[Primary Care]

Accuracy of Magnetic Resonance Imaging of the Knee in the Community Setting

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Background: Magnetic resonance imaging (MRI) is routinely used in the diagnosis of sports-related knee injuries.

Purpose: To determine the accuracy, sensitivity, and specificity of MRI compared with clinical evaluation in the diagnosis of meniscal pathology when the MRI facility and the radiologist are not preselected.

Methods: A total of 288 knee arthroscopies were retrospectively compared. Patients were divided into 3 groups: those who had MRI performed and interpreted at a single institution, MRI performed and interpreted at community facilities, or a clinical evaluation by a senior orthopaedic surgeon.

Results: The sensitivity, specificity, and accuracy of the diagnosis of medial meniscal pathology at a single institution were 90%, 59%, 76%; in community facilities, 73%, 68%, 70%; and by a clinical evaluation, 93%, 55%, 73%, respectively. For lateral meniscal pathology, the results were as follows: single institution, 75%, 76%, 81%; community facilities, 60%, 88%, 79%; and clinical evaluation, 45%, 90%, 79%, respectively. Sensitivity for medial meniscus was greater than for lateral meniscus, but specificity of diagnosis was better for lateral meniscus by MRI and clinical evaluation. While not statistically significant, there was increased sensitivity in the diagnosis of medial meniscus and lateral meniscus at SIs, but they have less specificity than at community facilities. The number of false-positive diagnoses (ie, no intra-articular pathology) that resulted in surgery was 4 of 288 (1.39%). The overall accuracy for medial meniscus by MRI was 73% vs 73% for clinical evaluation. The overall accuracy for MRI for lateral meniscus was 78% vs 79% for clinical evaluation.

Conclusion: Routine MRI may not be more beneficial than clinical evaluation when there is no preselection of MRI facility and interpreting radiologist.

Clinical Relevance: The use of MRI for diagnosing meniscal pathology should be reserved for those cases where the orthopaedic clinical examination is ambiguous.

Keywords: magnetic resonance imaging; meniscus; clinical evaluation; knee

At a time when there is great concern about rising health care costs and a need to provide care to uninsured and underinsured people, physicians should take every possible opportunity to practice cost-conscious medicine. Imaging studies in conjunction with clinical evaluation should be done only when such studies improve the accuracy of diagnosis, resolve clinical uncertainty, and provide for precise treatment.

Although magnetic resonance imaging (MRI) has been used to evaluate meniscal pathology for over 20 years, its role in decision making for arthroscopic surgery of the knee is still disputed.† The availability of MRI and the public's familiarity with it have led to an increased expectation of patients to have MRI when they present to a primary care physician with a complaint of knee pain. In this situation, the primary care physician orders MRI; the report indicates meniscal pathology; and the patient is referred to an orthopaedic surgeon with the expectation that surgery will be done.[11]

Prior studies evaluating the accuracy of MRI in the diagnosis of meniscal pathology have controlled variables such as MRI facility, magnet strength, study protocol, and the interpretation of the study.[1,8,16,21] In the majority of orthopaedic practices, patients have MRI at a facility chosen by their insurance providers or for personal preference or convenience. These variables cannot be controlled. The purpose of this study was to determine the overall accuracy of MRI performed in any available facility in a community compared with the accuracy of a single institution (SI) or orthopaedic surgeon's clinical evaluation. A similar study evaluating the quality of a country's magnetic resonance images

†References 1, 2, 4, 5, 7-9, 11, 14, 16, 18, 19, 21-26, 28, 30.

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Table 1. Patient demographics.

		Age, y		Examination, No.				Magnetic Resonance Imaging, No.				Arthroscopy, No.			
	M:F	Range	Mean	MMT	LMT	Both	Neither	MMT	LMT	Both	Neither	MMT	LMT	Both	Neither
No MRI				33	12	10	35	—	—	—	—	33	12	10	35
SI	51:53	15-72	45.5	58	12	22	12	39	16	32	17	40	26	18	20
CF	52:42	13-88	41.6	49	6	11	28	35	9	12	38	29	10	12	43

[a]M:F, males:females; MMT, medial meniscal tear; LMT, lateral meniscal tear; SI, single institution; CF, community facilities.

was reported in 2006 but was limited to a particular subset of patients, namely young soldiers.[2]

MATERIALS AND METHODS

The records of 313 consecutive patients who had arthroscopy of the knee for treatment of meniscal pathology during a period of 7 months were retrospectively reviewed to compare the findings at arthroscopy with the preoperative MRI results. Patients were selected for MRI based on the clinical judgment of the senior authors, or the patient arrived at the appointment with MRI done at the request of the primary care physician. After chart review, the records of 25 patients were incomplete because of unavailability of clinic note with preoperative examination, MRI results, or operative report. A summary of the remaining 288 patients, which includes demographics, clinical findings, and MRI results, is listed in Table 1.

Ninety patients did not undergo preoperative MRI, because the senior authors felt that MRI would not change or add to the clinical evaluation, so they went directly to arthroscopic evaluation and treatment. A clinical examination (CE) of each knee was performed in clinic by 1 of the 2 senior authors (W.A.G., R.E.H.). The examination included testing for joint line tenderness, McMurray sign, effusion, and a locked knee. The final assessment of diagnosis was used as the positive finding.

The remaining 198 patients underwent MRI at any available facility in the community; insurer or patient preference determined the site. MRI was interpreted by the facility's radiologist. The technical parameters of MRI, including machine strength, series performed, and cut width, were determined by the availability and protocol of the imaging center. These patients were further subdivided into those who had MRI performed and interpreted at an SI (The University of Arizona's Department of Radiology, with fellowship-trained musculoskeletal radiologists) and those who had MRI done in community facilities (CF). No attempt was made to qualify meniscal pathology based on tear location and type of tear due to variable terminology among the radiologists. If the final radiologic diagnosis was meniscal tear, then the MRI findings were considered positive.

The operative report was reviewed to determine the pathology found at arthroscopy, and these findings were compared with the MRI and examination findings. The rates of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were determined along with the rates of false negatives and false positives.

Statistical analysis was performed using a Z test for proportions with an alpha level of $P < 0.05$.

RESULTS

The 288 patients ranged in age from 13 to 88 years old with a mean age of 43 years. There were 147 males (51%) and 141 females (49%). Two experienced arthroscopists at 2 surgical centers performed the physical examination and arthroscopic surgeries. The patients were distributed in 1 of 3 groups. In sum, 104 patients had MRI at an SI; 94 patients had MRI from 1 of the multiple CF; and 90 patients had an orthopaedic CE and no MRI prior to arthroscopy. The demographics of the 3 groups were compared and evaluated for statistical differences. An analysis of variance was conducted, and no statistical difference was found in age as a function of sex or group. A χ^2 analysis was done to determine statistical difference in sex; in the SI and CE groups, there were 48% males and 52% females; in the CF, there were 71% males and 29% females. Based on t test and a χ^2 test to compare the patient populations for the 2 senior authors, no significant differences were found for age or sex (Table 1).

SI Interpretation vs Arthroscopy

For the 104 patients with MRI from a SI, sensitivity, specificity, PPV, NPV, and accuracy for medial meniscal tear (MMT) were 90%, 59%, 74%, 82%, and 76%, respectively. Of the 60 MMT at arthroscopy, 6 (10%) were missed on MRI, and there were 19 (26%) false positives on MRI. The sensitivity, specificity,

Table 2. Sensitivity, specificity, positive and negative predictive value, accuracy (in percentages).[a]

				Predictive Value		
Results		Sensitivity	Specificity	Positive	Negative	Accuracy
Single institution, n = 104	MMT	90	59	74	82	76
	LMT	75	76	69	81	75
Community facilities, n = 94	MMT	73	68	64	76	70
	LMT	60	88	63	87	81
Combined radiologist, n = 198	MMT	83	64	70	79	73
	LMT	70	83	67	84	78
Clinical examination, n = 90	MMT	93	55	66	90	73
	LMT	45	90	59	84	79

[a]MMT, medial meniscal tear; LMT, lateral meniscal tear.

Table 3. False positives and false negatives.[a]

		False Positive		False Negative	
Results		No.	%	No.	%
Single institution, n = 104	MMT	19	26	6	10
	LMT	15	31	11	25
Community facilities, n = 94	MMT	18	36	12	27
	LMT	9	38	10	40
Combined radiologist, n = 198	MMT	37	30	18	17
	LMT	24	33	21	30
Clinical examination, n = 90	MMT	21	34	3	7
	LMT	7	41	12	55

[a]MMT, medial meniscal tear; LMT, lateral meniscal tear.

PPV, NPV, and accuracy for lateral meniscal tear (LMT) were 75%, 76%, 69%, 81%, and 75%, respectively. Of the 44 LMT at arthroscopy, 11 (25%) were missed on MRI, and there were 15 (31%) false positives on MRI (Tables 2 and 3).

CF Interpretation vs Arthroscopy

For the 94 patients with MRI from the CF, the sensitivity, specificity, PPV, NPV, and accuracy for MMT were 73%, 68%, 64%, 76%, and 70%, respectively. Of the 44 MMT at arthroscopy, 12 (27%) were missed on MRI, and there were 18 (36%) false positives on MRI. The sensitivity, specificity, PPV, NPV, and accuracy for LMT were 60%, 88%, 63%, 87%, and 81%, respectively. Of the 25 LMT at arthroscopy, 10 (67%) were missed on MRI, and there were 9 (38%) false positives on MRI (Tables 2 and 3).

CE vs Arthroscopy

For the 90 patients without MRI evaluated clinically by an orthopaedic surgeon, sensitivity, specificity, PPV, NPV, and accuracy of MMT were 93%, 55%, 66%, 90%, and 73%

Table 4. False positives and their findings at arthroscopy.

Single Institution	No.	Community Imaging Centers	No.	Clinical Examination	No.
Medial meniscal false positives	19	Medial meniscal false positives	18	Medial meniscal false positives	21
Lateral meniscal tear	11	Chondromalacia of the patella	4	Chondromalacia of the patella	11
Chondromalacia of the medial femoral condyle	9	Chondromalacia of the trochlea	4	Chondromalacia of the medial femoral condyle	9
Findings: Chondromalacia of the patella, trochlea, or lateral femoral condyle; anterior cruciate ligament tear, plica, loose body		*Findings:* Chondromalacia of the medial femoral condyle, medial tibial plateau; anterior cruciate ligament tear, plica, loose body, lateral meniscal tear		*Findings:* Chondromalacia of the trochlea, lateral femoral condyle, medial tibial plateau, lateral tibial plateau; anterior cruciate ligament tear, plica, loose body, lateral meniscal tear	
		No pathology	1	No pathology	2
Lateral meniscal false positives	15	Lateral meniscal false positives	9	Lateral meniscal false positives	7
Medial meniscal tear	11	Anterior cruciate ligament tear	4	Chondromalacia of the patella	7
Chondromalacia of the medial femoral condyle	8	Chondromalacia of the medial femoral condyle	4	Chondromalacia of the medial femoral condyle	6
Findings: Chondromalacia of the patella, trochlea, lateral femoral condyle, medial tibial plateau; plica, loose body, anterior cruciate ligament tear		*Findings:* Chondromalacia of the patella, trochlea, or lateral tibial plateau; medial meniscal tear		*Findings:* Chondromalacia of trochlea, lateral femoral condyle, medial tibial plateau, lateral tibial plateau	
		No pathology	1		

respectively. Of the 43 MMTs diagnosed at arthroscopy, 3 (7%) were missed on physical examination, and there were 21 (34%) false positives on physical examination. The sensitivity, specificity, PPV, NPV, and accuracy of LMT were 45%, 90%, 59%, 84%, and 79%, respectively. Of the 22 LMTs diagnosed at arthroscopy, 12 (55%) were missed on physical examination, and there were 7 (41%) false positives from physical examination (Tables 2 and 3).

False-Positive Findings

Single institution. Of the 19 false-positive MMTs from the SI, the 2 most frequent diagnoses at arthroscopy were LMT and chondromalacia of the medial femoral condyle (Tables 4 and 5).

Of the 15 false-positive LMTs from the SI, the 2 most frequent diagnoses were MMT and chondromalacia of the medial femoral condyle (Tables 4 and 6).

Table 5. False-positive medial meniscal tears as evaluated by a single institution.[a]

No.	LMT	cMFC	cP	ACLT	cT	Plica	LB	cLFC
1	×	×		×				
2						×		
3	×	×						
4	×	×	×		×			
5	×	×	×		×			
6	×	×	×					
7	×	×	×				×	
8				×				
9			×					
10		×	×				×	
11	×	×			×		×	
12			×		×	×		
13		×	×		×			
14						×		
15				×				
16	×		×					×
17	×			×				×
18	×			×				
19	×							
Total	11	9	9	5	5	3	3	2

[a]LMT, lateral meniscal tear; cMFC, chondromalacia of the medial femoral condyle; cP, chondromalacia of the patella; ACLT, anterior cruciate ligament tear; cT, chondromalacia of the trochlea; LB, loose body; cLFC, chondromalacia of the lateral femoral condyle.

Community facilities. Of the 18 false-positive MMT from the CF, the 2 most frequent diagnoses were chondromalacia and trochlear chondromalacia (Tables 4 and 7).

There were 9 false-positive LMT and the 2 most frequent diagnoses were anterior cruciate ligament tear and chondromalacia of the medial femoral condyle (Tables 4 and 8).

By MRI, there were 2 patients with the diagnosis of meniscal tear found to have no evidence of intraarticular pathology.

Clinical examination. There were 21 false-positive MMT by CE, and the most frequent 2 diagnoses were patellar chondromalacia and chondromalacia of the medial femoral condyle (Tables 4 and 9).

There were 7 false-positive LMTs diagnosed by CE, and the 2 most frequent correct diagnoses were chondromalacia of the patella and medial femoral condyle (Tables 4 and 10).

Two patients with a preoperative diagnosis of medial meniscal problems were found to have no intra-articular pathology.

Table 6. False-positive lateral meniscal tears as evaluated by a single institution.[a]

No.	MMT	cP	cMFC	cT	ACLT	cLFC	LB	cMTP	Plica
1	×	×	×	×					
2	×	×	×	×					
3					×				
4		×	×				×		
5	×				×				
6	×								
7	×	×	×	×					
8	×	×	×					×	
9		×	×	×					
10	×	×							
11									×
12	×				×				
13	×								
14	×	×	×						
15	×	×	×	×		×			
Total	11	9	8	5	3	1	1	1	1

[a]MMT, medial meniscal tear; cP, chondromalacia of the patella; cMFC, chondromalacia of the medial femoral condyle; cT, chondromalacia of the trochlea; ACLT, anterior cruciate ligament tear; cLFC, chondromalacia of the lateral femoral condyle; LB, loose body; cMTP, chondromalacia of the medial tibial plateau.

Summary of Findings

The total number of false-positive diagnoses (ie, no intra-articular pathology) that resulted in surgery was 4 of 288 patients (1.39%). The overall accuracy for MMT by MRI was 73% vs 73% for CE. The overall accuracy of MRI for diagnosing a LMT was 78% vs 79% for CE.

Statistical Analysis

SI had better sensitivity compared with CF in the diagnosis of MMT ($P < 0.05$, $Z = 2.304$). SI had better sensitivity in the diagnosis of LMT than CE ($P < 0.05$, $Z = 2.411$).

CE was more specific than SI for the diagnosis of LMT ($P < 0.05$, $Z = 2.126$). The CE was more sensitive than CF in the diagnosis of MMT ($P < 0.05$, $Z = 2.469$).

Individually, both the SI and CF were more sensitive than CE in the diagnosis of LMT ($P < 0.05$, $Z = 2.124$).

DISCUSSION

Patients with a positive MRI finding frequently present to an orthopaedic surgeon with the expectation of surgical treatment. However, this study suggests that, in this community setting, MRI diagnosis is not better than CE, as has been shown in several previous studies.[4,7,14,18] The highest accuracy for CE—97% for the medial meniscus and 86% for the lateral meniscus—was shown when multiple examiners performed an examination at 2 different sessions.[7]

The overall accuracy of MRI in diagnosing meniscal pathology in this study for an unselected group of imaging facilities and radiologists was 73% (medial meniscus) and 78% (lateral meniscus). This is lower than the 89% accuracy for medial meniscal pathology and 88% for lateral meniscal pathology found by Fischer et al in a meta-analysis published in 1991.[9] A more recent meta-analysis published in 2003 by Oei et al reported diagnostic MRI accuracy rates of 83% for the

Table 7. False-positive medial meniscal tears as evaluated by community imaging centers.[a]

No.	ACLT	cP	cT	cMFC	Plica	LMT	cMTP	LB
1		×						×
2	×					×		
3					×			
4				×				
5					×			
6		×						
7					×			
8	×							
9	×							
10		×						
11	×			×				
12			×					
13		×	×				×	
14					×	×		
15[b]								
16			×					
17			×					
18				×				
Total	4	4	4	3	3	2	1	1

[a]ACLT, anterior cruciate ligament tear; cP, chondromalacia of the patella; cT, chondromalacia of the trochlea; cMFC, chondromalacia of the medial femoral condyle; LMT, lateral meniscal tear; cMTP, chondromalacia of the medial tibial plateau; LB, loose body.
[b]No pathology.

medial meniscus and 91% for the lateral meniscus.[20] Multiple factors may have contributed to the lower accuracy in this study. Higher rates are found in prospective studies,[13,14,18] in studies published in radiology journals,[21,28] in studies where mean patient age was lower,[18] and in studies that excluded patients having undergone prior meniscectomies. This study was retrospective; there was no exclusion of revision meniscectomy patients; and our mean patient age was 43 years. In a prospective study, the values (ie, tear or no tear) can be precisely defined and subsequently decrease the subjectivity of the results (ie, arthroscopic findings). "What one arthroscopist considers a frayed edge another may consider a tear,"[21] which can significantly reduce accuracy. Revision meniscectomy patients introduce error because postsurgical changes (ie, residual signal on MRI or irregular meniscal edge) can make determining a new tear difficult. With increasing age, patients are more likely to have degenerative changes, and it has been reported that "there is a continuum from meniscal degeneration to tear."[12] The decision to call degenerative fraying a tear is at the arthroscopist's discretion. The decreased accuracy of MRI in diagnosing meniscal pathology was predominantly due to "missed" tears, which seems to indicate a less conservative definition of meniscal tear at the time of arthroscopy.

The accuracy of diagnosing meniscal tears at a SI was similar to the accuracy of the CF. However, the results

Table 8. False-positive lateral meniscal tears as evaluated by community imaging centers.

No.	ACLT	cMFC	cT	MMT	cP	cLTP
1	×					
2	×	×				
3		×	×		×	
4			×			
5		×		×		
6	×					
7	×			×		
8		×	×	×	×	×
9[b]						
	4	4	3	3	2	1

[a]ACLT, anterior cruciate ligament tear; cMFC, chondromalacia of the medial femoral condyle; cT, chondromalacia of the trochlea; MMT, medial meniscal tear; cP, chondromalacia of the patella; cLTP, chondromalacia of the lateral tibial plateau.
[b]No pathology.

indicate that SI is better at identification of the presence of a problem but not better at the determination of a specific pathology. The SI tended toward increased sensitivity in the diagnosis of both MMT and LMT compared with the CF, but a statistically significant difference existed only for MMT. The CF demonstrated increased specificity in the diagnosis of both MMT and LMT but not a statistically significant difference. This may be attributable to community imaging centers aligning their imaging protocols with those established by academic centers, by upgrading equipment, and by increasing the level of training of the radiologists reading the MRI.[29]

In comparing MRI evaluation versus a physical examination performed by an orthopaedic surgeon, the physical examination is more sensitive for the diagnosis of medial meniscus but less specific, regardless of whether the MRI evaluation is from a SI or the CF.

The opposite is true for lateral meniscal injury, where the trend is for less sensitivity but more specificity in physical examination compared with MRI evaluation. The literature has shown that limitations in magnetic resonance sequencing leads to decreased sensitivity in diagnosis of meniscal tears, but it is less clear why it is more difficult to clinically diagnose a LMT than a MMT.[6,10,27]

The manner in which patients were selected to go directly to arthroscopy without undergoing MRI could have also influenced the results. It is possible that the more difficult or ambiguous cases were sent for MRI prior to arthroscopy, thus introducing bias. Statistical evaluation of patient demographics revealed only a difference in the sex distribution of patients, with an increased male-to-female ratio for the CF (Table 1).

Another limitation is that the surgeons were not always blinded to the MRI results during CE, because patients often presented for evaluation with their MRI images as well as the report of the radiologists' interpretations from CF. This could introduce bias into the final clinical diagnosis of meniscal tear. To prevent this bias, our CE group consisted of patients who did not undergo MRI evaluation.

Given the results in these settings, it seems that patients would be better served if the primary care providers would refer them for orthopaedic examination prior to the order of MRI.[3] While the reported high rates of sensitivity, specificity, and accuracy of MRI diagnosis of meniscal tear may be true for a single facility, with a very select patient population, based on this study, it does not hold true for MRI at multiple centers and a variable patient population (age, mechanisms of injury, past history). Physical examination has been noted to be accurate in the diagnosis of meniscal complaints, and our data support this as well.[14,15,17,23] If MRI is no better than physical examination, then perhaps patients should go straight to arthroscopic evaluation to avoid the additional cost of MRI. What could be lost by so doing is the opportunity to diagnose concomitant pathologies that could be treated without arthroscopic intervention or pathologies that should also be addressed at the time of surgery for which some prior planning is necessary. Routine MRI may not be any more beneficial or helpful than clinical evaluation

Table 9. False-positive medial meniscal tears as evaluated by clinical examination.[a]

No.	cP	cMFC	cT	LMT	ACLT	cLTP	LB	Plica	cLFC	cMTP
1		×			×					
2	×									
3	×		×				×			
4								×		
5	×	×	×				×		×	
6						×				×
7	×							×		
8	×	×								
9[b]										
10		×		×	×			×		
11				×	×	×				
12[b]										
13	×		×							
14	×	×	×							
15				×	×					
16	×		×	×						
17		×	×	×		×			×	
18	×	×	×		×	×	×			
19		×								
20	×			×						
21	×	×								
Total	11	9	7	6	5	4	3	3	2	1

[a]cP, chondromalacia of the patella; cMFC, chondromalacia of the medial femoral condyle; cT, chondromalacia of the trochlea; LMT, lateral meniscal tear; ACLT, anterior cruciate ligament tear; cLTP, chondromalacia of the lateral tibial plateau; LB, loose body; cLFC, chondromalacia of the lateral femoral condyle; cMTP, chondromalacia of the medial tibial plateau.
[b]No pathology.

when there is no preselection of MRI facility and interpreting radiologist and when patient population includes a variable patient population.

This study was done because of a clinical observation about the accuracy of MRI. The results of this study indicate that in this clinical setting, the accuracy of MRI does not meet previously reported data. A prospective study may be warranted.

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Table 10. False-positive lateral meniscal tears as evaluated by clinical examination.[a]

	cP	cMFC	cT	MMT	cLTP	cMTP	cLFC	LB
1	×	×	×	×				
2	×	×						×
3	×	×			×			
4	×	×	×	×		×		
5	×	×	×	×				
6	×	×	×				×	
7	×		×		×	×		
Total	7	6	5	3	2	2	1	1

[a]cP, chondromalacia of the patella; cMFC, chondromalacia of the medial femoral condyle; cT, chondromalacia of the trochlea; MMT, medial meniscal tear; cLTP, chondromalacia of the lateral tibial plateau; cMTP, chondromalacia of the medial tibial plateau; cLFC, chondromalacia of the lateral femoral condyle; LB, loose body.

REFERENCES

1. Barronian AD, Zoltan JD, Bucon KA. Magnetic resonance imaging of the knee: correlation with arthroscopy. *Arthroscopy.* 1989;5(3):187-191.
2. Ben-Galim P, Steinber EL, Amir H, Ash N, Dekel S, Arbel R. Accuracy of magnetic resonance imaging of the knee and unjustified surgery. *Clin Orthop Relat Res.* 2006;447:100-104.
3. Bernstein J, Cain EL, Kneeland JB, Dalinka MK. The incidence of pathology detected by magnetic resonance imaging of the knee: differences based on the specialty of the requesting physician. *Orthopedics.* 2003;26(5):483-485.
4. Brooks S, Morgan M. Accuracy of clinical diagnosis in knee arthroscopy. *Ann R Coll Surg Engl.* 2002;84:265-268.
5. Crawford R, Walley G, Bridgman S, Maffulli N. Magnetic resonance imaging versus arthroscopy in the diagnosis of knee pathology, concentrating on meniscal lesions and ACL tears: a systematic review. *Br Med Bull.* 2007;84:5-23.
6. De Smet AA, Tuite MJ, Norris MA, Swan JS. MR diagnosis of meniscal tears: analysis of causes of errors. *AJR Am J Roentgenol.* 1994;163:1419-1423.
7. Esmaili AA, Keyhani S, Zarei R, Moghaddam AK. Accuracy of MRI in comparison with clinical and arthroscopic findings in ligamentous and meniscal injuries of the knee. *Acta Orthop Belg.* 2005;71:189-196.
8. Feller JA, Webster KE. Clinical value of magnetic resonance imaging of the knee. *ANZ J Surg.* 2001;71:534-537.
9. Fischer SP, Fox JM, Del Pizzo W, Friedman MJ, Snyder SJ, Ferkel RD. Accuracy of diagnoses from magnetic resonance imaging of the knee: a multi-center analysis of one thousand and fourteen patients. *J Bone Joint Surg Am.*1991;73:2-10.
10. Fox M. MR imaging of the meniscus: review, current trends, and clinical implications. *Magn Reson Imaging Clin N Am.* 2007;15(1):103-123.
11. Galea A, Giuffre B, Dimmick S, Coolican MR, Parker DA. The accuracy of magnetic resonance imaging scanning and its influence on management decisions in knee surgery. *Arthroscopy.* 2009;25(5):473-480.
12. Hodler J, Haghighi P, Pathria MN, Trudell D, Resnick D. Meniscal changes in the elderly: Correlation with MR imaging and histologic findings. *Radiology.* 1992;184(1):221-295.
13. Jackson DW, Jennings LD, Maywood RM, Berger PE. Magnetic resonance imaging of the knee. *Am J Sports Med.* 1988;12(1):29-38.
14. Kocabey Y, Tetik O, Isbell WM, Atay ÖA, Johnson DL. The value of clinical examination versus magnetic resonance imaging in the diagnosis of meniscal tears and anterior cruciate ligament rupture. *Arthroscopy.* 2004;20(7):696-700.
15. Mahan BR, Gosul HS. Reliability of clinical diagnosis in meniscal tears. *Int Orthop.* 2007;31:57-60.
16. Mandelbaum BR, Finerman GAM, Reicher MA, et al. Magnetic resonance imaging as a tool for evaluation of traumatic knee injuries: anatomical and pathoanatomical correlations. *Am J Sports Med.* 1986;14:361-370.
17. Miller GK. A prospective study comparing the accuracy of the clinical diagnosis of meniscus tear with magnetic resonance imaging and its effect on clinical outcome. *Arthroscopy.* 1996;12(4):406-413.
18. Muellner T, Weinstabl R, Schabus R, Vecsei V, Kainberger F. The diagnosis of meniscal tears in athletes. *Am J Sports Med.* 1997;25(1):7-12.
19. Newman AP, Daniels AU, Burks RT. Principles and decision making in meniscal surgery. *Arthroscopy.*1993;9(1):33-51.
20. Oei EHG, Nikken JJ, Verstijnen ACM, Ginai AZ, Hunink MGM. MR imaging of the menisci and cruciate ligaments: a systematic review. *Radiology.* 2003;226:837-848.
21. Quinn SF, Brown TF. Meniscal tears diagnosed with MR imaging versus arthroscopy: how reliable a standard is arthroscopy? *Radiology.* 1991;181(3):843-847.
22. Reicher MA, Rauschning W, Gold RH, Bassett LW, Lufkin RB, Glen Jr W. High-resolution magnetic resonance imaging of the knee joint: normal anatomy. *AJR Am J Roentgenol.* 1985;145:895-902.
23. Rose NE, Gold SM. A comparison of accuracy between clinical examination and magnetic resonance imaging in the diagnosis of meniscal and anterior cruciate ligament tears. *Arthroscopy.* 1996;12(4):398-405.
24. Ryzewicz M, Peterson B, Siparsky PN, Bartz RL. The diagnosis of meniscus tears. *Clin Orthop Relat Res.* 2007;456:123-133.
25. Thomas S, Pullagura M, Robinson E, Cohen A, Banaszkiewicz P. The value of magnetic resonance imaging in our current management of ACL and meniscal injuries. *Knee Surg Sports Traumatol Arthrosc.* 2007;15:533-536.
26. Trieshmann HW Jr, Mosure JC. The impact of magnetic resonance imaging of the Knee on surgical decision making. *Arthroscopy.* 1996;12(5):550-555.
27. Van Dyck P, Gielen J, D'Anvers J, et al. MR diagnosis of meniscal tears of the knee: analysis of error patterns. *Arch Orthop Trauma Surg.* 2007;127:849-854.
28. Vincken PW, ter Braak BPM, van Erkell AR, et al. Effectiveness of MR imaging in selection of patients for arthroscopy of the knee. *Radiology.* 2002;223:739-746.
29. White LM, Schweitzer ME, Deely DM, Morrison WB. The effect of training and experience on the magnetic resonance imaging interpretation of meniscal tears. *Arthroscopy.* 1997;13(2):224-228.
30. Zuelzer WA. Magnetic resonance imaging in musculoskeletal assessment: a surgeon's perspective. *Top Magn Reson Imaging.* 1996;8(1):68-77.