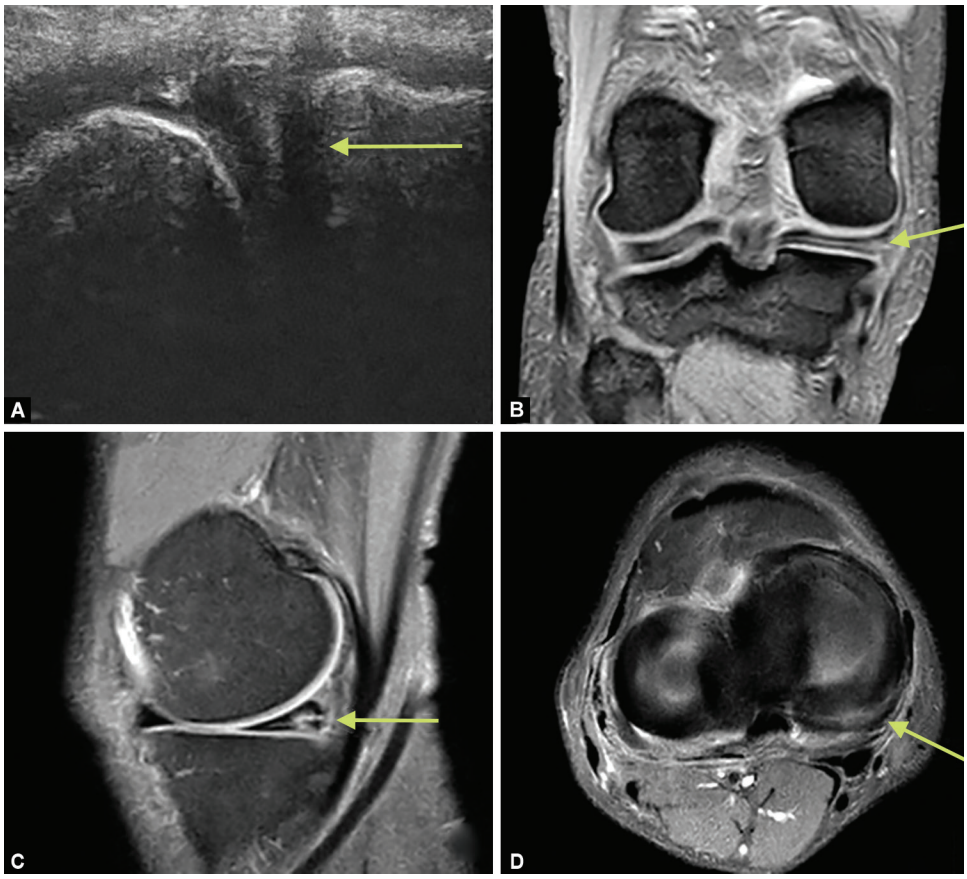
An intermediate or high signal intensity area in the substance of meniscus that extends unequivocally to the articular surface.

Grade I: Irregular or globular area of higher signal intensity limited within the meniscus and does not go beyond to the articular surface.

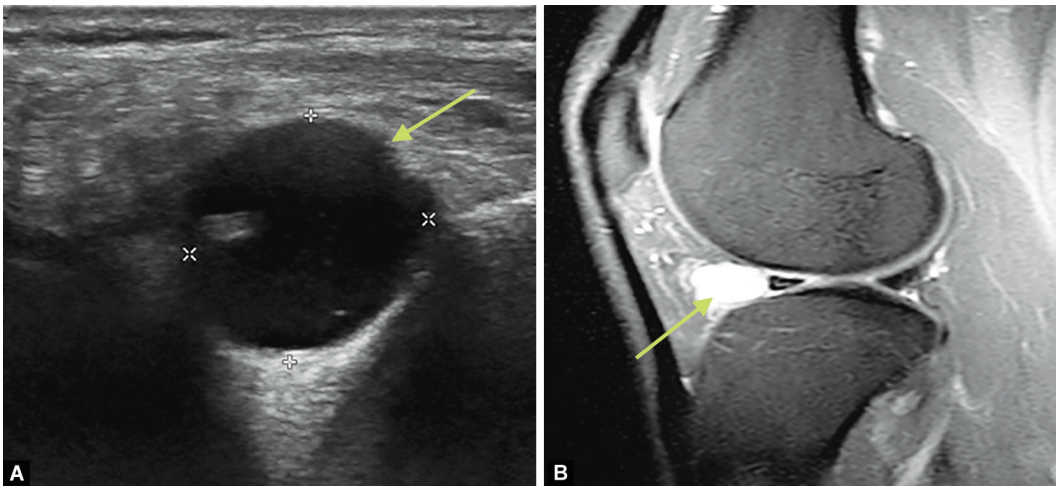
Grade II: A linear area of higher signal intensity is seen within the meniscus that does not cross either the inferior or the superior articular surfaces. It may, however, come into contact with the margin of capsule on the meniscus's posterior side (Figs 2C and D).

Grade III: A linear area of higher signal intensity that extends up to the superior and/or inferior articular surfaces[14] (Figs 3B to D).

In similar study done by Ravichandra et al.,[15] on sonography in diagnosing tear of medial meniscus and lateral meniscus shows the sensitivity of 62 and 23%, respectively, and specificity of 80 and 89%, respectively. They deducted that sonography may be used as a tool for screening purposes before undergoing arthroscopy in selected cases where these was contraindication to MRI or facilities



Figs 3A to D: Medial meniscus grade III tear. (A) USG image depicts hypoechoic medial meniscus with loss of its contours–medial meniscal tear; (B,C,D) PD SPAIR coronal, sagittal and axial images show hyperintense signal intensity in the body and posterior horn of medial meniscus which is reaching upto articular margins–meniscal tear grade III



Figs 4A and B: Parameniscal cyst with meniscal tear. (A) USG shows a well-defined cystic lesion with few fine intenal echoes within it noted in region of medial meniscus; (B) PD SPAIR sagittal image shows a well-defined hyperintense cystic lesion in anterior to the anterior horn of medial meniscus along with hyperintense signal in anterior horn of medial meniscus

were not accessible or if the patient is not affording. In a study of 74 cases, Alizadeh et al.[16] concluded that sonography is an important first-line investigation of choice for medial meniscus tears in people under the age of 30. Unlu et al.[17] also conducted a study in which they compared USG and MRI in the detection of meniscal tears and found moderate agreement (= 0.50.75, $p = 0.005$).

In a study of 198 participants, Timotijevic et al.[18] found that sonographic examination of acute injury of medial meniscus had a

sensitivity of 91.1%, a specificity of 80.0%, a positive predictive value of 83.6%, and a negative predictive value of 88.9%. In the diagnosis of meniscal tears, Peterson et al.[19] found that sonography had an 86% sensitivity and an 83% specificity. Our results for sensitivity, specificity, and accuracy of sonography were quite comparable to the more recent literature on sonography.

Visualization of joint effusion (hemarthrosis or hydrarthrosis) and cysts (which do or do not communicate with the joint) was also good on ultrasound.[20] The inability of USG to distinguish between different types of tears, as well as its failure to detect bucket handle tears, radial and oblique tears that had dislocated to the intercondylar notch, were all disadvantages in the evaluation of meniscal tears.

In our study, two participants with the tear of medial meniscus showed meniscal cysts as well-defined anechoic structures on sonography (Fig. 4).

Conclusion

Sonography is an excellent tool for evaluating people who have knee injuries, and it can be used as a primary imaging investigation because it allows for a quick, dynamic, and cost-effective examination of meniscal injuries in the knee joint. Ultrasound, on the other hand, has a limitation when it comes to evaluating deep-seated pathologies. Furthermore, sonography is operator-dependent and has a long learning curve; it will never be able to replace MRI, which is the preferred modality. It is, however, a good low-cost alternative when an MRI is not available or when the waiting period for an MRI could cause unnecessary management delays.

Orcid

Indermeet Mangat https://orcid.org/0000-0003-3794-4956
Parmeet Kaur https://orcid.org/0000-0001-9010-5241
Amandeep Singh https://orcid.org/0000-0003-0656-3368
Bikramjit Singh https://orcid.org/0000-0003-0039-0849

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