

# Knee sonography as a diagnostic test for medial meniscal tears in young patients

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## Abstract

**Purpose** To prospectively evaluate whether age of patient affects diagnostic accuracy of sonography and magnetic resonance imaging (MRI) in the diagnosis of medial meniscal tears.

**Methods** We prospectively evaluated 74 consecutive patients (54 males and 20 females), in two different groups [group A (37 patients  $\leq$  30 years; mean age:  $23.5 \pm 5$  years) and group B (37 patients  $>$  30 years; mean age:  $43.5 \pm 9.35$  years)] with clinical suspicion of medial meniscal tear. After inclusion, patients underwent ultrasonography and then MRI for signs of tearing. The ultrasonographic and MRI findings were compared with arthroscopic findings, which served as a gold standard for accurate detection of meniscal tearing.

**Results** The sensitivity, specificity, positive and negative predictive values and accuracy of ultrasonography in detecting medial meniscal tears in group A were 100, 88.9, 96.5, 100, 97.3 % and in group B were 83.3, 71.4, 92.6, 50,

81.1 %, respectively. The sensitivity, specificity, positive and negative predictive values and accuracy of MRI in group A were 100, 88.9, 96.5, 100, 97.3 % and in group B were 96.7, 85.7, 96.7, 85.7, 94.6 %, respectively.

**Conclusions** Given the fact that the sensitivity and specificity of the results of knee sonography matched that of MRI in patients who were 30 years old or less, we suggest ultrasonography as an effective initial investigation for tears of medial meniscus in this group of patients. Patients with negative ultrasonographic findings will need no further investigation.

**Level of evidence** Diagnostic studies—investigating a diagnostic test, Level II.

**Keywords** Meniscal tears · Diagnosis · Magnetic resonance imaging · Arthroscopy · Ultrasonography

## Introduction

Meniscal injury, especially medial one, is common not only in elite athletes but also in the general population. The results for clinical examination of the meniscal structures in young patients with reflectory muscle spasm or with acute trauma of the knee joint are poor [1]. Although the role of clinical examination in diagnosing meniscal tears is still marked, nonspecific pain of the knee joint often has too little specificity for meniscal tear [2].

Accurate diagnosis of meniscal tears depends upon the joint imaging. Knee arthrography has been largely replaced by magnetic resonance imaging (MRI) [2, 3] which is currently the diagnostic method of choice in evaluation of menisci [4]. The accuracy of MRI in diagnosing meniscal tears has been reported to be higher than 90 % [5, 6]. However, the use of MRI is not only expensive, but also

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associated with some limitations including metallic implants, claustrophobia, patients' motion artifacts and a long examination time [7]. Since MRI is not readily available, ultrasonography has replaced it for the diagnosis of the meniscal tears of the knee over the past 2 decades. [8–11].

Ultrasonography is cheaper, faster and more available than MRI. The sensitivity and specificity of some studies on the value of ultrasonography in the diagnosis of meniscal tears have varied greatly. [2, 12–15].

Our aim was to evaluate whether age of patient affects diagnostic accuracy of sonography and MRI in the diagnosis of medial meniscal tears.

## Materials and methods

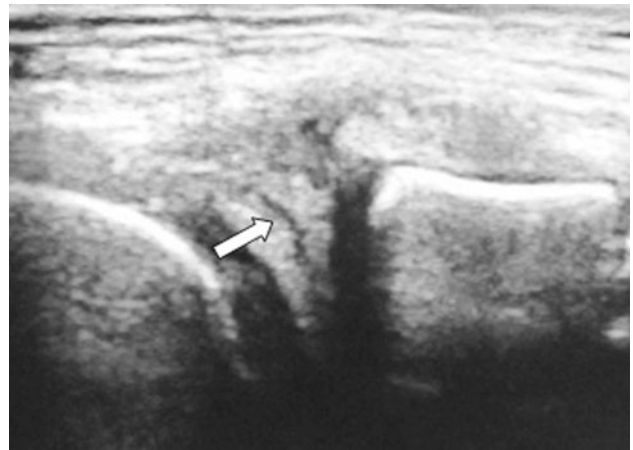
Seventy-four consecutive patients with clinically suspected medial meniscus tear were evaluated (54 males and 20 females). Subjects were divided into two different groups [group A (37 patients  $\leq$  30 years; mean age:  $23.5 \pm 5$  years) and group B (37 patients  $>$  30 years; mean age:  $43.5 \pm 9.3$  years)].

Patients with bilateral knee trauma, a history of knee surgery, known knee joint disease (e.g., rheumatoid arthritis) and metallic prostheses inside or around the knee and metallic prostheses in other parts of their body were excluded from our study.

Ultrasonography (US) was done on patients with unilateral knee trauma who were referred to the orthopedic clinic of the Poursina hospital suspected having medial meniscal tear (based on positive McMurray test, Apley grind test and joint line tenderness at least in the one examination). All patients underwent knee joint sonography and MRI followed by arthroscopy. First, all subjects were examined with B-mode US using a 14-MHz linear array transducer (SONIX OP). In order to evaluate posterior horn of the medial meniscus, the patient was laying prone on bed, the knee placed in full extension situation and a probe inserted on popliteal cavity.

To check the anterior horn of the medial meniscus, the patients were placed in the supine knee flexion at 30 degrees. Ultrasonography was performed at both rest and stress conditions. For better assessment of the medial meniscus, valgus stress position was used. Then, findings were compared with the ultrasonography of the patient's uninjured knee to provide an appreciation of the normal anatomy. Criteria for the diagnosis of meniscal tear included: hypo echoic line extending to the surface of the meniscus, edge unsharpness, meniscal cyst or irregular outline (Fig. 1).

Magnetic resonance imaging (MRI) was done in the same day as the ultrasound exam, using a 1.5-T scanner



**Fig. 1** Tear in posterior horn of medial meniscus (*arrow*) extending to inferior surface demonstrated on ultrasonography

with a transmit-and-receive cylindrical extremity coil. The diagnosis of a meniscal tear was made on the basis of presence of the increased linear or globular signal intensity extending to the articular surface (superior or inferior) of the meniscus on MRI (Figs. 2, 3).

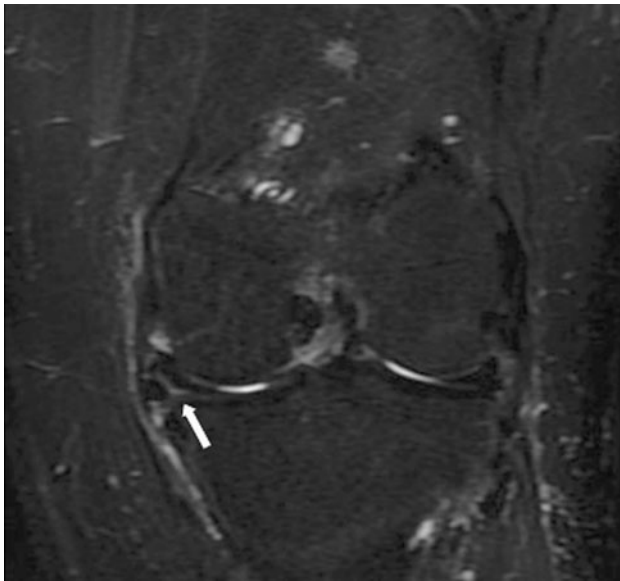
Knee arthroscopy was performed within 1–3 days after sonographic examination.

Each study was independently interpreted by a different investigator who was kept blind to the findings of the other ones.

The results of ultrasonography and MRI were compared with those of arthroscopy, and diagnostic indices including



**Fig. 2** A sagittal T1-weighted image depicts a tear in posterior horn of medial meniscus extending to inferior surface (*arrow*)



**Fig. 3** A coronal STIR image shows a tear in posterior horn of medial meniscus extending to inferior surface (arrow)

sensitivity, specificity, positive predictive value, negative predictive value and accuracy of ultrasonography and MRI in diagnosing meniscal tears were calculated.

Written informed consent was obtained from all participants.

All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 [16].

**Results**

The results comparing ultrasonography and arthroscopy and those comparing MRI and arthroscopy for each group are shown in Table 1.

The sensitivity, specificity, positive predictive value, negative predictive value and accuracy for each of the three techniques in each group are shown in Table 2. In first group ( $\leq 30$  years), there was a sensitivity of 100 % (95 % CI 88 to 100), specificity of 88.9 % (95 % CI 52 to 99),

positive predictive value of 96.5 % (95 % CI 82 to 99), negative predictive value of 100 % (95 % CI 63 to 100) and accuracy of 97.3 % (95 % CI 86 to 99) for ultrasound, and a sensitivity of 100 % (95 % CI 88 to 100), specificity of 88.9 % (95 % CI 52 to 99), positive predictive value of 96.5 % (95 % CI 82 to 99), negative predictive value of 100 % (95 % CI 63 to 100) and accuracy of 97.3 % (95 % CI 86 to 99) for MRI.

In second group ( $>30$  years), this showed a sensitivity of 83.3 % (95 % CI 65 to 94), specificity of 71.4 % (95 % CI 29 to 96), positive predictive value of 92.6 % (95 % CI 76 to 99), negative predictive value of 50 % (95 % CI 19 to 81) and accuracy of 81.1 % (95 % CI 65 to 92) for ultrasound. This compared with MRI sensitivity of 96.7 % (95 % CI 83 to 98), specificity of 85.7 % (95 % CI 42 to 99), positive predictive value of 96.7 % (95 % CI 83 to 99), negative predictive value of 85.7 % (95 % CI 42 to 99) and accuracy of 94.6 % (95 % CI 82 to 99).

**Discussion**

Although sonography has been used for the diagnosis of meniscal tears for over two decades [17], its effectiveness is still in question [2, 12–15]. A retrospective study of 321 patients by Azzoni and Cabitza [12] in 2002 showed that ultrasound was neither sensitive nor specific for diagnosing meniscal tears. They evaluated young males with clinically suspected meniscal tears. Only 216 had some form of radiological imaging and 126 had an arthroscopic evaluation. Thirty-three percent of the patients were excluded from the study because the ultrasound could not visualize the menisci. Since the arthroscopist was not blind to the imaging results pre-operatively, the study might have been associated with bias. Comparing with other modalities such as MRI and CT which had successfully identified a meniscal tear; the sensitivity and specificity for ultrasonography were 60 and 21 %, respectively.

In 2004, Bruce et al. [18] studied 56 consecutive patients who were clinically diagnosed for meniscal disorder. Ultrasonography was compared with both MRI and arthroscopy which was taken as the definitive assessment.

**Table 1** Details of the ultrasonographic and MRI findings versus the arthroscopic findings

	$\leq 30$ years		$>30$ years	
	Tear found at arthroscopy	Tear not found at arthroscopy	Tear found at arthroscopy	Tear not found at arthroscopy
Tear found on US	28	1	25	2
Tear not found on US	0	8	5	5
Tear found on MRI	28	1	29	1
Tear not found on MRI	0	8	1	6

**Table 2** Diagnostic efficacy indices for ultrasonography and MRI in detecting meniscal tear

	≤30 years		>30 years	
	Number	Percentage (95 % CI)	Number	Percentage (95 % CI)
<b>Ultrasonography</b>				
Sensitivity	28/28	100 (88–100)	25/30	83.3 (65–94)
Specificity	8/9	88.9 (52–99)	5/7	71.4 (29–96)
Positive predictive value	28/29	96.5(82–99)	25/27	92.6 (76–99)
Negative predictive value	8/8	100 (63–100)	5/10	50 (19–81)
Accuracy	36/37	97.3 (86–99)	30/37	81.1 (65–92)
<b>MRI</b>				
Sensitivity	28/28	100 (88–100)	29/30	96.7 (83–98)
Specificity	8/9	88.9 (52–99)	6/7	85.7 (42–99)
Positive predictive value	28/29	96.5 (82–99)	29/30	96.7 (83–99)
Negative predictive value	8/8	100 (63–100)	6/7	85.7 (42–99)
Accuracy	36/37	97.3 (86–99)	35/37	94.6 (82–99)

They did not mention whether they applied any blinding. They concluded that ultrasound studies of the knee in a general radiological practice do not offer significant information above clinical examination.

In these two studies, not all patients had imaging with both techniques. In our study, however, the two interpreting radiologists for MRI and ultrasound as well as the arthroscopist were blinded to the other results.

In 2007, Park G-Y et al. [7] prospectively evaluated twenty-two patients (16 females and 6 males; age range, 14–74 years; mean age, 50.4 years) with meniscal tears. MRI was used as the reference standard. The radiologist was blind to the patients' clinical data, identification and MRI results. Ultrasonography showed sensitivity, specificity, accuracy and positive and negative predictive values for meniscal tears of 86.2, 84.9, 85.4, 75.8 and 91.8 %, respectively. They concluded that ultrasonography is an accurate imaging study for diagnosing meniscal tears. They suggested ultrasonography as a useful imaging modality in uninjured knees. In this study, the results for ultrasonography were only compared with the MRI findings. Therefore, MRI was used as the reference standard while the gold standard for meniscal tears is arthroscopy.

In 2008, Shetty et al. [15] performed a prospective study investigating the sensitivity and specificity of ultrasonography in comparison with MRI in 35 patients clinically suspected having meniscal tear. The patients underwent pre-operative ultrasonography and MRI. There were 20 men and 15 women with a mean age of 47 years (14–73). The study showed a sensitivity of 86.4 % (95 % CI 75 to 97.7), specificity of 69.2 % (95 % CI 53.7 to 84.7), positive predictive value of 82.6 % (95 % CI 70 to 95.2) and a negative predictive value of 75 % (95 % CI 60.7 to 81.1)

for ultrasound, as compared with MRI sensitivity of 86.4 % (95 % CI 75 to 97.7), specificity of 100 %, positive predictive value of 100 % and negative predictive value of 81.3 % (95 % CI 74.7 to 87.9). Since the sensitivity of ultrasonography matched that of MRI, their findings supported the use of ultrasonography in the diagnosis of meniscal tears. In this study, the specificity of ultrasonography was lower than that of MRI.

None of the previous studies evaluated the impact of age on diagnostic effectiveness of the ultrasound. We, however, evaluated patients in two different age groups: age ≤ 30 years (common age for sport's trauma) and age > 30 years. It was found that the sensitivity, specificity, positive and negative predictive values and accuracy of ultrasonography and MRI were quite similar in the younger age group. Thus, ultrasonography may be used with a similar accuracy as MRI in detecting medial meniscal tears.

These parameters, however, were different for the patients in the second group in whom MR study turned to be more sensitive and specific. This difference represents the limited ability of ultrasonography for diagnosis of the meniscal tears as compared with MRI in patients 30 years of age or older.

The difference in accuracy of ultrasonography in detecting medial meniscus tears between two groups could be related to several factors. First of all, increase in rate of mucoïd degeneration in the medial meniscus which may produce inhomogeneous echogenicity. This may be misdiagnosed as tearing. However, extension of the signal abnormality into the articular surface could be a diagnostic clue. Secondly, decrease in cartilage thickness results in joint space narrowing which limits the field of view during

sonography. The last not the least, marginal osteophytes around the knee may produce posterior shadows that limit the penetration of ultrasound beam, thus produce inappropriate view of deep portions of the meniscus.

However, in 2011, Wareluk et al. [19] performed a prospective study on 160 knees in 80 patients (42 female, 38 male) with mean age 36.2 years, range 16–70 years. All of their patients underwent ultrasonography and arthroscopy. They analyzed their data in three different age groups (<30 years [ $n = 70$ ], 30–50 years [ $n = 50$ ] and >50 years [ $n = 40$ ]). The overall sensitivity, specificity, positive predictive value and negative predictive value of sonographic examination in the assessment of meniscal tears were 85.4, 85.7, 67.3 and 94.4 %, respectively. The highest sensitivity (>90 %) was obtained in medial menisci. They did not find age, sex, body mass index, weight, physical activity, mechanism of injury and time lapse from injury to have a statistically significant impact on the usefulness of ultrasonography.

In the present study, both knees joints were evaluated in all patients. The injured knee joints were compared with contralateral asymptomatic knee to understand the sonographic appearance and highlight the normal anatomic features of the meniscus more accurately. However, the discrepancy between the results of our study and those of the Wareluk et al. mandates further larger studies to evaluate the impact of age on sonographic meniscal findings and resolve some of the current unsolved issues.

The main limitation of our study is the relatively small number of patients. In addition, we only evaluated the medial meniscus.

In conclusion, although our study is a pilot one it has potential findings of importance for the diagnosis of medial meniscal tears in young people. Based on our results, ultrasonography was found to be quite sensitive and specific as compared with MR study for the detection of meniscal tears in patients <30 years of age. Therefore, ultrasonography is suggested as an effective initial investigation in this group of subjects suspected having injuries of the medial meniscus.

**Conflict of interest** The authors declare that they have no relevant financial interests and no potential benefits in any form from a commercial party related directly or indirectly to the subject of this manuscript or any of them in this manuscript.

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