MRI EVALUATION OF SPORTS RELATED KNEE INJURIES

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ABSTRACT

PURPOSE
To investigate the accuracy of MRI in evaluation of sports related knee injuries.

MATERIALS AND METHODS
From June 2015 to 1st week of July 2016.

Thirty patients referred for sports related knee pain have been included in this study. Patients were subjected to a dedicated MR knee study (GE HD XT 1.5T MR System) and correlated knee arthroscopy and surgery.

RESULTS
The study included Thirty patients complaining of sports related knee pain, only 5 patients (16.67 %) were with normal MRI findings and 25 patients (83.33%) were with abnormal MRI findings.

Among the 25 patients who had injuries of their knees, 15 patients (60%) had ACL injuries, 6 patients (24%) had PCL injuries, 10 patients (40%) had meniscal injuries, 8 patients (32%) had collateral ligament injuries, 5 patients (20%) had bone injuries and 2 patients (8%) had muscular injuries. Only 5 patients (20%) were represented with isolated injury and 20 patients (80%) were represented with combined injuries. In correlation with arthroscopies and surgeries, morphological analysis was true-positive in 23 (92%) patients of the 25 injured patients, and true-negative in 1 (60%) patient of the 2 normal patients. Morphological analysis revealed overall 92% sensitivity and 60% specificity. Regarding the 15 patients who had ACL injuries, 13 patients (86.6%) were true-positive and 8 patients (80%) of the 10 patients who had meniscal injuries were true-positive.

CONCLUSION
MRI represents the optimal imaging modalities in the evaluation of the sports related knee injuries, which has been shown to be an accurate and non-invasive method of diagnosing ligament, meniscal, cartilage and muscular knee injuries.

KEYWORDS
MRI Knee injuries, Knee, Knee injuries.

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INTRODUCTION: The knee is a major weight bearing joint that provides mobility and stability during physical activity as well as balance while standing.(1) Traumatic knee injuries are frequently encountered both in general practice and in the hospital setting. These injuries are often caused by sports activities and may lead to severe pain and disability.(2) Magnetic resonance imaging (MRI), with its multiplanar capabilities and excellent soft tissue contrast, has established itself as the leading modality for noninvasive evaluation of the sports knee injuries.(3) Magnetic resonance imaging is a well-accepted imaging modality in the diagnostic workup of patients with knee complaints and has largely replaced diagnostic arthroscopy for this purpose.(4) It is regarded as the top imaging and diagnostic tool for the knee joint as a result of its ability to evaluate a wide range of anatomy and pathology varying from ligamentous injuries to articular cartilage lesions. Imaging of the knee requires excellent contrast, high resolution and the ability to visualise every small structures, all of which can be provided by MR imaging. The development of advanced diagnostic MR imaging tools for the joints is of increased clinical importance as it has been recently shown that musculoskeletal imaging is a rapidly growing field in MR imaging applications.(5) Arthroscopy is considered "the gold standard" for the diagnosis of traumatic intra-articular knee injuries. However, arthroscopy is an invasive procedure that requires hospitalisation and anaesthesia, thus presenting all the potential complications of a surgical procedure. Since its introduction in the 1980s, MRI has gained in popularity as a diagnostic tool for knee injuries. Many surgeons believe that MRI is an accurate, non-invasive method to diagnose knee injuries, and gives sufficient information to support decisions for conservative treatment and save the patient from unnecessary arthroscopy.(6)

AIMS & OBJECTIVES: To investigate the accuracy of MRI in evaluation of sports related Knee injuries

MATERIALS & METHODS:
Subjects and Methods: The study was conducted in the Department of Radio-diagnosis for one calendar year.

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Source of Data: The prospective study of minimum 30 consecutive cases with sports related knee injuries were carried out in the Department of Radio-diagnosis for one calendar year correlated with arthroscopy and surgery.

Sample Size: 30 consecutive cases with sports related knee injuries, who met selection criteria.

Duration: From June 2015 to 1st week of July 2016 for a period of 1 year.

Inclusion Criteria: Patients with history of sports injuries.

Exclusion Criteria: Post-operative cases and patients with no history of sports injuries.

MRI Evaluations: Patients and methods. Thirty patients have been included in this study, the age of the patients ranged between 15 and 30 years with a mean age of [21.4 ±3.45] (Table 1 and Fig. 1), regarding sex distribution, 20 patients (66.67%) were males, while 10 patients (33.33%) were females (Table 2 and Fig. 2). Patients were subjected to a dedicated MR knee study and correlated knee arthroscopy and surgery. All patients in this study were examined using a 1.5-T MR (GE HDXT 1.5T MRI System) and dedicated knee coil with sequences as follows:

Sagittal: PDW (SPIR).

- Sagittal T1W, T2W, PDFS.
- Coronal STIR.
- Coronal T1W, T2W.
- PDFS Axial, Coronal Sagittal.
- Axial T1W, T2W.

Age	Patient No.	%
15–19	6	20
20–24	18	60
25-30	6	20
Total	30	100

Table 1: Distribution of Patients According to Age

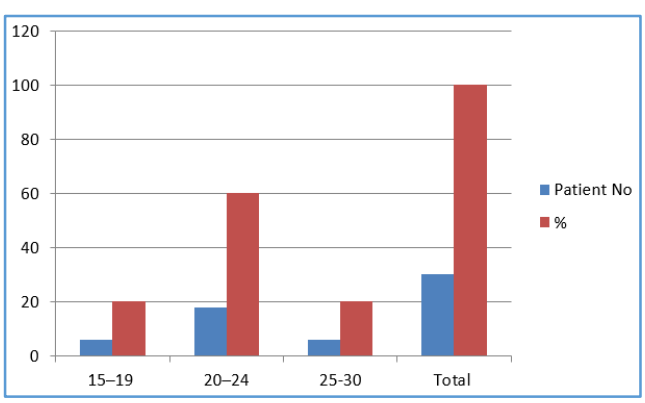

Fig. 1

Sex	Number of Patients	%
Male	20	66.67
Female	10	33.33
Total	**30**	**100**

Table 2: Distribution of Patients According to the Sex

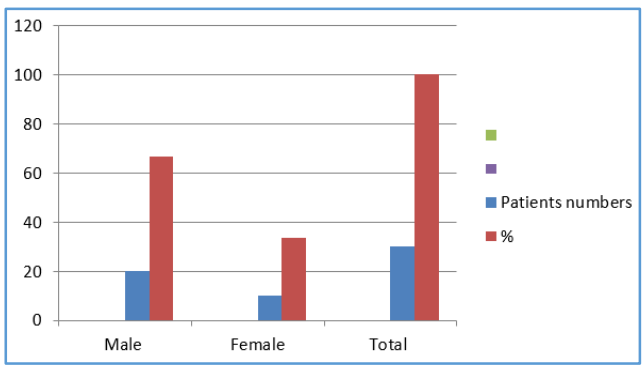

Fig. 2

MRI	Patient Numbers	%
Normal MRI findings	5	16.67
Abnormal MRI findings	25	83.33
Total	**20**	**100**

Table 3: Distribution of Patients According to MRI Findings

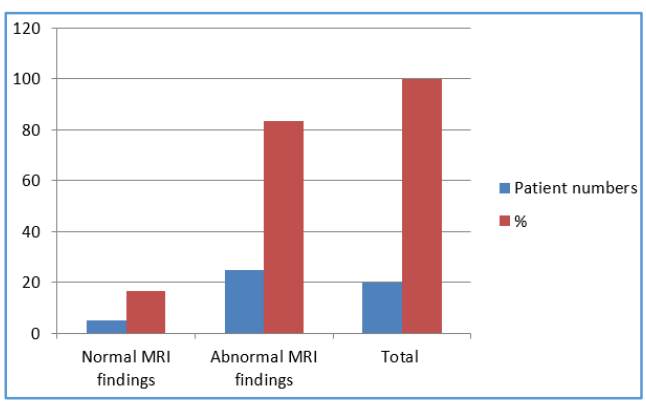

Fig. 3

Knee Injuries	Patients Numbers	%
ACL	15	60
PCL	6	24
Meniscus	10	40
Collateral	8	32
Bone	5	20
Muscular	2	8
Combined	15	60

Table 4: Distribution of the Patients According to the Knee Injuries

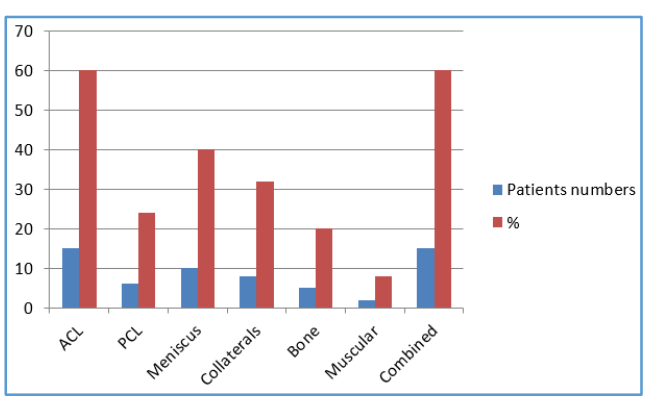

Fig. 4

Injury	Numbers	%
Isolated	5	20
Combined	20	80
Total	**25**	**100**

Table 5

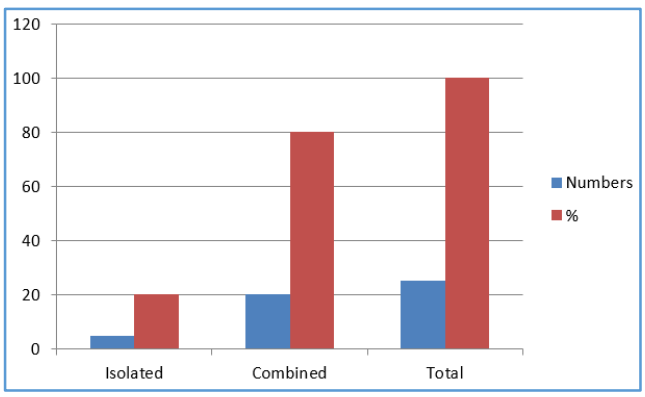

Fig. 5: Distribution of Patients According to type of Injury. Isolated & Combined

The results of the MRI were compared to the knee arthroscopy and/or surgery done to the patient later on and the analysis for the data was done using SPSS program version 16 results; description of quantitative variables as mean, SD and range, description of qualitative variables as number and percentage;

- Sensitivity = true positive/true positive + false negative = ability of the test to detect positive cases.
- Specificity=true negative/true negative + false positive=ability of the test to exclude negative cases.
- PPV (positive predictive value) = true positive/true positive+ false positive= % of true positive cases to all positive.
- NPV = true negative/true negative + false negative = % of the true negative to all negative cases.
- Accuracy = true positive + true negative/total.

RESULTS & OBSERVATIONS: The study included thirty patients complaining of sports related knee pain, only 5 patients (16.67%) were with normal MRI findings and 25 patients (83.33%) were with abnormal MRI findings (Table 3 and Fig. 3).

Among the 25 patients who had injuries of their knees, 15 patients (60%) had ACL injuries, 6 patients (24%) had PCL injuries 10 patients (40%) had meniscal injuries, 8 patients (32%) had collateral ligament injuries), 5 patients (20%) had bone injuries (Fig. 10) and 2 patients (8%) had muscular injuries Only 5 patients (20%) represented with isolated injury and 20 patients (80%) represented with combined injuries.

The leading sports of knee injuries were cricket, football, jogging, karate and others; the distribution of patients according to leading sports is represented in Table 6 and Fig. 6.

In correlation with arthroscopies and surgeries, morphological analysis was true-positive in 23 (92%) patients of the 25 injured patients, and true-negative in 3 (60%) patients of the 5 normal patients. Morphological analysis revealed overall 92% sensitivity and 60% specificity.

Regarding the 15 patients who had ACL injuries, 13 patients (86.6%) were true-positive, and 8 patients (80%) of the 10 patients who had meniscal injuries were true-positive.

DISCUSSION: MRI of the knee has become a reliable tool in the detection of knee injuries. Injuries to menisci and cruciate ligaments can be diagnosed on MRI with a high degree of sensitivity and specificity, but accuracy of MRI decreases in patients with multiple injuries.[7]

Although arthroscopy has been considered the Gold Standard in diagnosis of meniscal and ligament injuries, MRI remains a reliable, non-invasive modality, which can reduce the use of diagnostic arthroscopy.

Zairul-Nizam et al. studied patients with knee injuries and concluded that the MRI is very sensitive in diagnosing meniscus and ligamentous injuries.[8]

Nikolaou et al. studied 46 patients and concluded that the diagnostic power of MRI in knee injuries was substantially more than physical examinations.[6]

However, in other studies there were contradictory findings, Madhusudhan et al. in the UK studied 109 injured knees. In their study, the physical examinations, with the exception of meniscus tears, were superior to MRI results.[9]

In a study in Mashhad on 92 patients with knee injuries, Mazlomy et al. noted similar results and reported a high accuracy for clinical examinations.[10]

Behairy et al. is an Egyptian study of 70 patients that noted high diagnostic accuracy of both physical examination and MRI, and in most cases, only slight differences existed between the two methods, which was also confirmed in a study by Thomas et al.[11,12]

Major causes for the differences in the results were related to different skill levels of personnel involved in MRI interpretation, arthroscopy and clinical examination. The difference in technique used for the MRI is of importance. Studies have shown that if the examination is performed by a skilled technician, the results will be accurate.[13]

However, in our study, MRI showed that the sensitivity of meniscal MRI is 80% and these results demonstrate a sensitivity less than Kuikka et al. and Ramnath et al. which reported sensitivity of MRI of 91.7%.[14,15]

Sports	Numbers	%
Cricket	15	50
Football	5	16.67
Jogging	4	13.33
Karate	2	6.67
Others	4	13.33
Total	**30**	**100**

Table 6: Distribution of Patients according to Leading Sports. Cricket, Football, Jogging, Karate, Others

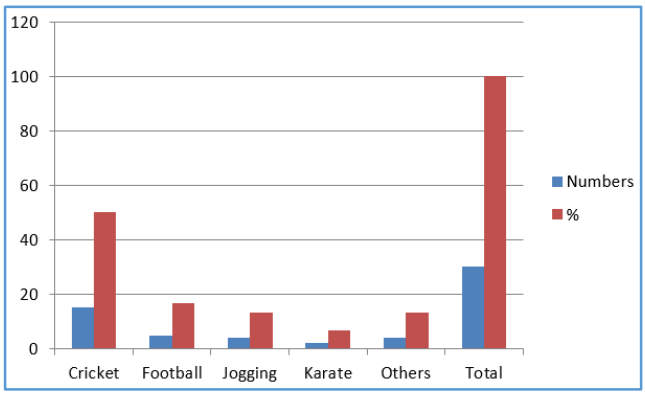

Fig. 6

There are several explanations for the misleading results of MRI regarding the menisci. Mackenzie et al summarised the four most common reasons for false positive diagnosis; wrong diagnosis due to variable anatomic structures, overestimation of pathology countered as meniscus tear (For example chondral injuries that mimic meniscus tears), false negative arthroscopic findings and tears within the meniscus without expansion to the articular surface.[16]

Jee et al. concluded that MRI in the presence of ACL tears has lower sensitivity for detecting meniscal tears due to missed lateral meniscal tear, and this may represent one of the causes of the misinterpretation of meniscal injures in this study.[17] Specificity of meniscal MRI in this study is 85% which agrees with the study of Kuikka et al. and Ramnath et al. which reported 87.1% specificity for meniscal MRI.[14,15]

The sensitivity and specificity of ACL MRI in this study were 86% & 90%, respectively, which almost correlated with Khandha et al as they observed in their study sensitivity and specificity for ACL were 86.67% and 91.43%, respectively.[18] Rayan et al. presented similar results, as they report 81% sensitivity of the ACL MRI.[19]

Regarding the PCL, Witonski and Vaz et al. reported that both the sensitivity and specificity of MRI in making the diagnosis of PCL tears are 100%.[20,21] In our study, we evaluated 6 PCL injuries and all were identified by MRI with 100% sensitivity and specificity & our results were well correlated with Witonski and Vaz et al studies.[20,21]

Some authors reported that specific imaging sequences improve the sensitivity and specificity for detecting meniscal and ligamentous tears.[22]

The value of our work is that we studied the accuracy of MRI and its agreement with arthroscopy and surgery as it is actually done without using a specific imaging protocol.

Despite the fact that this study has a limitation due to small number of patients, we believe it could become a baseline and give guidance for further studies.

Fig. 7: Sagittal PDFS shows Tear in the Posterior Horn of the Medial Meniscus

Fig. 8: Shows Bony Contusions

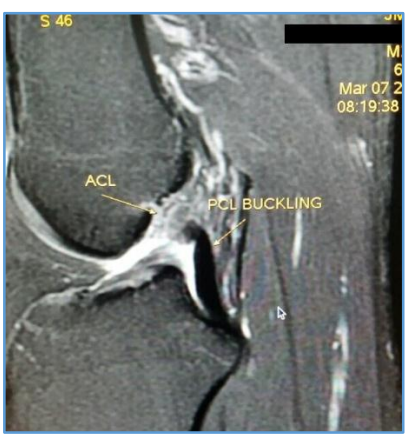

Fig. 9: Show ACL tear with Buckling of the PCL

Fig. 10: Shows ACL & PCL Tears

Fig. 11: Shows Double PCL sign

Fig. 12: Sagittal MR image shows Post Traumatic Bulky Hyperintense PCL (Arrow)

Fig. 13: Coronal MR Image, Bulky undulating LCL (Arrows)

Fig. 14: Coronal MR Image shows LCL Injury (Retracted LCL)

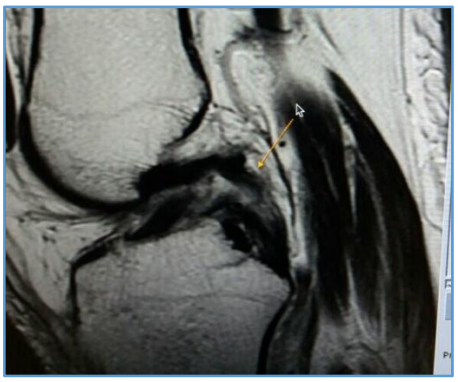

Fig. 15: Sagittal MR Image shows PCL Injury (Arrow)

Fig. 16: Shows bulky Hyperintense PCL with intraligamentous Fluid

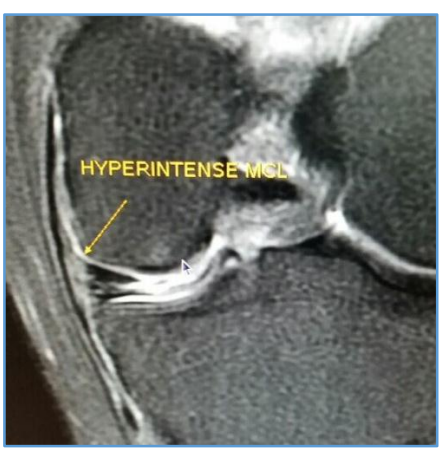

Fig. 17: Shows MCL Injury (Hyperintense MCL)

Fig. 18: Shows MCL Injury

Fig. 19: Shows Bone Oedema

Validity	%
Sensitivity	92
Specificity	60
PPV	92
NPV	60
Accuracy	86

Table 7: The Validity of the Knee MRI

PPV=positive predictive value, NPV=negative predictive value.

Injury	Sensitivity (%)	Specificity (%)
ACL	86.6	90
PCL	100	100
Meniscus	80	85
Collateral	85	90
Bones	100	100
Muscles	100	100
Others	100	100

Table 8: Sensitivity and Specificity of MRI for Knee Injuries

CONCLUSION: In conclusion, MRI is non-invasive and accurate and so is superior to the diagnostic arthroscopy, and we recommend MRI as a primary diagnostic tool for the evaluation of sports knee injuries. MRI represents the optimal imaging tool in the evaluation of the sports related knee injuries, which has been shown to be an accurate and non-invasive method of diagnosing ligament, meniscal, cartilage and muscular knee injuries.

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