ORIGINAL ARTICLE

The Role of Preoperative Magnetic Resonance Imaging in Internal Derangement of the Knee

Z F Zairul-Nizam, M Y Hyzan, S Gobinder, M A Razak M A, Department of Orthopaedics and Traumatology, Hospital Universiti Kebangsaan Malaysia, Jalan Tenteram, Cheras 56000 Kuala Lumpur

Summary

We attempted to compare the accuracy of our clinical examination and the usage of magnetic resonance imaging (MRI) in evaluating patients suspected of having internal derangement of the knee who were seen in our Orthopaedic clinic. This was done using the findings of arthroscopy as the 'gold standard'. The accuracy of MRI in detecting cruciate ligament tears was between 80-96% against 82-93% for clinical examination. MRI accuracy for meniscus injuries was 80-84% compared to 48-65% for clinical examination. We thus propose that MRI examination is an effective first-line investigation for patients with suspected internal knee derangement, especially menisci injuries; allowing arthroscopy to be reserved for patients in whom surgery is truly indicated.

Key Words: Internal derangement of knee, Magnetic resonance imaging, Arthroscopy

Introduction

Internal derangement of the knee joint refers to a collection of intra-articular lesions found to be the causes of problems relating to the knee joint. In the evaluation of internal knee derangement, surgeons are often hard pressed to come to a diagnosis. Several papers have elucidated the unreliability of clinical examination in assessing the menisci and cruciate ligaments in the acute setting[1-4]. Often, patients are referred for arthroscopic evaluation when the diagnosis is uncertain or if the patients fail to recover as expected through conservative measures. Arthroscopy has revolutionized internal visualization of the joint by allowing quick examination and prompt diagnosis.

Although arthroscopy is often regarded as the 'gold standard' in evaluating internal knee disorders with an accuracy rate of between 64% to 98.6%2,[5-7], it is invasive as a surgical procedure and predisposes the patient to risks inherent to anaesthesia and surgery. Magnetic resonance imaging (MRI) provides an alternative non-invasive technique in diagnosis which is safe, and rapid. In skilled hands, an accuracy rate approaching that of arthroscopy may be obtained [2,7-9,14].

In this study, we aimed to compare the effectiveness of clinical examination, and MRI in diagnosing internal knee derangement. In doing so, we attempted to elucidate the cost-effectiveness of the MRI as a first-line investigation with a specific aim to reduce the need for diagnostic surgery and thus the surgical and anaesthetic risks involved. The following are the early results of our effort.

Materials and Methods

Between June 1998 and June 1999, a total of 55 patients were selected to be included in our prospective, controlled study. All patients underwent thorough history taking and clinical examination to determine the presence of either a meniscus and/or cruciate ligament injury which was the main determinant for entry into the study. Routine preoperative anteroposterior, lateral, and Merchant's or skyline radiological examinations of the knees were also assessed to exclude the presence of fractures, loose bodies, and degenerative changes so as not to influence in any way the outcome of the study.

All 55 patients were seen by one of us and all the relevant clinical findings noted after a thorough history taking. An anterior cruciate ligament is considered clinically affected when any two of clinical tests were positive: anterior drawer, Lachman, or pivot shift test. The posterior cruciate is suspected when the posterior drawer test is positive. The menisci are considered suspect if either joint line tenderness or a positive McMurray test is noted.

Group 1 consisted of 26 patients who were seen by one of us and an MRI ordered. Imaging was done on a 1.5T superconducting magnet using a dedicated knee coil. The images were acquired contiguously with 4mm section thickness, 0.4mm interslice gap, field of view of 180mm and using 256x256 imaging matrix. The knee was externally rotated during sagittal imaging.

The menisci were described as either normal, degenerated, or torn (Table I). The cruciate ligaments were similarly described as either normal, partially torn, or completely torn (Table II). Regardless of the results of the MRI, and whether the results were either known to the surgeon or otherwise, these patients subsequently underwent arthroscopy by one of us (G.S.). The MRI findings were then compared against that of arthroscopy.

Table I
MRI classification of meniscal lesions

Normal	
Degenerated	Area of increased signal intensity within meniscus that does not extend to articular surface
Torn	Area of increased signal intensity extending to articular surface or free margin of meniscus

Table II
MRI classification of cruciate ligament lesions

Normal	
Partially torn	Inhomogeneity and increased signal intensity within ligament but with some fibres intact
Completely torn	Total discontinuity or an area of strongly increased signal intensity extending completely across ligament

Group 2 consisted of 29 patients all of whom subsequently underwent arthroscopy by one of us (G.S.) without the benefit of an MRI and the clinical findings were compared against the arthroscopic findings.

A finding is considered true positive (TP) when the diagnosis is confirmed at arthroscopy. Conversely, a true negative (TN) diagnosis is made when no similar finding is made at arthroscopy. A false positive (FP) finding indicated a lesion noted on clinical / MRI examination but is not revealed at arthroscopy, and a false negative (FN) diagnosis means a lesion which is noted at arthroscopy but not on clinical / MRI examination. Accuracy is determined by the total number of true positives and true negatives divided by the sample number.

Results

In group 1, the patients range of age was between 16 to 49 years (average 30.01 [SD=8.10]). There were 21 men and 5 women. 13 patients had problems with the left knee compared to 13 whose problems were right-sided. Sport injuries predominated as the causative mechanism of injury in this group. The findings of the MRI compared to that of arthroscopy is summarized in Table III.

Table III
MRI and clinical examination findings compared to arthroscopy

		True Positive	True Negative	False Positive	False Negative	Accuracy (%)
ACL	Group 1 (n=26)	16	5	4	1	80.8
	Group 2 (n=29)	11	13	1	4	82.8
PCL	Group 1	3	22	0	1	96.2
	Group 2	2	25	2	0	93.1
MM	Group 1	12	10	3	1	84.6
	Group 2	8	6	11	4	48.3
LM	Group 1	12	9	5	0	80.7
	Group 2	6	13	6	4	65.5

ACL- anterior cruciate ligament: PCL-posterior cruciate ligament; MM-medial meniscus; LM-lateral meniscus

The interval between MRI and arthroscopy was on average 62.3 days (SD=53.2) with a range between 8 to 272 days. None of these patients reported any additional injury to the affected knee during the interval.

The false positives for the ACL injury were actually partial intra-substance tears on arthroscopy. The false negative for ACL injury was a partial lesion on MRI but noted to be a complete one on arthroscopy with the ACL attached to the PCL. A partial tear of the PCL was not noted on the MRI. A radial tear was noted in one MM on arthroscopy but was not picked up on MRI. False positive MRI findings for MM were flap tear of the posterior horn in one meniscus, a transverse tear of the posterior horn in another, and a degeneration which was noted on MRI but found at arthroscopy to be osteoarthritis of the medial tibial condyle. Five false positives were noted for the LM - one involving the anterior and posterior horns, one degenerative tear of the body, two others involving the posterior horn in isolation, and another involving the anterior horn in isolation. In all these cases, no meniscal tears were seen; instead, there was noted either synovitis or osteoarthritic changes.

Group 2 consisted of patients with their ages ranging from 17 to 48 years (average 29.17 years [SD=9.08]). There were 24 men compared to 5 women in this group. There were 16 patients with problems in the left knee and 13 on the right. The clinical findings were compared to arthroscopy and the results are summarized in Table III.

The average interval between clinical examination and arthroscopy was 51.7 days with a range of between 6 to 162 days. No additional injuries were reported during this interval.

The false negatives for ACLs consisted of 2 partial and 2 complete tears. A partial ACL injury was diagnosed clinically but was found to be intact on arthroscopy hence the false positive result. In the case of PCLs, the false positives involved cases with one complete and one partial ACL each. False positives for the MM consisted of 2 cases of paradoxical McMurray tests and 9 cases of either osteoarthritis or synovitis of the medial compartment. Clinical examination failed to detect 4 cases of tears of the MM in the body (2 cases) and posterior horn (2 cases). For the LM, 5 cases of osteoarthritis of the lateral compartment were wrongly diagnosed as meniscus tears. Another case of osteochondritis dessicans of the medial femoral condyle was wrongly diagnosed as a lateral meniscus tear. Clinical examination failed to detect 4 cases involving the posterior horn and body (2 cases respectively).

Discussion

Admittedly, the sample size of this study is rather small. This is because the study was performed within a limited time constraint for the completion of a post-graduate dissertation project.

These 2 groups are comparable in terms of age and sample size to allow a fairly accurate analysis. We looked at only the meniscus and cruciate ligaments as these were the structures commonly affected and because there were standard clinical tests described for their presence. In terms of accuracy, the MRI is much more adept at detecting internal knee derangement compared to clinical examination[1,2,8,9]. Some studies have stated the unreliability of clinical examination. Our own study revealed a cruciate ligament detection of 82.8 to 93.1% and meniscal detection of only between 48.3 to 65.5%. The tests for detecting tears of the menisci are particularly fallible. Kim et al described the accuracy rate for clinical meniscal examination to be between 68.5 to 87% at best[10]. In our study, the medial meniscus is more prone to be wrongly diagnosed compared to the lateral meniscus. Although the McMurray test is the clinical test most widely used to detect meniscal injuries, its accuracy remains inconsistent. Joint line tenderness is too vague a clinical finding for any definite diagnosis to be formed based on its presence. The Paradoxical McMurray test occurred twice in our study and both were for the medial meniscus. The presence of the possibility of a paradoxical test further adds to the confusion of clinical findings[10]. For the cruciates, both the clinical examination and the MRI appear to be at par in terms of overall accuracy. In attempting to interpret this difference, it may be that the tests for the cruciate ligaments rely on direct stretching of the ligament whereas the McMurray test depends on the meniscal lesion being displaced by the articulating surface of the femur - which is more difficult to reproduce.

Based on other reports, the accuracy of the MRI in our study has approached that of the arthroscope. Silva et al described an accuracy rate of 68.8 to 76.3% for meniscal lesion detection via the arthroscope[11] while Williams et al described an overall arthroscopy accuracy rate of 55 to 94%[12]. The duration of the interval between MRI and arthroscopy may be a factor in explaining the rates of inaccuracies of the imaging in the absence if additional injury. It is possible that healing of the lesion may have occurred during this time thus accounting for the 'false' result [5]. This is especially so for peripherally based tears of the menisci. The MRI inaccuracies may also be explained in terms of the actual inability of the arthroscope to detect lesions especially those in the posterior horn of menisci, and inferiorly based meniscus tears [2,6,13,14]. Due to the 30-degree offset of the arthroscope and the difficulty in bringing the posterior horn into full view even with stress, these lesions may not be easily seen; even with the use of a probe. Inferiorly based tears are almost impossible to be fully visualized. The MRI may therefore be more accurate in detecting certain lesions compared to the arthroscope especially if degeneration of a meniscus is the cause of knee pain [15,16]. Some authors have highlighted this fact; in fact some have actually questioned the ability of the arthroscope as a 'gold standard' [13]. The comparatively high of predictive values obtained through this study also lends to our belief that a preoperative MRI is justified to support or refute clinical impressions.

By accepting the accuracy rates revealed above, then, based on the results of group 2, a large number of patients will have undergone surgery without an adequate appreciation of the lesions involved. In considering the risks of surgery and anaesthesia, the cost of an additional non-invasive investigation appears justified. MRI alone could have detected 'simple' injuries which do not require any surgical intervention such as partial ACL injuries and simple peripheral meniscal injuries. Conversely, tears not detected on arthroscopy may have been left untreated and perpetuated when this lesion may have been more easily seen on MRI. It thus follows that should an MRI be carried out preoperatively, then the surgeon may be 'guided' towards seeking a noted lesion as well as helping in patient counseling [7,15,16]. Patients who may in fact not require surgical intervention may be saved the effects (and cost - either actual or perceived) of arthroscopy[13]. This in fact expresses cost-effectiveness in the projected economics of patient care especially when we consider the probable complications such as instrument breakage, compartment syndrome, nerve injuries, infections, etc. [17-19] OT expenditures, instrument maintenance, working hours lost and so forth may be reduced based on MRI evidence of injuries, or lack thereof. The waiting list of diagnostic

arthroscopy may also be reduced with additional overall savings [1,2,5,9,12,13,20]. In cases where the diagnosis is in doubt, it will therefore be wiser to perform an MRI by a dedicated musculoskeletal radiologist. Should a lesion which is amendable only by surgical means be found, then surgical intervention may be promptly instituted if necessary. Otherwise, a course of conservative therapy may be all that is required.

In conclusion, we believe that the MRI provides a cost-effective first-line non-invasive investigation for patients with internal derangement of the knee. This does not mean that thorough clinical examination is replaced; rather, it will allow augmentation of sound clinical judgement.

Acknowledgements

The authors would like to acknowledge the assistance of Dr. S. Shanti of the Radiological Department, Hospital Universiti Kebangsaan Malaysia.

References

1. Boeree NR, Ackroyd CE. Assessment of the menisci and cruciate ligaments: An audit of clinical practice. Injury 1991; 22 (4): 291-4.
2. Boeree NR, Watkinson AF, Ackroyd CE, Johnson C. Magnetic resonance imaging of meniscal and cruciate injuries of the knee. J Bone Joint Surg 1991; 73B (3): 452-7.
3. Lawson GM, Nutton RW. A prospective audit of the knee arthroscopy: A study of the accuracy of clinical diagnosis and therapeutic value of 325 knee arthroscopies. J R Coll Surg Edin 1995; 40: 135-7.
4. Tait GR, Maginn P, Macey AC, Beverland DE, Mollan RAB. Unnecessary arthroscopies. Injury 1992; 23 (8): 555-6.
5. Chissell HR, Keightley A, Allum RL. MRI of the knee: Its cost-effective use in a district general hospital. Ann R Coll Surg Engl 1994; 76: 26-9.
6. Ireland J, Trickey EL, Stoker DJ. Arthroscopy and arthrography of the knee. A critical review. J Bone Joint Surg 1980; 62B (1): 3-6.
7. Polly DW, Callaghan JJ, Sikes RA, McCabe JM, McMahon K, Savory CG. The accuracy of selective magnetic resonance imaging compared with the findings of arthroscopy of the knee. J Bone Joint Surg 1988; 70A (2): 192-8.
8. Lee JK, Yao L, Phelps CT, Wirth CR, Czapca J, Lozman J. Anterior cruciate ligament tears: MR imaging compared with arthroscopy and clinical tests. Radiology 1988; 166: 861-4.
9. Spiers ASD, Meagher T, Ostlere SJ, Wilson DJ, Dodd CAF. Can MRI of the knee affect arthroscopic practice? A prospective study of 58 patients. J Bone Joint Surg 1993; 75B (1): 49-52.
10. Kim SJ, Min BH, Han DY. Paradoxical phenomena of the McMurray test. An arthroscopic investigation. Am J Sports Med 1996; 24 (1): 83-7.
11. Silva Jr. I, Silver DM. Tears of the meniscus as revealed by magnetic resonance imaging. J Bone Joint Surg 1988; 70A (2): 199-202.
12. Williams RL, Williams LA, Watura R, Fairclough JA. Impact of MRI on a knee arthroscopy waiting list. Ann R Coll Surg Engl 1996; 78: 450-2.
13. Quinn SF, Brown TF. Meniscal tears diagnosed with MR imaging versus arthroscopy: How reliable a standard is arthroscopy? Radiology 1991; 181: 843-7.
14. Rappeport ED, Wieslander SB, Stephensen S, Lausten GS, Thomsen HS. MRI preferable to diagnostic arthroscopy in knee joint injuries. A double-blind comparison of 47 patients. Acta Orthop Scand 1997; 68 (3): 277-81.

15. Raunest J, Hotzinger J, Burrig KF. Magnetic resonance imaging (MRI) and arthroscopy in the detection of meniscal degenerations. Correlation of arthroscopy and MRI with histology findings. Arthroscopy 1994; 10 (6): 634-40.

16. Raunest J, Oberle K, Loehnert J, Hotzinger H. The clinical value of magnetic resonance imaging in the evaluation of meniscal disorders. J Bone Joint Surg 1991; 73A (1): 11-6.

17. Bamford DJ, Paul AS, Noble J, Davies DRA. Avoidable complications of arthroscopic surgery. J R Coll Surg Edinb 1993; 38: 92-5.

18. Kieser C. A review of the complications of arthroscopic knee surgery. Arthroscopy 1992; 8 (1): 79-83.

19. Sherman OH, Fox JM, Snyder SJ, Pizzo WD, Friedman MJ, Ferkel RD, Lawley MJ. Arthroscopy - "No-problem surgery". J Bone Joint Surg 1986; 68A (2): 256-65.

20. Carmicheal IW, MacLeod AM, Travlos J. MRI can prevent unnecessary arthroscopy. J Bone Joint Surg 1997; 79B (4): 624-5.