The Accuracy of Magnetic Resonance Imaging in the Diagnosis of Knee Chondral Lesions

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Citation

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Abstract

Objective: To evaluate the sensitivity, specificity, and accuracy of routine 1.5-Tesla MRI in detecting chondral lesions of the knee.Method: This is a retrospective review of 300 knee arthroscopic procedures performed between January 2004 and September 2008. Nineteen patients were included in the study. MRI was performed in a 1.5-Tesla machine, with proton density, T1 and T2 sequences in axial, coronal, and sagittal planes. The pre-operative MRI scans were performed by a single radiologist. For the purpose of this study, the MRI scans were re-evaluated by the same radiologist who was unaware of the prior results at arthroscopy. Chondral lesions were classified at the time of arthroscopy according to the Outerbridge classification. The MRI report of at least one chondral lesion found at arthroscopy was considered as a positive correlation between both diagnostic instruments.Results: Of the 19 patients, 11 (58%) were females and 9 (42%) were males, with an average age of 38 years (range 11 years – 64 years). There were 26 lesions in 14 knees. Chondral lesions showed a predilection for the medial femoral condyle (30.7%). The majority of cartilage lesions were grade III (41.9%). MRI had a sensitivity of 21.4%, a specificity of 100%, and an accuracy of 42.1%.Conclusions: Our study shows that routine 1.5-Tesla MRI is not sensitive, but is specific and somewhat accurate in detecting articular cartilage lesions. Arthroscopy cannot be replaced by 1.5-Tesla MRI in detection of cartilage lesions.

INTRODUCTION

Magnetic Resonance Imaging (MRI) allows unparalleled accuracy in the detection of meniscal and ligamentous injuries of the knee [123]. However, the detection and evaluation of cartilage lesions by standard MRI, even when cartilage-specific sequences are used is difficult [4567]. Arthroscopic knee surgeries are often performed because of the low positive predictive values of MRI in detecting chondral lesions. In situations where no cartilage lesions were found at arthroscopy, it could be argued that an unnecessary surgical procedure was performed.

The aim of this study was to evaluate the sensitivity, specificity and accuracy of routine 1.5-Tesla MRI in detecting chondral lesions of the knee.

PATIENTS AND METHODS

Between January 2004 and September 2008, 300 knee arthroscopic procedures were performed by three surgeons in the same hospital. Patients without a pre-operative MRI and those whose surgery was not performed within a year of the pre-operative MRI evaluation, were excluded from the study. Thirty patients met the inclusion criteria, however, the MRI scans of 11 patients could not be found. Missing MRI scans excluded a further 11 patients, leaving a study population of 19 patients. Indications for arthroscopic surgery included lateral meniscal tears in six patients, medial meniscal tears in four patients, anterior cruciate ligament tears in three patients, posterior cruciate ligament tears in one patient, early osteoarthritic changes in two patients, synovial plica in one patient, anterior knee pain in one patient and a loose body in one knee.

MRI was performed in a 1.5-Tesla GE Machine (GE Medical Systems, Milwaukee, WI), with proton density fat saturated, T_1 and T_2 sequences in axial, coronal, and sagittal views. The pre-operative MRI scans were performed by a single radiologist. For the purposes of the study, the MRI scans were re-evaluated by the same radiologist who was blinded to the results of arthroscopy. In addition, the radiologist was directed to evaluate only the articular cartilage of each knee.

Chondral lesions were classified at the time of arthroscopy according to the Outerbridge classification [8] [Table 1]. The

MRI report of any chondral lesion confirmed at arthroscopy constituted a true positive result. A report stating no chondral lesion confirmed at arthroscopy constituted a true negative result. A report showing no chondral lesion when arthroscopy demonstrated otherwise, was considered a false negative. No attempt was made to grade the cartilage lesions based on the MRI findings.

Figure 1

Table 1: Outerbridge Classification

Grade	Description of the Lesion
0	
I	Normal cartilage
II	Cartilage with softening and swelling
	Partial thickness defect with fissures on the surface that do not reach subchondral bone or exceed 1.5cm in diameter
III	Fissuring to the level of subchondral bone in an area with a diameter more than 1.5cm
	Exposed subchondral bone
IV	

RESULTS

Of the 19 patients, there were 11 females (58%) and 8 males (42%) with an average age of 38 years (range 11 years – 64 years). The right knee was involved in 59% of the patients. There were 26 lesions in 14 knees. Single and double lesions accounted for equal numbers of chondral defects [42.8%] (Table 2).

Figure 2

Table 2: Number of chondral lesions found per arthroscopic procedure

Number of chondral lesions	Number of knees (n=14)	Percentage
1	6	42.8
2	6	42.8
3 or more	2	14.2

Chondral lesions showed a predilection for the medial femoral condyle [30.7%] (Table 3).

Figure 3

Table 3: Location of knee chondral lesions

Location	Incidence	Percentage
Medial femoral condyle	8	30.7
Lateral femoral condyle	4	15.3
Medial patellar surface	5	19.2
Lateral patellar surface	2	7.6
Lateral tibial plateau	4	15.3
Medial tibial plateau	3	11.5

The majority of cartilage lesions identified at arthroscopy were classified as grade III [41.9%] (Table 4).

Figure 4

Table 4: Grade of chondral lesions found at arthroscopy

Grade	Incidence	Percentage
0	5	16
I	4	12.9
II	8	25.8
III	13	41.9
IV	1	3

When MRI and arthroscopic findings were compared, there were three true positive, five true negative, and 11 false negative results. Therefore, the MRI had a sensitivity of 21.4%, a specificity of 100% and an accuracy of 42.1%. Of the three cartilage lesions detected by MRI, two were classified as grade III and one as grade IV at arthroscopy. The lesions were present in the femoral condyles and tibial plateau.

DISCUSSION

In our study arthroscopy confirmed that of the 19 patients, 14 knees revealed 26 chondral defects of which 41.9% were Outerbridge grade III lesions. Single and double lesions accounted for equal numbers of chondral defects. In comparison Figueroa et al [5] found 115 lesions in 82 knees of which 34.8% were graded as Type 2 using the International Cartilage Repair Society (ICRS) classification. Curl et al [9] found 63% of cartilage defects in 31,516 patients of which 19% were Outerbridge IV lesions.

A 1.5-Tesla MRI was used in our study, showing a sensitivity of 21.4%, a specificity of 100% and an accuracy of 42.1%. No patellar defects were identified by MRI. MRI detected the only grade IV chondral lesion which was identified at arthroscopy, but detected only 2 of the 13 grade III lesions. Munk et al [10] compared the diagnostic and predictive value of the 1.5-Tesla MRI using T_1 and T_2 weighted sequences and three-dimensional gradient echo sequence with arthroscopy in 61 knees. Sensitivity of the

MRI was 0%, as was the positive predictive value. In the series by Munk et al [10] none of the nine lesions found at the articular surface of the patellar was seen at MRI and more significantly, none of the five cases of arthrosis were revealed by MRI. A 1.5-Tesla MRI was used by Figueroa et al [5] and the overall results showed a sensitivity of 45% and a specificity of 100%. The sensitivity was 12.5% for grade I lesions, 22.6% for grade II, 64.3% for grade III, and 73.3% for grade IV lesions. Kuikka et al [6] reported on the results of a 1.0-Tesla MRI in detection of fresh traumatic chondral lesions of the knee in young adults. The sensitivity and diagnostic accuracy for grade I lesions were 16.7%; sensitivity and diagnostic accuracy were 31.6% for grade II lesions and the sensitivity and diagnostic accuracy were 57.1% for grade III lesions.

Von Engelhardt et al [4] evaluated 240 articular cartilage surfaces in the knees of 40 patients with a 3-Tesla magnet. The sensitivities, specificities, positive predictive values, and negative predictive values of 3-Tesla MRI were 29%, 95%, 39%, and 92% respectively, for the detection of grade I lesions; 62%, 90%, 57%, and 92%, respectively for grade II lesions; 63%, 90%, 60%, and 91% respectively, for grade III lesions; and for grade IV lesions 74%, 95%, 74% and 95% respectively.

Studies have shown that the sensitivity, specificity and accuracy of the MRI in detecting chondral lesions are dependent on the type of MRI machine, the magnetic sequences used, size and thickness of the lesion and the experience of the radiologist [1112]. Higher field strength (3-Tesla) increase MRI accuracy in detecting articular cartilage lesions [4]. MRI field strength affects the homogeneity of fat suppression. Fat is more homogenous and better suppressed by higher field strength. Without fat suppression sequences, interpretation of cartilage is more difficult and less sensitive [6]. Most studies have shown that the MRI is more sensitive and accurate in detecting grade III and grade IV lesions [456]. In our study, the lesions detected were grades III and IV.

The use of more specific MRI sequences, known as gadolinium enhanced MRI or MR arthrography has been shown to increase the sensitivity of MRI [1314]. However, both of these methods are seldom used in routine MRI of the knee.

The weaknesses of this paper are that it was a retrospective study and the patient population was very small. However, our study demonstrated that routine 1.5-Tesla MRI is not sensitive but is specific and somewhat accurate in detecting articular cartilage lesions. Arthroscopy remains the gold standard for detailed assessment and grading of cartilage lesions and cannot be replaced by 1.5-Tesla MRI.

CORRESPONDENCE TO

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