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The role of magnetic resonance imaging in routine decision making for meniscal surgery

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Abstract This clinical study evaluated factors affecting the decision for meniscal surgery in a patient population seen routinely at a trauma clinic. The study hypothesis was that patients who sustain a traumatic injury to the knee or have a long history of clinical symptoms are likelier to be operated on. We investigated 149 patients clinically and by magnetic resonance imaging (MRI). Group A (n = 62) underwent arthroscopic surgery and group B (n = 87) were treated conservatively. Multiple logistic regression analysis was used to examine correlations with regard to age, gender, injury pattern, period between the injury and first clinical examination, and MRI results. We found no significant difference between the two groups with regard to gender (P = 0.1), injury pattern (P = 0.44), or period between injury and first clinical examination (P = 0.5). Patients in group A were significantly older than those in group B (P = 0.044), and, as expected, MRI signal alterations were significantly higher in group A than in group B (P = 0.001). In acutely injured patients MRI helps to establish an accurate diagnosis, and in cases of positive MRI findings in a symptomatic patient, the surgeon should not wait 4–6 weeks but should immediately recommend surgery.

Key words Meniscal tears · Diagnosis · Magnetic resonance imaging · Surgical decision making

Introduction

The meniscus is the most commonly injured structure of the knee requiring surgery. Traditionally the diagnosis of a meniscal tear is based on patient history and clinical examination. However, it has been reported that the false diagnosis rates based on such clinical examinations lie between 40% and 80% [1, 3, 6, 12, 15]. The resulting high costs and potential morbidity related to arthroscopic operations has led to the search for less invasive methods of diagnosing meniscal tears. One such method is magnetic resonance imaging (MRI), its foremost advantage being greater diagnostic accuracy, thereby reducing the diagnostic arthroscopy rate [17, 18].

The continuing improvement in diagnostic methods now available makes it especially important to compare the results and recommendations offered in the literature. Considering the mainly trauma-related meniscal tears in athletes, it is obvious that the relatively high accuracy of the clinical examination is due to the difference in the diagnostic approach between traumatic and degenerative meniscal tears [9]. Moreover, recent studies have found no difference in accuracy between clinical and MRI diagnosis of meniscal tears [8, 14]. The disadvantages of these studies were that Rose and Gold [14] included only patients who were treated symptomatically for at least 3 months before surgery, and in the study of Miller [8] MRI investigations were performed at 12 different centers.

Unfortunately, the diversity of patient populations, the high demand of scientific study protocols (for example, MRI availability, special MRI sequences), and clinical routine all complicate the use of study recommendations. The aim of this clinical study was therefore to evaluate factors affecting the decision making in meniscal surgery in a patient population seen routinely at a trauma clinic. The study hypothesis was that patients who sustain a traumatic injury to the knee or have a long history of clinical symptoms are likelier to be operated on.

Material and methods

A prospective study was devised in which the clinical diagnosis of a torn meniscus was established by one of ten experienced knee surgeons. Special attention was paid to signs of meniscal abnormalities including: the presence or absence of effusions, limitation of knee motion, and several tests for clinical diagnosis of a meniscal tear (i.e., tenderness on palpation of the joint line, Boehler test, McMurray's test, Apley grinding test, and Payr test), all of which have been previously described [9]. The inclusion criteria were no signs of ligamentous instability (neither crucial or collateral), no marked effusions, no signs of a locked knee, and no previous therapy at any other institution with regard to their knee injury before the clinical examination at our clinic.

MRI was performed within 3 weeks after the first clinical examination on a Siemens Medical System Magnetom 1.5 T with a 256 × 256 matrix. Spine echo and gradient echo images were performed with slices 2- to 4 mm thick. The MRI slices were evaluated for signal alterations, which were graded from 0 to IV, as previously described [7, 9, 13]. Clinical information was made available to the musculoskeletal radiologist before interpretation of the slices. In collaboration with the patient, the indication for surgery was established by a staff member experienced in knee surgery.

A total of 149 patients treated for a clinically diagnosed meniscal tear were included in the statistical analysis. There were 82 men and 67 women patients with a mean age of 35.7 ± 13.4 years; 62 sustained their injury during sports activity. Two groups were formed: group A (n = 62) consisted of patients who underwent arthroscopic surgery, and group B (n = 87) included patients who were treated conservatively.

Differences between groups A and B in terms of age, gender, and injury pattern were tested by Student's t test. Categorical data were described as absolute and relative frequencies, and associations between the groups were tested by the χ^2 test. The correlation between age and MRI signal alterations was assessed by Spearman's correlation coefficient. Multiple logistic regression was used to whether potential prognostic factors (age, patient's gender, injury pattern, MRI results, period between injury and first clinical examination) could discriminate between groups A and B. This analysis was carried out using the statistical software package SAS (version 6, SAS Institute, Cary, N.C., USA). Continuous data are described with as mean ± standard deviation. All P values are two-sided and $P < 0.05$ was considered statistically significant.

Results

Patients in group A were significantly older than those in group B (P = 0.044, Table 1). There was no significant difference with regard to the injury pattern between the two groups (P = 0.44, Table 1). As expected, MRI signal alterations were significantly higher in group A than in

Table 1 Patients population profile (*n/a* not applicable)

	Group A	Group B	*P*
Gender			0.1
Male	39	43	
Female	23	44	
Age	38.3 (± 12.9)	33.86 (± 13.4)	0.024
Clinical diagnosis			
Medial meniscus tear	40	66	
Lateral meniscus tear	16	19	
Medial and lateral meniscus tear	6	2	
MRI diagnosis (≥ III)			
Medial meniscus tear	32	11	
Lateral meniscus tear	10	5	
Medial and lateral meniscus tear	4	0	
Arthroscopic diagnosis			
Medial meniscus tear	35	n/a	
Lateral meniscus tear	11	n/a	
Medial and lateral meniscus tear	3	n/a	
Medial shelf syndrome	2	n/a	
Synovitis	2	n/a	
Hoffa hypertrophy	3	n/a	
Cartilage defects	4	n/a	
Normal	2	n/a	
Injury pattern			0.44
Sports activity	31	38	
Others	31	49	
Delay: injury to 1st examination			
Median (days)	2	3	0.5
Range (days)	0–506	0–528	

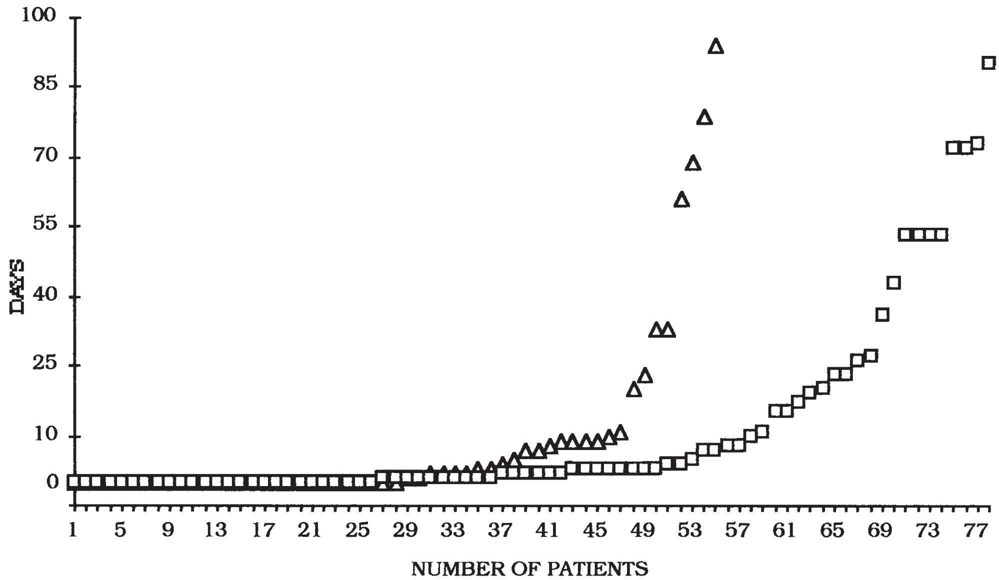
Table 2 MRI results of groups A and B

Group	Grade of signal alteration				
	0	I	II	III	IV
A (n = 62)	6	1	9	44	2
B (n = 87)	21	10	40	14	2

group B (P = 0.001, Table 2). The delay between injury and first clinical examination was not significantly different between the two groups (P = 0.5, Table 1). In groups A and B 50% of the patients were investigated within 2 or 3 days, respectively, after the injury (Fig. 1).

Group A patients were operated on after a median of 24.5 days (range 1–280) after the first clinical examination (Fig. 2). The arthroscopic findings are shown in Table 1. In 45 patients from group A, arthroscopic findings confirmed the MRI diagnosis of a meniscal tear. One positive MRI result was not confirmed arthroscopically. In 16 patients the MRI did not show a meniscal tear although arthroscopically a meniscal tear was found in four of these patients. Overall four false-negative and one false-positive MRI result were found (Table 3). The accuracy (correct classification × 100/number of patients) was therefore 92%. In two patients no pathological condition was identified arthroscopically which could have caused the clinical symptoms. Neither injury pattern nor patient gender

Fig. 1 Period between injury and clinical examination. (Seven patients from group A *(triangles)* and 9 from group B *(squares)* could not recall an injury within the 3 months before the first clinical examination and therefore are not included.) *Symbols* number of days elapsed between injury and clinical examination for each individual patient



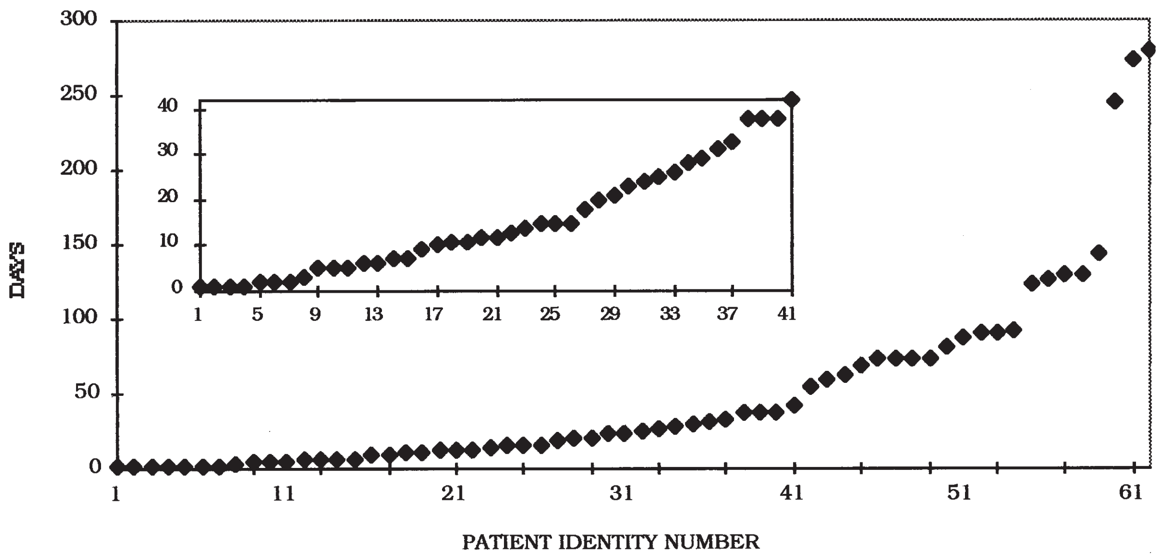


Fig. 2 Period between first clinical examination and arthroscopic operation (group A). *Inset* 41 patients operated on within 6 weeks after the first clinical examination. *Symbols* number of days after which surgery was performed on each individual patient

Table 3 False-positive or false-negative MRI results in group A (*Delay 1* time from injury to first clinical examination, *Delay 2* time from first clinical examination to operation, *MM* medial meniscus, *LM* lateral meniscus)

Age (years)	Sex	Injury pattern	Delay 1	MRI result	Delay 2	OP findings	Location
26	F	Cross-country	174	II	10	Buckethandle tear	LM
57	F	Walking	9	II	130	Radial tear	MM
58	F	Stair climbing	33	III	135	No tear	–
27	F	Ski	0	II	60	Radial tear	MM
49	M	Walking	3	I	39	Degenerative tear	MM

Table 4 Spearman's correlation for age with regard to injury pattern and gender

	Age (years)	*P*
Gender		
Men	36.1 ± 12.4	0.71
Women	35.3 ± 14.6	
Injury pattern		
Sports related	32.0 ± 11.0	0.0012
Others	30.0 ± 14.4	

was significantly associated with false-positive or false-negative MRI results.

Since the MRI results in group B were not confirmed arthroscopically, no accuracy was calculated (Table 2). By July 1997 none of these patients had received any invasive treatment for their initial symptoms, and remained free of complaints. Spearman's correlation revealed that, higher MRI signal alterations were found with increasing age ($r = 0.33$; $P < 0.0001$), and that injuries due to sports activities were less common with increasing age. The mean age of patients not operated on (group B) with grade III and IV signal alterations was 40.2 ± 11.3 years, and that in patients with grade 0–II signal alterations was 28.810.5 years. This difference is statistically significant ($P = 0.02$).

Discussion

Making the diagnosis of a meniscal tear on clinical grounds alone is often difficult [1, 4, 6, 12, 15, 18]. It has been shown that the longer symptoms exist, the higher is likelihood of a correct clinical diagnosis of a meniscal injury [11]. When "unclear" symptoms for a meniscus tear are present, a conservative treatment for 4–6 weeks was recommended by Newman et al. [11] Today, however, many patients find such a delay unacceptable. Moreover, it is not unusual for patients to request or demand MRI evaluation. The purpose of this study was therefore to evaluate factors affecting surgical decision making in meniscal injuries, with special attention to patient profile (age, gender, history, injury pattern, and MRI results). The study design differed in several ways from previous experimental studies [4, 7, 9, 18]. First, the radiologist was informed that a meniscal lesion was clinically suspected, and the surgeon also reviewed the MRI. Second, this report incorporates data of both patient profiles (i.e., those operated on and those not operated on). Third, a heterogeneous patient's population was studied, including athletic injuries and injuries attained during nonathletic activities. All these circumstances could bias results in particular ways (e.g., patients and surgeons may have insisted on operative therapy as a result of MRI results). This investigation was conducted to study the routine clinical practice in a trauma department and was not planned as a randomized, double-blinded study, which of course would have been necessary to confirm experimental effects and eliminate bias. Patient gender was not found to affect the surgical decision making ($P = 0.1$), although relatively more male patients were in group A than in group B. Even though it may have been easier to believe that sports trauma related patients would be more readily operated on, the injury pattern did not affect the decision for surgery ($P = 0.44$). Statistical analysis revealed that there was no significant difference between the two groups with regard to patient history ($P = 0.5$). This was somewhat surprising, considering the fact that a longer history of meniscal symptoms was expected to be a likelier indication for surgery.

Patient age was found to differ significantly between the two groups. The correlation with injury pattern showed that older patients who sustained their injury during sports activity underwent arthroscopic treatment significantly more often ($P = 0.0012$; Table 4). Aside from the MRI results, this was the only significant difference which was found between the two groups. Since increased signal intensity occurs in most menisci as a part of the aging process, and the incidence rises with age, one must be careful in interpreting MRI slices in older patients [5, 10]. In the present study 60% of patients did not undergo operative treatment, due to vanishing of the clinical symptoms, and 18% of these showed grade III or IV signal alterations on MRI.

In this study only two patients (3%) underwent surgery, defined by the operating surgeons as solely diagnostic. Considering the long delay in surgical intervention for four patients having false-negative MRI results, one could suppose that the preexisting degenerative changes seen in the MRI were a predisposition to the development of a degenerative meniscal tear. A similar situation was also described by Negendank et al. [10]. On the other hand, the tear in the patient with a "false-positive" MRI result may have already healed [19].

This clinical study again confirms the high accuracy of MRI, allowing the number of unnecessary arthroscopies in patients with knee complaints to be limited [7, 9, 11, 13, 14, 16–18]. Although MRI is an expensive investigation, it has become a routine diagnostic investigation method to rule out meniscal pathology. Due to the possibility of false MRI results it should not be misapplied when the ultimate treatment decision of surgery is made in patients whose meniscal symptoms fail to improve or worsen after 3 months of symptomatic treatment [14]. However, in the acutely injured patient MRI helps to establish an accurate diagnosis. In the case of a positive MRI finding in a symptomatic patient, the surgeon should not wait 4–6 weeks but should recommend surgery immediately. Sixty-six of our patients who reported continuous clinical symptoms were operated on within 6 weeks of the first clinical examination. Some of these showed no meniscal tear in the MRI but had persistent clinical symptoms, which indicated the possibility of a false clinical/ MRI diagnosis.

The cost-effectiveness of MRI with regard to knee injuries has been previously evaluated [2, 17, 18]. Unfortunately, there are still some concerns about the actual cost-efficacy of MRI in patients with clinically suspected meniscal tears. Although the MRI investigation itself is expensive, insurance companies can save costs by reducing the number of arthroscopies and, in turn, sick-leave days. With a negative MRI result the rehabilitation of a clinically suspected meniscal tear can also be more aggressive, promising cost savings (i.e., sick-leave days). However, further studies are needed to establish MRI criteria on which a conservative treatment of meniscal tears can be based upon. The study hypothesis that patient profile and surgical intervention are directly correlated could not be completely confirmed, and therefore underlines the need for patients to be treated individually for optimal results.

Conclusion

This study demonstrates that factors affecting surgical decision making in meniscal injuries are based more or less only on the patient's clinical symptoms. The MRI is a useful diagnostic accessory, and should not be misused as the sole operative indicator. It has now become a routine diagnostic tool for meniscal injuries, but we believe that the request for a MRI should not be prescribed as often as it is in many places. The requirements of experimental studies (e.g., experienced radiologist, special MRI sequences, special patients population) all complicate the use of study recommendations in routine situations.

An algorithm for the diagnosis and treatment of meniscal lesions can be recommended. It is justifiable to say that when the clinical symptoms clearly imply a meniscal tear, arthroscopy should be the next step. We do not recommend a conservative treatment for 4–6 weeks to "wait and see" whether symptoms subside if there are some questions about the actual diagnosis. Our everyday strategy in patients with obvious clinical signs of a meniscal tear, but without a locked knee, is to start with a conservative rehabilitation program consisting of rest, ice, anti-inflammatory drugs, and isometric muscle exercises. After about 5–7 days these patients are reexamined, and if the clinical diagnosis of a meniscal tear is reconfirmed, we recommend arthroscopic surgery. We recommend MRI in patients with a high risk due to a bad internal condition and in those without a clear clinical diagnosis.

Obviously, athletes insist on receiving a definite diagnosis and therapy in order to be able to plan delay in sports activities or their return to them. An MRI investigation is a helpful and recommended step if certain aspects of the correct diagnosis remain unclear. Clearly athletes, interested in evading unnecessary operations, demand MRI. This will logically then have to be considered.

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