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Role of MRI in evaluation of knee joint injuries and its correlation with arthroscopic findings

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Abstract
Background: The knee joint represents a common anatomical site susceptible to injury. Although, Arthroscopic procedures play a vital role in both diagnostics and therapeutics, offering insights into the nature of the injury. However, the invasive nature of arthroscopy and its potential complications underscore the need for alternative diagnostic methods. MRI has gained acceptance as the preferred non-invasive modality for evaluating knee injuries. This study aims to systematically evaluate the effectiveness of MRI results in comparison to arthroscopy findings in knee joint injuries, with arthroscopy serving as the gold standard for assessment.
Material and methods: This is a prospective study with 50 no. of patients. The study group includes patients coming to Al-Ameen Medical College Hospital, Vijyapura, India, clinically diagnosed to have ligamentous injuries of knee and undergoing MRI in the Department of Radiology. The study was conducted between August 2022-July 2024.
Results: In the present study, it was observed that majority of patients, 82% were male and 18% were females. 40% of patients were in age group 18-28 years. There were no instances of bilateral knee involvement, with the right knee joint (64%) being more frequently affected than the left knee (36%). Accuracy of MRI in reference to Arthroscopy in detecting ACL, PCL, Medial meniscus and lateral meniscus was found to be 94%, 100%, 96% and 94%, respectively.
Conclusion: The results demonstrate that MRI is a highly accurate, radiation free and non-invasive diagnostic tool for assessing a variety of knee pathologies, particularly ligamentous tears (ACL, PCL) and meniscal injuries (medial and lateral meniscus). MRI's high sensitivity and specificity for these structures make it a valuable tool for guiding treatment decisions and potentially reducing unnecessary arthroscopic procedures.

Keywords: Knee injuries, MRI, arthroscopy, ACL, PCL, medial meniscus, lateral meniscus

Introduction

The knee joint represents a common anatomical site susceptible to injury, primarily due to factors such as road traffic accidents, domestic falls, repetitive activities, and sports activities [1]. As a complex type of synovial joint with limited osseous reinforcement, the knee joint's stability is primarily reliant on its ligamentous apparatus. Therefore, ligament and meniscal injuries are exceedingly prevalent. Cruciate ligaments and the Menisci of the knee joint are generally affected in these injuries [2, 3] with initial symptoms like pain and swelling, ultimately impacting the normal functions of the knee joint and potentially leading to premature degeneration [4, 5]. Prompt and accurate diagnosis of the type and severity of injuries is imperative for both operative and nonoperative treatments. For the treatment of such injuries, the patient's clinical evaluation serves as the primary diagnostic approach utilized by surgeons. Sometimes, in acute cases, examination may not be required. Although symptoms and signs aid in diagnosis, they can occasionally be ambiguous, potentially leading to diagnostic delays and poorer prognosis. Therefore, confirmation of knee injuries necessitates further clinical assessment by specific imaging techniques, such as radiography, computerized tomography [6], and magnetic resonance imaging (MRI) [7]. Although, Arthroscopic procedures play a vital role in both diagnostics and therapeutics, offering insights into the nature of the injury. However, the invasive nature of arthroscopy and its potential complications underscore the need for alternative diagnostic methods. Among these, MRI has gained acceptance as the preferred non-invasive modality for evaluating knee injuries [8]. Since its clinical introduction in the mid-1980s, MRI has demonstrated high diagnostic accuracy without the use of ionizing radiation [9], making it a reliable and safe option. Its superiority over diagnostic arthroscopy [10], the current reference standard for internal knee derangements, lies in its non-invasiveness, improved soft tissue contrast, shorter imaging time, and absence of radiation exposure [11, 12]. This study aims to systematically evaluate the effectiveness of MRI results in comparison to arthroscopy findings in knee joint injuries, with arthroscopy serving as the gold standard for assessment.

Methodology

This is a prospective study with 50 no. of patients. The study group includes patients coming to Al-Ameen Medical College Hospital, Vijyapura, India, clinically diagnosed to have ligamentous injuries of knee and undergoing MRI in the Department of Radiology. The MRI was done on the advice of the referring doctor and no patient was made to undergo MRI for the sole purpose of this study. Arthroscopic studies were done in collaboration with Orthopaedic Department of Al-Ameen Medical College Hospital, Vijyapura, India. The study was approved by the Ethical Committee of the Institute.

Inclusion criteria: Patient between age group of 18 to 60 years and both sexes, all cases willing to undergo MRI with painful knee movements were included in this study.

Exclusion criteria: Patient not consenting for the study, previously undergone knee surgery, active infection and neoplasm of knee joint, patient on cardiac pacemaker, stapedial implants, cochlear implants and prosthetic heart valves or patient on metal implants and neurostimulators were excluded from the study.

Data Collection: For all patients admitted with a knee injury, a comprehensive medical history was obtained from the patient and/or attending caregivers. This history focused on elucidating the mechanism of injury and the severity of the trauma. Subsequently, a clinical assessment was performed to evaluate the patient's general health status and the specific characteristics of the knee injury.

MRI Evaluation: Patients meeting the study inclusion criteria underwent magnetic resonance imaging (MRI) examinations of the knee joint. The MRI scans were performed using a 1.5 Tesla Siemens Magnetom Essenza scanner. The specific MRI sequences employed may have included conventional spin echo T1-weighted, T2-weighted, proton density-weighted, or gradient echo sequences, depending on the specific clinical investigation required.

Arthroscopy data: Arthroscopy was done in collaboration with Orthopedic Department of Al-Ameen Medical College Hospital, Vijyapura, India.

Method of analysis of data: The acquired data was disseminated utilizing tabular and diagrammatic representations. Sensitivity, specificity, accuracy, PPV and NPV were determined through calculation. Subsequently, the data underwent analysis to ascertain significant correlations between MRI knee assessments and arthroscopic observations, employing kappa statistics. Statistical analysis was conducted using MedCalc Easy-to-use statistical software and GraphPad software.

Results

A total of 50 cases of knee injuries were selected by simple random sampling. Among these, it was observed that majority of patients, 82% were male and 18% were females (Table 1). The female to male ratio was found to be 1: 4.55. 40% of patients were in age group 18-28 years followed by 29-39 years (32%), followed by 40-50 years (20%) and only 8% patients were above 60 years of age (Table 2). There were no instances of bilateral knee involvement, with the right knee joint (64%) being more frequently affected than the left knee (36%) (Table 3).

ACL: In the present study, it was found that the anterior cruciate ligament (ACL) was the primary structure involved, while PCL was found to be least involved. In our study, MRI showed 37 (74%) cases of ACL injury in which Arthroscopic procedure confirmed 38 (76%) cases (Table 4). Out of these, 15 patients (30%) had complete ACL tears while 22 patients (44%) had partial ACL tears on MRI while in Arthroscopy these findings were 13 (26%) and 25 (50%) no. of patients, respectively (Table 5).

PCL: In our study, MRI showed 5 cases (10%) of PCL injury in which Arthroscopic procedure confirmed all 5 cases (10%) (Table 6). Out of these 4 (8%) patients had complete PCL tears while 1 patient (2%) had partial PCL tear on MRI and similar results were found in arthroscopy as well (Table 7).

Medial Meniscus: In our study, MRI showed 32 (64%) cases of Medial Meniscus tear in which Arthroscopic procedure confirmed 31 (62%) cases while 1 more case of Medial Meniscus tear was confirmed by Arthroscopy that was missed by MRI (Table 8). Out of the 32 patients with medial meniscal tears, 7 (14%) showed Grade-I signal, 11 (22%) showed grade-II signal and 14 (28%) showed grade-III signals on MRI while in arthroscopy these findings were 7 (14%), 9 (18%) and 16 (12%) no. of patients, respectively (Table 9).

Lateral Meniscus: In our study, MRI showed 14 (28%) cases of lateral Meniscus tear in which Arthroscopic procedure confirmed 13 cases while 2 more case of lateral Meniscus tear was confirmed by arthroscopy (30%) that was missed by MRI (Table 10). Out of these 14 patients with lateral meniscal tears, 3 showed Grade-I signal (6%), 4 showed grade-II signal (8%) and 7 showed grade-III signal (14%) on MRI while in Arthroscopy, these findings were 3 (6%), 6 (12%) and 6 (12%) no. of patients, respectively (Table 11).

Discussion

The intricate osseous and soft tissue architecture of the knee joint presents a significant challenge for comprehensive diagnostic imaging. Consequently, a multimodal approach is often employed to evaluate various knee pathologies. Conventional radiography provides excellent visualization of bony structures but offers limited information regarding soft tissues. Scintigraphy can identify areas of increased metabolic activity, while computed tomography excels at depicting osseous detail and can be particularly useful for evaluating fractures. However, magnetic resonance imaging (MRI) has emerged as the preeminent modality for knee joint assessment due to its exceptional ability to differentiate between various soft tissues such as ligaments, menisci, and articular cartilage. Numerous comparative studies have demonstrated a high degree of concordance between MRI findings and arthroscopic visualization, particularly for the evaluation of ligamentous injuries. This robust correlation underscores the invaluable role of MRI in the clinical evaluation of knee disorders.

This investigation aimed to assess the diagnostic accuracy of magnetic resonance imaging (MRI) for internal derangements of the knee joint by comparing its findings with those obtained through diagnostic arthroscopy, the established gold standard. Arthroscopic visualization of intra-articular knee pathology served as the reference point for evaluating the concordance with MRI results.

The present study prospectively evaluated the utility of MRI in diagnosing knee joint injuries and its correlation with subsequent Arthroscopic findings. The study population included adult patients of both genders referred to the Department of Radiology at Al-Ameen Medical College Hospital, Vijayapura, for knee MRI between August 2022 and July 2024. Inclusion criteria encompassed individuals with a history of knee pain and injury scheduled for MRI during the specified period. Patients with prior knee surgery or not consenting for the study or with active infection or neoplasm and contraindications for MRI were excluded from this study. Following informed consent, participants underwent demographic data collection and MRI evaluation

of Knee injuries using a 1.5 Tesla Siemens Magnetom Essenza scanner. Subsequently, all patients underwent therapeutic Arthroscopy based on the MRI findings.

MRI images were screened for the confirmation of injuries of: 1) ACL 2) PCL 3) Medial Meniscus 4) Lateral meniscus.

In the present study, males comprised the majority of patients with knee injuries, with the right knee being the most commonly affected. Similar data has been reported in other studies as well [13, 14]. Male preponderance may be related to Activity Levels and Anatomy while right knee being the most commonly affected as most people are right-handed, and this can lead to a slight dominance of the right leg. This dominance might translate to more stress placed on the right knee during activities like walking, running, or jumping.

It was observed that majority of patients were in age group 18-28 years followed by 29-39 years. The patients above age 40 years were 28%. Similar findings were reported in a study conducted by Asif Rahman *et al*. on the diagnostic accuracy of magnetic resonance imaging for meniscal injuries, where the patients' ages ranged from 22 to 66 years, with a mean age of 37 years [15]. Venkateshwaran Arumugam *et al*. conducted a study on MRI evaluation of acute internal derangement of the knee and observed that the majority of cases were in the age group of 20 to 30 years [16].

In our study, it was found that the anterior cruciate ligament (ACL) was the primary structure involved, followed by the medial meniscus (MM) followed by lateral meniscus. PCL was found to be least involved (Fig 1).

ACL: In our study, MRI showed 37 cases of ACL injury in which Arthroscopic procedure confirmed 38 cases. Sensitivity and specificity of MRI with respect to Arthroscopy was found to be 94.74% and 91.67% respectively showing a standard relationship with arthroscopy in diagnosing ACL. The PPV, NPV, accuracy & kappa were found to be 97.30%, 84.62%, 94.00% and 0.840, respectively (Fig 2). In a similar study conducted by Sahni and group sensitivity, specificity, PPV, NPV and accuracy of MRI with respect to Arthroscopy was found to be 93.3%, 86.6%, 87.5%, 88.8% and 91.1%, respectively [17].

In the present study, it was found that 15 patients had complete ACL tears while 22 patients had partial ACL tears on MRI while in Arthroscopy these findings were 13 and 25 no. of patients, respectively. In a similar study reported by Iqbal and group had shown 43.6% of patients had full-thickness tears, 52.7% had partial-thickness tears, and 3.6% had interstitial edema on MRI, while Arthroscopy revealed full-thickness tears in 41.8% of patients, partial-thickness tears in 52.7%, and interstitial edema in 5.5%. These results suggest a high degree of concordance between MRI and arthroscopy for diagnosing ACL tears [18]. Our study found that buckling of the PCL and bone contusions were the most frequently observed secondary signs. Notably, there was one case where a clinically suspected ACL tear was missed on MRI but confirmed by Arthroscopic examination. This highlights the importance of considering both primary and secondary MRI findings alongside clinical presentation for accurate ACL diagnosis.

Different imaging sequences in various planes were utilized for knee imaging, including T1-weighted (T1w), T2-weighted (T2w), proton density (PD), and fat-saturated images in coronal, axial, and sagittal planes. For detecting ACL tears, only certain sequences were found to be useful, such as sagittal T1w and PD images, as well as coronal T1w images. Among these, the most useful sequence was the sagittal PD images.

PCL: Sensitivity and specificity of MRI with respect to Arthroscopy for detecting PCL tears was found to be 100% and 100%, respectively showing a standard relationship with arthroscopy in diagnosing PCL. The PPV, NPV, accuracy & kappa were found to be 100%, 100%, 100% and 1, respectively (Fig 2).

In the present study, it was found that 4 patients had complete PCL tears while 1 patient had partial PCL tear on MRI and similar results were found in arthroscopy as well. In a similar study conducted by Grover *et al*. involving 610 patients to evaluate MRI for PCL injury detection. MRI demonstrated high diagnostic accuracy with 100% sensitivity and specificity with respect to Arthroscopy. Notably, no PCL injuries were missed by MRI among the 202 patients who underwent arthroscopy [19].

PCL injuries are less common than ACL tears, but diagnosing them can be tricky as well. Though, MRI plays a crucial role in diagnosing PCL injuries, but often requires confirmation or additional information from arthroscopy.

Medial Meniscus: Sensitivity and specificity of MRI with respect to Arthroscopy for detecting Medial Meniscus tear was found to be 96.88% and 94.44% respectively showing a standard relationship with arthroscopy in diagnosing medial meniscus tear. The PPV, NPV, accuracy & kappa were found to be 96.88%, 94.44%, 96% and 0.913, respectively (Fig 2). Shantanu and group has also almost similar statistics for medial meniscus tear with sensitivity (89.5%) and specificity (85.4%) of MRI with respect to Arthroscopy showing an standard relationship with arthroscopy in diagnosing medial meniscus tear. The PPV, NPV and kappa were found to be 73.9%, 94.6%, and 0.62, respectively(8). In a similar study conducted by Sahni and group Sensitivity, specificity, PPV, NPV and accuracy of MRI with respect to Arthroscopy was found to be 92.8%, 83.3%, 68.4%, 96.7%, and 86%, respectively [17]. In our study, it was found that out of the 32 patients with medial meniscal tears, 7 showed Grade-I signal, 11 showed grade-II signal and 14 showed grade-III signals on MRI while in arthroscopy these findings were 7, 9 and 16 no. of patients, respectively. In a similar study reported by Iqbal and group, out of the 32 patients with medial meniscal tears, 2 showed Grade-I signal, 5 showed grade-II signal, 23 showed grade-III signal and 2 showed bucket handle tear on MRI while in arthroscopy these findings were 2, 6, 22 and 2 no. of patients, respectively [18].

Lateral Meniscus: Sensitivity and specificity of MRI with respect to Arthroscopy for detecting lateral Meniscus tear was found to be 86.67% and 97.14% respectively showing a standard relationship with arthroscopy in diagnosing lateral meniscus tear. The PPV, NPV, accuracy and kappa were found to be 92.86%, 94.44%, 94% and 0.85, respectively (Fig 2). Shantanu and group have also almost similar statistics for lateral meniscus tear with sensitivity and specificity of MRI with respect to Arthroscopy is 87.5% and 94.2% respectively showing a standard relationship with arthroscopy in diagnosing lateral meniscus tear the PPV, NPV and kappa were found to be 70.0%, 98%, and 0.785, respectively [8]. In a similar study conducted by Sahni and group Sensitivity, specificity, PPV, NPV and accuracy of

MRI with respect to Arthroscopy was found to be 87.5%, 92.8%, 70%, 97.5%, and 92%, respectively [17].

In our study, out of the 14 patients with lateral meniscal tears, 3 showed Grade-I signal, 4 showed grade-II signal and 7 showed grade-III signal on MRI while in Arthroscopy, these findings were 3, 6 and 6 no. of patients, respectively. In a similar study reported by Iqbal and group out of the 19 patients with lateral meniscal tears,1 showed Grade-I signal, 5 showed grade-II signal and 13 showed grade-III signal on MRI while in arthroscopy these findings were 1, 5 and 11 no. of patients, respectively [18].

Conclusion

This study investigated the role of Magnetic Resonance Imaging (MRI) in evaluating knee joint injuries and its correlation with Arthroscopic findings. The results demonstrate that MRI is a highly accurate, radiation free and non-invasive diagnostic tool for assessing a variety of knee pathologies, particularly ligamentous tears (ACL, PCL) and meniscal injuries (medial and lateral meniscus). MRI's high sensitivity and specificity for these structures make it a valuable tool for guiding treatment decisions and potentially reducing unnecessary arthroscopic procedures.

In conclusion, MRI has emerged as the primary imaging modality for evaluating knee injuries due to its accuracy, safety, and ability to depict internal joint structures in detail. While arthroscopy remains the gold standard for definitive diagnosis and treatment in some cases, MRI serves as a powerful non-invasive alternative for a comprehensive evaluation of knee joint injuries.

Table 1: Distribution of patients according to Sex

Gender distribution of patients		
Sex	**No. of patients**	**Percentage**
Male	41	82%
Female	9	18%
Total	50	100%

Table 2: Distribution of patients according to age

Age distribution of patients		
Age group (years)	**No. of patients**	**Percentage**
18- 28	20	40%
29-39	16	32%
40-50	10	20%
51-60	4	8%
Total	50	100%

Table 3: Distribution of patients according to Knee joint side injured

Distribution of patients according to involved knee joint		
Side	**No. of patients**	**Percentage**
RIGHT	32	64%
LEFT	18	36%
TOTAL	50	100%

Table 4: Comparison between MRI and Arthroscopic findings for ACL tear

Comparison between mri and arthroscopic findings for acl tear			
MRI	**Arthroscopy**		**Total**
	Positive	**Negative**	
Positive	36	1	37
Negative	2	11	13
Total	38	12	50

Table 5: Types of ACL tears

Type of acl tear		
	MRI	**ARTHROSCOPY**
COMPLETE	15	13
PARTIAL	22	25

Table 6: Comparison between MRI and Arthroscopic findings for PCL tear

Comparison between mri and arthroscopic findings for pcl tear			
MRI	**Arthroscopy**		**Total**
	Positive	**Negative**	
Positive	5	0	5
Negative	0	45	45
Total	5	45	50

Table 7: Types of PCL tears

Type of pcl tear		
	MRI	**Arthroscopy**
Complete	4	4
Partial	1	1

Table 8: Comparison between MRI and Arthroscopic findings for medial meniscus tear

Comparison between mri and arthroscopic findings for medial meniscus tear			
MRI	**Arthroscopy**		**Total**
	Positive	**Negative**	
Positive	31	1	32
Negative	1	17	18
Total	32	18	50

Table 9: Grades of Medial Meniscus tear

Grades of Medial Meniscus		
Grade of Tear	**MRI**	**Arthroscopy**
Grade I	7	7
Grade II	11	9
Grade III	14	16

Table 10: Comparison between MRI and Arthroscopic findings for Lateral MENISCUS tear

Comparison between mri and arthroscopic diagnosis for lateral meniscus tear			
MRI	**Arthroscopy**		**Total**
	Positive	**Negative**	
Positive	13	1	14
Negative	2	34	36
Total	15	35	50

Table 11: Grades of lateral Meniscus tear

Grades of lateral meniscus		
Grade of Tear	**MRI**	**Arthroscopy**
Grade I	3	3
Grade II	4	6
Grade III	7	6

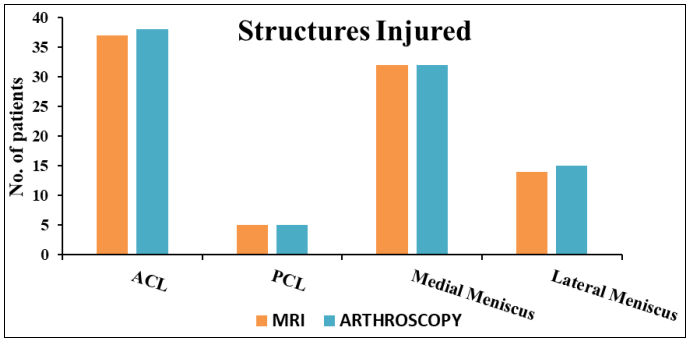

Fig 1: Distribution of patients according to Structures injured

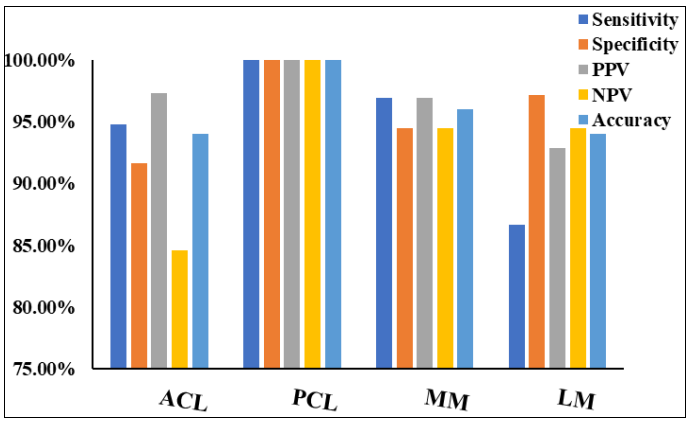

Fig 2: Sensitivity, specificity, positive predictive value, andnegative predictive value of various ligament and meniscal injuries of knee joint in study population

Conflict of interest: Nil

References

1. Thornton DD, Rubin DA. Magnetic resonance imaging of the knee menisci. Semin Roentgenol,2000:35(3):217–30.
2. Tayeb AM, Almohammadi AA, Hegaze AH, Roublah F, Althakafi KA. Anterior Cruciate Ligament injury in association with other knee injuries in King Abdulaziz University Hospital, Saudi Arabia. Cureus,2020:12(9):1–11.
3. Lin EC. Radiation risk from medical imaging. Mayo Clin Proc,2010:85(12):1142–6.
4. Mangine RE, Minning SJ, Eifert-Mangine M, Colosimo AJ, Donlin M. Management of the patient with an ACL/MCL injured knee. N Am J Sports Phys Ther [Internet],2008:3(4):204–11. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21509122%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC2953343
5. Dargel J, Gotter M, Mader K, Pennig D, Koebke J, Schmidt-Wiethoff R. Biomechanics of the anterior cruciate ligament and implications for surgical reconstruction. Strateg Trauma Limb Reconstr,2007:2(1):1–12.
6. Gray SD, Kaplan PA, Dussault RG. Imaging of the knee: current status. Orthop Clin North Am [Internet],1997:28(4):643–58. Available from: https://www.sciencedirect.com/science/article/pii/S0030589805703114
7. Kaplan PA, Walker CW, Kilcoyne RF, Brown DE, Tusek D, Dussault RG. Occult fracture patterns of the knee associated with anterior cruciate ligament tears: assessment with MR imaging. Radiology [Internet],1992:183(3):835–8. Available from: https://doi.org/10.1148/radiology.183.3.1584943
8. Shantanu K, Singh S, Srivastava S, Saroj AK. The validation of clinical examination and MRI as a diagnostic tool for cruciate ligaments and meniscus injuries of the knee against diagnostic arthroscopy. Cureus, 2021, 13(6).
9. Major NM, Beard LNJ, Helms CA. Accuracy of MR imaging of the knee in adolescents. AJR Am J Roentgenol,2003:180(1):17–9.
10. Umap R, Anurag B, Bagale S, Shattari N. Evaluation of traumatic knee joint injuries with MRI. Int J Contemp Med Surg Radiol,2018:3(3):77–81.
11. Klenk C, Gawande R, Uslu L, Khurana A, Qiu D, Quon A, *et al*. Ionising radiation-free whole-body MRI versus 18F-fluorodeoxyglucose PET/CT scans for children and young adults with cancer: a prospective, non-randomised, single-centre study. Lancet Oncol [Internet],2014:15(3):275–85. Available from: https://doi.org/10.1016/S1470-2045(14)70021-X
12. Hartwig V, Giovannetti G, Vanello N, Lombardi M, Landini L, Simi S. Biological effects and safety in magnetic resonance imaging: a review. Int J Environ Res Public Health,2009:6(6):1778–98.
13. Chia L, De Oliveira Silva D, Whalan M, McKay MJ, Sullivan J, Fuller CW, *et al*. Non-contact anterior cruciate ligament injury epidemiology in team-ball sports: a systematic review with meta-analysis by sex, age, sport, participation level, and exposure type. Sports Med,2022:52:2447–67.
14. Almaawi A, Awwad W, Bamugaddam A, Alasheikh M, Muaddi M, Almutair O, *et al*. Prevalence of knee injuries among male college students in Riyadh, Kingdom of Saudi Arabia. J Orthop Surg Res,2020:15(1):126.
15. Rahman A, Nafees M, Akram MH, Andrabi AH, Zahid M. Diagnostic accuracy of magnetic resonance imaging in meniscal injuries of knee joint and its role in selection of patients for arthroscopy. J Ayub Med Coll Abbottabad,2010:22(4):10–4.
16. Arumugam V, Ganesan G, Natarajan P. MRI evaluation of acute internal derangement of knee. Open J Radiol,2015:5:66–71.
17. Sahni G, Kumar S, Rehncy J. No title. Natl J Physiol Pharm Pharmacol,2022:12(2):166–9.
18. Khan DI, Swarnkar CP, Yadav R. Role of MRI in diagnosis of anterior cruciate ligament injuries of knee assuming arthroscopy as gold standard. In 2020. Available from: https://api.semanticscholar.org/CorpusID:216093534
19. Grover JS, Bassett LW, Gross ML, Seeger LL, Finerman GA. Posterior cruciate ligament: MR imaging. Radiology,1990:174(2):527–30.