THE CLINICAL DIAGNOSIS OF MENISCAL TEAR IS NOT EASY. RELIABILITY OF TWO CLINICAL MENISCAL TESTS AND MAGNETIC RESONANCE IMAGING.

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Aim: to clarify the reliability of two clinical meniscal tests, McMurray's and Apley's and the MRI imaging, in order to establish how to reduce unjustified arthroscopies. Methods: 102 patients were selected out of 160. All patients were submitted to a triple clinical examination (by a young surgeon and two skilled surgeons), MRI and an arthroscopic procedure. The investigated clinical tests were McMurray's and Apley's test. The positivity or negativity of the tests and MRI were compared to arthroscopic findings. Arthroscopy is considered the gold standard for the diagnosis of meniscal lesions. We measured the length of the meniscal lesions in order to correlate it to the clinical findings. Results: From the clinical examination, we got the following data: McMurray's test: sensitivity 79.7%, specificity 78.5%, accuracy 79.4%, positive likelihood ratio 3.7, negative likelihood ratio 0.2. Apley's test: sensitivity 83.7%, specificity 71.4%, accuracy 80.3%, positive likelihood ratio 2.9, negative likelihood ratio 0.2. The composite assessment is strictly dependent on how the discordance of the two tests is evaluated. The assessment of the clinical tests was done even in relation to medial or lateral meniscal lesion. No statistical difference was found about the length of the meniscal tear. MRI gave the following results: sensitivity 78.3%, specificity 85.7%, accuracy 80.3%. Conclusions: If we use, as diagnostic means, McMurray's and Apley's clinical tests and MRI as imaging procedure, we have an accuracy of about 80%. It is important to keep in mind that it is not possible to have the absolute certainty of make a correct diagnosis in case of meniscal lesions. Patients, too, have to be informed about the risk of a negative arthroscopy.

Meniscal lesions are among the most common knee disorders encountered by the practicing orthopaedic surgeon.

The clinical diagnosis of a meniscal lesion depends on the insight and experience of the physician. The patient with meniscal pathology typically presents with symptoms referable to the joint line, either medially or laterally. In traumatic cases, an injury is brought on with the knee in flexion, weight bearing, followed by rotation. A pop may or may not be felt. Symptoms are frequently worsened by flexing and loading the knee, and activities such as squatting and kneeling are poorly tolerated. Patients will frequently complain of a "pop" or "clunk" sensation as the knee is brought through the range of motion.

An effusion may be present to a varying extent. Patients most frequently will have specific joint line point tenderness. Often, the examiner may appreciate a small focus of swelling or bogginess in the area of the point tenderness, particularly if the knee is in flexion.

A number of tests have been described in order to appreciate meniscal pathology. According to the literature, the reliability of clinical examination for the diagnosis of meniscal lesion has a great variability (1-6).

To confirm the diagnosis of meniscal tear, the best recognized imaging procedure is Magnetic Resonance Imaging (MRI). According to the literature, the accuracy of MRI in meniscal lesions varies from 52% to 99% for medial meniscus, from 81% to 100% for lateral meniscus, with a sensitivity from 71% to 100% for medial meniscus, 70% to 100% for lateral meniscus, and a specificity of 66 to 97% for medial meniscus, 83 to 100% for lateral meniscus (4, 7, 8)

Two of the most used tests are McMurray's and Apley's. The aim of the present paper was to evaluate the

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reliability of these two tests and MRI.

MATERIALS AND METHODS

Between January 2008 and December 2009, 160 consecutive patients, aged 20-50 years, who suffered from knee pain consequent to an acute injury to the knee, were enrolled in a prospective study. All the patients were clinically examined by a first orthopaedic surgeon (A.C.) and underwent a magnetic resonance imaging (MRI). This first examiner collected the following information: 1. patient's history of pain, 2. previous problems with his or her knee (previous diagnoses, like osteoarthritis, previous episodes of knee pain in the absence of trauma), 3. diagnosed rheumatic diseases (rheumatoid arthritis, systemic lupus erythematosus, gout, etc.), 4. previous diagnosis of conditions that can cause osteoarthritis (psoriasis, articular fractures), 5. previous surgery on the injured knee. The primary exclusion criteria were: diagnosed osteoarthritis, rheumatic diseases, psoriasis, previous articular fractures, previous surgery, ACL tear. From the original pool of patients, 33 met the primary exclusion criteria. All the patients who presented with a mechanical locking of the knee (18) were excluded. In a period between the firth and the fifth week from injury, all the patients of the main group (group A) were separately re-examined by two experienced orthopaedic surgeons (G. R., A. D., both had performed more than 2000 knee arthroscopic procedures), blinded to the patient's history, MRI result and the first clinical examination. Indication for arthroscopic procedure was given in case of positivity of clinical examination for meniscal lesion, confirmed by positivity of MRI, but also in case of positive MRI combined with uncertain clinical diagnosis, and in case of positive clinical examination, in association with negative MRI. Of the remaining 109 patients, 7 were excluded because of no agreement in the clinical meniscal tests between the two experienced examiners (secondary exclusion criterium).

The assessed meniscal clinical tests were the following:

1. McMurray's test (9)**:** The patient lies supine and the knee is acutely and forcibly flexed. One of the examiner's hand is placed on the knee so that the thumb and index fingers are along the joint line of the knee, while the other hand grasps the patient's ankle and externally rotates the tibia on femur as far as possible and then the knee is slowly extended to check the medial meniscus. For the lateral meniscus, the maneuver is repeated in the position of internal rotation of tibia on femur.

2. Apley's test (10): The patient is in a prone position and the tibia is rotated over a fixed femur, while the knee is alternatively compressed and distracted to elicit pain. This differentiates pain due to a meniscal lesion (worse on compression) from pain due to other soft tissue injuries (worse on distraction).

If only one of the two assessed clinical tests was diversely interpreted by the two examiners, the patient was excluded from the study. Totally, 102 remaining patients were included in the definitive study. There were 75 men and 27 women, of a mean age of 27.8 years. In the 102 cases examined, a comparison between the clinical tests and the arthroscopic finding was done, considering arthroscopic procedure as the gold standard for meniscal tear diagnosis. The same was done with MRI report.

Table I a. *Accuracy of McMurray's and Apley's test*

TEST	TRUE POSITIVES	TRUE NEGATIVES	FALSE POSITIVES	FALSE NEGATIVES	ACCURACY
McMurray	59	22	6	15	**79.4%**
Apley	62	20	8	12	**80.3%**

Table I a. True positives, true negatives, false positives, false negatives and accuracy of McMurray's and Apley's test. The meniscal lesions are 74 out of 102.

Table I b *McMurray's and Apley's: sensitivity and specificity*

TEST	SENSITIVITY (TP / TP+FN)	SPECIFICITY (TN / TN+FP)	PPV (TP / TP+FP)	NPV (TN/ TN+FN)
McMurray	79.7%	78.5%	90.7%	59.4%
Apley	83.7%	71.4%	87.3%	62.5%

Table I b: Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the two maneuvers.

Table I c *Positive and negative likelihood ratios of the tests.*

TEST	POSITIVE Likelihood Ratio	NEGATIVE Likelihood Ratio
McMurray	3.7	0.2
Apley	2.9	0.2

Table I c: Positive and negative likelihood ratios of the two clinical tests.

Table II a. *Reliability of composite assessment of the two tests.*

TESTS	TRUE POSITIVES	TRUE NEGATIVES	FALSE POSITIVES	FALSE NEGATIVES
MM + AP (concordance)	56	18	10	18
MM + AP (discordance)	69	25	3	5

Table II a: The table illustrates the positivity and negativity of the two tests, McMurray's (MM) and Apley's (AP) associated. In the first row ("concordance"), when the two tests are not concordant, are considered not correct. In the second row ("discordance"), a discordance of the two test is evaluated as correct (it is sufficient only one true test).

Table II b. *Reliability of composite assessment of the two tests.*

TEST	SENSITIVITY (TP / TP+FN)	SPECIFICITY (TN / TN+FP)	PPV (TP / TP+FP)	NPV (TN/ TN+FN)
MM + AP (concordance)	75.6%	64.2%	84.8%	50%
MM + AP (discordance)	93.2%	89.2%	95.8%	83.3%

Table II b: The table illustrates the sensitivity, the specificity, the positive predictive value (PPV) and the negative predictive value (NPV) of the two tests, McMurray's (MM) and Apley's (AP) associated. In the first row ("concordance"), when the two tests are not concordant, are considered not correct. In the second row ("discordance"), a discordance of the two test is evaluated as correct (it is sufficient only one true test).

Table II c. *Composite assessment of the two tests: positive and negative likelihood ratios.*

TEST	POSITIVE Likelihood Ratio	NEGATIVE Likelihood Ratio
MM + AP (concordance)	2.1	0.3
MM + AP (discordance)	8.6	0.1

Table II c: The table illustrates the positive and the negative likelihood ratios of the two tests, McMurray's (MM) and Apley's (AP) associated. In the first row ("concordance"), when the two tests are not concordant, are considered not correct. In the second row ("discordance"), a discordance of the two test is evaluated as correct (it is sufficient only one true test).

We measured the length of the meniscal lesions, during arthroscopic procedure, with a specific probe, and divided the lesions into three groups: lesions less than 1 cm long, lesions between 1 and 2 cm, lesions longer than 2 cm.

Sensitivity, specificity, false positive, false negative and diagnostic accuracy values were calculated for the clinical tests and MRI report comparing with the arthroscopic diagnosis.

RESULTS

From the 102 arthroscopic procedures, there were 74 cases of meniscal tear. We found 55 lesions of the medial meniscus, 12 lesions of the lateral meniscus, 7 lesions of both menisci.

In table I a, b and c all the findings are illustrated.

The **McMurray test** had an accuracy of 79.4%: 59 true positive, 22 true negative, 6 false positive, 15 false negative. This test had a sensitivity of 79.7% and a specificity of 78.5%, a positive predictive value (PPV) of 90.7%, a negative predictive value (NPV) of 59.4%. The accuracy of the **Apley test** was 80.3%, with a sensitivity of 83.7% and a specificity of 71.4%, a PPV of 87.3%, a NPV of 62.5%. McMurray's test showed a positive likelihood ratio of 3.7 and a negative likelihood ratio of 0.2, Apley's test showed a positive likelihood ratio of 2.9 and a negative likelihood ratio of 0.2.

We calculated the sensitivity, specificity, false positive, false negative and diagnostic accuracy values also for the tests combined. In this case, we necessitate to establish how to judge a combination of the tests when they are not concordant. If we evaluate a combination of tests as correct when only one of tests was correct (true positive or true negative), the accuracy of the clinical examination increases (tab. I a, b, c) to 92%. Differently, if we attribute false (positive or negative) values if only one test

Table III a *Medial meniscus lesions.*

TEST	TRUE POSITIVES	TRUE NEGATIVES	FALSE POSITIVES	FALSE NEGATIVES
McMurray	51	31	9	11
Apley	52	31	9	10

Table III a: The table illustrates the data of the lesions of the medial meniscus. The isolated lesions of the medial meniscus were 55, those of the lateral meniscus 12. The lesions of both menisci were 7. No lesion in 40 cases.

Table III b *Lateral meniscus lesions.*

TEST	TRUE POSITIVES	TRUE NEGATIVES	FALSE POSITIVES	FALSE NEGATIVES
McMurray	14	77	6	5
Apley	15	74	9	4

Table III b: The table illustrates the data of the lesions of the lateral meniscus. The isolated lesions of the medial meniscus were 55, those of the lateral meniscus 12. The lesions of both menisci were 7. No lesion in 40 cases.

Table III c *Sensitivity and specificity for medial and lateral meniscal lesions.*

TEST	SENSITIVITY (TP / TP+FN)	SPECIFICITY (TN / TN+FP)	PPV (TP / TP+FP)	NPV (TN/ TN+FN)
McMurray (MM/ML)	82/73 %	77/92 %	85/70 %	73/94 %
Apley (MM/ML)	83/79 %	77/89 %	85/62 %	75/94 %

Table III c: Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of McMurray's and Apley's tests differentiating the lesions of the medial meniscus (MM) and those of lateral meniscus (LM).

was wrong (respectively, false positive or false negative), the accuracy of the complete examination decreases in comparison with the single test examination (72.5%).

We also assessed the two tests by distinguishing medial and lateral meniscal tears. The results are illustrated in table III a, b, c.

The length of the meniscal tear did not appear statistically significant in clinical examination ($p<0.05$).

As regards the **MRI**, we compared the report of the radiologist with the arthroscopic finding (table IV). We found 58 true positives, 24 true negatives, 4 false positives, 8 false negatives. In 7 cases the report was true positive for meniscal lesion, but for the wrong meniscus (lesion of the lateral meniscus instead of medial, and vice versa). In order to calculate the sensibility and the specificity of MRI, we need too distinguish if the errors of specificity have to be considered as correct (right indication for surgery) or wrong. In the first case (tab. V a), we found a sensitivity of 86.5% and a specificity of 85.7% (accuracy 86.3%), in the second case (tab. V b), the sensitivity was 78.3%, the specificity 85.7% (accuracy 80.3%).

DISCUSSION

Two of the most used clinical tests for the diagnosis of meniscal tears are McMurray's test and Apley's test. As regards imaging, the most accurate procedure is Magnetic Resonance (MRI).

The aim of the present study was to assess the reliability of the two clinical tests and the accuracy of MRI, in order to evaluate the risk of unjustified surgery.

In projecting the present study, our goal was to maximally reduce bias.

The role of the first examiner (A.C.) was to take the decision about the indication to surgery. The first examiner was the only physician who possessed the complete information about the patient (history, complete physical examination, MRI results, clinical findings of the second examiners). In fact, it was him who cohordinated the study. The experienced physicians (G.R. and A.D.)

Table IV *Magnetic resonance imaging*

TRUE POSITIVES	TRUE NEGATIVES	FALSE POSITIVES	FALSE NEGATIVES	ERRORS OF SPECIFICITY
58	24	4	9	7

Table IV: True positive, true negatives, false positives, false negatives of magnetic resonance imaging in detecting meniscal lesions. The data are extracted from the radiologist's report. "Errors of specificity" means that the radiologist has mistaken the lesion of the medial meniscus for a lesion of the lateral meniscus, or vice versa.

Table V a *MRI. Errors of specificity included in true positives.*

Sensitivity (TP/TP+FN)	Specificity (TN/TN+FP)	PPV (TP/TP+FP)	NPV (TN/TN+FN)
86.5%	85.7%	93.5%	72.7%

Table V a: Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of magnetic resonance imaging in detecting meniscal lesions. The data are extracted from the radiologist's report. In this table the errors of specificity (see table IV) are included in the true positives.

Table V b *MRI. Errors of specificity included in false negatives.*

Sensitivity (TP/TP+FN)	Specificity (TN/TN+FP)	PPV (TP/TP+FP)	NPV (TN/TN+FN)
78.3%	85.7%	93.5%	60%

Table V b: Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of magnetic resonance imaging in detecting meniscal lesions. The data are extracted from the radiologist's report. In this table the errors of specificity (see table IV) are included in the false negatives positives.

were blinded to a large amount of information, in order to maximally reduce bias. They only performed the six clinical tests for meniscal lesions, without knowing the history of the patients (neither the mechanism of the trauma), the MRI findings, the clinical findings of the first examiner and the other experienced physician, the positivity or negativity of the other physical maneuvers (tests for ligaments, tests for patella).

The present study revealed that the assessed clinical tests for detecting meniscal tears are only partially reliable. Our results are similar to those reported by other Authors.

As regards the combination of the two tests, it is necessary to specify that, in our opinion, it is not an implicit condition that, when only one of the tests is correct (true positive or true negative), the association of the two tests is convenient. According to some Authors (11-14), indeed, the composite assessment increases the accuracy. We found that, if we evaluate the combination of the two tests as correct even in case that only one test is correct, this combination actually increases the accuracy, but, if you judge the discordance as an error, either the sensitivity or the specificity of the clinical examination is reduced. In our opinion, combining the tests can correspond to a higher risk of confusion, in case of lack of correlation among them.

The length of meniscal lesion, measured during arthroscopy, did not show any statistical difference about clinical tests.

The physical examination has to be integrated with MRI, to further reduce the risk of performing negative arthroscopic procedures. For both orthopaedic surgeons and primary health-care physicians, MRI has currently become the most widely used noninvasive imaging method of detecting meniscal injuries. However, the cost of MRI scans is high, and the wide use of the method is restricted to certain health-care systems in different countries. Furthermore, the reports of MRI by us collected, show a sensitivity of 78% and a specificity of 85.7%, with an accuracy of 80%. That means that in 2 cases out of 10, the MRI can fail. The MRI collected by

our hospital are prevalently done in radiologic institutes of the central and south regions of Italy, where, in part, the MRI machines are old and have, consequently, an higher risk of error. What is striking is that, in 7 cases, the diagnosis was incorrect because the radiologist identified a lesion of the opposite meniscus (lateral instead of medial, or vice versa).

The history alone can suggest meniscal tears in 75% of the patients (15). This means that, sometimes, a well reported history can help more than clinical examination and MRI.

CONCLUSIONS

To limit as much as possible the risk of unjustified surgery, the precise description of the mechanism of the trauma by the patient is very important. We believe that it is important to perform the most accurate tests, keeping in mind that each test has a certain percentage of error. To add a further help to make the right diagnosis, it is necessary to perform a MRI. It is important to keep in mind that it is not possible to have the absolute certainty of making a correct diagnosis in case of meniscal lesions. Patients, too, have to be informed about the risk of a negative arthroscopy.

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