

THE VALUE OF CLINICAL EXAMINATION AND MRI VERSUS INTRAOPERATIVE FINDINGS IN THE DIAGNOSIS OF MENISCAL TEARS

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Abstract

The aim of this study was to compare the accuracy of the clinical examination and magnetic resonance imaging versus intraoperative findings in meniscal tears.

We evaluated 400 patients retrospectively in a 5-year period from 2001–2006 with knee pain and diagnosed with a meniscal tear. Accuracy, sensitivity, specificity, and positive/negative predictive values were established, comparing the clinical results and the results of MRI with the intraoperative findings as the “gold standard”.

The clinical examination produced less true-positive results compared to the MRI, false-positive results were less in MRI compared to the clinical examination. The rate of true-negative results was higher in MRI compared to the clinical diagnosis, false-negative results could be found frequently in clinical diagnosis compared to the MRI.

Comparing the results of the MRI with arthroscopic findings it is obvious that the accuracy, specificity, sensitivity, and the positive and negative predictive values are higher than in the group of the clinical examination versus arthroscopic results. These results indicate that an MRI is necessary to complete an exact clinical diagnosis in meniscus tears, but surgery should only follow an MRI, when positive clinical symptoms have been exactly identified.

Key words

Meniscus tear, Clinical diagnosis, MRI, Intraoperative findings, Arthroscopic knee joint surgery

INTRODUCTION

Injuries to the meniscus occur frequently and are often followed by arthroscopic surgery, which is the most commonly performed procedure in knee joint surgery (1). Nevertheless, even for an experienced surgeon it is not always possible to finish up a clinical knee joint examination with an accurate clinical diagnosis.

Meniscal injuries can be divided into traumatic and degenerative types. Traumatic injuries primarily occur in young, active patients and are often associated with ACL lesions (2). In the past decades the diagnosis of meniscal lesions was limited to the clinical examination and standard radiographic evaluation. Over a long period of time arthrography had been used to augment the evaluation of ligamentous

and meniscal conditions. The clinical examination often failed to produce exact results and false diagnosis rates between 40-85% (3-7) were the consequence. Diagnostic arthroscopies with no other operative intervention were standard procedures, only based on clinical examination. The rate of complications during a diagnostic arthroscopy is low, but still existent with 3% (17). In the 1980's Kean *et al.* began using magnetic resonance imaging in the diagnosis of knee disorders (8). The ongoing technical improvement and personal experience made the MRI to a diagnostic tool with an overall accuracy of up to 93% (9-16).

The aim of this study was to compare the accuracy of clinical examination and the magnetic resonance imaging (MRI) with intraoperative findings in meniscal tears in non-standardised "everyday" clinical situations.

PATIENTS AND METHODS

From 01 Jan 2001 to 31 Dec 2006, 4727 patients underwent clinical examination due to knee pain at our level-I trauma centre and were diagnosed with meniscus rupture or meniscal lesion. All patients' histories were sighted thoroughly and 400 could be chosen for this study. The inclusion criteria were a complete set of collected data. An MRI presenting a grade three or four rupture (*Tab. 1*) following the clinical examination, and consecutive arthroscopic surgery, further an exact and detailed documentation of all three procedures were necessary for inclusion into the study. The exclusion criteria for this study were previously sustained knee joint injuries with consecutive meniscologamental disorders, and patients presenting other pathological findings mimicking meniscal lesions, such as plica, chondral fractures or loose bodies, further mucoid or eosinophil degeneration causing false-positive MRI results (23). Two hundred and forty-nine male patients, aged from 17 to 66 years, average 39 years, and 151 female patients, aged from 14 to 64 years, average 42 years, were evaluated. The clinical examination was performed using one or more of six different clinical tests to detect meniscal disorders (*Tab. 2*). *Table 3* shows the sensitivity and the positive predictive value of these tests (4). Further, a disturbing pain over the joint line and/or a mechanical knee joint disorder was referred to a meniscal lesion. Only patients with no former history of meniscal pathology were included into the study group. Further evaluation was carried out by MRI. A standardised grading of the meniscal tears was used, ranging from I to IV (*Tab. 1*). In this study grade III and IV ruptures were considered to be positive.

In all 400 cases arthroscopic surgery followed. Our statistical evaluations were based on arthroscopic findings. A meniscus was considered as torn under arthroscopy, if the pattern of the cleavage produced a mechanical disorder, which caused a fragment dislocation by knee motion or probing with an arthroscopic hook. All arthroscopic procedures were performed under general or spinal anaesthesia, standard equipment for visualisation was inserted using anteromedial and anterolateral portals, further photo and/or video documentation took place.

A result was considered to be *true-positive*, when the positive clinical or MRI diagnosis was confirmed by positive intraoperative findings.

A *false-positive* result was defined as a positive clinical or MRI diagnosis with missing pathological intraoperative findings.

A result was considered *true-negative*, when the absence of pathological findings in the clinical examination or MRI could be verified by intraoperative findings.

A *false-negative* result was defined as a positive intraoperative finding following a negative clinical examination or a negative MRI.

Further equations could be established for the clinical diagnosis and the MRI, described in our results in detail.

Table 1

| Classification of meniscus rupture in MRI (13, 36) | |
|--|---|
| I° | globular intensity, not adjacent to either articular surface |
| II° | linear signal within the meniscus |
| III° | linear signal that extends to either the superior or inferior articular surface |
| IV° | meniscus fragmentation |

Table 2

| Clinical tests to detect meniscal lesions and ruptures | |
|--|---|
| 1. | Joint line tenderness is one of the most important clinical signs in diagnosing meniscal disorders and can be found in 60 – 80 % of patients with meniscus lesions. (34) |
| 2. | Boehler test. This test correlates with the testing of the stability of the collateral ligaments. The medial meniscus is painful in varus stress, the lateral meniscus in valgus stress. (35) |
| 3. | McMurray’s test. At various stages of knee flexion internal and external tibial rotation is performed. A palpable click and pain is considered as a positive test. (36) |
| 4. | Steinmann test I & II. The Steinmann test I is comparable to the McMurray test in 90° knee flexion, the patient seated, hanging leg. The Steinmann test II relies on the fact that increasing knee flexion moves the menisci posteriorly. In case of a meniscal lesion the pain will move posteriorly, too, and the test is considered as positive. (35) |
| 5. | Apley grinding test. The patient is in prone position, the hip is extended and the knee flexed in 90°. The examiner applies axial pressure onto the foot and rotates the tibia. The resulting knee joint pain is regarded as a positive test. (37) |
| 6. | Payr test. In 90° knee flexion a varus stress leads to pain in the medial knee compartment due to compression. A positive test is associated with a lesion of the medial posterior horn. (35) |

Table 3

| Sensitivity and positive predictive value (PPV) of six common tests for clinical diagnosis of meniscal tear (4) | | |
|---|-------------|---------|
| | Sensitivity | PPV (%) |
| Steinmann I | 42 | 51 |
| Steinmann II | 13 | 76 |
| Payr | 39 | 53 |
| Apley | 46 | 55 |
| McMurray | 35 | 55 |
| Joint line tenderness | 74 | 48 |

RESULTS

We chose a set-up with arthroscopy as the key reference point because it is widely accepted as the gold standard in validation of other diagnostic tools in knee joint disorders. Arthroscopy has an accuracy of up to 98 % (6, 16).

Reviewing our results, accuracy, specificity, sensitivity, positive- (PPV) and negative predictive values (NPV) were set up using specific equations:

$$\text{Accuracy} = (\text{true-positive} + \text{true-negative}) / \text{total examined knees} \times 100$$

The accuracy is the percentage of patients in whom the clinical examination or the MRI is correct.

$$\text{Sensitivity} = \text{true-positive} / (\text{true-positive} + \text{false-negative}) \times 100$$

The sensitivity is the ability of a test to detect an abnormality.

$$\text{Specificity} = \text{true-negative} / (\text{true-negative} + \text{false-positive}) \times 100$$

The specificity is an assessment of the accuracy of a test result such that the more specific a test is, the fewer are false-positive results.

$$\text{Positive Predictive Value (PPV)} = \text{true-positive} / (\text{true-positive} + \text{false-positive}) \times 100$$

The PPV correlates a positive test result on either clinical examination or MRI with the finding at surgery.

$$\text{Negative Predictive Value (NPV)} = \text{true-negative} / (\text{true-negative} + \text{false-negative}) \times 100$$

The NPV correlates a negative diagnostic result with the finding at surgery.

Out of 400 patients, the clinical examination produced less true-positive results in the medial meniscus (MM) with 155 and 23 in the lateral meniscus (LM), whereas the MRI showed 237 in MM and 68 in ML. False-positive results were less in MRI with 51 in MM and 31 in ML, compared to the clinical examination with 82 in MM and 64 in ML. The rate of true-negative results was higher in MRI with 93 in MM and 265 in ML, whereas the clinical examination showed 66 in MM and 231 in ML. A great difference lies between the false-negative results of MRI and clinical examination. The MM had only 19 false-negative results in MRI, whereas the clinical examination produced 97 missed diagnoses of meniscal tear. The LM showed a similar tendency with 35 in MRI and 81 in the clinical examinations.

Following further equations, the results show that our clinical accuracy lies at 55 % in the (MM) and at 64 % in the (LM), whereas the MRI presents an accuracy of 83 % in both menisci. Evaluating the positive predictive value we can see that it ranges from 82 % in MM and 69 % in LM, which is considerably higher than in the clinical examination with 65 % in MM and 26 % in LM. A similar situation can be seen concerning the negative predictive value in MRI with 83 % in MM and 88 % in LM, compared to the results of the clinical examination with 40 % in MM and 74 % in LM. The MRI identified meniscal tears with a sensitivity of 93 % in MM and 66 % in LM, compared to the clinical examination with 62 % in MM and 22 % in LM. The specificity of the MRI showed the same trend with 65 % in MM and 90 %

in LM, compared to the results in the clinical examination with 45 % in MM and 78 % in LM.

All our results are listed in *Table 4*, showing the total amount of diagnosed meniscal tears diagnosed clinically, in MRI and under arthroscopy, and *Table 5*, summarising the statistical results described above, comparing the clinical examination and the MRI with the arthroscopically gained diagnosis.

DISCUSSION

It is often difficult to state the diagnosis of a meniscal tear only based on a clinical examination alone (3), and many patients nowadays already request an MRI evaluation. *Newman et al.* recommended a conservative treatment for 4-6 weeks, when unclear meniscal symptoms are present, but today many patients find such a delay unacceptable (25).

This study investigated the value of MRI in diagnosing meniscal pathology of the knee in the “everyday” clinical situation and this setting was designed to replicate an ordinary clinical situation as close as possible, because the necessity of evaluating meniscal lesions by MRI is being called into question due to its high costs, which are put into relation to the presumed reliability of clinical examination. Various studies can be found in the literature which compare the accuracy, specificity, and sensitivity of the MRI under standardised conditions, and discuss the cost effectiveness of the MRI (26). Regardless of the cost factor the number of ordered MRI investigations rises continuously year by year.

For many people active in sports, injuries to the knee cause more problems than injuries to any other joint. There is a high incidence of positive MRI findings in asymptomatic knees (2), which can lead to arthroscopic surgery after a minor injury. The percentage of the asymptomatic individuals with positive MRI findings has been reported to range from 5.6 % to 36 % in some prospective series (7). *Boden et al.* (37) showed that 16 % of asymptomatic patients who underwent MRI showed meniscal abnormalities consistent with a meniscal tear, the incident rising with the patient age (38). There are probably many contributing factors to the MRI errors made in diagnosing meniscal tears. Several authors have suggested, as reported in *Rose et al.*, that MRI findings involving the posterior horn of the medial menisci were considered false-positive results because of the arthroscopist’s lack of recognition of a lesion and, therefore, were actually false-negative arthroscopic examinations. Many normal anatomical structures in the knee may mimic meniscal and ligamentous pathology resulting in false-positive readings. For example, the transverse geniculate ligament may appear to be a lateral meniscal tear in the region of confluence between this ligament and its attachment to the anterior horn of the lateral meniscus. The bursa of the popliteus tendon and the ligament of Humphry may mimic a tear in the posterior horn of the lateral meniscus (7). *Fischer et al.* (35) found a relatively high number of false-positive results relative to false-negative

Table 4

| | MM | | | | | LM | | | | | |
|-------------|-----|--|----|----|-----|----|-----|--|----|----|----|
| | Σ | | AH | PI | PH | | Σ | | VH | PI | PH |
| CLINICAL | 237 | | 3 | 1 | 2 | | 89 | | 1 | 0 | 8 |
| MRI | 288 | | 12 | 34 | 251 | | 101 | | 29 | 15 | 64 |
| ARTHROSCOPY | 254 | | 25 | 51 | 212 | | 104 | | 20 | 32 | 68 |

Meniscus tears diagnosed clinically, in MRI and under arthroscopy (MM = medial meniscus, LM = lateral meniscus, AH = anterior horn, PM = pars intermedia, PH = posterior horn)

Table 5

| | Clin. exam. vs. arthroscopy | | | MRI vs. arthroscopy | | |
|---------------------------------|--------------------------------|-----|-----|------------------------|-----|-----|
| | | MM | LM | | MM | LM |
| true-pos | | 155 | 23 | | 237 | 68 |
| false-pos | | 82 | 64 | | 51 | 31 |
| true-neg | | 66 | 231 | | 93 | 265 |
| false-neg | | 97 | 81 | | 19 | 35 |
| Accuracy | | 55% | 64% | | 83% | 83% |
| Specificity | | 45% | 78% | | 65% | 90% |
| Sensitivity | | 62% | 22% | | 93% | 66% |
| Positive Predictive Value (PPV) | | 65% | 26% | | 82% | 69% |
| Negative Predictive Value (NPV) | | 40% | 74% | | 83% | 88% |

Clinical examination and MRI compared to arthroscopy (MM = medial meniscus, LM = lateral meniscus)

results for the medial meniscus and vice versa for the lateral meniscus. In our study, too, there were more false-positive medial menisci /51/ relative to lateral menisci /31/ and more false-negative lateral menisci /35/ relative to medial menisci /19/ for the MRI group. *Fischer et al.* suspected that this finding in the MRI group may result from the fact that there are relatively more medial meniscal tears and radiologists may tend to overinterpret medial meniscal lesions and vice versa. Although magnetic resonance imaging and arthroscopy have become more and more important in the treatment of meniscal disorders, a carefully performed physical examination and an exactly taken history remains essential and is the first diagnostic step taken. Depending on the results of the clinical examination the surgeon will decide if an MRI examination is necessary, or the patient can be admitted to surgery relying on the clinical examination. MRI has been shown to accurately diagnose tears of the meniscus in approximately 85 % (48 %-94 %) (30-34). *Fischer et al.* reported the accuracy from individual MRI centres as varying from 64 % to 94 % (35). In our study MRI had an accuracy of 83 % for diagnosing medial and lateral meniscal tears. Differences in accuracy could also result from differences in scanning protocols. Most probably using one radiologist would have improved the consistency of radiological diagnoses (36). Of course, various examiners do not all have the same level of experience, therefore the accuracy varies. Historically, several investigators have shown that the clinical diagnosis is approximately 70 % accurate (range 35 % to 87 %) in diagnosing knee pathology (13, 17, 27, 28, 29). This study shows that the accuracy and the positive predictive value are significantly higher in MRI. The clinical examination presented an accuracy of 55 % in diagnosing tears of the medial meniscus and 64 % for the lateral meniscus in our study group. Our results are in agreement with those of the authors of recent publications, as reported by *Munk et al.* (24). Reviewing the false-negative and false-positive results, a very high number of ruptures are missed in the clinical examination. The MRI misses notably less ruptures. These results lead to the fact that an MRI, completing a thoroughly performed clinical examination, is helpful in diagnosing meniscal disorders. Another reason for prearthroscopic MRI is a thorough preoperative planning. The surgeon can be aware of abnormalities shown in the MRI and is more likely to detect them under arthroscopy by extensive probing (7).

Therefore injuries to the knee are still a diagnostic and therapeutic challenge.

CONCLUSION

Reviewing our results in respect of the false-positive and false-negative results, we recommend using the MRI as a clarifying diagnostic tool, especially when diagnosing ruptures in the lateral meniscus. Nevertheless, clinical symptoms are superior to MRI findings when indicating an operative intervention. The MRI should only be a tool to verify the clinical diagnosis.

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