



## Original Article

# Diagnosis of knee injuries: comparison of the physical examination and magnetic resonance imaging with the findings from arthroscopy<sup>☆</sup>



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## ABSTRACT

**Objectives:** To ascertain the sensitivity, specificity, accuracy and concordance of the physical examination (PE) and magnetic resonance imaging (MRI) in comparison with arthroscopy, in diagnosing knee injuries.

**Methods:** Prospective study on 72 patients, with evaluation and comparison of PE, MRI and arthroscopic findings, to determine the concordance, accuracy, sensitivity and specificity.

**Results:** PE showed sensitivity of 75.00%, specificity of 62.50% and accuracy of 69.44% for medial meniscal (MM) lesions, while it showed sensitivity of 47.82%, specificity of 93.87% and accuracy of 79.16% for lateral meniscal (LM) lesions. For anterior cruciate ligament (ACL) injuries, PE showed sensitivity of 88.67%, specificity of 94.73% and accuracy of 90.27%. For MM lesions, MRI showed sensitivity of 92.50%, specificity of 62.50% and accuracy of 69.44%, while for LM injuries, it showed sensitivity of 65.00%, specificity of 88.46% and accuracy of 81.94%. For ACL injuries, MRI showed sensitivity of 86.79%, specificity of 73.68% and accuracy of 83.33%. For ACL injuries, the best concordance was with PE, while for MM and LM lesions, it was with MRI ( $p < 0.001$ ).

**Conclusions:** Meniscal and ligament injuries can be diagnosed through careful physical examination, while requests for MRI are reserved for complex or doubtful cases. PE and MRI used together have high sensitivity for ACL and MM lesions, while for LM lesions the specificity is higher.

Level of evidence II – Development of diagnostic criteria on consecutive patients (with universally applied reference “gold” standard).

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## Diagnóstico das lesões do joelho: comparação entre o exame físico e a ressonância magnética com os achados da artroscopia

### R E S U M O

#### Palavras-chave:

Traumatismos do joelho/diagnóstico  
Traumatismos do joelho/terapia  
Meniscos tibiais

**Objetivos:** Verificar a sensibilidade, especificidade, acurácia e concordância entre o exame físico (EF) e a ressonância magnética (RM) em comparação com a artroscopia, no diagnóstico das lesões do joelho.

**Métodos:** Estudo prospectivo com 72 pacientes avaliados quanto ao EF, à RM e aos achados artroscópicos. Foram comparados os achados entre si e observaram-se a concordância, acurácia, sensibilidade e especificidade.

**Resultados:** O EF demonstrou sensibilidade de 75%, especificidade de 62,50% e acurácia de 69,44% para as lesões meniscais mediais (MM). Para o menisco lateral (ML) encontraram-se sensibilidade de 47,82%, especificidade de 93,87% e acurácia de 79,16%. O EF demonstrou, para lesões do ligamento cruzado anterior (LCA), sensibilidade de 88,67%, especificidade de 94,73% e acurácia de 90,27%. As lesões do MM, às imagens de RM, apresentaram sensibilidade de 92,50%, especificidade de 62,50% e acurácia de 69,44%. As lesões do ML apresentaram sensibilidade de 65%, especificidade de 88,46% e acurácia de 81,94%. A RM evidenciou para as rupturas do LCA sensibilidade de 86,79%, especificidade de 73,68% e acurácia de 83,33%. Para o LCA, a melhor concordância foi com o EF; e para MM e ML, com a RM ( $p < 0,001$ ).

**Conclusões:** O exame físico cuidadoso diagnostica as lesões meniscais e ligamentares. A RM é reservada para casos complexos ou duvidosos. Associados, EF e a RM têm alta sensibilidade para as lesões do LCA e do MM, porém para o ML é a especificidade que é maior.

Nível de Evidência II – Desenvolvimento de critérios diagnósticos em pacientes consecutivos (com padrão de referencia “ouro” aplicado).

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## Introduction

Accurate diagnosing of knee injuries is directly linked to taking the clinical history and making a careful physical examination. Meniscal and ligament injuries of this joint can be evaluated by means of magnetic resonance imaging (MRI) examinations, which provide images showing abnormalities of the morphology that are characterized. The sensitivity of this examination can be raised according to the methods used by radiologists.<sup>1</sup> MRI is usually an accurate type of complementary examination for knee assessment, but it has high cost.<sup>2</sup>

MRI has high applicability to the knees, in comparison with other joints, and it provides excellent diagnostic capacity for evaluating lesions of different types, such as ligament, meniscal, tendon, bone and chondral injuries.<sup>3</sup> However, no evidence to suggest that MRI might reduce the number of negative arthroscopic procedures has been demonstrated.<sup>4</sup> It has been shown that lesion of the anterior meniscal cornu seen on MRI may not any significant clinical presentation, and correlation with the physical examination is recommended.<sup>5</sup> Heterogenous results regarding the accuracy of physical examinations on meniscal injuries have been observed because of deficiencies of clinical practice.<sup>6</sup>

Qualified orthopedic surgeons can safely diagnose anterior cruciate ligament and meniscal injuries through physical examination, while reserving MRI for complicated and confusing cases. This practice is not recommended initially, and it impairs the surgeon's training.<sup>7</sup>

The progress of arthroscopic surgery over recent decades, together with clinical and complementary examinations, in association with the low morbidity of the surgical procedure, has encouraged its use for diagnosing, treating and making prognoses in relation to intra-articular knee injuries.<sup>8</sup>

The objective of the present study was to determine the accuracy, sensitivity, specificity and concordance of the findings from physical examinations and MRI on the knee, taking arthroscopy on this joint to be the gold standard.

## Materials and methods

Between June 2012 and December 2013, a prospective cohort study was conducted on 72 patients (72 knees: 44 right knees and 28 left knees) of mean age 33.54 years, ranging from 17 to 59 years (SD 34 ± 9), and distributed according to sex as 61 males (84.72%) and 11 females (15.28%). These patients presented meniscal and ligament injuries of the knee and were evaluated as outpatients and through intraoperative arthroscopic findings.

The patients included in the study presented meniscal and/or ligament injuries for which, after outpatient evaluation, there was an indication for surgical treatment. 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 injuries; multiple ligament injuries;

acute injuries (less than four weeks since the injury); chondral injuries; femoropatellar pathological conditions; and refusal to sign the free and informed consent statement.

Each patient's previous history of pathological conditions was taken. Emphasis was given to the cause of the injury. The different etiologies of the injuries were grouped as follows: 58 related to sports (79.2%), 12 were due to trauma unrelated to sports (16.7%) and two were idiopathic (the patient could establish a causal link with the injury). The patients were asked about their symptoms, such as pain, joint effusion, episodes of instability and episodes of joint locking. A detailed physical examination was undertaken by a surgeon with more than five years of experience of treating pathological conditions of the knee. In order to evaluate meniscal injuries, the McMurray test was used. For anterior cruciate ligament (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 physical examination. For the purposes of this study, only the report of the examinations and not the interpretations of the images was taken into consideration. The MRIs were produced in four different imaging centers and the radiologists did not have any contact with the patients and did not know about the present study. The MRI reports and physical examination findings were noted according to the anatomical structure involved, such as cruciate ligaments and menisci.

The surgery was performed by one of the authors who had not participated in the initial attendance of the case. The ligament stability was again tested, under anesthesia. Arthroscopy was performed through the anterolateral and anteromedial portals. During the operation, the intra-articular injuries of the knee found through arthroscopy were noted. Any type of meniscal lesion encountered during the surgery was considered to be a positive finding, independent of the type (radial or longitudinal, simple or complex, or degenerative) and the side was noted (medial or lateral). Arthroscopy was considered to be the gold standard in making the diagnosis of knee joint injuries. This study did not take into consideration the type of treatment for the joint injuries (meniscal and ACL).

The results from comparing the findings from the physical examination, MRI and arthroscopy were obtained through this database, and the sensitivity, specificity, accuracy, positive predictive value, negative predictive value and concordance were evaluated.

Some of the concepts used in this study are defined below:

- (1) Sensitivity – this demonstrated the efficiency of MRI and the physical examination for diagnosing lesions through arthroscopy.

TP/TP + TN

- (2) Specificity – this demonstrated the efficiency of the parameters for diagnosing the absence of lesions through arthroscopy.

TN/TN + FP

- (3) Accuracy – this demonstrated the capacity of the physical examination or MRI to correctly define the presence or absence of lesions through arthroscopy.

TP + TN/No. of examinations

- (4) Positive predictive value (PPV) – this was the likelihood that the lesion diagnosed on MRI or in the physical examination would be present through arthroscopy.

TP/TP + FP

- (5) Negative predictive value (NPV) – this was the likelihood that there would not be any lesion when the physical examination or MRI was normal.

TN/TN + FN

- (6) True positive (TP): physical examination or MRI showing lesion, and arthroscopy showing lesion.
- (7) True negative (TN): physical examination or MRI normal, with arthroscopy normal.
- (8) False positive (FP): physical examination or MRI showing lesion, with arthroscopy normal.
- (9) False negative (FN): physical examination or MRI negative, and arthroscopy showing lesion.

The descriptive analysis was performed by means of the Minitab statistical software, version 14.1. The kappa concordance analysis was performed through the website of the Epidemiology and Statistics Laboratory (<http://www.lee.dante.br/pesquisa/kappa/>). In this analysis, the significance level taken for decision-making was 5%.

All the patients read and signed the free and informed consent statement and the study was submitted to and approved by the institution's research ethics committee, under the ethics assessment certificate (CAAE) number 16051913.4.0000.0007.

## Results

Through the physical examination, 42 knees were diagnosed with medial meniscal injuries. From the arthroscopic findings, 40 knees presented injuries. Thus, the sensitivity was 75%, specificity 62.50% and accuracy 69.44%. For the lateral meniscus, the total number of injuries encountered was 14 and there were positive arthroscopic findings in 23 knees, with sensitivity of 47.82%, specificity of 93.87% and accuracy of 79.16%.

Anterior cruciate ligament injuries were found in 48 knees from the clinical examination and 53 through arthroscopy, with sensitivity of 88.67%, specificity of 94.73% and accuracy of 90.27% (Table 1).

The MRI showed medial meniscal injuries in 46 knees and arthroscopy showed injuries in 40 menisci, thus presenting sensitivity of 92.50%, specificity of 62.50% and accuracy of 69.44%. For the lateral meniscal lesions, the following results were found: 19 knees with injuries on MRI and positive arthroscopic findings in 20 knees, with sensitivity of 65%, specificity of 88.46% and accuracy of 81.94%.

MRI showed ACL injuries in 51 knees and arthroscopy showed 53 injuries, with sensitivity of 86.79%, specificity of

**Table 1 – Correlation of physical examination with arthroscopy.**

Results from correlating physical examination with arthroscopy in the cases of 72 knees			
	Sensitivity (%)	Specificity (%)	Accuracy (%)
Medial meniscus	75.00	62.50	69.44
Lateral meniscus	47.82	93.87	79.16
ACL	88.67	94.73	90.27

ACL, anterior cruciate ligament.

**Table 2 – Correlation of MRI with arthroscopy.**

Results from correlating MRI with arthroscopy in the cases of 72 knees			
	Sensitivity (%)	Specificity (%)	Accuracy (%)
Medial meniscus	92.50	74.19	83.33
Lateral meniscus	65.00	88.46	81.94
ACL	86.79	73.68	83.33

ACL, anterior cruciate ligament.

**Table 3 – Correlation of physical examination and MRI with arthroscopy.**

Results from correlating physical examination/MRI with arthroscopy in the cases of 72 knees						
	Sensitivity		Specificity		Accuracy	
	Physical (%)	MRI (%)	Physical (%)	MRI (%)	Physical (%)	MRI (%)
Medial meniscus	75.00	92.50	62.50	74.19	69.44	83.33
Lateral meniscus	47.82	65.00	93.87	88.46	79.16	81.94
ACL	88.67	77.35	94.73	73.68	90.27	76.38

MRI, magnetic resonance imaging; Physical, physical examination; ACL, anterior cruciate ligament.

**Table 4 – Cross-correlation of physical examination and MRI with arthroscopy.**

	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)
ACL	97.0	86.7	75.0	95.3	92.9
MM	96.2	76.5	52.8	86.2	92.8
LM	55.6	97.7	66.7	83.3	91.5

Physical, physical examination; MRI, magnetic resonance imaging; ACL, anterior cruciate ligament; MM, medial meniscus; LM, lateral meniscus; PPV, positive predictive value; NPV, negative predictive value.

**Table 5 – Evaluation of concordance between the diagnostic methods for ACL injuries by means of arthroscopy, MRI and physical examination.**

Diagnostic examinations	Kappa	Concordance	p-Value
Art versus MRI versus physical <sup>a</sup>	0.55	Moderate	<0.001
Art versus MRI <sup>b</sup>	0.51	Moderate	<0.001
Art versus physical <sup>c</sup>	0.66	Strong	<0.001

ACL, anterior cruciate ligament; Art, arthroscopy; MRI, magnetic resonance imaging; Physical, physical examination.

<sup>a</sup> Concordance was found between the three methods.  
<sup>b</sup> Concordance was found between arthroscopy and MRI.  
<sup>c</sup> Concordance was found between arthroscopy and MRI.

**Table 6 – Evaluation of concordance between the diagnostic methods for medial meniscal injuries by means of arthroscopy, MRI and physical examination.**

Diagnostic examinations	Kappa	Concordance	p-Value
Art versus MRI versus physical <sup>a</sup>	0.367	Slight/fair	<0.001
Art versus MRI <sup>b</sup>	0.630	Strong	<0.001
Art versus physical <sup>c</sup>	0.322	Slight/fair	<0.001

MM, medial meniscus; Art, arthroscopy; MRI, magnetic resonance imaging; Physical, physical examination.

<sup>a</sup> Slight/fair concordance was found between the three methods.  
<sup>b</sup> Strong concordance was found between arthroscopy and MRI.  
<sup>c</sup> Slight/fair concordance was found between arthroscopy and MRI.

73.68% and accuracy of 83.33% (Table 2). Table 3 shows a summary of the data presented above. Table 4 shows the physical examination and MRI values combined, with arthroscopy taken to be the gold standard for the diagnosis.

In order to investigate the concordance of findings of ACL injuries between the examinations, the kappa statistical test ( $\kappa$ ) was applied. It was observed that the examinations were concordant. However, the best concordance was

**Table 7 – Evaluation of concordance between the diagnostic methods for lateral meniscal injuries by means of arthroscopy, MRI and physical examination.**

Diagnostic examinations	Kappa	Concordance	p-Value
Art versus MRI versus physical <sup>a</sup>	0.358	Slight/fair	<0.001
Art versus MRI <sup>b</sup>	0.530	Moderate	<0.001
Art versus physical <sup>c</sup>	0.375	Slight/fair	<0.001

MM, lateral meniscus; Art, arthroscopy; MRI, magnetic resonance imaging; Physical, physical examination.

<sup>a</sup> Slight/fair concordance was found between the three methods.

<sup>b</sup> Strong concordance was found between arthroscopy and MRI.

<sup>c</sup> Slight/fair concordance was found between arthroscopy and MRI.

between arthroscopy and the physical examination, for which the kappa value was 0.665; this concordance was significant ( $p < 0.001$ ). For the medial meniscus, the best concordance observed was between arthroscopy and MRI ( $\kappa = 0.630$ ;  $p < 0.001$ ) and for the lateral meniscus, the best concordance encountered was also between arthroscopy and MRI ( $\kappa = 0.530$ ;  $p < 0.001$ ) (Tables 5–7).

## Discussion

Ligament and meniscal injuries of the knee are generally diagnosed by orthopedic surgeons by means of physical examination, with complementary aid from MRI. In this study, the concordance between these two types of diagnostic method was investigated in comparison with the arthroscopic findings from the knee.

According to Magee et al.,<sup>1</sup> comparison between arthroscopy and MRI presented sensitivity for meniscal injuries of the knee of 89% and demonstrated that signal abnormalities seen on MRI gave information about morphological alterations of injuries. In their study, the sensitivity and specificity values for MRI and arthroscopy were respectively 70.4% and 50% for meniscal injuries.

Brooks et al.<sup>4</sup> demonstrated that MRI did not have the capacity to decrease the number of negative arthroscopy procedures, given that the physical examination had concordance of 79% with the arthroscopic findings and MRI showed concordance of 77% with arthroscopy.

Studies conducted by Shepard et al.<sup>5</sup> 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. This suggests that there is a correlation of interpretations of MRI with the physical examination. As demonstrated by Kocabey et al.<sup>7</sup> in 2004, there was no statistical significance ( $p > 0.05$ ) in comparing MRI with the physical examination, in diagnosing meniscal and ligament injuries of the knee in relation to the arthroscopic findings. This suggests that well-trained orthopedic surgeons can safely diagnose anterior cruciate ligament injuries and that the routine of indicating MRI before the physical examination is not recommended.

Analyses conducted by Polly et al.<sup>9</sup> concluded that MRI has adjuvant value in relation to physical examination, in preoperative 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.

MRI should be used as an auxiliary tool in diagnosing meniscal and ligament injuries, according to Chang et al.,<sup>10</sup> who demonstrated sensitivity of 92% and specificity of 87% for MRI in comparison with arthroscopy, for knees with meniscal injuries.

In acute injuries in which physical examination may be inconclusive, MRI helps in the diagnosis in this population and may guide the surgical indication, according to Munshi et al.<sup>11</sup> However, its correlation with arthroscopy in this population has not yet been documented.

Combined methods for diagnosing knee injuries consisting of physical examination and MRI were found to be capable of diminishing the number of negative arthroscopy procedures by 5%, as demonstrated by Munk et al.<sup>12</sup> 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.

In a double-blind study, Rappeport et al.<sup>13</sup> commented that knee arthroscopy was performed without prior knowledge of the MRI data. The accuracy of the MRI was greater than arthroscopy as the gold standard for diagnosis, and when MRI was used as the standard, the accuracy of the arthroscopy was lower, given that in a certain small number of patients, some injuries found on MRI were not shown during arthroscopy. It was suggested that MRI should be used initially for diagnosing knee injuries, which would also diminish the number of negative arthroscopy procedures.

Gelb et al.<sup>14</sup> demonstrated that MRI has been used excessively in cases of knee disorders and does not have a favorable cost-benefit relationship in relation to physical examination, in comparisons with arthroscopy. For physical examination, these authors found sensitivity and specificity of 100%, whereas in comparing MRI with arthroscopy, they found values of 95% and 88%.

In a Brazilian study, Schneider et al.<sup>15</sup> 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.

In the present study, the sensitivity and specificity values for MRI compared with arthroscopy were 86.79% and 73.68% respectively, for ACL injuries.

Severino et al.<sup>16</sup> suggested that MRI was an appropriate method for complementing the physical examination in cases of ligament and meniscal injuries of the knee and demonstrated sensitivity and specificity values for MRI for injuries of the ACL, medial meniscus and lateral meniscus of respectively 82% and 96%, 96% and 66%, and 87% and 88%, in comparison with arthroscopy.

In the analyses of Yousef et al.<sup>17</sup> 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 the 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 in which the physical examination was inconclusive.

In the present study, physical examination and MRI were evaluated and compared with arthroscopy. This was different from the studies cited above, in which other parameters were evaluated. The accuracy of the physical examination for medial meniscal injuries was found to be 69.44% and the accuracy of MRI was 83.33%. For the lateral meniscus, the values were 79.16% for the physical examination and 81.94% for MRI. For ACL injuries, the accuracy of the physical examination was found to be 90.27% and the accuracy of MRI was 83.33%.

The accuracy of MRI for detecting knee injuries was more than 90% when it was evaluated by specialists, as demonstrated by Ben-Galin et al.,<sup>18</sup> but they found a false-positive rate of 47% for ACL injuries, in comparison with the intraoperative findings. The accuracy rate was 80% for ligament injuries. Thus, 37% of the surgical procedures indicated because of significant alterations seen on MRI were performed unjustifiably.

According to Vincken et al.,<sup>19</sup> patients who require arthroscopic treatment can be appropriately identified by means of MRI examination, because of the sensitivity and specificity rates of 87% and 88%. Their data were similar to what was found in the present study.

Gobbo et al.<sup>20</sup> concluded that the set of maneuvers for meniscal injuries had good accuracy and significant value, compared with MRI, especially for ruling out other joint injuries.

In 2013, Navali et al.<sup>21</sup> stated that physical examination and MRI had acceptable diagnostic power in relation to knee injuries, although physical examination was slightly superior. Thus, because of the cost, MRI should be reserved for cases in which there were doubts, or for complex injuries.

Differing from the above citations, Yan et al.<sup>22</sup> stated that MRI had greater accuracy, sensitivity and negative predictive value than clinical maneuvers in cases of meniscal injuries. 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 accuracy, sensitivity and negative predictive values greater than those from physical examination, respectively as follows: medial meniscus, 83.33% versus 69.44%, 92.50% versus 75% and 88.46% versus 66.66%; and lateral meniscus, 81.94% versus 79.16%, 65% versus 47.82% and 86.79% versus 79.31% (MRI versus physical examination).

The efficacy of MRI in relation to acute knee trauma has not been studied appropriately. In a double blind study, Muhammad et al.<sup>23</sup> evaluated the clinical efficacy of MRI in cases of acute knee trauma with inconclusive physical 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 medial meniscal injuries and 88% and 73% for the lateral meniscus. 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.<sup>23</sup>

The objective of evaluating the accuracy of physical examination in comparison with arthroscopy and MRI was the topic of a study by Venu et al.<sup>24</sup> They stated that physical examination alone was unsatisfactory for diagnosing knee injuries and reported that MRI and arthroscopy were concordant in 94% of the patients evaluated.

In our evaluation, the physical examination presented greater accuracy in relation to arthroscopy than did MRI for ligament injuries. However, for meniscal injuries, MRI presented greater accuracy in relation to arthroscopy.

Evaluations of knee injuries were made by means of physical examination in this study. However, Solomon et al.<sup>25</sup> concluded from analyzing the accuracy of physical examination for meniscal and ligament injuries that this 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.

In 2009, Ryan et al.<sup>26</sup> also came to the conclusion that physical examination performed carefully could provide the same or even a better diagnosis of meniscal and ligament injuries, in comparison with MRI.

In 2012, Ercin et al.<sup>27</sup> reported that physical examinations that were performed well, by experienced surgeons using multiple maneuvers, were sufficient for making the diagnosis of meniscal injuries. Their findings were similar to the results from the present study.

The study by Valles-Figueroa et al.<sup>28</sup> was more emphatic in contraindicating routine requests for MRI examinations for evaluating knee injuries. These authors stated that physical examination was sufficient for diagnosing meniscal and ligament injuries of this joint.

For medial meniscal injuries, physical examination has greater sensitivity than MRI, although its accuracy and specificity are low, according to Sharma et al.<sup>29</sup> Their data differ somewhat from ours, in which MRI was more sensitive than physical examination, although the accuracy and specificity of physical examination were low in our study too, in relation to MRI.

According to the literature,<sup>30</sup> with regard to arthroscopy, there is a risk of approximately 8% in relation to the surgical procedure. For this reason, the present authors do not use it only as a diagnostic method, but also as a therapeutic method. In addition, arthroscopy used only for diagnosis is an invasive tool, and it is slower and more expensive than MRI.

In order to evaluate the concordance among the parameters analyzed, we used the kappa coefficient ( $\kappa$ ), as described by Vieira and Garret,<sup>31</sup> with concordance values as expressed in Fig. 1. Through this, the best concordance was found to be between the physical examination and ACL injuries ( $\kappa = 0.665$ ), which was significant concordance ( $p < 0.001$ ). For medial meniscal injuries, the best concordance was observed between arthroscopy and MRI ( $\kappa = 0.630$ ;  $p < 0.001$ ); and for lateral meniscal injuries, the best concordance was also found to be between arthroscopy and MRI ( $\kappa = 0.530$ ;  $p < 0.001$ ). We did not find any similar values in the current literature.

Among the limitations of the present study, the lack of standardization of the MRI examinations can be cited. These were performed in several imaging centers, and this may have increased the dispersion of the data. Another limitation was that the time that elapsed 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. The meniscal injuries were only diagnosed using the McMurray test, which may have diminished the rate of diagnosing these injuries. For diagnosing anterior

Interpretation of kappa						
	Poor	Slight	Fair	Moderate	Significant	Almost perfect
Kappa	0.0	0.20	0.40	0.60	0.80	1.0
<b>Kappa</b>	<b>Concordance</b>					
<0	Less than an association by coincidence					
0.01–0.20	Slight association					
0.21–0.40	Fair association					
0.41–0.60	Moderate association					
0.61–0.80	Significant association					
0.81–0.99	Almost perfect association					

**Fig. 1 – Interpretation of the kappa coefficient; Vieira and Garret,<sup>31</sup> 2005.**

instability, only the Lachman maneuvers were applied. The method applied for treating these injuries, along with the long-term follow-up of these patients, was outside of the scope of the present study.

## Conclusions

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

## Conflicts of interest

The authors declare no conflicts of interest.

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