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MAGNETIC RESONANCE IMAGING OF THE INTERNALLY DERANGED KNEE JOINT. A PRELIMINARY LOCAL EXPERIENCE

Mohammed Moussa, MCh(Ortho),PhD*Abdulla Al-Othman, FRCS, JMC(Ortho)**

Objectives: To determine the validity of magnetic resonance imaging (MRI) as a diagnostic modality in the internally deranged knee joint, and to evaluate the effectiveness of MRI in reducing the number of diagnostic arthroscopies.

Design: A retrospective study was conducted on two groups of patients with internal derangement of the knee joint. All were arthroscoped before and after the installation of the MRI machine.

Setting: King Fahd University Hospital (KFUH), Al-Khobar, Saudi Arabia.

Subjects: Group 1 of 63 cases who underwent knee arthroscopy after MRI examination was compared to group 2 of 57 knees who satisfied the same inclusion criteria, but were scoped during the period before installation of the MRI machine.

Results: The accuracy values of MRI for the internally knee at our hospital were moderate, and there was no significant difference between the number of diagnostic arthroscopies that were not followed by further surgical procedures in the two groups.

Interpretation and Conclusion: These observations indicate that currently our MRI equipment needs improvement and development of new techniques. Awareness of the limitations and indications of this diagnostic modality in the internally deranged knee are warranted. Bahrain Med Bull 1996;18(1):

Many believe magnetic resonance imaging (MRI) to be the best diagnostic tool for evaluation of the internally deranged knee[1-4]. Some have even suggested that MRI may reduce the number of unnecessary arthroscopies6. However different centres report conflicting results in the accuracy of imaging of the menisci and cruciate ligaments[5].

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* Lecturer
** Assistant Professor
Department of Orthopedic Surgery
College of Medicine & Medical Sciences
King Faisal University
Dammam, Saudi Arabia

The present study seeks to determine the usefulness of MRI in the evaluation of the internally deranged knee and whether it really decreases unnecessary arthroscopies at our centre.

METHODS

All patients with suspected internal derangement of the knee who underwent MRI examinations and arthroscopy at the King Faisal University Hospital (KFUH), Saudi Arabia during the period from March 1992 to March 1994 (Group 1) were included in the study (63 cases) and compared to another control group of similar cases who underwent arthroscopy and were admitted at KFUH during the period between January 1986 to December 1988 before the installation of the MRI

machine (Group 2, 57 cases). The study was confined to patients who satisfied the following criteria:

1. No clinical or radiological evidence of fracture or arthritis of the affected knee joint.
2. No history of previous knee surgery.
3. A provisional diagnosis of meniscal tear, ligamentous injury, or internal derangement of the knee joint.
4. Cases scoped by the authors to reduce inter-observer variations.
5. Meniscal tears reported as Grade 1 and/or 2 by the radiologist were excluded as these are not detectable arthroscopically[7].
6. No other invasive diagnostic test (e.g. arthrography) was performed.

MRI Examinations: All patients in Group 1 had MRI examination of the symptomatic knee, using a 0.3 Tesla permanent magnet (Ultimate Fonar, USA). The technique of image reconstruction was 2 DFT. Patients were positioned supine and the lower extremity was externally rotated approximately 15-20 degrees for improved imaging of the anterior cruciate ligament (ACL) in the sagittal plane. A standard head RF receiver coil was applied. MRI sequences consisted of sagittal, and coronal images. Single spin echo (SE) pulse sequences were used with repetition time (TR) between 500-2000 msec, and echo time (TE) between 20-85 msec. Three excitations were employed to obtain images with an 18 cm field of view acquired on a 256 x 256 image display matrix. The slice thickness was 4 mm with 0.5 mm interslice gap, and the imaging time for each patient was approximately 45 minutes. These MRI studies were reported by one of three radiologists who were briefly informed about the clinical picture and the suspected lesion in the MRI request form. Any abnormalities of the menisci, cruciate ligaments or cartilage were described.

All patients were arthroscoped by one of the authors or both together. They were aware of the MRI findings. The arthroscopy findings were recorded in the operative reports. The reference diagnosis was based on the arthroscopic and the operative findings. Cases were reviewed by extracting data from the clinical records and MRI, arthroscopic, and operation reports. We determined the validity of MRI in the diagnosis of meniscal or ligamentous tears in Group 1 by calculating its sensitivity, specificity, predictive values of a positive and a negative result and accuracy. Statistical evaluation of the comparison between the number of diagnostic arthroscopies that were not followed by any surgical procedure in Group 1 and 2 was performed by using chi-square test of proportions with a confidence level of $P < 0.05$.

RESULTS

All of the 63 patients in Group 1 were males and their ages ranged from 17 to 45 years (mean 25.6, SD 6.5). The right knee was affected in 35 cases (55.6%). At arthroscopy, 78 cruciate ligament and/or meniscal tears were detected (Table 1). There were 47 meniscal tears in 43 patients, 26 of the medial and 21 of the lateral meniscus. Arthroscopy showed 24 complete tears of the ACL and two of the Posterior Cruciate Ligament (PCL). In addition, two partial ACL tears and 3 cases of laxity of this ligament were diagnosed arthroscopically. MRI correctly diagnosed all the complete tears, but none of the partial tears. Also laxity of the ACL was not identified at MRI examination. Radiolucent loose bodies were detected arthroscopically in 2 cases, and hypertrophied thick medial plicae were seen in 3 more knees with a negative MRI examination. Large chondral lesions (ulcers) were identified arthroscopically in two or more cases and were not detected by MRI. The results of MRI examination in relation to the reference

diagnosis are shown in Table 1. Eighteen (28.6%) of the scoped knees in this group had no additional surgical procedures.

Table 1
MRI examination results in relation to reference diagnosis based on arthroscopy and operative findings (Group 1)

MRI result	Medical meniscus tear	Lateral meniscus tear	ACL tear	PCL tear
True positive	21	17	24	2
False positive	10	7	9	0
True negative	27	35	25	61
False negative	5	4	5	0
Total	63	63	63	63

ACL = Anterior Cruciate Ligament
PCL = Posterior Cruciate Ligament

The other 45 knees had further operative procedures including meniscectomies (35), repair of meniscal tear (4), trimming of the ACL stumps (20), reconstruction of the ACL (4), removal of loose bodies (2), excision of medial plica (3), and drilling of chondral ulcers (2 knees).

Table 2 show the validity of MRI examination in terms of sensitivity, specificity, predictive value of a positive result, predictive value of a negative result, and accuracy with reference to medial meniscus, lateral meniscus, ACL and PCL injuries.

Table 2
Validity of MRI examinations

	Sensitivity		Specificity		Pred. value of +ve result		Pred. value of -ve result		Accuracy	
	n/N	%	n/N	%	n/N	%	n/N	%	n/N	%
MM	21/26	81	27/37	73	21/31	68	27/32	84	48/63	76
LM	17/21	81	35/42	83	17/24	70	35/39	90	48/63	76
ACL	24/29	83	25/34	74	24/33	73	25/30	83	49/63	78
PCL	2/2	100	61/61	100	2/2	100	61/61	100	63/63	100

MM: Medial Meniscus, LM: Lateral Meniscus, ACL: Anterior cruciate ligament, PCL: Posterior cruciate ligament

Group 2 included 57 consecutive knees in 56 patients who had arthroscopy and satisfied the same criteria of patient selection during the period before installation of the MRI machine in our hospital. This group of cases matched Group 1 in age and sex distribution, and all were scoped by the authors. Thirty-seven of the knees in this group had further surgical procedures including meniscectomies (32 knees), removal of loose bodies (3 cases), repair of the medial meniscus (1 case) and shaving of the patella (1 case). Twenty (35.1%) of the knees in this group have had no further surgical procedures other than the diagnostic arthroscopy.

The difference between the number of diagnostic arthroscopies in group 1 and 2 was statistically insignificant (P = 0.5688) (Table 3).

Table 3
Comparison between numbers of diagnostic arthroscopies in Group 1 and 2

	No. of Diagnostic Arthroscopies	No. of Arthroscopies followed by surgical procedures	Total
Group 1	18*	45	63
Group 2	20*	37	57
Total	38	82	120

* Chi-square > 0.05

DISCUSSION

The high incidence of knee injuries continues to be a problem to the orthopaedic surgeon and needs adequate diagnostic evaluation. Early in 1992, a new MRI machine was installed at King Fahad University Hospital, Alkhobar, Saudi Arabia. The early results of MRI have confirmed its ability to identify internal derangement of the knee reasonably. The advantages of MRI include its non-invasive nature, the ability to evaluate the knee in multiple planes, absence of ionizing radiation, the superior soft tissue contrast compared with x-ray based techniques and its capacity to evaluate the knee joint in the presence of effusion or painful haemarthrosis[8].

MRI currently is considered by many investigators to be the best screening test for the evaluation of internal derangement of the knee[3,4]. However, its accuracy of imaging the menisci ranged from 45 to 98%, and that of imaging the cruciate ligaments from 90 to 100%[q] Fischer et al[5] conducted a multicentre study on MRI examinations of the knee and the results varied substantially among centres. The accuracy ranged from 64 to 95% for the medial meniscus, from 83 to 94% for the lateral meniscus, and from 78 to 97% for the ACL. The accuracy of MRI at our hospital was 76% for the medial and lateral meniscus, 78% for the ACL, and 100% for the PCL. These values of the accuracy of the diagnoses were better than those of Raunest et al[13], and Glashaw et al[5], but lower than those reported by others[4,6,14]. We believe that our results lie between the upper and lower levels of previous reports. The false positive MRI findings in our study have been a greater source of error than false negative findings, although Grade 1 and 2 degenerative tears of the menisci were excluded. This is demonstrated by the relatively higher predictive values of a negative result (Table 2) which is in accordance with other reports[15]. Moreover, we found that MRI was not sensitive for the detection of ligamentous laxity and partial tears of the ACL, chondral ulcers, and cartilaginous loose bodies in the knee.

The wide differences in accuracy of diagnosis from MRI of the knee from different centres may be attributed to many variables including the expertise of the radiologist, the type of magnetic resonance unit, and the parameters that were used for imaging. Our results presented in this study represent the early experience with MRI in the evaluation of internal derangement of the knee and some of the errors may have been related to a learning curve. Fischer et al[5] multicentre study suggested increased accuracy for the units that had a stronger magnetic field. The strength of our magnet was low (0.3 Tesla). Also computer software programmes that are used to generate the image, the type of surface coil and parameters of the imaging sequences would affect reliability of the

findings. T2 weighted images in this series were not very clear as noted by the radiologists because of the low strength of the electromagnet used, and a technical problem with the software programme. This problem has been solved with the manufacturer recently. Furthermore, axial scans were not taken routinely leading to missing of 3 cases with plica syndrome, and 9 meniscal tears were also not identified by MRI probably due to the relatively large slice thickness (4 mm) and the interslice gap used (0.5 mm) in addition to the other factors. To improve diagnostic accuracy, continuous scanning without interslice gaps is done in a three-dimensional mode[7]. These would reduce errors associated with volume averaging and achieve better definition of anatomical details[16,17].

The present study was also designed to see how MRI could affect our arthroscopic practice and its effectiveness in reducing the number of diagnostic arthroscopies. The appropriate uses of MRI and arthroscopy in the diagnosis of internal derangement of the knee are controversial and are a topic of current debate18. It has been suggested that MRI could be used to exclude arthroscopically treatable lesions in one-third to one half of patients subjected to diagnostic arthroscopy[6,19]. The moderate validity values of our current machine have confirmed that our MRI was not effective in reducing the need for diagnostic arthroscopy with its risk as an operative procedure. Although the number of diagnostic arthroscopies that were not followed by further surgical procedures in Group 1 was smaller than in Group 2 (29% and 35%), yet the difference was statistically insignificant ($P > 0.05$). There are probably many reasons for this. First, we consider very much the importance of careful history taking and a proper conduct of physical examination. Our previous report[20] and other[21,22] have shown that the reliability of clinical examination for the diagnosis of disorders of the knee ranged from 64 to 95%. However, clinical evaluation of knee problems cannot define the extent and morphology of the different lesions. Secondly, we believe that a conservative healing of minor insignificant injuries and only those cases with a persistent symptomatic knee should undergo further diagnostic invasive procedures e.g. arthroscopy[23,24]. This conservative approach has resulted in a decreased number of diagnostic arthroscopies in the two groups of the present study (18 & 20 cases). Thirdly, and the most significant was the relatively moderate validity results of our current machine because of the different factors noted earlier. In an era of cost-containment, we agree with Silva and Silver[12] that MRI should not be used as a routine screening test for meniscal lesions.

CONCLUSION

The present study, although highly selective for many reasons, it did prove that MRI in the first two years after installation at our hospital provided only a moderate diagnostic accuracy for the internally deranged knee. Currently this diagnostic modality needs improvement, development of new techniques, and increasing experience. Our study indicates that MRI should not be used as a routine screening test for all patients with internal derangement of the knee or as a precursor to every arthroscopic procedure. This expensive study with moderate reliability at our hospital is of limited value in the clinically detectable cases with a high suspicion index, and in patients undergoing a planned reconstructive surgery for a torn ACL. It seems to be more valuable for cases with equivocal symptoms and signs of meniscal tears not responding to conservative measures, cases with acute painful traumatic haemarthrosis, the postoperative symptomatic knee, before a second-look arthroscopic examination, and for patients refusing arthroscopy.

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