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ORIGINAL STUDY

Ultrasound assessment of internal derangement of the knee

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In a prospective double-blind study we investigated internal knee disorders with ultrasound and compared the results with Magnetic Resonance Imaging (MRI) and arthroscopy. The aim was to determine the effectiveness of ultrasound in diagnosing Internal Derangement of the Knee (IDK) and to compare the results with MRI. Over an 18-months period, 81 patients were examined. All were male ; they had a mean age of 35 years. For various technical reasons 21 patients were subsequently excluded from the study. After initial clinical examinations, patients had an ultrasound and MRI scan at the same visit. Arthroscopy was performed within a month of this. Different radiologists who were unaware of the clinical findings independently reported on the ultrasound and MRI. The surgeon performing the arthroscopy was made aware only of the MRI findings. Structures accessed were the lateral and medial menisci and the anterior (ACL) and posterior (PCL) cruciate ligaments. Arthroscopy was taken as the gold standard.

Ultrasound showed good sensitivity, ranging from 76% for the ACL to 90% for the medial meniscus, and excellent specificity, ranging from 92% for the medial meniscus to 100% for the ACL. Accuracy ranged from 86% for the ACL to 98% for the lateral meniscus. These figures were comparable to the MRI findings.

We concluded that ultrasound is a simple, accurate, inexpensive and non-invasive way of assessing internal knee disorders. There is a learning curve, but results are similar to MRI.

Keywords : internal derangement of the knee ; diagnosis ; ultrasound.

INTRODUCTION

Internal Derangement of the Knee (IDK) remains a common injury in sports (*7*). Clinical examination even by the most experienced staff using the strictest of clinical methods is not always enough to diagnose IDK (*7, 8*). Arthroscopy has been considered as the gold standard for the diagnosis of IDK, but is invasive, expensive and requires day surgery admission. MRI is now the non-invasive gold standard for the diagnosis of IDK, but MRI has long waiting lists and long examination times, and is expensive.

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Ultrasound examination has been tried for the diagnosis of IDK with variable results. It is a simple, inexpensive and non-invasive method (*4, 8, 9, 13*). There are studies on the use of ultrasound in the diagnosis of IDK all comparing the results with arthroscopy or arthrography (*8, 12, 14*). To our knowledge, there is no study comparing the results of ultrasound with MRI.

We devised a double blind, prospective study to assess the effectiveness of ultrasound in the diagnosis of IDK and compared the results with MRI and arthroscopy.

PATIENT AND METHODS

Between July 1997 and March 1999, we recruited 81 patients into the study. It was a double blind prospective study involving one consultant orthopaedic surgeon and two consultant radiologists.

Patient who came to the Accident and Emergency department with knee injuries were seen in the next trauma clinic within one week of their injury. They were seen by the consultant orthopaedic surgeon who documented a full history and undertook a full clinical examination of the involved knee. All findings were recorded on a pre-devised proforma. The patients were referred to the radiology department for ultrasound and MRI, with no clinical information provided on the referral form.

The ultrasound and MRI were carried out at the same appointment. The consultant radiologist performing the ultrasound had no knowledge of the clinical findings. The MRI was reported by a consultant radiologist unaware of the clinical or the ultrasound findings. The ultrasound was carried out in the following manner and findings recorded on a proforma.

Ultrasound of the knee was performed with an Acuson 128 using a linear array 7.5 MHz probe. The patient was initially placed supine with the knee extended. The anterior horns were examined from the medial and lateral aspects respectively. The knee was then flexed to 90 degrees and the probe rotated laterally to examine the Anterior Cruciate Ligament (ACL). This was a dynamic examination with the knee being serially extended during the procedure. The patient was then turned prone and the posterior horns were examined from the medial and lateral aspects respectively. The Posterior Cruciate Ligament (PCL) was then examined with the probe rotated medially.

Normal menisci appeared as homogeneous wedge shaped structures with uniform appearance throughout. The popliteal hiatus appeared as a low echogenic peripheral band. Suspicious menisci were classified as either abnormal when the echo-pattern was inhomogeneous giving a mosaic pattern or when there was blunting of the inner aspect. Menisci were called definitely torn when a separate fragment was identified or when there was abnormality extending beyond the free edge of the meniscus. The menisci were classified as normal, abnormal or definitely torn.

The normal ACL appeared as a band shaped structure, which could be followed from the tibial plateau to the femoral condyle. The fibres showed elongation and thinning as the knee was stressed. Abnormal ligaments showed complete interruption of the fibres or remained thick and shortened during stress. The PCL was a homogenous C-shaped structure with uniform echo-pattern throughout its length. The ligaments were classified as normal, torn or intact/not seen.

MRI was carried out with a 1.5 Tesla unit with a dedicated knee coil. The menisci were classified as normal, torn (vertical or horizontal), showing abnormal signal but not torn. The cruciates were classified as normal, partially torn or completely torn.

The patients then had an arthroscopy performed within one month of the initial injury. The surgeon was aware of the MRI finding only as a pre-requisite to arthroscopy, but was blinded to the ultrasound findings.

An examination under anaesthesia was followed by a routine arthroscopy and the anatomical structures were assessed with a probe, and findings documented. The pathology was dealt with accordingly.

RESULTS

There were 81 patients in total. Twenty-one of these were excluded from the study for various technical reasons (table I).

There were 60 patients left in the study, all of whom were males. The mean age was 35 years (range : 20 to 60). There were 40 right and 20 left knees. The findings of ultrasound and MRI were compared with the findings of arthroscopy, which was taken as the gold standard.

Summary of results are given in tables II, III and IV.

Ultrasound picked up seven of the 8 lateral menisci which were found to be torn on arthroscopy, with a sensitivity and specificity of

Table I. — Patients excluded from the study

9	No ultrasound done
4	Ultrasound and MRI reported by same radiologist
8	Arthroscopy delayed/not performed

87.5% and 100% respectively. The sensitivity and specificity of MRI for lateral meniscus was 75% and 100%.

Out of the 32 torn medial menisci, ultrasound was able to pick up 30. The sensitivity and specificity of ultrasound was 93% and 92.8% ; that of MRI was 87.5% and 85.7%.

There were 24 complete and 8 partial tears of the ACL on arthroscopy. Ultrasound correctly diagnosed 24 of the complete tears but was not able to pick up the partial tears. MRI correctively diagnosed all completely torn ACL's. The sensitivity and specificity for ultrasound and MRI were exactly the same at 75% and 100%.

Table II. — Summary of results

Lesions of	Arthroscopy			Ultrasound			MRI		
	Torn	Normal		Abnormal	Torn	Normal	Abnormal	Torn	Normal
LM	8	52		7	0	53	0	6	54
MM	32	28		24	6	30	8	28	24
	Comp	Partial	Normal						
ACL	24	8	28	16	8	36	4	20	36
PCL			60			60	1		59

LM = lateral meniscus ; MM = medial meniscus ; ACL = anterior cruciate ligament ; PCL = posterior cruciate ligament.

Table III. — Summary of statistics

Lesions	Stats	Ultrasound	MRI
Lateral Meniscus	True Positive	7	6
	True Negative	52	52
	False Positive	0	0
	False Negative	1	2
Medial Meniscus	True Positive	30	28
	True Negative	26	24
	False Positive	2	4
	False Negative	2	4
Anterior Cruciate Ligament	True Positive	24	24
	True Negative	28	28
	False Positive	0	0
	False Negative	8	8
Posterior Cruciate Ligament	True Positive	0	0
	True Negative	60	59
	False Positive	0	1
	False Negative	0	0

Table IV. — Arthroscopy versus Ultrasound and MRI

Structure Assessed	Sensitivity		Specificity		Accuracy		Positive Predictive value		Negative Predictive value	
	Ultra Sound	MRI	Ultra Sound	MRI	Ultra Sound	MRI	Ultra Sound	MRI	Ultra Sound	MRI
LM	87.5%	75%	100%	100%	98.3%	96.6%	100%	100%	98.1%	96.6%
MM	93%	87.5%	92.8%	85.7%	93.3%	86.6%	93.7%	87.5%	92.8%	85.7%
ACL	75%	75%	100%	100%	86.6%	86.6%	100%	100%	77.7%	77.7%
PCL	N/L	N/L	N/L	N/L	100%	98%	N/L	N/L	N/L	N/L

LM = lateral meniscus ; MM = medial meniscus ; ACL = anterior cruciate ligament ; PCL = posterior cruciate ligament ; N/L = no lesions.

There were no PCL lesions in the series, although one PCL looked abnormal on MRI.

DISCUSSION

Ultrasound diagnosis of orthopaedic/trauma conditions have gathered pace in recent years. It has become popular because it is safe, quick, inexpensive and fairly reliable (*1, 8*). Ultrasound diagnosis of IDK has been tried in various studies with variable results. Most of these studies compare ultrasound with arthroscopy or arthrography (*4, 9, 11, 13, 14*).

Some of the cadaver and clinical studies on the diagnostic efficiency of ultrasound in IDK report high yield rates with sensitivity for menisci ranging from 76% to 100% and specificity from 50% to 97% (*4, 8, 9, 12-14*).

In other studies the sensitivity for menisci was as low as 30% to 40% (*8, 11*). To our knowledge there is no study in the literature, comparing ultrasound findings to those of MRI in IDK. There is also scarce literature on the diagnosis of cruciate ligaments by ultrasound in IDK (*10*).

The use of 7.5 MHz probe for the visualisation of the menisci is well established and our experience was the same (*2*).

In our study the sensitivity and specificity for the lateral meniscus was 87.5% and 100% respectively. The sensitivity and specificity for the medial meniscus was 93% and 92.8% respectively. The number of lateral menisci was very low and therefore the results should be interpreted with caution. However, the number of medial menisci was significant ; both showed a high sensitivity and specificity. We also had good sensitivity and specificity for the ACL but did not have any PCL injuries in the series.

All structures, i.e. medial meniscus, lateral meniscus, ACL and PCL were visualised clearly in all knees. Although there were no PCL injuries, the PCL was clearly visualised with ultrasound, whereas its visualisation can be a problem on MRI.

As it is shown from our results, the ultrasound findings in IDK compare well with both arthroscopy and MRI. In some cases, as for example the PCL, we think it was even more helpful than MRI. Ultrasound is not widely used as a diagnostic test for knee injuries, and there has to be a learning curve for its routine use (*3, 15*). Although we think this learning curve could be short, we recommend that ultrasound could be used at present as a screening test before an MRI is performed or where clinical examination is difficult or unclear (*5, 6*).

CONCLUSION

Our study, assessing the usefulness of ultrasound in the diagnosis of IDK and comparing the results with MRI, is, to our knowledge, the first study of its kind.

The sensitivity and specificity of ultrasound for IDK are high and compare well with those of MRI and arthroscopy.

The use of ultrasound in IDK is limited at present, and we understand there has to be a learning curve, for it to be used routinely. At present we recommend the use of ultrasound as a screening tool before MRI or where clinical examination is difficult or unclear.

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