Accuracy of hand-held ultrasound scanning in detecting meniscal tears

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The diagnosis of a meniscal tear may require MRI, which is costly. Ultrasonography has been used to image the meniscus, but there are no reliable data on its accuracy. We performed a prospective study investigating the sensitivity and specificity of ultrasonography in comparison with MRI; the final outcome was determined at arthroscopy. The study included 35 patients with a mean age of 47 years (14 to 73).

There was a sensitivity of 86.4% (95% confidence interval (CI) 75 to 97.7), a specificity of 69.2% (95% CI 53.7 to 84.7), a 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 ultrasonography. This compared favourably with a sensitivity of 86.4% (95% CI 75 to 97.7), a specificity of 100.0%, a positive predictive value of 100.0% and a negative predictive value of 81.3% (95% CI 74.7 to 87.9) for MRI.

Given that the sensitivity matched that of MRI we feel that ultrasonography can reasonably be applied to confirm the clinical diagnosis before undertaking arthroscopy. However, the lower specificity suggests that there is still a need to improve the technique to reduce the number of false-positive diagnoses and thus to avoid unnecessary arthroscopy.

Injury to the menisci of the knee has been recognised for over 130 years and its treatment is a common requirement of modern orthopaedic practice. The clinical diagnosis of a meniscal tear, however, can be difficult even for the experienced orthopaedic surgeon. Meniscal tears generally occur in a fit and economically active population and there may be delays in obtaining diagnostic imaging. MRI is the usual method used to confirm the diagnosis but is expensive. An alternative to MRI is ultrasound scanning which is quick to perform and much less costly.

The use of ultrasonography for the study of the menisci of the knee and particularly for defining tears has been proposed since 1989. However, its accuracy remains controversial.

In 2000 Grobbelaar and Bouffard stated that ultrasonography was not a reliable means of visualising the meniscus. An earlier review in 1993 of 179 patients with a suspected meniscal tear concluded that ultrasonography “is an experimental method without any clinical application”. By contrast, in 1996 Richter et al reported its value in a study using 64 cadavers. In 1998, De Maeseneer et al compared the ultrasonographic and MRI findings in the knees of eight cadavers and concluded that the former was not accurate for diagnosing tears of the menisci. However, in a study of 52 patients by Petersen and Rasmussen, it was found that ultrasonographic diagnosis of tears was confirmed by arthroscopy in 42 (81%).

Our aim was to assess the accuracy of a simple ultrasound device in assessing the menisci in a prospective, comparative study using the arthroscopic findings as the ultimate reference and MR imaging as the comparison technique against which to judge our results.

Patients and Methods
A total of 35 patients was consecutively identified from one surgeon’s acute knee injury clinic after a clinical examination which suggested the presence of a meniscal tear. Each patient was placed on the waiting list for arthroscopy and underwent pre-operative ultrasonography and MRI. Informed consent was obtained from all the patients. There were 20 men and 15 women with a mean age of 47 years (14 to 73).

An orthopaedic senior registrar (AAS) and a senior superintendent radiographer (KWF) with a special interest in musculoskeletal ultrasonography carried out the ultrasound scans. Neither had undergone any formal training in meniscal ultrasonography, but
both had used the technique previously to image the popliteal structures. An ESAOTE Technos MPS machine (Bracco UK Ltd, High Wycombe, United Kingdom) with a linear array probe of 5 mHz to 13 mHz was used (Fig. 1). Dynamic coronal images were taken with the knee of interest in 30° of flexion. The findings were compared with the ultrasound scans obtained from the patient’s asymptomatic knee.

They identified the tears in two ways. In the first, the most obvious evidence of a tear was the presence of hypoechogenic area within the meniscus itself (Fig. 2). In the early stages of the study, the sonographer occasionally misinterpreted the popliteal hiatus as a lateral meniscal tear. Comparison with the asymptomatic knee provided an appreciation of the normal anatomy. The second method was to observe outward movement (extrusion) of the meniscus during dynamic examination, again comparing the findings with those of the contralateral knee (Fig. 3).

Subsequently an MR scan of the symptomatic knee was undertaken. The T1 and T2 sagittal and coronal images were assessed by a senior musculoskeletal radiologist who was blinded to the results of ultrasonography.
Arthroscopy was undertaken by a senior orthopaedic surgeon who was blinded to the results of both imaging investigations. The arthroscopic findings were taken as the definitive assessment of the knee. The results of the three investigations were compared using 2 \times 2 contingency tables. The sensitivity, specificity, positive predictive value and negative predictive value of each investigation were calculated with their 95% confidence intervals (CI).

### Results

No patient was lost to follow-up. The results comparing ultrasonography and arthroscopy and those comparing MRI and arthroscopy are shown in Table I. The sensitivity, specificity, positive predictive value and negative predictive value for each of the three techniques with their 95% CI are shown in Table II. This 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. This 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).

### Discussion

In 2002 Azzoni and Cabitza\(^{11}\) published a retrospective study of 321 patients, and concluded that ultrasound was neither sensitive nor specific for diagnosing meniscal tears. Their sample group consisted of young males all with clinically-suspected meniscal tears. Only 126 had an arthroscopic evaluation and only 216 had some form of radiological imaging. In 33% of the ultrasound scans, the menisci could not be visualised, and these patients were excluded from the study. In addition, the arthroscopist was aware of all imaging results pre-operatively which may have produced bias. The sensitivity and specificity for ultrasonography were 60% and 21%, respectively, when compared with whichever other modality (MRI or CT) had successfully identified a meniscal tear. In 2004, Bruce et al\(^{12}\) studied 56 consecutive patients who were believed to have a meniscal disorder which had been diagnosed by clinical examination. Either MRI or arthroscopy was taken as the definitive assessment against which ultrasonography was compared, depending on which had been used. There was no mention whether any blinding was applied. They found that “ultrasound studies of the knee in a general radiological practice do not offer significant information above clinical examination.”

These two studies\(^{11,12}\) highlight the problems in the current literature. It therefore seemed appropriate to perform a prospective study in which all researchers were blinded to the results of the other techniques, and every patient had imaging with each technique. This provided a matched series for comparison of different techniques with less bias in the methodology.

Ultrasonography of a meniscal tear encompassed a static observation of a hypoechogenic area and a dynamic appreciation of meniscal extrusion; both were more readily identified by comparison with the findings in the patient’s normal knee. The extrusion of the meniscus when torn depended on a disruption of the ultrastructure and hence function of the meniscus. One of the meniscal functions is to convert axial compressive forces into hoop stresses. The meniscus is stabilised by the radially-orientated linking fibres; the role of the circumferential fibres is to control the axial load by converting compressive load to transfer forces.\(^{13}\) These resist the hoop stresses and prevent the meniscus from displacing peripherally as the axial load increases. In the presence of a tear the intrinsic stability of the meniscus on loading is lost and this can be detected.

The low specificity of clinical examination in the diagnosis of a torn meniscus is demonstrated by the larger number of our patients (13), who were believed to have a tear after...
clinical examination, but were found not to at arthroscopy. This supports the use of diagnostic imaging before embarking on surgery.

The accuracy of ultrasonography in our study judged by its sensitivity of 86.4%, which matched that of MR scanning, supports its use in the diagnosis of meniscal tears. Given the rapidity with which the investigation can be conducted and the relative lack of expense it is a good investigation for use in a ‘one-stop’ clinic. However, the slightly low specificity of ultrasonography found in our study (69.2%) may represent poor technique and may improve as experience with the method increases. Before routine use of ultrasonography in the diagnosis of meniscal tears, further improvement is required to address the problem of false-positive results which could lead to inappropriate surgery being performed. Our three false negatives were not the same patient for each imaging modality and had no particular tear geometry or characteristic. We found ultrasound to be less specific during the earlier, learning curve stage of the study.

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References