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Original Article

Evaluation of clinical tests and magnetic resonance imaging for knee meniscal injuries: correlation with video arthroscopy☆

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ABSTRACT

Objective: To determine the specificity, sensitivity, accuracy, likelihood, and correlation of the findings of meniscal tests and magnetic resonance imaging (MRI) to knee video arthroscopy.
Methods: A cross-sectional study, conducted between June and December 2015, which evaluated 84 patients with meniscal tears (MT) selected for video arthroscopy. Two orthopedic trainees and a resident performed a physical examination with specific tests. The results and reports from MRI were compared with arthroscopy findings. The data were analyzed in the statistical program R.
Results: The Steinmann I test was the most specific, with specificity of 86% and 91% for medial meniscus tears (MMT) and lateral meniscus tears (LMT), respectively. With regard to accuracy, the pain test on palpation of the joint interline (PPJI) showed values of 67% and 73% for detection of MMT and LMT, respectively. The PPJI test showed higher sensitivity, with a 77% chance of detecting MMT. Analysis of the set of three tests (McMurray, PPJI, and Steinmann I) compared to arthroscopy showed 85% sensitivity for MMT and 70% sensitivity for LMT. MRI showed a greater specificity for the diagnosis of MMT and LMT; the values were 82% and 91%, respectively.
Conclusion: The combination of the three tests shows better results compared to the isolated tests and thus can be associated to the MRI to make an effective diagnosis. However, further studies assisting in the development of a protocol to standardize diagnostic evaluation are required.

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Avaliação dos testes clínicos e da ressonância magnética para lesões meniscais do joelho: correlacão com a videoartroscopia

Palavras-chave:
Exame físico
Joelho
Artroscopia
Ressonância magnética

RESUMO

Objetivo: Determinar a especificidade, sensibilidade, acurácia, razão de verossimilhança e correlação dos achados dos testes meniscais e da ressonância magnética (RM) com a videoartroscopia do joelho.

Métodos: Estudo transversal feito entre junho e dezembro de 2015. Avaliaram-se 84 pacientes selecionados para tratamento videoartroscópico das lesões meniscais (LM). Dois ortopedistas especializados em cirurgia do joelho e um residente em ortopedia fizeram o exame físico com testes específicos. Os resultados obtidos e laudos da RM foram comparados com os achados da videoartroscopia. Os dados foram tratados no programa estatístico R.

Resultados: O teste de Steinmann I foi mais específico, com especificidade de 86% e 91% para lesões de menisco medial (LMM) e lesões de menisco lateral (LML), respectivamente. Quanto à acurácia, o teste de dor à palpação da interlinha articular (DPIA) apresentou valores de 67% e 73% para detecção de LMM e LML, respectivamente. O teste de DPIA apresentou maior sensibilidade, com 77% de chance de detectar LMM. A análise do conjunto de três testes (McMurray, DPIA e Steinmann I) comparada com a videoartroscopia apresentou 85% de sensibilidade para as LMM e 70% de sensibilidade para as LML. A RM apresentou maior especificidade para o diagnóstico de LMM e LML; 82% e 91%, respectivamente.

Conclusão: O conjunto dos três testes apresentou melhores resultados se comparado com os testes isolados e pode ser associado à RM para elaboração de um diagnóstico efetivo. Entretanto, são necessários outros estudos que auxiliem na elaboração de um protocolo para padronizar a avaliação diagnóstica.

Introduction

Meniscal tears (MT) are caused by excessive compression and shear forces on normal or degenerate menisci. The exact incidence and prevalence of MT are unknown and there is no correlation with ethnicity. They are usually more common in young male athletes. A second peak of incidence is seen in people over the age of 55 because the degenerated meniscus is more susceptible to tears from low energy trauma.[1]

The diagnosis is made by medical history and physical examination, and complemented by magnetic resonance imaging (MRI). Kocabey et al.[2] evaluated the pain tests on palpation of the joint line (PPJL), and found that all of these tests had an accuracy of 80% for medial meniscus tear (MMT) and 92% for lateral meniscus tear (LMT). In addition, Harrison et al.,[3] in their study for validation of the Thessaly test, found that, when positive, sensitivity was 90.3% and specificity was 97.7%, confirmed through video arthroscopy.

Imaging analyses have made the diagnosis of MT more precise, and MRI is the exam of choice because it is highly accurate.[2,4] Regarding the therapeutic methods, video arthroscopy is less aggressive and provides a postoperative period with a lower rate of complications.[2] In the face of technological advances in the diagnosis of MT, the search for an effective approach that is comfortable and easy for the physician and the patient is inevitable.

The aim of this study was to determine the specificity, sensitivity, accuracy, likelihood ratio and correlation of meniscal and MRI findings with knee video arthroscopy.

Material and methods

This is a cross-sectional study performed between June and December 2015 that evaluated patients undergoing video arthroscopy in the hospitals where the knee surgery and rehabilitation group of our hospital work. These hospitals attend patients of health plans, and private and public network patients. The evaluation was made through case history, specific tests and knee MRI. All patients were previously examined by four experienced surgeons, knee specialists, who indicated video arthroscopy.

Only after this evaluation were the patients with MT referred to video arthroscopic surgical treatment and thus included in the study. At this stage, a preoperative physical examination was performed by two specialists in knee surgery and an orthopedics and traumatology resident physician that received specific training to standardize the examination. These latter reviewers were masked to avoid bias. Next, the MRI reports were evaluated and the data for the study were taken from the reports issued by the respective radiologists. Knee MRI was made in several diagnostic centers in Belo Horizonte, state of Minas Gerais.

Regarding knee video arthroscopy, the patient was referred to the operating room and, after anesthesia, asepsis, and

antisepsis, a pneumatic tourniquet was inflated. Video arthroscopy was performed with parapatellar, anterolateral and anteromedial portals. Joint inspection was performed with the introduction of the optics through the anterolateral portal; the lateral and medial compartments, the intercondylar, the plateaus, the condyles and the patellofemoral joint were observed. The findings of the meniscal tears were identified and recorded by the specialist surgeon in knee surgery. The results of physical examination, MRI and video arthroscopy were recorded in a pre-established collection instrument.

The inclusion criterion was of patients with video arthroscopy indication for treatment of meniscal tear. The exclusion criteria were the presence of anterior cruciate ligament (ACL) and posterior cruciate ligament (LCP) lesions; inability to complete all stages of assessment; patients who presented intra-articular loose body; chondral lesion requiring surgical treatment; age below 15 years and over 65 years; and patients submitted to previous surgical treatment of the knee.

The sample consisted of 84 patients, 46 males and 38 females, with an average age of 49.04 years and a variation of 15–64. In relation to sports, 31% reported practicing sports. As to the side the patient was operated on, 54.77% of patients were operated on the left knee and 45.23% on the right knee. Most patients (92.9%) undergoing video arthroscopy presented chronic tears, that is, for more than six weeks. Regarding the type of tear, the highest percentage found (61.9%) was the traumatic type, and 38.1% the degenerative type. The average time between MRI and video arthroscopy was six to 11 months. All patients underwent video arthroscopy, and the pathological findings were cataloged during the surgical procedure. The description of the set of specific tests for MT diagnosis consisted of those presented in Table 1 (Figs. 1 and 2).[5–9]

Performance characteristics of diagnostic tests, such as sensitivity, specificity, likelihood and accuracy, were presented for a better understanding of the association between meniscal tests and MRI with video arthroscopy findings. The data of the research were treated in the statistical software R, version 3.2.3. A 95% confidence interval was considered in all statistical tests used.

The project was duly approved by the Ethics and Research Committee of our institution, through the Brazil Platform (CAAE: 49997715.4.0000.5120), and all patients were informed about the research. The term of free and informed consent was read and signed by the patients that were included in the study, as determined by Resolution 466 of December 12, 2012.

Table 1 – Description of meniscal tests.

McMurray: It is performed with the patient in the supine position, hip at 90°, fully flexed knee, The examiner holds the foot by the heel and his forearm is used as a lever. The knee is now stabilized by the surgeon. With the other hand, palpating the interlinear joints, the leg is rotated over the thigh with the knee still in full flexion. During this movement, the posterior portion of the meniscus is rotated with the head of the tibia, and if there is a tear on the posterior horn of the meniscus, it will produce a crackle and/or pain in the joint. The medial meniscus will be tested by external rotation of the leg and the lateral meniscus by internal rotation. By alternating the position of flexion and extension of the entire joint, the posterior portion of the menisci may be examined according to the rotation of the leg.[5]

Steinmann I test: It is done with the patient sitting on the table with the lower limbs hanging and the knees bent at 90°. To assess a possible medial meniscal lesion a sudden rotation of the tibia is made externally by holding the foot. A positive test produces pain along the medial joint line. A sudden internal tibial rotation is used in a similar manner to confirm a lateral meniscal tear and will result in pain along the lateral joint line.[6]

Pain on Palpation of the Joint Interline (PPJL) (Fig. 1): The palpation is done from anterior to posterior throughout the medial path, and then the lateral pathway with the knee in 90° flexion and light abduction of the hip. In meniscal tears, palpation of the articular interlines may cause pain in the corresponding interline.[7,8]

Thessaly test (Fig. 2): The test is performed with the patient standing with load on the injured knee at 5° and 20° degrees of flexion (Fig. 1). The examiner holds the patient's hands for balance, and then the patient makes an internal and external rotation of the knee three times. The test is positive if there is pain, clicking or feeling of knee distortion. The test is initially performed on the normal knee, so that the patient can be trained and recognize, by comparison, a possible positive result in the symptomatic knee.[9]

Results

MRI images revealed MMT only in 64.29%, while only 21.43% involved LMT, and 14.28% were found to have tears on both menisci.

On video arthroscopy evaluation, 63.1% MMT were found. LMT occurred in 26.2% and 10.71% had tears in both menisci (Table 2).

Each test was analyzed individually in comparison with video arthroscopy and their respective values of accuracy, likelihood ratio, sensitivity and specificity. The Steinmann I test showed a specificity of 86% for MMT and 91% for LMT, which were higher than the other tests. Regarding accuracy, the PPJL test presented a value of 67% for MMT detection, and 73% for LMT. Regarding sensitivity, the PPJL test presented a value of 77% for the detection of MMT, which was the highest among the tests (Table 3).

The comparative analysis between MRI and video arthroscopic findings revealed that there was 100% sensitivity for MMT and 83% sensitivity for LMT. Regarding specificity, the values were 82% for MMT and 91% for LMT. Accuracy for MMT was 95% and 88% for LMT. The likelihood ratio+ was 5.50 in MMT and 9.00 in LMT. The likelihood ratio was 0.0 for MMT and 0.18 for LMT (Table 4).

The comparative analysis between the four meniscal tests (McMurray, Thessaly, PPJL and Steinmann I) and video arthroscopy presented 89% sensitivity for MMT, and 70% sensitivity for LMT. Regarding specificity, the values were 27% for MMT and 63% for LMT. The accuracy of all four tests was 73% for MMT, and 65% for LMT. The likelihood ratio+ was 1.22 in MMT and 1.89 in LMT. The likelihood ratio was 0.41 for MMT and 0.48 for LMT (Table 5).

The analysis of the three meniscal tests (McMurray, PPJL and Steinmann I) and video arthroscopy showed 85% sensitivity for MMT and 70% for LMT. Regarding specificity, the values were 36% for MMT and 67% for LMT. Accuracy was 73% for MMT and 68% for LMT. The likelihood ratio+ was 1.34 for MMT

Fig. 1 – Photo demonstrating the pain test on palpation of the joint interline, the most sensitive among the isolated tests.

Fig. 2 – Photo demonstrating the Thessaly test.

and 2.10 for LMT. The likelihood ratio was 0.40 for MMT, and 0.45 for LMT (Table 6).

It is worth mentioning that for the evaluation of the set of three and four tests, a positive physical examination was considered even when only one of them was positive.

Discussion

The meniscal tests help in the formulation of the possible diagnosis of MT, and in clinical practice they are often associated with MRI for diagnostic complementation. Thus, the objective of this study was to correlate the reliability of the clinical and MRI tests with video arthroscopy findings. Video arthroscopy was used as the gold standard for the diagnosis of MT.

This study differs from most studies found in the literature because it excluded all patients with ACL lesion. Rangel et al.[10] identified greater efficiency on physical examination for MT in the absence of ACL lesion, since the presence of this lesion reduced accuracy.

Recently, Orlando et al.[11] concluded that the association between physical examination and MRI has a high sensitivity for ACL lesions and MMT, but for MT the specificity is greater.

According to Pookarnjanamorakot et al.,[12] the Steinmann I test had a specificity of 100% in MT when associated with an insufficient ACL. In the present study, the results were lower, since a specificity of 89% for MMT, and 91% for LMT was identified for Steinmann I, the test with greater specificity.

When applying the Thessaly test for MMT, a sensitivity of 63% and specificity of 68% were found. Goossens et al.,[13] when applying this same test, obtained similar results, since they found a sensitivity of 64% and specificity of 53%. This same study evaluated the association of the Thessaly and McMurray tests and obtained sensitivity of 53% and specificity of 62%. This study concluded that the Thessaly test alone or in combination with McMurray does not appear to be useful for determining the presence or absence of MT.

Snoeker et al.[14] also concluded that although the Thessaly test has a moderate level of reliability, it is sufficiently accurate to assist in the diagnosis of MT in primary care. In the present study, the Steinmann I, McMurray and PPJL tests (all three tests) were associated, and an 85% sensitivity and 36% specificity were reached for MMT. The best result was for the LMT with a sensitivity of 70% and specificity of 67%. A second proposed association was the set of four tests. However, the results regarding the measures of sensitivity, specificity and accuracy are contained in the 95% confidence interval, which would not justify the addition of one more test. It can be said that the adoption of all three tests would facilitate patient evaluation by being faster and causing less discomfort. In addition, when applying the Thessaly test, it was difficult for patients to understand the guidelines for its correct execution. From these results, it can be inferred that the set of the three tests could provide more effective results for clinical practice (Fig. 3).

Lowery et al.[7] also evaluated the tests together in an attempt to create a score to improve the clinical diagnosis of MT. Five tests were evaluated: McMurray, pain in hyperextension, history of mechanical symptoms, PPJL, pain in

Table 2 – Results regarding the distribution of meniscal lesions on magnetic resonance imaging and video arthroscopy.

Findings	MM	LM	Both menisci	Total
MT-MRI	54 (64.29%)	18 (21.43%)	12(14.28%)	84 (100%)
MT-Artro	53 (63.1%)	22 (26.2%)	09 (10.71%)	84 (100%)

Table 3 – Measures of the individual meniscal tests with the findings of video arthroscopy of the patients in the sample.

McMurray MMT	Estimative (95%)	McMurray LMT	Estimative (95%)
Sensitivity	0.60 (0.46, 0.72)	Sensitivity	0.43 (0.25, 0.63)
Specificity	0.59 (0.36, 0.79)	Specificity	0.78 (0.64, 0.88)
Likelihood ratio+	1.46 (0.85, 2.51)	Likelihood ratio+	1.95 (1.02, 3.72)
Likelihood ratio−	0.68 (0.43, 1.08)	Likelihood ratio−	0.73 (0.52, 1.03)
Accuracy	0.60 (0.48, 0.70)	Accuracy	0.65 (0.54, 0.76)
Steinmann 1 MMT	**Estimative (95%)**	**Steinmann 1 LMT**	**Estimative (95%)**
Sensitivity	0.48 (0.35, 0.61)	Sensitivity	0.17 (0.06, 0.35)
Specificity	0.86 (0.65, 0.97)	Specificity	0.91 (0.80, 0.97)
Likelihood ratio+	3.55 (1.20, 10.48)	Likelihood ratio+	1.80 (0.57, 5.72)
Likelihood ratio−	0.60 (0.45, 0.80)	Likelihood ratio−	0.92 (0.77, 1.10)
Accuracy	0.58 (0.47, 0.69)	Accuracy	0.64 (0.53, 0.74)
Thessaly MMT	**Estimative (95%)**	**Thessaly LMT**	**Estimative (95%)**
Sensitivity	0.63 (0.50, 0.75)	Sensitivity	0.40 (0.23, 0.59)
Specificity	0.68 (0.45, 0.86)	Specificity	0.87 (0.75, 0.95)
Likelihood ratio+	1.98 (1.04, 3.75)	Likelihood ratio+	3.09 (1.36, 6.99)
Likelihood ratio−	0.54 (0.35, 0.84)	Likelihood ratio−	0.69 (0.51, 0.94)
Accuracy	0.64 (0.53, 0.74)	Accuracy	0.70 (0.59, 0.80)
PPJL MMT	**Estimative (95%)**	**PPJL LMT**	**Estimative (95%)**
Sensitivity	0.77 (0.65, 0.87)	Sensitivity	0.57 (0.37, 0.75)
Specificity	0.36 (0.17, 0.59)	Specificity	0.81 (0.69, 0.91)
Likelihood ratio+	1.22 (0.86, 1.71)	Likelihood ratio+	3.06 (1.61, 5.81)
Likelihood ratio−	0.62 (0.30, 1.28)	Likelihood ratio−	0.53 (0.35, 0.82)
Accuracy	0.67 (0.56, 0.77)	Accuracy	0.73 (0.62, 0.82)

Table 4 – Correlation of magnetic resonance with video arthroscopy.

RM MMT	Estimative (95%)	RM LMT	Estimative (95%)
Sensitivity	1.00 (0.91, 1.00)	Sensitivity	0.83 (0.65, 0.94)
Specificity	0.82 (0.60, 0.95)	Specificity	0.91 (0.80, 0.97)
Likelihood ratio+	5.50 (2.27, 13.35)	Likelihood ratio+	9.00 (3.85, 21.06)
Likelihood ratio−	0.00 (0.00, NaN)	Likelihood ratio−	0.18 (0.08, 0.41)
Accuracy	0.95 (0.88, 0.99)	Accuracy	0.88 (0.79, 0.94)

Table 5 – Measures of diagnostic between video arthroscopy and the set of four meniscal tests of patients of the sample.

Set of four tests MMT	Estimative (95%)	Set of four tests LMT	Estimative (95%)
Sensitivity	0.89 (0.78, 0.95)	Sensitivity	0.70 (0.51, 0.85)
Specificity	0.27 (0.11, 0.50)	Specificity	0.63 (0.49, 0.76)
Likelihood ratio+	1.22 (0.93, 1.60)	Likelihood ratio+	1.89 (1.24, 2.87)
Likelihood ratio−	0.41 (0.16, 1.10)	Likelihood ratio−	0.48 (0.27, 0.85)
Accuracy	0.73 (0.62, 0.82)	Accuracy	0.65 (0.54, 0.76)

Table 6 – Diagnostic measures between video arthroscopy and the set of three meniscal tests of the patients of the sample.

Set of three tests MMT	Estimative (95%)	Set of three tests LMT	Estimative (95%)
Sensitivity	0.85 (0.74, 0.93)	Sensitivity	0.70 (0.51, 0.85)
Specificity	0.36 (0.17, 0.59)	Specificity	0.67 (0.53, 0.79)
Likelihood ratio+	1.34 (0.96, 1.87)	Likelihood ratio+	2.10 (1.35, 3.27)
Likelihood ratio−	0.40 (0.18, 0.91)	Likelihood ratio−	0.45 (0.25, 0.80)
Accuracy	0.73 (0.62, 0.82)	Accuracy	0.68 (0.57, 0.78)

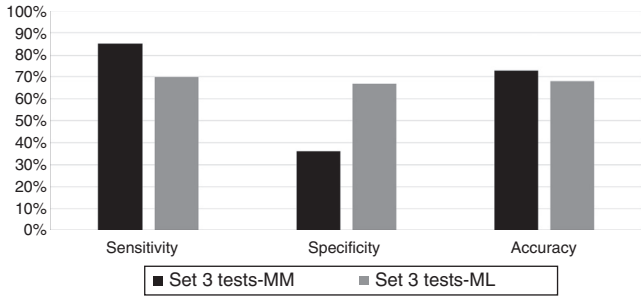

Fig. 3 – Diagnostic comparison between video arthroscopy and the set of meniscal tests in our patients.

hyperflexion and, when all were positive, there was a positive predictive value of 92.3%, specificity of 99%, but a sensitivity of 11, 2% of finding a MT. However, when evaluating the isolated tests, they found similar results to this study, since the most sensitive test was PPJL. Positive predictive values decreased with a concomitant ACL lesion and increased with degenerative tears, and had a higher rate of false positive results (ACL) and false negative results (degenerative tear). Gobbo et al.,[15] in the same way, concluded that the set of tests for MT has good accuracy and significant value, and is useful to rule out the tear.

Yan et al.[16] found the general diagnostic value of MRI for MT accuracy of 88.8%; 95.7% sensitivity, and 75.8% specificity, and concluded that MRI has higher values than clinical trials for MT, and recommend its routine request. In this study, when the MRI results were evaluated, 100% sensitivity was found for MMT and 83% sensitivity for LMT. Regarding the specificity, the values were 82% for MMT and 91% for LMT. The accuracy for MMT was 95% and 88% for LMT (Fig. 4).

Kocabey et al.[2] compared the accuracy of the tests with the MRI and concluded that physical examination had a better accuracy than the MRI. Navali et al.[17] also defined that physical examination has a slight preference when compared to MRI in the diagnosis of knee injuries. Thus, because of the cost, MRI should be reserved for cases in which there are doubts or complex tears.

Both studies differ from the results of this study and also from the meta-analysis by Smith et al.,[18] because they identified that the precision of the special tests for the diagnosis of MT remains poor. These authors state that special tests could be abandoned because they lack reliability and validity.

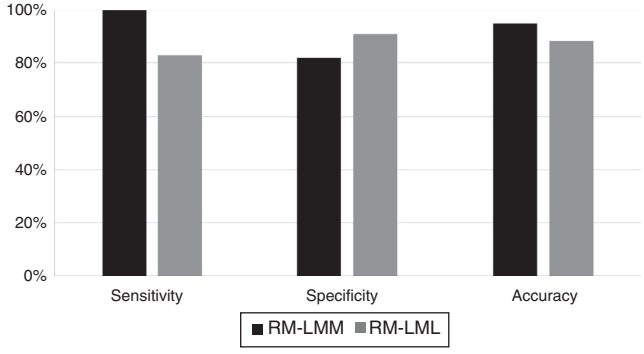

Fig. 4 – Comparison of MRI and video arthroscopy.

However, the results presented by this meta-analysis should be used with caution due to the methodological flaws found in the included studies, such as biases, heterogeneous samples and low number of included studies, which made the data grouped unreliable.

The present study has some limitations. Difficulty of some patients to understand the correct way of performing the Thessaly test was observed. The test is described in a comparative way between limbs, which can increase false-positive rates. Likewise, video arthroscopy results were evaluated by more than one surgeon, which may decrease their reliability.

Conclusion

The set of three tests had similar results when compared to the association of the Thessaly test and, therefore, its use would not significantly alter the results. It is worth mentioning that the most sensitive test in this study was the PPJL test and, therefore, its introduction into the routine of orthopedists could be a useful tool in the diagnosis of MT.

The MRI results indicate that this is an effective method in the diagnosis of MT and should be complementary to the meniscal tests. This exam should be requested by the orthopedic surgeon, who is the best qualified professional for making therapeutic indications for these tears, in order to avoid unwanted indications that burden health system expenses.

The need for primary studies evaluating the applicability of meniscal tests is emphasized. These studies should be elaborated with methodological precision in order to contribute to the creation of a protocol with the purpose of standardizing the diagnostic evaluation and thus to guide the professionals of the area to a clinical practice based on evidence.

Conflicts of interest

The authors declare no conflicts of interest.

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