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Original Research Article

The Assessment of the Role of Magnetic Resonance Imaging (MRI) in Knee Joint Injuries in Correlation with Arthroscopy

Swagat Soubhagya Mohapatra[1], Akash Samal[2]

[1]Senior Resident, Department of Orthopaedics, PGIMER, Bhubaneswar, Odisha, India[1]
[2]Senior Resident, Department of Orthopaedics, SCB Medical College and Hospital, Cuttack, Odisha, India[2]

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Corresponding author: Swagat Soubhagya Mohapatra
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Abstract

Knee joint trauma is a significant cause of morbidity among individuals who are physically active and in their younger years. The attainment of a precise diagnosis pertaining to the injury holds paramount significance in facilitating prompt and conservative therapeutic interventions. Arthroscopy and magnetic resonance imaging (MRI) are the two predominant diagnostic modalities employed for the evaluation of knee joint pathology.

Objective: The aim of this study is to evaluate the role of MRI in knee joint injuries in correlation with arthroscopy.

Methods: A prospective study was conducted at the Department of Orthopaedics. A cohort of 100 patients (100 knees) was subjected to examination, comprising 84 males and 22 females, spanning an age range of 16 to 61 years. These individuals presented with diverse knee joint injuries.

Results: The present study conducted a comparative analysis of two distinct methodologies for the treatment of knee injuries. The findings obtained from this investigation align with previous research, thereby reinforcing the validity and reliability of the conclusions drawn. The prevalence of anterior and medial meniscal injuries surpasses that of posterior and lateral counterparts. The utilization of magnetic resonance imaging (MRI) in elucidating the characteristics of anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) injuries plays a pivotal role in aiding the orthopedic surgeon in determining the appropriate course of action, be it conservative management or definitive reconstruction through arthroscopy.

In conclusion, it is evident that individuals who have experienced knee trauma frequently present with meniscal and ligamentous injuries.In comparison to the posterior cruciate ligament (PCL) and lateral meniscus (LM), it is more commonly observed that the anterior cruciate ligament (ACL) and medial meniscus (MM) sustain tearing. ACL and medial collateral ligament (MCL) tears have been observed to be commonly associated with meniscus medial (MM) tears. Conversely, injuries to the lateral collateral ligament (LCL) have shown a strong correlation with meniscus lateral (LM) tears.

Keywords: Knee MRI, Arthroscopy, Meniscus tears, Knee joint, Cruciate ligament.

Introduction

Knee pain is responsible for over one million visits to the emergency department and 1.9 million visits to primary care outpatient clinics each year [1]. A considerable incidence of knee joint pain has been documented by multiple authors [2,3]. Arthroscopy, while exhibiting a diagnostic accuracy ranging from 64% to 94%, is a procedure of an invasive nature that carries inherent risks of complications. The anterior cruciate ligament (ACL) is a frequently afflicted ligament within the knee joint. Meniscal injuries are commonly observed in conjunction with [4]. In the 1980s, Kean et al. employed magnetic resonance imaging (MRI) for knee assessment [5]. The diagnostic accuracy of magnetic resonance imaging (MRI) in the assessment of knee lesions is notably high, with reported sensitivity ranging from 80% to 100% [6]. Magnetic resonance imaging (MRI) of the knee is presently regarded as the preferred diagnostic modality for the identification and assessment of injuries affecting the menisci, ligaments, and tendons, as well as bone contusions and concealed fractures within the knee joint[7].Magnetic resonance imaging (MRI) exhibits a notable sensitivity ranging from 80% to 100% in the accurate detection and identification of knee lesions [6,7]. Magnetic resonance imaging (MRI) has emerged as the preferred diagnostic modality for the evaluation of meniscal, ligamentous, and tendinous injuries, as well as bone bruising and

occult fractures within the knee joint. Arthrography and diagnostic arthroscopy have been largely replaced by this technique in the majority of medical centers [8, 9].

The failure to accurately diagnose and effectively manage knee injuries can lead to a significant decline in one's quality of life, a loss of productivity due to missed work, and the development of premature osteoarthritis [12].Magnetic resonance imaging (MRI) has emerged as the preferred diagnostic modality for the evaluation of meniscal, ligamentous, and tendinous pathologies, as well as bone contusions and occult fractures within the knee joint. Arthrography and diagnostic arthroscopy have been largely replaced by this technique in the majority of medical centres [8, 9]. The failure to accurately diagnose and effectively manage knee injuries can lead to a significant decline in one's quality of life, a loss of productivity due to missed work, and an increased risk of developing osteoarthritis at an earlier age [10].

In the year 2003, a total of approximately 19.4 million patient encounters were documented wherein individuals sought medical consultation specifically for knee-related concerns. Meniscal injuries are frequently observed in cases of knee trauma, particularly in incidents involving road traffic accidents and among young males participating in sports activities [11].Osteoarthritis, a highly prevalent arthritic condition, is widely treated in the medical field on a global scale. For instance, in the United States, the incidence rate reaches 3532 cases per 100,000 individuals [12,13].Radiography is capable of visualizing osteophytes, which are bony outgrowths located at the joint margin, as well as the narrowing of the joint space. However, it lacks the ability to visualize soft tissue pathology [14].

The diagnosis of osteoarthritis is established through the evaluation of clinical examination findings and radiographic imaging. Population-based longitudinal studies conducted in the United States [15] and the United Kingdom [16] have demonstrated that the lifetime risk of knee osteoarthritis escalates in correlation with advancing age. Moreover, these studies have revealed that individuals classified as obese exhibit the highest susceptibility to this condition [15].

Magnetic resonance imaging (MRI) effectively captures various elements within the knee joint, encompassing the articular cartilage, menisci, intra-articular ligaments, and potential abnormalities in the intraarticular bony structure. These findings are not discernible through conventional radiography methods [17].In contrast, magnetic resonance imaging (MRI) has the capability to visualize a multitude of clinically relevant tissues, which play a crucial role in terms of structural progression that may not be discernible through radiography. Magnetic resonance imaging (MRI) has the capacity to reveal incidental findings in individuals who are otherwise asymptomatic [18]. The primary objective of our study was to conduct a comparative analysis between magnetic resonance imaging (MRI) and arthroscopy techniques for the comprehensive assessment of knee injuries.

Methods

Sample population

A prospective study was conducted at the Department of Orthopaedics. A cohort of 100 participants (consisting of 100 knees) underwent a comprehensive examination. The study population comprised 84 males and 22 females, spanning an age range of 16 to 61 years. These individuals presented with diverse knee joint injuries.

Inclusion and Exclusion Criteria

The study included a cohort of adult patients, ranging in age from 16 to 61 years, who expressed their willingness to undergo magnetic resonance imaging (MRI) scanning for the evaluation of knee injuries based on clinical suspicion. Furthermore, these patients provided informed consent for the aforementioned procedure. All patients who presented with complaints of pain and/or swelling at the knee joint in the absence of a documented history of trauma were deemed ineligible for participation in the study. Additionally, individuals with pain and swelling at the knee joint resulting from inflammatory, degenerative, neoplastic, or infectious causes were also excluded from the study population. Furthermore, individuals who had previously undergone arthroscopy involving meniscal and ligament repair, expressed unwillingness to partake in the research, or possessed a cardiac pacemaker, metal implants, or neurostimulators were also deemed ineligible for inclusion in the study.

Arthroscopic examination and MRI

The integrity of the anterior cruciate ligament (ACL) was assessed by evaluating coronal, axial, and sagittal images to determine whether it remained intact or exhibited signs of tearing. Upon observation, a hypointense band-like structure was noted, which was deemed to exhibit characteristic features.

ACL tears were characterized as a focal discontinuity or total absence of the ligament, the abnormal signal intensity of the ligament, irregular contour, or inadequate delineation of its ligamentous fibers. An observation of a hypointense meniscus with no discernible alterations in signal intensity was noted, indicating a normal condition. The identification of an

intradiscal high-signal intensity was deemed indicative of a tear, which was subsequently classified according to its extent of reaching the articular surface. Arthroscopy, a surgical intervention, facilitates the visualization and optimal management of tissues within the knee joint. The procedure is commonly performed under the administration of a short-acting general anesthetic. The arthroscope, a fiber-optic instrument, is introduced into the knee joint through two small incisions. The arthroscope is equipped with an optical device, incorporating a camera, which captures visual data. Subsequently, the acquired image is projected onto a television monitor for visualization and analysis. The arthroscope comprehensively evaluates the entirety of the knee joint, encompassing the meniscus, cartilage surfaces, patella, synovial lining, and ligaments.

Results

The study cohort consisted of 100 participants who had a documented medical history of experiencing a severe knee joint injury. Arthroscopy was performed on all patients. The results of the magnetic resonance imaging (MRI) were compared to the findings of the arthroscopy procedure, and the sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were calculated. The study comprised a cohort of 100 patients, with 80 being male and 20 being female.

Table 1: Type of tear injuries in the knee joint trauma

Type of tear	Number of cases	Percentage
Fractures	14	14%
BC	42	42%
Joint effusion	50	50%
Lateral collateral ligament	18	18%
Medial collateral ligament	28	28%
Posterior cruciate ligament	6	6%
Anterior cruciate ligament	76	76%
Lateral meniscus	22	22%
Medial meniscus	34	34%

According to the findings presented in Table 1, the predominant abnormal magnetic resonance imaging (MRI) outcome observed in our study was the presence of an anterior cruciate ligament (ACL) tear, which was identified in approximately 76 patients (76%). This was followed by the occurrence of joint effusion, which was observed in 50 patients (50%). The prevalence of meniscal damage was observed in 34 cases (34%), with the medial meniscus being the most commonly affected. The occurrence of an anterior cruciate ligament (ACL) tear was predominantly associated with concomitant medial meniscal damage, as observed in 26 cases within the scope of our study.

A total rupture of the anterior cruciate ligament (ACL) was observed in approximately 50 instances of cruciate ligament injury. Among the cohort of 56 patients with meniscal injuries, it was observed that up to 26 individuals presented with a grade 3 tear specifically affecting the posterior horn of the medial meniscus.

Table 2: Accuracy of MRI findings in the context of medical diagnosis using arthroscopic findings

Tears	Sensitivity	Specificity	PPV	NPV	Accuracy
Anterior cruciate ligament	94.59%	80%	94.50%	80%	94%
Posterior cruciate ligament	100%	100%	100%	100%	100%
Medial meniscus	68.42%	86.66%	76.47%	81.20%	80%
Lateral meniscus	69.23%	94.10%	81.81%	88.88%	88%

Sensitivity, specificity, positive predictive value, and negative predictive value (NPV) were calculated in order to evaluate the reliability of the MRI data, as per the aforementioned categories.

The magnetic resonance imaging (MRI) technique demonstrated a sensitivity of 94.59%, indicating its ability to correctly identify individuals with ACL injury. The specificity of MRI was determined to be 80.0%, indicating its ability to accurately identify individuals without ACL injury. The negative predictive value (NPV) of MRI was found to be 80%, indicating the probability of correctly identifying individuals as not having ACL injury. The positive predictive value (PPV) of MRI was determined to be 94.5%, indicating the probability of correctly identifying individuals as having ACL injury. Overall, the diagnostic accuracy of MRI for

ACL injury was determined to be 94%. The sensitivity of PCL injury was determined to be 100%, indicating that the test correctly identified all individuals with PCL injury. Similarly, the specificity was found to be 100%, indicating that the test accurately ruled out PCL injury in individuals without the condition. The positive predictive value (PPV) was determined to be 100%, indicating that when the test result was positive, there was a 100% chance that the individual truly had PCL injury. The negative predictive value (NPV) was also found to be 100%, indicating that when the test result was negative, there was a 100% chance that the individual did not have PCL injury. Overall, the diagnostic accuracy of the test was determined to be 100%, indicating that it correctly classified all individuals as either having or not having P The sensitivity for medial meniscal injuries was found to be 68.42%, indicating the proportion of true positive cases correctly identified by the diagnostic test. The specificity was determined to be 86.66%, representing the proportion of true negative cases correctly identified by the test. The positive predictive value (PPV) was calculated to be 76.47%, indicating the probability of a positive test result accurately indicating the presence of a medial meniscal injury. The negative predictive value (NPV) was determined to be 81.20%, representing the probability of a negative test result accurately ruling out the presence of a medial meniscal injury. Overall, the diagnostic accuracy of the test for medial meniscal injuries was determined to be 80%. Table 2 presents the findings pertaining to lateral meniscal injuries, revealing a sensitivity of 69.23%, specificity of 94.10%, positive predictive value (PPV) of 81.81%, negative predictive value (NPV) of 88.88%, and overall diagnostic accuracy of 88%.

After conducting an arthroscopic evaluation, the MRI diagnostic findings were categorized into one of four groups as outlined below:

1. The presence of a true positive was ascertained through the confirmation of a tear diagnosis during the MRI examination during the arthroscopic assessment to evaluate the condition of the joint.
2. The presence of a false positive was observed in the diagnostic imaging findings, as the magnetic resonance imaging (MRI) examination indicated the existence of a tear. However, subsequent arthroscopic evaluation did not corroborate the presence of any tear.
3. The arthroscopy procedure confirmed the MRI assessment of no tear, indicating a true negative result.
4. False negative: In the case where the magnetic resonance imaging (MRI) examination yielded negative results, it was subsequently discovered during arthroscopy that a tear was indeed present.

Discussion

In a comparable investigation conducted by Singh et al., it was observed that 45.08% of the subjects exhibited anterior cruciate ligament (ACL) tear. Among this population, 66.67% presented with partial ACL tear, while 21.13% displayed complete ACL tear. The authors reached the conclusion that injuries to the anterior cruciate ligament (ACL) are more prevalent compared to other types of ligamentous injuries [17].The study conducted by Singh et al. [10] reported the sensitivity, specificity, and accuracy of magnetic resonance imaging (MRI) in the detection of anterior cruciate ligament (ACL) tears to be 98.7%, 98.9%, and 98.8%, respectively. In a study conducted by Ha et al [18], the authors reported the findings regarding the sensitivity, specificity, and accuracy of magnetic resonance imaging (MRI) in the detection of anterior cruciate ligament (ACL) tears.

The results indicated a sensitivity, specificity, and accuracy rate of 96%. The study conducted by Yaqoob et al. reported the sensitivity, specificity, and accuracy of magnetic resonance imaging (MRI) in the detection of anterior cruciate ligament (ACL) tear to be 91.6%, 95.2%, and 94.4%, respectively [19].The study conducted by Saurav et al reported a sensitivity of 88.5 percent, a specificity of 71.4 percent, and positive and negative predictive values of 85.2 and 76.9 percent, respectively. These findings align with the results of our own study[20].

Vertical tears were identified as the most prevalent form of meniscal tear. This finding stands in contrast to the previous discovery made by Pasupuleti B et al, which identified horizontal tear as the most prevalent type of meniscal tear [21].The presence of vertical tears observed in our study exhibited a significant correlation with a documented history of trauma. The existing literature also delineates vertical tears as having a traumatic etiology [21,22].A total of three patients were observed in our study to exhibit a bucket-handle tear specifically affecting the medial meniscus. The existing literature also documents that a majority of bucket-handle tears primarily affect the medial meniscus [23,24]. The most prevalent pathology observed in the anterior cruciate ligament (ACL) is tear, with the majority of cases presenting as acute in nature. The findings demonstrate comparability to the study conducted by Sohali K et al [25].The tibia exhibited a higher incidence of contusions compared to the femur, with a greater frequency of involvement observed in the lateral femoral condyle as opposed to its medial counterpart [26].In our study, it was observed that acute tears of the anterior cruciate

ligament (ACL) were commonly accompanied by bone contusions. A comparable correlation was documented in prior investigations [27-29].The present study's diminished sensitivity in detecting MM tears can be attributed to a multitude of injuries. The sensitivity and specificity of the present study are comparable to those reported in the investigation conducted by Taryn et al. [30]. The present study identified a robust correlation between magnetic resonance imaging (MRI) and arthroscopy, with our results aligning with the outcomes reported in prior investigations.

Conclusion

Magnetic resonance imaging (MRI) is a highly valuable and non-invasive modality that exhibits exceptional diagnostic accuracy, sensitivity, and negative predictive value. Consequently, it serves as a dependable screening tool for the evaluation of traumatic knee injuries. The diagnostic modality exhibits a notable degree of sensitivity in detecting injuries to the anterior cruciate ligament (ACL). Consequently, medical professionals specializing in arthroscopy can perform therapeutic interventions through this minimally invasive procedure on patients who present with a favorable clinical assessment and a corroborating positive magnetic resonance imaging (MRI) examination. Despite arthroscopy being widely regarded as the preferred method for assessing knee pathologies, it does possess certain limitations. These limitations encompass challenges in detecting abnormalities beyond the joint space, as well as posterior and inferior meniscal tears.

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