ORIGINAL ARTICLE

Diagnostic Efficacy of Magnetic Resonance Imaging in Evaluation of Injured Knee

SAULAT SARFRAZ, SHAFIQUE AHMED

ABSTRACT

Objectives: To correlate outcome of clinical assessment, radiographic and MRI (magnetic resonance imaging) findings with operative results. To recommend some approaches in diagnostic evaluation of injured knee.
Study design: Comparative diagnostic study.
Setting: Study was conducted in the Department of Diagnostic Radiology, Shaikh Zayed Postgraduate Medical Institute, Lahore.
Duration of study: From January 2005 to August 2005.
Patients and methods: Fifty patients (41 males and 9 females) were included in this study with clinical suspicion of internal derangement in injured knee. Clinical assessment, plain x-ray and MRI findings were recorded in each patient. Reports of surgical findings were collected in all cases. A correlation between clinical, plain x-ray and MRI findings with surgical findings was made in each case.
Results: Plain x-ray had very limited role in evaluation of soft tissue injury of knee. Clinical assessment raised suspicion of some internal derangement but failed to detect precise lesion. There was no significant difference between MRI and surgical findings. MRI was found to have sensitivity of 92%, specificity of 50% and accuracy of 89.28% for depiction of ACL (anterior cruciate ligament) injury. It had a sensitivity of 89.28%, specificity of 66.67% and accuracy of 87.09% for detection of meniscal tear. It had an overall sensitivity of 93.18%, specificity of 16.67% and accuracy of 84% for depiction of internal derangement.
Conclusions: Magnetic resonance imaging is far superior to plain x-ray and better than clinical assessment and has a high sensitivity, accuracy and positive predictive value.
Keywords: Injured knee, Plain radiograph, Clinical assessment, Magnetic resonance imaging.

INTRODUCTION

The knee is a frequently injured joint in the body. Although physical examination and plain radiography provide some clue towards diagnosis[1]. Accurate diagnosis of a knee injury is often difficult because of the complexity of the joint. Although arthroscopy is considered as a diagnostic tool in expert hand, this is an invasive test. Since the introduction of magnetic resonance imaging (MRI) in early 1980s, it has proven to be an excellent technique for evaluating patients with knee problems including acute or chronic trauma cases. Magnetic resonance imaging has a high soft tissue contrast. It provides direct visualization of soft tissue structures, including ligaments, tendons, joint capsules, menisci, and joint cartilages – structures that are impossible to see on plain radiographs and often not clearly distinguishable by CT[2]. Studies have shown it to be highly sensitive, specific[3] and accurate[4] non-invasive[5] method for diagnosing internal derangement of knee involving menisci[6], ligaments, patellofemoral joints and other soft tissues and osseous structures in the knee[7]. Magnetic resonance imaging has a high negative predictive value[8,9] therefore, a normal MR knee examination is highly accurate in excluding an internal derangement. Clinical examination of acute traumatic knee is essential, however its value for detecting precise lesions is poor. Magnetic resonance imaging provides better results than clinical examination[10]. Magnetic resonance imaging can reveal many clinically silent changes in the knee, also after minor injuries[11]. The significance of these magnetic resonance imaging (MRI) findings must await long-term follow up.

In acutely injured patients MRI helps to establish an accurate dignosis[12] and can efficiently replace emergency diagnostic arthroscopy. Magnetic resonance imaging is the only method able to evidence osteochondral injuries and soft tissues associated lesions in traumatic knees. Magnetic resonance imaging has gained importance in sports medicine for evaluation of acutely injured knee as it can reliably diagnose radiographically and arthroscopically occult torn cartilage, meniscal, ligament and tendon injury and is helpful in

Department of Radiology, Sh. Zayed Hospital, Lahore
Correspondence to Dr. Saulat Sarfraz, Mobile: 0321-4334992 Email: saulatsarfraz@gmail.com

appropriate patient management. Magnetic resonance imaging can therefore help in selection of those patients who need therapeutic arthroscopy[13].

RESULTS

Fifty patients were selected for this study. Study was conducted in Radiology Department of Shaikh Zayed Hospital, Lahore. Duration of study was eight months from January 2005 to August 2005. Out of these 50 patients 41 were males and 9 were females. Male predominance was mainly due to more physical and outdoor activities. Range of age was from 14 to 64 years and mean age was 39 years. Less common presenting complaints in addition to pain were swelling in 15 patients (30%), instability in 9 patients (18%), locking in 5 patients (10%), difficulty to walk in 2 patients (4%) and restricted knee movements in 1 patient (2%). Joint effusion was suspected clinically in 28 patients (56%), while MRI showed presence of joint effusion in 46 patients (92%). ACL injury was clinically suspected in 13 patients (26%) while MRI showed it to be present in 28 patients (56%).

Medial meniscal tear was suspected in 12 patients (24%), MRI showed medial meniscal tear in 20 patients (40%). Lateral meniscal tear was suspected clinically in 5 patients (10%), while MRI showed it to be present in 11 patients (22%). In 6 patients (12%) with clinical suspicion of medial meniscal tear and 2 patients (4%) with suspicion of lateral meniscal tear, only intrasubstance degeneration within menisci was found i.e. no evidence of meniscal tear.

Plain x-ray of knee in anteroposterior and lateral projections were obtained in all cases. Abnormal findings were seen in 14 patients (28%). Soft tissue swelling (joint effusion) was seen in 3 patients (6%). Anterior subluxation of tibia as a result of ACL was evident in 7 patients (14%). Lateral tibial plateau fracture was seen in 3 patients (6%) with avulsion fracture in one of them. A sclerotic lesion was seen in 1 patient – incidental finding. MRI also showed all these bony findings, in addition it also showed internal derangements in these cases. It characterized nature of sclerotic lesion in one case and showed it to be chondromatus.

Surgical findings in these 50 patients showed joint effusion to be present in 44 patients (88%). ACL injury was confirmed in 26 patients (52%). Meniscal tears were present in 28 patients (56%), out of which 19 patients (36%) were having medial meniscal and 10 patients (20%) lateral meniscal involvement.

Other findings were LCL tear in 1 patient (2%), MCL tear in 1 patient (2%), tibial plateau fractures in 3 patients (6%), type I bony injury in 5 patients (10%) and baker's cyst in 1 patient (2%). MRI showed joint effusion in 46 patients (92%), surgery confirmed joint effusion in 44 patients (88%). A P value of 0.50 was found for joint effusion. ACL injury was seen in 28 patients (56%) on MRI, surgery proved it to be present in 26 patients (52%) (p value 0.68). Meniscal injury was shown on MRI in 31 patients (62%). Surgery confirmed meniscal injury in 28 patients (56%) (P value 0.54). Out of other 11 findings (22%), all were confirmed on surgery (P value 1.0). So there was no significant difference between MRI findings and surgical outcome in this study.

Out of 50 patients, 41 patients were those in which both MRI and surgery showed presence of lesion. In 5 patients findings were shown by MRI but surgery showed no such lesion. In 3 patients lesion was present surgically but MRI missed it. One patient had no MRI finding that was confirmed by surgery.

In my study MRI was found 93.18% sensitive and 16.67% specific for depiction of internal derangement in injured knee. It had a positive predictive value of 89.13% and negative predictive value of 25%. Internal derangements in injured knee were found to be 92% prevalent by MRI and 88% prevalent by surgery. Accuracy of MRI for depiction of internal derangement was found to be 84%.

Magnetic resonance imaging detected ACL injury in 28 patients. In 24 patients MRI showed ACL injury that was confirmed on surgery, while in 1 patient MRI showed ACL injury but surgery proved it to be absent. MRI failed to show ACL injury in 2 cases that were proved to have ACL injury on surgery. One patient was found to have no evidence of ACL injury on both MRI and surgery.

Magnetic resonance imaging showed a sensitivity of 92.30% and specificity of 50% for depiction of ACL injuries. It showed a positive predictive value of 96% and a negative predictive value of 33.3%. ACL injury showed 89.28% prevalence by MRI and 92.85% prevalence by surgery. MRI accuracy was 89.28% for detection of ACL injury.

MRI detected meniscal tear in 31 patients. A comparison with surgical outcome showed that out of these 31 patients, tear was confirmed on surgery in 25 patients, while was found to be absent in 1 patient. In 3 patients MRI failed to pick meniscal tear seen on surgery. In two patients absence of meniscal tear shown by MRI was confirmed on MRI.

Magnetic resonance imaging was found to have a sensitivity of 89.28% for depiction of meniscal tear and a specificity of 66.67%. It has a positive predictive value of 96.15% and a negative predictive value of 40%. Meniscal tears were found 83.87% prevalent by MRI and 90.32% prevalent by surgery. Accuracy of MRI for detection of meniscal tear was found 87.9%.

Table 1: Sex distribution of patients (n=50)

Sex	=n	%age
Male	41	82
Female	9	18

Male to female ratio 4.55:1

Table 2: Age distribution of patients

Age (years)	=n	%age
11 – 20	8	16
21 – 30	12	24
31 – 40	14	28
41 -50	8	16
51 – 60	6	12
61 – 70	2	4

Table 3: Presenting complaint at time of MRI examination

Presenting complaints	=n	%age
Pain knee	50	100
Swelling knee	15	30
Instability	9	18
Locking	5	10
Difficulty to walk	2	4
Rebicked knee movements	1	2

Table 4: Nature of knee injury

Nature of Knee Injury	=n	%age
Road traffic accident	22	44
Sports injury	10	20
Types of injuries e.g., twisting, fall etc.	18	36

Table 5: Abnormal findings in MRI

Detail of MRI lesion	No.	%age	Statistical analysis (95% confidence limits)
Joint effusion	46	92	79.88% to 97.40%
Anterior cruciate ligament injuries	28	56	41.34% to 69.73%
Meniscal injuries	31	62	47.16% to 75%
Others	11	22	12% to 36.33%

Table 6: Comparison between clinical suspicion and MRI findings for joint effusion

MRI Findings	Clinical suspicion		Total
	Yes	No	
Positive	28	18	46
Negative	0	4	4

Table 7: Comparison between clinical assessment and MRI findings for medial meniscal tear

MRI Findings	Clinical suspicion		Total
	Yes	No	
Positive	12	8	20
Negative	6	24	30

Table 8: Comparison between clinical assessment and MRI findings for lateral meniscal tear

MRI Findings	Clinical Suspicion		Total
	Yes	No	
Positive	5	6	11
Negative	2	37	39

Table 9: Validation analysis (2x 2 analysis) of MRI findings

MRI findings	Surgical findings		Total
	Lesion Yes	Lesion No	
Lesion Positive	41	5	46
Lesion Negative	3	1	4

Table 10: Validity of MRI for depicting the internal derangement of knee joint

Validation parameters	%age	Statistical Analysis (95% Confidence limits)	
		Lower limit	Upper limit
Sensitivity	93.18	85.73	100
Specificity	16.67	0.00	46.40
Predictive value positive	89.13	80.13	98.12
Predictive value negative	25	0.00	67.43
Prevalence by MRI	92	84.48	99.52
Prevalence by surgery	88	78.99	97
Accuracy	84	70.13	92.88

Table 11: Validity of MRI for depicting anterior cruciate ligament Injuries

Validation parameters	%age	Statistical analysis (95% confidence limits)	
		Lower limit	Upper limit
Sensitivity	92.30	82.06	100
Specificity	50	0.00	100
Predictive Value positive	96	88.31	100
Predictive Value negative	33.3	0.00	86.67
Prevalence by MRI	89.28	77.82	100
Prevalence by surgery	92.85	83.31	100
Accuracy	89.28	70.62	97.19

DISCUSSION

This comparative diagnostic study was performed in the Department of Diagnostic Radiology, Shaikh Zayed Hospital, Lahore in about eight months duration i.e. from January 2005 to August 2005. Fifty patients were selected for this study selection of this

number was on basis of average turn over of patients with injured knee for MR examination in our department. Out of these 50 patients 41(82%) were males and 9(18%) were females. Right knee was involved in 29(58%) patients and left knee was involved in 21 patients (42%). In another study reported in literature and conducted by Bari and Murad[3] 2003, 56 patients were studied, 36 were males (72%) and 20 were females (40%), right knee was involved in 33 patients (59%) and left knee was involved in 47 patients (84%).

Range of age was from 14 to 64 years and mean age was 39 years. So majority of patients were male and young. This is most likely due to more physical and outdoor activities and traveling in these gender and age groups. Also young males are involved more in sports activities so chances to sustain injuries are more in them. It is stated that a study conducted by Jerosch, Riemer[14], 2004, also showed age range from 16 to 76 years with mean age of 38.5 years.

In my study most common finding detected on MRI was joint effusion seen in 46 patients (92%). Second common finding was meniscal injuries seen in 31 patients (62%). ACL injury was found in 28 patients (56%). This occurrence is comparable and close to that done in study by Bari and Murad[3] 2003, who studied 56 patients and found joint effusion in 84%, meniscal injury in 45% and ACL injury in 41% patients in descending order of percentage.

A correlation between clinical assessment and MRI findings in this study was done. It was observed that MRI provided better results than clinical assessment on injured knee. Although clinical assessment provided some clue towards presence of internal derangement, yet its value in detecting precise lesion was found to be limited. Similar observations have been reported in literature by LeVot, Solcroup[10] 1994.

Comparison between plain x-ray and MRI findings in my study showed that MRI was far superior to plain x-ray in depiction of not only soft tissue injury but it also picked bony findings very well, including bone bruise in 5 patients (10%) which were not evident on plain x-ray. This comparative findings are quite similar to those reported in literature by Duncan, Hunter[15] 1996. My study proved MRI to be sensitive for bony as well as soft tissue injury.

MRI findings were finally compared with surgical findings in all 50 cases. There was no significance difference between MRI and surgical findings. MRI was found to have a sensitivity of 93.18% and specificity of 16.67% for depiction of internal derangement in injured knee. It showed by positive predictive value of 89.13% and negative predictive value of 25%. Accuracy of MRI was 84% for detection of internal derangement. In my study prevalence of internal derangement by MRI was found to be 92%. A study was conducted by Colletti[16] 1996 showed a prevalence of internal derangement by MRI in injured knee to be 97%.

In this study MRI was found to have a sensitivity of 92.30% and a specificity of 50% for depiction of anterior cruciate ligament injuries. It showed a positive predictive value of 96% and negative predictive value of 33.3% and was found 89.28% accurate for ACL injuries. A study reported in literature by Ghanem, Abou[17] 2002, showed accuracy of MRI for depiction of ACL injury to be 95.39%. Another study by Bari and Murad[3], 2003 reported MRI to have 95% sensitivity, 96% specificity and 96% accuracy for ACL injury.

This study showed sensitivity of MRI for depiction of meniscal injury to be 89.28%, a specificity of 66.67%, a positive predictive value of 96.15% and an accuracy of 87.9%. It has been reported in literature by Manco abd Berlow[18] 1989, that MRI was found to have an accuracy of 89.5% for detection of meniscal tears.

It was observed that MRI failed to detect meniscal tear in 3 patients (6%). These patients were having injury of ACL as well. This observation correlates well with similar observation correlates well with similar observation reported in literature by DeSmet and Graf[19] 1994, who found out that sensitivity of MRI decreases significantly for meniscal tears when ACL is torn.

The bone contusion was found on MRI in 5 patients (10%). All of them were found to have concomitant ACL injury. Out of these 5 patients 3 patients (60%) had contusion involving lateral tibial plateau. In another study conducted by Murphy, Smith, Uribe[20] 1992, ACL tear have been reported to have association with contusion involving lateral tibial plateau in over 90% cases.

In this study specificity of MRI for depiction of internal derangement was found low i.e for ACL injury it was 50% and for meniscal tear it was 66.67%. It was due to that fact that cases selected for this study were already clinically screened and were suspected for some internal derangement in injured knee.

CONCLUSIONS

Clinical examination and assessment of traumatic knee is essential and it provides some clues towards suspected internal derangement, yet its value for detecting precise lesions is poor. Magnetic resonance imaging provides much better results than clinical assessment in injured knee. Yield of plain radiograph in injured knee with suspected internal derangement is very low. It fails to pick any ligamentous or meniscal injury directly. Magnetic

resonance imaging on the other hand shows both bony and soft tissue injury. Magnetic resonance imaging has got high sensitivity, positive predictive value and accuracy in evaluation of injured knee.

REFERENCES

1. Ege G, Akman H, Kuzucu K, Ertem E, Sahlan S Knee injuries. Trauma Derg 2001; 7: 60-5.
2. Deutsch AL, Mink JH. MRI of the musculoskeletal system: A teaching file 2nd edition. Philadelphia: Lippincott Raven, 1996.
3. Bari V, Murad M. Accuracy of magnetic resonance imaging in the knee. J Coll Phy Surg Pak 2003; 13: 408-11.
4. Feller JA, Webster KE. Clinical value of magnetic resonance imaging of the knee. Aust Nz J Surg 2001; 71: 534-36.
5. Stabler A, Glasei C, Reiser M. Musculoskeletal MR knee. Eur Radiol 2000; 10: 230-41.
6. Fritz RC. Magnetic resonance of meniscal and cruciate ligament injuries. Clin North Am 2003; 11: 283-93.
7. William EB, Clyde AH. Magnetic resonance imaging of the knee. In: William EB, Clyde AH editors. Fundamental of diagnostic radiology 2nd ed. Clin Orthop 1996; 330: 288-303.
8. Crues JI, Mink J, Levy T. Meniscal tears of the knee: accuracy of MR imaging. Radiology 1987; 164: 445-8.
9. Mink JJH, Deutsch AL. Magnetic resonance imaging of the knee. Clin Orthop 1989; 244: 29-47.
10. LeVot J, Solacroup JC, Leonetti P, Nun P, Gueguen E, LeBihan E. Correlation between clinical examination/MRI/ arthroscopy in the acute traumatic knee. J Chir (Paris) 1994; 131: 144-53.
11. Odgaard F, Tuxoe J, Joergensen U, Lange B, Lausten G, Brettlau T et al. Clinical decision making in the acutely injured knee based on repeat clinical examination and MRI. Scand J Med Sci Sports 2002; 12: 154-62.
12. Muellner T, Wikolic A, Kubiena H. The role of magnetic resonance imaging in routine decisions making for meniscal surgery.
13. Crues JV. Emergency and musculoskeletal imaging, cedars-sinai. Sportverletz sportschaden 1994; 8: 156-69.
14. Jerosch J, Riemer S. How good are clinical investigative procedures for diagnosing meniscus lesion? Sportverletz sportschaden 2004;18:59-67.
15. Duncan JB, Hunter R, Purnell M, Freeman J. Injured stable knee with acute effusion: MRI evaluation. J South Orthop Assoc 1996; 5: 13-9.
16. Colletti P, Greenberg H, Terk MR. Magnetic resonance findings in patients with acute tibial plateau fractures. Comput Med Imaging Graph 1996; 20: 389-94.
17. Ghanen I, Abou JS, Kharrat K, Dagher F. It MRI effective in detecting intra-articular abnormalities of injured knee? J Med Liban 2002; 50: 168-74.
18. Manco LG, Berlow MT. Meniscal tears – comparison of arthrography, CT and MRI. Crit Rev Diagn Imaging 1989;29:151-79.
19. DeSmet A, Graf B. Meniscal tears missed on MR imaging: relationship to meniscal tear patterns and anterior cruciate ligaments tears. Am J Roentgenol1994; 162: 905-11.
20. Murphy B, Smith R, Uribe J. Bone signal abnormalities in the posterolateral tibia and lateral femoral condyle in complete tears of the anterior cruciate ligament: a specific sign? Radiology 1992;182:221-4.