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Comparing the Diagnostic Precision of Clinical Examination and MRI with Findings from Arthroscopy in Traumatic Knee Injuries with Femur or Tibia Shaft Fracture

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Abstract

Background: *Diagnosis of knee injuries following trauma to the lower extremity is very important and needs to be carefully examined. This study aimed at comparing the diagnostic precision of clinical examination (CE) and MRI with findings from arthroscopy in traumatic knee injuries with femur or tibia shaft fracture.*

Methods: *A cross-sectional study was conducted on 164 patients with traumatic knee injuries with femur or tibia shaft fracture who had been referred to Imam Hossein Hospital, Shahroud, between March 2014 and February 2015. We compared CE and MRI with arthroscopic findings (gold standard) to determine the concordance, accuracy, sensitivity, and specificity of injuries to the meniscus and knee ligaments.*

Results: *The results showed that internal mucus rupture was the most common trauma, noted in 83 cases (50.6%), followed by anterior corrosion rupture, noted in 65 cases (39.6%). CE sensitivity was 68.4% and specificity was 96.2% for medial meniscal (MM) injuries, while sensitivity was 53.6% and specificity was 96.4% for lateral meniscal (LM) injuries. For anterior cruciate ligament (ACL) injuries, CE showed sensitivity of 77.2% and specificity of 91.8%. For posterior cruciate ligament (PCL) injuries, CE showed sensitivity of 52.6% and specificity of 98.6%. For MM injuries, MRI showed sensitivity of 92.5% and specificity of 86.5%, while for LM injuries, it showed sensitivity of 85.00% and specificity of 98.6%. For ACL injuries, MRI showed sensitivity of 86.7% and specificity of 93.8%, and for PCL injuries, MRI showed sensitivity of 84.5% and specificity of 98.8. For ACL injuries, the best concordance was with CE, while for MM and LM injuries, it was with MRI ($P<0.001$).*

Conclusions: *Meniscal and ligament injuries in traumatic knee injury can be diagnosed through careful clinical examination, while requests for MRI can be reserved for complex or doubtful cases. CE and MRI used together have high sensitivity for ACL, PCL, and MM lesions, while for LM lesions, the specificity is higher.*

Keywords: Knee injury, Clinical examination, MRI, Meniscus, Ligament.
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Introduction

Trauma in medical science includes any damage caused by increased energy intake. Trauma is divided into two groups, namely high energy trauma and low energy trauma, based on the amount of energy.[1] The most common of these injuries is bone fracture of the lower limbs. The damage to these fractures can be attributed to the lesions of soft adjacent structures such as ligaments and even knee joints that are far less tight.[1-2] The lack of timely diagnosis and timely treatment of lesions of the knee joint, which are the body's most important parts for weight bearing, can lead to long-term inability of the patient.[3] Accurate diagnosis of knee injuries is directly linked to taking the clinical history and to a careful clinical examination. Meniscal and ligament injuries of this joint can be evaluated using MRI, which provides images showing morphological abnormalities that are characterized.[4-5] The sensitivity of MRI can be increased depending on the methods used by radiologists.[6] MRI is usually an accurate type of complementary examination for knee assessment, but it has a high cost. It has high applicability to the knees compared to other joints, and it provides excellent diagnostic capacity for evaluating lesions of different types, such as ligament, meniscal, tendon, bone, and chondral injuries.[7-8] However, no evidence to indicate that MRI might reduce the number of negative arthroscopic procedures has been presented.[9] It has been shown that lesion of the anterior meniscal corn seen on MRI may not show any significant clinical presentation, and correlation with clinical examination is recommended.[10] Heterogeneous results regarding the accuracy of clinical examinations on meniscal injuries have been reported because of deficiencies in clinical practice.[10-11]

Qualified orthopedic surgeons can safely diagnose anterior cruciate ligament (ACL) and meniscal injuries through clinical examination, while reserving MRI for complicated and confusing cases. This practice is not initially recommended, and it impairs the surgeon's training.[11] Progress in arthroscopic surgery over recent decades, together with clinical and complementary examinations, in association with low morbidity of the surgical procedure, has encouraged the use of MRI for diagnosing, treating and making prognoses in relation to intra-articular knee injuries.[12] The objective of the present study was to determine the accuracy, sensitivity, specificity, and concordance of the findings from clinical examinations and MRI of the knee, considering arthroscopy on this joint to be the gold standard.[12-13] Keeping in mind the high rates of accidents and fractures in Shahroud city due to geographical location the and lack of accurate statistics on clinical diagnosis and

arthroscopic knee injury following these events, this study was conducted with the aim of comparing the diagnostic precision of clinical examination and MRI with findings from arthroscopy in traumatic knee injuries with femur or tibia shaft fracture.

Materials and Methods

Between March 2014 and February 2015, a prospective study was conducted on 164 patients diagnosed with fracture of the shaft of the thigh or legs. In doing this research, we observed all the ethical requirements of the research, and oral satisfaction were obtained from all patients. The patients, who met the inclusion criteria of our study, were approached by all authors who described the study in detail. All patients were assured of the confidentiality of the data and were told they could withdraw from the study at any time. The patients were also assured that not participating, or withdrawing after giving consent, would not affect the quality of care. The patients were asked about their symptoms, such as pain, joint effusion, episodes of instability, and episodes of joint locking.[3,6] A detailed clinical examination was undertaken by a surgeon with>5 years of experience in treating pathological conditions of the knee. To evaluate meniscal injuries, the McMurray test was used. For ACL injuries, the Lachman tests were used. Varus and valgus stress tests and posterior drawer tests were also performed. The patients' MRI examinations were then evaluated, always after the clinical examination. The following patient characteristics were used as exclusion criteria: history of previous knee surgery; sequelae from fractures; presence of degenerative diseases, which could be inflammatory or primary (osteoarthritis); posterior cruciate ligament (PCL) injuries; multiple ligament injuries; acute injuries (<4 weeks since the injury); chondral injuries; femoropatellar pathological conditions; and refusal to sign the free and informed consent statement. At the next stage, diagnostic and therapeutic arthroscopy was performed for patients with positive clinical examination. Arthroscopy was performed through the anterolateral and anteromedial portals. During the surgery, intra-articular injuries of the knee found through arthroscopy were noted. Any type of meniscal lesion encountered during the surgery was considered a positive finding, independent of the type (radial or longitudinal, simple or complex, or degenerative) and side (medial or lateral). Arthroscopy was considered the gold standard for diagnosing knee joint injuries. The results from comparing the findings from the clinical examination, MRI, and arthroscopy were obtained through this database, and the sensitivity, specificity, positive predictive value (PPV), and negative predictive values (NPV) were evaluated. Descriptive analysis was performed using SPSS, version 16. In this analysis, the significance level taken for decision-making was set at 5%. All patients read and signed the free and informed consent statement, and the study was submitted to and approved by vice chancellery of research of Shahroud University of Medical Sciences, under assessment certificate number 95.115.

Results

For the 164 patients (86 right knees and 78 left knees), the mean age was 33.2±23.2 years (14–78 years); 133 were males (81.1%) and 31 females (18.9%). The most common mechanism of trauma was car accident (78.7%).

Through clinical examination, 68 knees (41.5%) were diagnosed with ACL injuries, 12 (7.3%) with PCL injuries, 45 (27.4%) with medial meniscal (MM) injuries, and 19 (11.6%) with lateral meniscal (LM) injuries. With MRI evaluation, 75 knees (45.7%) were diagnosed with ACL injuries, 17 (10.4%) with PCL injuries, 107 (65.2%) with MM injuries, and 24 (14.6%) with LM injuries. From the arthroscopic findings, 79 knees (48.2%) were diagnosed with ACL injuries, 19 (11.6%) with PCL injuries, 112 (68.3%) with MM injuries, and 26 (15.9%) with LM injuries. The sensitivity, specificity, and positive and negative predictive values of clinical examination and MRI evaluation to arthroscopy are shown in tables 1 and 2. Also, some of the patients' knee MR images are presented in figures 1 to 3.

Table 1. Comparison of Sensitivity, Specificity, PPV and NPV of clinical examination to Arthroscopy for Knee

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Medial meniscal (MM)	68.4	96.2	95.6	42.1
Lateral meniscal (LM)	53.6	96.4	73.7	75.7
Anterior cruciate ligament (ACL)	77.2	91.8	89.7	81.3
Posterior cruciate ligament (PCL)	52.6	98.6	83.3	87.2

Table 2. Comparison of Sensitivity, Specificity, PPV and NPV of MRI evaluation to Arthroscopy for Knee

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Medial meniscal (MM)	92.5	86.5	96.4	53.2
Lateral meniscal (LM)	85.0	98.6	86.4	77.5
Anterior cruciate ligament (ACL)	86.7	93.8	92.3	85.2
Posterior cruciate ligament (PCL)	84.5	98.8	89.5	91.7

Figure 1. Rupture of the medial meniscal (MM)

Figure 2. Rupture of the anterior cruciate ligament (ACL)

Figure 3. Rupture of the lateral meniscal (MM) and posterior cruciate ligament (PCL)

Discussion

Our results showed CE sensitivity of 68.4% and specificity of 96.2% for MM injuries, sensitivity of 53.6% and specificity of 96.4% for LM injuries, sensitivity of 77.2% and specificity of 91.8% for ACL injuries, and sensitivity of 52.6% and specificity of 98.6% for PCL injuries. MRI showed sensitivity of 92.5% and specificity of 86.5% for MM injuries, sensitivity of 85.00% and specificity of 98.6% for LM injuries, sensitivity of 86.7% and specificity of 93.8% for ACL injuries, and sensitivity of 84.5% and specificity of 98.8% for PCL injuries.

In the study by Kim, patients with fractures of the shaft of the hip were examined for simultaneous injuries of the ligaments and meniscus of the knee.[14] Ligament and meniscal injuries of the knee are generally diagnosed by orthopedic surgeons through physical examination, with complementary aid from MRI. In this study, the concordance between these two diagnostic methods was investigated and compared with arthroscopic findings from the knee.

According to Emami, the sensitivity of the clinical examination MM injuries of the knee in compared to arthroscopy was 89%.[15] In their study, the sensitivity and specificity values for MRI and arthroscopy were 92.5% and 86.5%, respectively, for MM injuries.

Brooks demonstrated that MRI did not have the capacity to decrease the number of negative arthroscopy procedures, given that the clinical examination had a concordance of 79% with the arthroscopic findings and MRI showing concordance of 77% with arthroscopy.[16]

Studies conducted by Shepard have suggested that meniscal injuries of the anterior cornu, which are found through an increase in the MRI signal, commonly do not have apparent clinical signs.[17] This suggests that there is a correlation of interpretations of MRI with the clinical examination. As demonstrated by Kocabey in 2004, there was no statistical significance ($P>0.05$) in comparing MRI with clinical examination in diagnosing meniscal and ligament injuries of the knee in relation to arthroscopic findings.[18] This suggests that well-trained orthopedic surgeons can safely diagnose ACL injuries and that the routine of indicating MRI before the clinical examination is not recommended.[19]

Analyses conducted by Polly concluded that MRI has adjuvant value in relation to clinical examination, in pre-operative planning for knee operations, with sensitivity and specificity of 66.7% and 95.1%, respectively, for meniscal injuries, and 100% and 96.9% for ACL injuries evaluated using MRI.[20]

MRI should be used as an auxiliary tool in diagnosing meniscal and ligament injuries, according to Chang, who demonstrated sensitivity of 92% and specificity of 87% for MRI in comparison with arthroscopy, for knees with meniscal injuries.[21]

In acute injuries in which clinical examination may be inconclusive, MRI helps in diagnosis in this population and may guide the surgical indication, according to Munshi.[22]

Combined methods for diagnosing knee injuries consisting of clinical examination and MRI were found to be capable of diminishing the number of negative arthroscopy procedures by 5%, as demonstrated by Makhmalbaf.[23] This suggests that MRI has diagnostic value and helps in relation to the type of anesthesia and treatment, and that it may significantly reduce the need for a second arthroscopic intervention.[24]

In a double-blind study, Rappeport commented that knee arthroscopy was performed without prior knowledge of MRI data. The accuracy of MRI was greater than of arthroscopy as the gold standard for diagnosis, and when MRI was used as the standard, the accuracy of arthroscopy was lower, given that in a small number of patients, some injuries found on MRI were not shown on arthroscopy.[25]

In a Brazilian study, Schneider found that MRI was a reliable examination for diagnosing knee injuries, with sensitivity of 53% and specificity of 95% for ACL injuries, in comparison with arthroscopy.[26] In the present study, the sensitivity and specificity values for MRI compared with arthroscopy were 86.7% and 93.8%, respectively, for ACL injuries.

In the analyses of Yousef on the correlation between MRI and arthroscopy in diagnosing knee joint injuries, the following sensitivity, specificity and accuracy values were demonstrated, respectively: 89%, 72% and 81% for the internal meniscus; 64%, 88% and 76% for the external meniscus; and 90%, 93% and 92% for ACL. It was concluded that MRI was an appropriate examination for diagnosing meniscal and ligament injuries of the knee and would be the preferred examination in cases where the clinical examination was inconclusive.[27] In the present study, clinical examination and MRI were evaluated and compared with arthroscopy. This was different from the studies cited above in which other parameters were evaluated.[28]

According to Vincken, patients who require arthroscopic treatment can be appropriately identified with MRI evaluation, because of the sensitivity and specificity rates of 87% and 88%. Their data were similar to what we found in the present study.[29]

Gobbo concluded that the set of maneuvers for meniscal injuries had good accuracy and significant value, compared with MRI, particularly for ruling out other joint injuries.[30]

In 2010, De Campos stated that clinical examination and MRI had acceptable diagnostic power in relation to knee injuries, although clinical examination was slightly superior. Thus, because of the cost, MRI should be reserved for cases in which there were doubts, or for complex injuries.[31]

Differing from the above citations, Yan stated that MRI had greater accuracy, sensitivity and negative predictive value than clinical maneuvers in cases of meniscal injuries.[32] They recommended that MRI should be routinely requested for detecting this type of injury. These findings were corroborated in the present study, with similar results, comprising sensitivity and negative predictive values greater than those from clinical examination, respectively.

The efficacy of MRI in relation to acute knee trauma has not been appropriately studied.[33] In a double-blind study, Muhammad evaluated the clinical efficacy of MRI in cases of acute knee trauma with inconclusive clinical examinations, and used arthroscopy as the diagnostic gold standard. The sensitivity and specificity of MRI were 90% and 67%, respectively, for detecting any ACL injuries; 50% and 86% for MM injuries; and 88% and 73% for the lateral meniscus.[34] They therefore suggested that evaluations using MRI should be used to guide the need for surgery when the clinical examination was inconclusive, as in acute knee injuries.[35]

The objective of evaluating the accuracy of clinical examination in comparison with arthroscopy and MRI was the topic of a study by Venu. They stated that clinical examination alone was unsatisfactory for diagnosing knee injuries and reported that MRI and arthroscopy were concordant in 94% of the patients evaluated.[36]

Evaluations of knee injuries were made by clinical examination in this study. However, Gerard concluded from analyzing the accuracy of clinical examination for meniscal and ligament injuries that clinical examination might be better used for diagnosis when associated with the patient's history and use of a set of maneuvers, instead of specific maneuvers for meniscal and ligament injuries applied separately.[37]

In 2009, Ryan also came to the conclusion that clinical examination performed carefully could provide the same or even a better diagnosis of meniscal and ligament injuries compared to MRI.[38]

In 2012, Ercin reported that physical examinations that were performed well by experienced surgeons using multiple maneuvers were adequate for diagnosing meniscal injuries. Their findings were similar to the results of the present study.[39]

For MM injuries, clinical examination has greater specificity than MRI, although its sensitivity is low. Their findings were similar to results reported by the Sharma study.[40]

Although MRI and arthroscopy are excellent complementary methods for diagnosing intra-articular knee injuries, clinical examination can still provide a precise diagnosis when carefully performed by an experienced surgeon, particularly in cases of ACL injury. This may even promote lower healthcare costs. MRI should be used only to complement the findings in doubtful cases or in complex injuries wherein clinical examination is inconclusive, and arthroscopy should be used for treating these injuries. MRI should be for optional examination, rather than for routine examination. When clinical examination and MRI were used together, their sensitivity for ACL and MM injuries was high and specificity for the lateral meniscus was higher. For ACL injuries, there was concordance between the examinations. However, the best concordance was between arthroscopy and clinical examination. For the medial meniscus, the best concordance was observed between arthroscopy and MRI, and for the lateral meniscus, it was also between arthroscopy and MRI.

One of the limitations of the present study was that elapsed time between the injury and admission to the outpatient clinic, and then until the surgical procedure, was not taken into consideration. This period could have given rise to new injuries.

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Conflict of Interest

The authors declared that they have no conflict of interest.

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