Accuracy of clinical diagnosis in patients undergoing knee arthroscopy

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Abstract A retrospective analysis of patients who underwent knee arthroscopy was undertaken to determine the accuracy of clinical diagnosis when compared with arthroscopic findings, and to see whether any specific pathologies were difficult to diagnose. The preoperative diagnosis was compared with the operative findings and the accuracy, sensitivity and specificity of the clinical diagnosis calculated. Six hundred ninety-eight patients were included. The overall accuracy, sensitivity and specificity of clinical diagnosis was 99%, 70% and 99%, respectively. Ninety percent of patients underwent a beneficial procedure, while 10% had a normal knee diagnosed at operation. Medial meniscal tear was the hardest pathology to diagnose with accuracy, sensitivity and specificity rates of 82%, 92% and 79%, respectively. Clinical examination remains an accurate method of assessing whether patients would benefit from an arthroscopy, although the correct diagnosis may not be determined preoperatively, particularly if pain was located in the medial tibio-femoral joint.

Introduction

Clinical diagnosis, encompassing an accurate history, thorough examination and interpretation of investigations, is an art all doctors are expected to master during their career. A number of previous studies have examined the accuracy of clinical diagnosis in traumatic meniscal or ligamentous injuries of the knee [1–12]. However, few studies have investigated the accuracy of diagnosis of all

presentations to a knee clinic, but those that have, have found wide variation in the results obtained. Two previous studies, which report overall correct diagnosis rates, have suggested that the clinical diagnosis is accurate in approximately 80% of cases [13, 14]. Other studies have suggested that the accuracy of clinical diagnosis is much lower than this, and is dependent on the number of lesions present [12, 15, 16]. All of these studies had relatively small sample sizes, limiting their applicability. A literature search revealed that available meta-analyses focus on the diagnosis of traumatic knee conditions [1–3, 5]. No review articles could be found which evaluated the overall accuracy of clinical diagnosis for all knee pathologies.

Arthroscopic surgery is a commonly performed method of investigating and treating internal derangements of the knee, and its accuracy of diagnosis has been reported in previous studies to be 95% [17, 18]. Provided that an experienced and proficient operator performs the arthroscopy, it is considered to be the ‘gold standard’ investigative method. Its high diagnostic accuracy allows it to be used as a benchmark when assessing the usefulness and sensitivity of other diagnostic methods.

A retrospective analysis of an arthroscopy database was performed to assess the reliability of clinical diagnosis of knee pathologies by comparing the initial preoperative diagnosis with the operative diagnosis. The aims of this study were:

1. To determine the accuracy of the preoperative diagnosis by comparing the clinical diagnosis with arthroscopic findings
2. To determine whether there are any pathologies which are difficult to diagnose
3. To determine the number of patients who were diagnosed with a normal knee at arthroscopy

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Materials and methods

A retrospective analysis of the Norfolk and Norwich University Hospital Arthroscopy database was performed. The database contained 698 patients who underwent an arthroscopy to investigate and treat suspected internal knee pathologies at the Norfolk and Norwich University Hospital between December 1994 and October 2004. The database and all the information used in the study was stored on a password-protected secure computer located in the Institute of Orthopaedics at the Hospital, in accordance with the Data Protection Act 1998.

Preoperatively, all patients attended a consultant-led specialist knee clinic, which accepted primary, secondary and tertiary referrals. Here they were examined thoroughly by either a consultant or a specialist registrar. Plain film radiographic examination was performed if warranted by the symptoms or examination findings, following which a preoperative diagnosis was made. No patients underwent an MRI scan prior to their initial diagnosis. Patient demographics (gender and age), as well as examination findings and preoperative diagnosis, were then recorded using a standardised proforma. Intraoperatively, the operative diagnosis, details of the procedure performed, and grade of the surgeon performing the procedure were all recorded. For the purpose of this study, the operative diagnosis was taken to be the true diagnosis. There were no inclusion or exclusion criteria for entrance into the study.

Comparison of the pre- and peroperative diagnoses was performed to see how accurately each condition was diagnosed preoperatively. Following this, the sensitivity, specificity, positive and negative predictive values, percentage missed, probability of missed diagnosis and probability of false diagnosis were calculated for each condition that

was diagnosed intraoperatively, using a two-by-two table. The formulae used are provided in Table 1.

The data was then analysed to determine how many patients underwent a beneficial procedure. A beneficial procedure was defined as “a procedure from which the patient is likely to have benefited, either as a result of confirming the diagnosis or therapeutic intervention”.

Statistical analysis was performed using Stata Version 9.0 (StataCorp, Texas, USA). During the analysis a *p* value of <0.05 was regarded as significant.

As only routinely collected information was used ethical approval was not required in order to conduct the study.

Results

In total the data of 698 patients were analysed, of whom 449 (64%) were male and 249 (36%) were female. There were 329 (47%) left knees and 369 (53%) right knees. The mean age overall was 41 years (range 9–92), for males 39 years (range 12–79) and for females 47 years (range 9–92). Consultants performed 655 (94%) of the arthroscopies and registrars performed 43 (6%). The preoperative diagnoses of patients listed for arthroscopy were medial meniscal tear (238; 34%), osteoarthritis (185; 26%) and others as listed in Table 2.

At operation the two most common diagnoses were osteoarthritis, representing 32% (225 patients) of the operative diagnoses, and medial meniscal tear with 19% (133 patients). The frequencies of operative diagnoses are shown in Table 3. The mean age of the patients diagnosed with osteoarthritis was 57 years (SE=0.98), which was significantly higher than those with other diagnoses.

Table 1 Formulae used for statistical analysis

Test	Formula	Definition
Accuracy	$\frac{\text{TruePOSITIVE} + \text{TrueNEGATIVE}}{\text{TOTAL}} \times 100$	The overall ability to confirm the presence or absence of a specific pathology
Sensitivity	$\frac{\text{TruePOSITIVE}}{\text{TruePOSITIVE} + \text{FalseNEGATIVE}} \times 100$	The proportion of true positives correctly identified by a test
Specificity	$\frac{\text{TrueNEGATIVE}}{\text{TrueNEGATIVE} + \text{FalsePOSITIVE}} \times 100$	The proportion of true negatives correctly identified by a test
Positive predictive value	$\frac{\text{TruePOSITIVE}}{\text{TruePOSITIVE} + \text{FalsePOSITIVE}} \times 100$	The proportion of patients with a positive test result who are correctly diagnosed
Negative predictive value	$\frac{\text{TrueNEGATIVE}}{\text{TrueNEGATIVE} + \text{FalseNEGATIVE}} \times 100$	The proportion of patients with a negative test result who are correctly diagnosed
Percentage missed	$\frac{\text{FalseNEGATIVE}}{\text{FalseNEGATIVE} + \text{TruePOSITIVE}} \times 100$	
Probability of missed diagnosis	1 – Sensitivity	
Probability of false diagnosis	1 – Specificity	

Table 2 Preoperative diagnoses of knee pathologies

Preoperative diagnosis	Patients (<i>n</i>)	(%)
Medial meniscal tear	238	34
Osteoarthritis	185	26
ACL tear	79	11
Lateral meniscal tear	55	8
Loose body	33	5
Tight lateral retinaculum	12	2
Synovitis	10	2
Lateral meniscal cyst	5	1
Other	81	11

ACL anterior cruciate ligament

The overall accuracy, sensitivity and specificity of diagnosis was 99%, 70% and 99%, respectively. The overall positive and negative predictive values were 69% and 100%, respectively. Six hundred twenty-nine (90%) underwent a beneficial procedure. Sixty-nine (10%) normal knees were diagnosed intraoperatively (negative arthroscopy). The preoperative diagnoses for those knees that were normal at operation are outlined in Table 4.

The accuracy, sensitivity, specificity, positive and negative predictive values, percentage missed, probability of missed diagnosis and probability of false diagnosis for the most common operative diagnoses are shown in Table 5.

Medial meniscal tear was the hardest pathology to diagnose, irrespective of age, with an overall accuracy of 82%, a sensitivity of 92% and a specificity of 79%. The diagnosis of medial meniscal tear was correct in 122 (51%) and incorrect in 116 (49%) cases. When the diagnosis was incorrect, the actual diagnosis was predominantly a normal knee (31%), osteoarthritis (28%), or lateral meniscal tear (10%). Tight lateral retinaculum appears to be the easiest condition to diagnose, with an overall accuracy, sensitivity

Table 3 Operative diagnoses of knee pathologies

Operative diagnosis	Patients (<i>n</i>)	(%)
Osteoarthritis	225	32
Medial meniscal tear	133	19
ACL tear	79	11
Normal knee	69	10
Lateral meniscal tear	52	7
Loose body	18	3
Synovitis	14	2
Tight lateral retinaculum	12	2
Other	96	14

ACL anterior cruciate ligament

Table 4 Preoperative diagnoses of knees diagnosed as normal at arthroscopy

Diagnosis	Patients (<i>n</i>)	(%)
Medial meniscal tear	36	52
Lateral meniscal tear	13	20
Loose body	5	7
ACL tear	3	4
Osteoarthritis	3	4
Other	9	13

ACL anterior cruciate ligament

and specificity of 100%. The accuracy, sensitivity and specificity of diagnosing ACL rupture were 97%, 86% and 98%, respectively. Analysis of specific tests used to diagnose ACL injuries revealed that the Lachman test was the most effective, with an overall accuracy, sensitivity and specificity of 92%, 85% and 92%, respectively. The pivot shift test had an accuracy of 93%, a sensitivity of 63% and a specificity of 97%. The anterior draw test had an accuracy of 77%, a sensitivity of 81% and a specificity of 77%.

Discussion

This study has shown that the overall accuracy, sensitivity, and specificity of clinical diagnosis were 99%, 70% and 99%, respectively, in a cohort of patients seen in a specialist knee clinic having undergone arthroscopy but no preoperative MRI scans. Although the correct diagnosis may not have been made preoperatively, 90% underwent a beneficial procedure where significant pathology was found and treated. The remaining 10% had a normal knee diagnosed at arthroscopy. A preoperative diagnosis of a medial meniscal tear was the hardest pathology to diagnose with an accuracy of 82%, a sensitivity of 92%, and a specificity of 79%. This was probably because medial tibio-femoral articular damage has similar clinical findings.

Our results compare favourably with previous studies reporting the overall accuracy of clinical diagnosis, which range from 56 to 80% [12–16]. One possible reason for these differences is that it is assumed that the arthroscopic diagnosis is the ‘true’ diagnosis. However, published data suggests that arthroscopy is approximately 95% accurate [17, 18]. This suggests that some operative diagnoses may be incorrect, especially when performed by inexperienced operators. In our study all preoperative diagnoses were made at a consultant-led knee clinic. Consultants, experienced in arthroscopic knee surgery performed 94% of the arthroscopies. This is likely to have increased the reliability of the results obtained and may account for the higher rates of accuracy than those found in other studies. A second

Table 5 Reliability of preoperative clinical diagnosis

Diagnosis	True positive	True negative	False positive	False negative	Accuracy (%)	Sensitivity (%)	Specificity (%)	PV+ (%)	PV- (%)	Percentage missed (%)	Probability missed diagnosis	Probability false diagnosis
Medial meniscal tear	122	449	116	11	82	92	79	51	98	8	0.08	0.21
Osteoarthritis	169	457	16	56	90	75	97	91	89	25	0.25	0.03
ACL tear	68	608	11	11	97	86	98	86	98	14	0.14	0.02
Lateral meniscal tear	28	619	27	24	93	54	96	51	96	46	0.46	0.04
Loose body	17	664	16	1	98	94	98	52	100	6	0.06	0.02
Tight lateral retinaculum	12	686	0	0	100	100	100	100	100	0	0.00	0.00
Synovitis	8	682	2	6	99	57	100	80	99	43	0.43	0.00
Lateral meniscal cyst	1	693	4	0	99	100	99	20	100	0	0.00	0.01

PV+ positive predictive values, PV- negative predictive values, ACL anterior cruciate ligament

possible reason for the higher rates of accuracy in this study is that operators' experience, especially that of consultants, have increased substantially since some of the earlier studies were reported. The overall sensitivity of clinical diagnosis was lower than expected. However, the high results obtained for overall accuracy and specificity of diagnosis suggest that clinical diagnosis is a reliable method of identifying pathology of the knee.

Meniscal pathology was the most common preoperative diagnosis, accounting for 300 (43%) patients. While the sensitivity and negative predictive value for diagnosing medial meniscal tears were high (92% and 98%, respectively), the accuracy, specificity and positive predictive values were considerably lower (82 %, 79% and 51%). This suggests that clinical diagnosis is accurate at identifying medial meniscal tears when they are present, but false-positive diagnoses are often made. This pattern of results is similar to that found by other studies [4, 6, 13]. Terry et al. [13] found that the sensitivity and specificity of diagnosing medial meniscal tear were 99% and 72%, respectively. The majority of the false-positive cases were actually fibrotic plicas or fat pad impingement. This differs from the current study where the most common actual diagnoses were normal knee or osteoarthritis. Again, lateral meniscal tear had a low positive predictive value, and a high negative predictive value, suggesting that while false-positive diagnoses are made, clinical diagnosis is effective at excluding the presence of the condition.

Osteoarthritis was the most common operative diagnosis. The fact that the degree of the condition was not taken into account in this study probably accounts for the reason why the sensitivity, as well as the positive and negative predictive values, are not higher, as earlier degrees of articular cartilage damage, identifiable at arthroscopy, are often missed during clinical examination. The accuracy of clinical diagnosis for osteoarthritis was reported by Yoon et al. [16], who found that the sensitivity of diagnosing osteoarthritis was 94%. One possible reason for this difference is that 50 patients in the Yoon et al. study underwent MRI scanning before a diagnosis was made. In our study no MRI scans were performed. Secondly, in the Yoon et al. study, decisions as to whether the diagnosis was correct were not made until one year after presentation. In our study decisions regarding whether the diagnosis was correct were made at operation and were categorised as either correct or incorrect; unlike the Yoon et al. study where no mention is made as to whether incomplete diagnoses were counted as true-positive diagnoses in sensitivity analysis (decisions were either categorised as being correct, incomplete or incorrect).

Clinical examination was effective at identifying both the presence and absence of ACL tears. Our results compare favourably with those from the published litera-

ture, suggesting that ACL tear is a condition which can be diagnosed with a high level of accuracy. Perhaps more interesting is the effectiveness of a commonly performed test for assessing the integrity of the ACL. In our study, the Lachman test was found to be the most effective method of diagnosing ACL pathology, with an accuracy, sensitivity and specificity of 92%, 85% and 92%, respectively. The pivot shift test had a high accuracy and specificity, but a sensitivity of 63%. The anterior draw test was the least effective test, with an accuracy of 77%, a sensitivity of 81%, and a specificity of 77%. These results are comparable to those found by two meta-analyses [1, 3]. The results suggest that the Lachman test is the best test to use when examining patients, but because of its high specificity, the pivot shift test should also be performed in order to exclude other pathologies.

At operation, 69 (10%) knees were diagnosed as normal. This figure is higher than that found by Brooks et al. [14], although our study had significantly more patients than that study. Caution should be taken before making the conclusion that these patients did not receive any benefit from the procedure. Anecdotally, many surgeons can recall cases in which patients have benefited from procedures where very little intervention has been performed. These patients may want to know that their painful knee is anatomically normal. Whether the reason for this benefit is a placebo effect is unclear, and cannot be answered in this study. We are planning in the future to conduct a study to investigate whether any of these patients have sought further medical interventions since undergoing arthroscopy. It is also worth noting that at the beginning of the data collection, the indications for MRI scanning were much more restricted. In today's practice, some of these patients would have had a scan instead of an arthroscopy, reducing the number of normal knees diagnosed at operation.

Comparison of the results of our study with those from published literature where accuracy of MRI diagnosis was assessed [6, 9–11, 19–23] found that clinical examination falls within the range of figures from other studies. Our results highlight the fact that the main benefit of MRI is investigating the diseases of the menisci, which have relatively high false positive rates when clinical diagnosis alone is used.

The main strengths of this study are that a relatively large number of study subjects were used compared to other similar studies. Data collection also took place over a ten-year period and involved multiple surgeons, which increases the applicability of the results obtained.

There are a number of limitations of this study. The first is that patients with an operative diagnosis of a normal knee were not followed-up after discharge. The second limitation of this study was that the retrospective design prevented analysis of how the clinical diagnosis was arrived at.

Finally, failure to follow-up prevented analysis of how many patients were still receiving a benefit from the procedure after one year.

To conclude, our results show that clinical examination remains an effective method of diagnosing intraarticular pathologies of the knee. Lesions of the menisci appear to be the hardest to diagnose clinically with relatively high false positive rates. Although the correct diagnosis may not have been made preoperatively, 90% of patients had a treatable lesion found at arthroscopy.

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Conflict of interest The authors declare that they have no conflicts of interest.

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