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Efficacy of the axially loaded pivot shift test for the diagnosis of a meniscal tear

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Abstract Although magnetic resonance imaging (MRI) has improved the diagnostic accuracy of meniscal pathology, the authors believe that physical examination remains essential to the evaluation of knee pathology. In this study, the diagnostic accuracy of five clinical tests for meniscal pathology was prospectively evaluated in 160 patients, who thereafter underwent arthroscopy. 69% (109 knees) of the knees tested had associated ACL deficiency. There were 144 meniscal lesions in 130 of the 160 knees which were examined. The sensitivity of the tests was lower than the specificity. Conventional tests such as McMurray and Apley tests showed a low accuracy rate of 45% and 28% respectively. The diagnostic value of the axially loaded pivot shift test was significantly higher, indicating that this remains a useful diagnostic aid.

Résumé Ils évaluent prospectivement la précision diagnostique de cinq différentes épreuves cliniques employées pour confirmer des déchirures méniscales chez des 160 sujets ayant subi une évaluation arthroscopique. Soixante–neuf pour cent (109) des genoux contrôlés par les auteurs présentaient une carence arthrocinétique complexe. Ils ont observé 144 déchirures méniscales sur 130 genoux. Toutes les épreuves cliniques présentaient généralement une sensibilité inférieure à leur spécificité. Quant au test de déplacement du pivot sous charge axiale, le fait que sa valeur diagnostique est, dans l'ensemble, significativement supérieure à celle des autres manoeuvres diagnostiques en fait un supplément de choix dans l'arsenal diagnostique.

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Introduction

Despite the increasing use of noninvasive and invasive diagnostic procedures for meniscal lesions, careful physical examination remains essential to the evaluation of the injured knee. Although many tests have been described for the diagnosis of meniscal lesions, the reported accuracy of these tests in predicting pathology varies widely [1, 2, 5, 6, 14, 15], suggesting that these tests may be unreliable and subjective. We have noticed that many patients experience pain with a click when performing the pivot shift test for screening ACL integrity and found at arthroscopy that many of these patients had meniscal lesions regardless of the state of the ACL. We also noticed that this test was more likely to be positive when significant axial compression and internal rotation were applied to the leg. The purpose of this study was to evaluate the accuracy of the conventional examination and also to assess the significance of the axially loaded pivot shift test in the diagnosis of chronic meniscal tears.

Materials and methods

A prospective study was conducted on patients who underwent arthroscopy to assess meniscal lesions, which were suspected either as isolated injuries or associated with ACL rupture. All patients had persistent symptoms more than eight weeks after injury. Acute injuries were excluded. Each patient underwent a clinical assessment without knowledge of the history of the injury. There were 83 male and 73 female patients. Knees with radiographic degenerative changes were excluded. The average age of the patients was 23 years (9–54 yrs). Each patient was examined by two of the senior authors.

Clinical tests

The physical examination included record of joint line tenderness, pain on forced extension, the McMurray test, the Apley grinding test in compression and distraction as well as the modified pivot shift test with axial compression.

Joint line tenderness was tested with the patients supine and the knees flexed at 90 degrees. The McMurray and Apley tests

were conducted as described in the original articles [2, 10]. The modified pivot shift test with forced axial compression was performed as follows (Fig. 1). The patient lay in a supine position with the knee in extension. A valgus force was applied to the proximal tibia with maximum internal rotation of the tibia. At this point, axial compression was applied and the knee flexed to 30 and 45 degrees of flexion. This manoeuvre was repeated whilst returning the knee to full extension, again with axial compression. This test is similar to the previously described pivot shift test [7, 9] except that forced axial compression and maximum internal rotation are applied to the knee. A characteristic glide (clank) was noted in all of the ACL deficient knees, however, this phenomenon and patient's apprehension for this test was not regarded as positive. This test was only regarded as positive when the patient felt specific pain along the joint line or a click was felt by the examiner.

It was not possible to differentiate those patients with associated medial and lateral meniscal lesions from those with an isolated meniscal lesion.

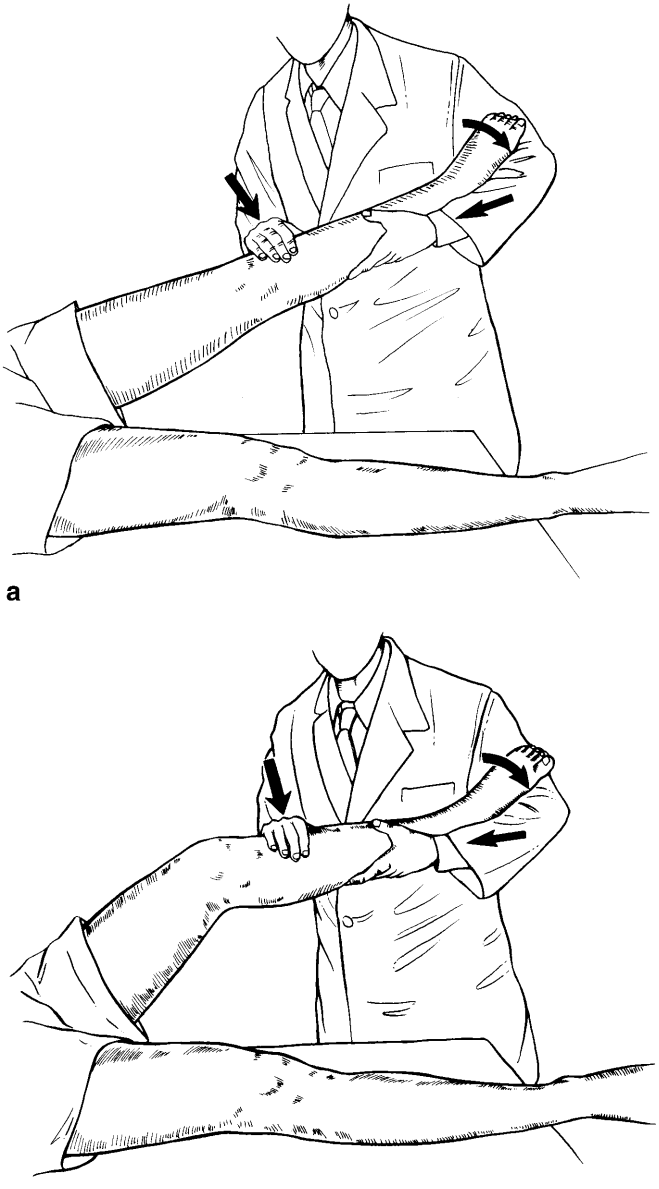

Fig. 1 The axially loaded pivot shift test manoeuvre. With the patient supine and the knee in full extension a combination of axial compression and valgus forces are applied to the proximal tibia in maximum internal rotation and the knee is flexed to 30–45°. This manoeuvre was repeated whilst extending the knee to full extension.

Evaluation

All patients underwent examination under anaesthesia and arthroscopy by the same surgeon (MK) and meniscal and other pathology was recorded. These findings were then compared with the preoperative clinical findings.

Data analysis

Chi-square analysis was used to analyse the sensitivity, specificity and accuracy of each test; and a post hoc t test (Duncan's multiple range test) was employed to analyse these differences. All differences were considered to be significant at a probability level of 95% ($P</=0.05$). Statistical analyses were performed on a personal computer (Macintosh 7200, Apple Computer, Inc, Cuppertino CA) using Statview IV (Abacus Concepts, Inc. Berkeley CA).

Results

There were 144 meniscal tears in 130 out of 160 knees examined. The distribution of types of lesion is listed in Table 1. 68% (109 knees) had chronic ACL deficiency. Although some patients with ACL deficiency had minimal symptoms suggestive of meniscal pathology, they had a high incidence of an associated meniscal lesion (82 out of 109 knees). A high incidence of an associated lateral meniscal lesion with an acute ACL injury has been reported [16]. Our data, however, showed that an associated medial meniscal tear was more common in the chronic ACL deficient group.

In the group as a whole, no clinical tests showed an accuracy of over 75%. The sensitivity was lower than the specificity in all the tests indicating that a small percentage of the patients with meniscal lesions exhibited a positive sign at physical examination (Table 2).

At clinical examination, the axially loaded pivot shift test was found to have the highest sensitivity (71%). Although only 13 knees were found to exhibit click with this test, all of these knees were found to have meniscal lesion suggesting that click was a specific sign. The axi-

Table 1 Distribution of the types of the meniscal lesion

Types of the meniscal lesion	No. of knees
Medial meniscus injury with torn ACL	52
Lateral meniscus injury with torn ACL	17
Medial and lateral meniscus injury with torn AC L	13
Isolated medial meniscus injury	17
Isolated lateral meniscus injury	30
Medial and lateral meniscus injury without torn ACL	1
Torn ACL without meniscus injury	27
Intact knees	3
Total	160

ally loaded pivot shift test also showed high specificity (83%) and significantly higher accuracy (73%) compared with each of the other tests ($P<0.0001$). The Apley test (13%) and the McMurray test (37%) showed lower sensitivity and were unpredictable with an accuracy of 28% and 45% respectively.

The diagnostic accuracy of each test in relation to combined pathology is shown in Tables 3 and 4. Joint line tenderness and pain on forced extension were found to be positive in about 50% of the knees with meniscal lesions. The axially loaded pivot shift was the most accurate test. The incidence of pain by this test was high in cases without associated ACL deficiency. When medial and lateral meniscal tears were compared, this tended to be more specific for lateral mensical lesions, although this was not statistically significant. When the knees which showed a false positive axially loaded pivot shift test were analysed, 5 out of 30 knees without meniscal injury were positive (specificity 83%). Of these cases, 3 had full thickness chondral lesions of the medial femoral condyle, imitating meniscal pathology.

Table 2 Sensitivity, specificity and accuracy of the clinical tests

	Sensitivity (%)	Specificity (%)	Accuracy (%)
Joint line tenderness	55	67	57
Pain on forced extension	47	67	51
McMurray test	37	77	45
Apley test	13	90	28
Modified pivot shift test	71	83	73

Sensitivity, specificity and accuracy were calculated as follows:
Sensitivity=true positive ×100 / true positive + false negative
Specificity=true negative ×100 / true negative + false positive
Accuracy=true positive + true negative ×100 / total

Discussion

With the advent of MRI and modifications including surface coils and stronger magnetic fields, diagnostic accuracy for knee pathology, especially meniscal lesions has improved. Diagnostic accuracy rates of 90% to 97% have been reported [8, 12, 13, 17]. However, to rely on MRI alone may lead to inappropriate treatment in a high percentage of cases [11]. It has been reported that the majority of patients with a history and physical examination suggestive of meniscal lesion will undergo arthroscopy regardless of additional information provided by MRI [4].

Noble and Erat [14] analysed a number of symptoms and clinical tests and concluded that there was no reliable method of diagnosing meniscal tears clinically.

Table 3 The number of the knees manifested a true positive (or negative) sign in each test in relation to the medial or lateral meniscal injury

Location of the tear	No. of knees	Joint line tenderness	Pain on forced extension	McMurray test	Apley test	Modified pivot shift
Medial meniscus	69	35*(51**)	30 (43)	23 (33)	9 (13)	46 (67)
Lateral meniscus	47	26 (55)	24 (51)	18 (38)	6 (13)	35 (74)
Med. & lat.meniscus	14	10 (71)	7 (50)	7 (50)	2 (14)	11 (79)
No meniscus	30	20 (67)	20 (67)	23 (77)	27 (90)	25 (83)
Total	160	91 (57)	81 (51)	71 (45)	44 (28)	117 (73)

An asterisk (*) indicates the number of the knees and two asterisks (**) represent percentages of the knees which manifested a positive sign.
Medial meniscus and Lateral meniscus indicate a medial and lateral meniscal tear respectively.
In the intact knees (expressed as no meniscus), the number of the knees which showed a negative sign (true negative) is listed in the table.

Table 4 The number of the knees manifested a true positive (or negative)sign in each test in relation to the combination of the meniscal injury and the ACL deficiency

	No. of knees	Joint line tenderness	Pain on forced extension	McMurray test	Apley test	Modified pivot shift
ACL (+), Meniscus (+)	82	44*(54**)	35 (43)	31 (38)	11 (13)	58 (71)
ACL (–), Meniscus (+)	48	27 (56)	26 (54)	17 (35)	6 (13)	34 (71)
ACL (+), Meniscus (–)	27	18 (67)	17 (63)	21 (78)	24 (89)	23 (85)
ACL (–), Meniscus (–)	3	2 67)	3 (100)	2 (67)	3 (100)	2 (67)
Total	160	91 (57)	81 (51)	71 (45)	44 (28)	117 (73)

An asterisk (*) indicates the number of the knees and two asterisks (**) represent the percentages of the knees which manifested a positive sign.
The cases with meniscal tears and torn ACLs are expressed as Meniscus (+) and ACL(+) respectively. Meniscus (–) and ACL (–) indicate the intact meniscus and ACL.
In the knees without a meniscal tear, the number of the knees which showed a negative sign (true negative) is listed in the table.

Evans et al. [5] examined the accuracy and interexaminer reliability of the McMurray test for the diagnosis of meniscal tears and concluded that this test could not be relied upon. Fowler [6] reported that no one clinical test was predictive in the diagnosis of meniscal lesions, and recommended a combination of tests. Barry et al. [3] reported that a combination of symptoms and signs will provide the correct diagnosis in most cases.

There are many reasons to explain the diversity of results in these reports. The patient criteria varies in each study. For example, the diagnostic accuracy is less in patients with multiple pathology. Secondly, many different meniscal lesions are associated with ACL rupture, and some previous studies did not take account of the effect of the associated ACL lesion. The symptoms may be those of the ACL rupture and the meniscal lesion an incidental associated finding at arthroscopy.

In most of the previously described meniscal tests a rotational force is superimposed on flexion and extension to encourage the pathological meniscus to be trapped between the tibia and the femur, thus producing a painful click. Anderson et al. [1] reported a manipulative test that included valgus and varus stresses in slight flexion. However, an axial compression force which seems to be critical in reproducing pain originating from meniscal injury was not included in this test. The accuracy of the clinical tests obtained in our study was relatively low compared to that in previous reports [1, 5, 6, 15]. An associated chondral lesion was found to be difficult to differentiate from a meniscal lesion. Nevertheless, the overall accuracy of the axially loaded shift test was significantly higher than other tests ($P<0.001$).

In conclusion it is recommended that clinical examination remains essential in the evaluation of patients with chronic knee symptoms and the axially loaded pivot shift test should be performed in combination with other diagnostic procedures to increase diagnostic accuracy.

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