



Spectrum of MRI Findings in Sports-related Knee Injuries

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Abstract

Introduction: Magnetic Resonance Imaging (MRI) plays a vital role in assessing various internal knee injuries resulting from sports activities without resorting to invasive methods. This research centres on common anatomical issues and underscores the significance of MRI in identifying precise injury patterns when evaluating patients with sports-related knee injuries.

Methods: This cross-sectional observational study carried out at a tertiary care hospital, focusing on 55 patients referred to the radiology department for their initial sports-related knee injuries between April 2022 and March 2023. Patients meeting the inclusion criteria underwent knee Magnetic Resonance Imaging (MRI) using the SIEMENS 1.5 Tesla Magnetom Sempra MRI scanner.

Results: Among the 55 patients diagnosed with knee injuries, athletic activities accounted for the majority of sports-related knee injuries. MRI revealed findings in 51 cases of sports-related injuries, with joint effusion being the most common presentation (40 cases). The primary injury observed was an anterior cruciate ligament (ACL) tear, occurring in 18 cases, followed by injuries to the medial collateral ligament (MCL), medial meniscus, posterior cruciate ligament (PCL), lateral meniscus, and lateral collateral ligament (LCL).

Conclusions: "MRI, known for its high-contrast imaging of soft tissues, serves as a noninvasive method to evaluate various internal knee injuries in patients with sports-related knee injuries."

INTRODUCTION

Approximately 80% of all injuries sustained in sports are triggered by sports-related incidents, predominantly musculoskeletal injuries.^{1,2} Athletics, both competitive and recreational, are prone to joint injuries, especially those affecting the knee. Sports-related activities frequently result in traumatic knee injuries, which can cause severe discomfort and functional impairment.² The best non-invasive technique for assessing knee injuries in sports is magnetic resonance imaging (MRI), which is renowned for its multi-planar imaging capabilities and superior soft tissue contrast.³

Both professional athletes and non-competitive participants are concerned about sports injuries. The nature and patterns of knee-related sports injuries change

depending on the athlete's age and sport.⁴⁻¹⁰ Recent trends in sedentary people's participation in recreational sports, such as badminton, cricket, running, and jogging, have increased the risk of sports-related injuries.

The largest and most intricate joint in the human body is the knee joint, also known as the tibiofemoral joint which is prone to sports-related injuries due to its inherent instability primarily caused by its unstable bony articular surfaces. Knee stability largely depends on the supporting ligamentous structures, and meniscal and ligament injuries are common. Knee injuries from sports are a major cause of morbidity in both young and older populations.¹¹ Due to the knee joint's important role in daily life, employment, and amateur and professional sports, it is prone to damage to the menisci, ligaments, hyaline cartilage, and degenerative changes brought on by osteoarthritis. It's crucial to diagnose intra-articular knee lesions accurately and quickly. The effectiveness of treatment for intra-articular knee lesions depends heavily on accurate and prompt diagnosis.¹² Magnetic resonance imaging is a useful tool to evaluate patients with recent knee injuries or long-term sports-related knee pain.¹³ With superior soft tissue contrast, high spatial resolution, and the ability to display images in orthogonal planes, it is regarded as the gold standard for non-invasive examination of intra and extra-articular structures.^{14,15} A common diagnostic procedure for identifying and evaluating acute and ongoing internal derangement injuries to the knee is magnetic resonance imaging (MRI) of the knee.¹³ It is an essential tool for guiding patient care. While radiography is still the primary imaging method used to diagnose knee disorders, MRI improves the assessment of bone and soft tissue structures. The menisci, cruciate ligaments, collateral ligaments, extensor mechanisms, as well as diseases of the articular cartilage, synovium, and tendons, are all well-characterized by MRI.¹⁵

MATERIALS AND METHODS

This cross-sectional observational study titled 'Spectrum of MRI Findings in Sports-Related Knee Injuries' was carried out in the Radiodiagnosis Department of a tertiary care hospital. It involved 55 patients aged 18 years and above, who exhibited signs and symptoms of knee joint trauma from

sports-related activities in the Orthopedics Department before being referred for MRI examination in the Radiology Department. We examined MRI scans from 55 patients to evaluate the types and severity of sports injuries affecting the knee joint, including those related to the bones, ligaments, meniscus, and cartilage.

METHODOLOGY

After receiving ethical clearance from the Institute's ethical committee, all patients meeting the specified inclusion criteria (those aged 18 years and above with a history of knee joint sports injury and providing written consent for participation in the study) were included. Socio-demographic information was collected via a questionnaire. Examination is carried out for every patient after obtaining consent.

MRI TECHNIQUE

We conducted imaging using a 1.5 Tesla Siemens Magnetom Sempra machine equipped with a flex coil. Patients were positioned supine, with the knee extended within the coil at an angle of 10 to 15 degrees in external rotation to optimize visualization of the ACL on sagittal images. Subsequently, the knee was slightly flexed at an angle of 5 to 10 degrees, to improve accuracy in assessing the patellofemoral compartment and patellar alignment. The MRI sequences used to acquire images were as follows

- Proton density (PD) W fast spin-echo (FSE) fat saturated sequences in axial, sagittal and coronal planes.
- T2 W sequence in the sagittal plane.
- T1 W sequences in coronal and axial planes.
- Additional sequences are performed depending on the situation and when further evaluation is needed.
- Field of view is 14 to 16 cm, slice thickness 3 to 4 mm thin sections and matrix 512 x 512.

STATISTICAL ANALYSIS

The data entry was inputted in Microsoft excel and analysis was conducted using Epi Info software 7.2.2.2. Descriptive statistics such as frequencies and percentages for categorical data, mean and SD for

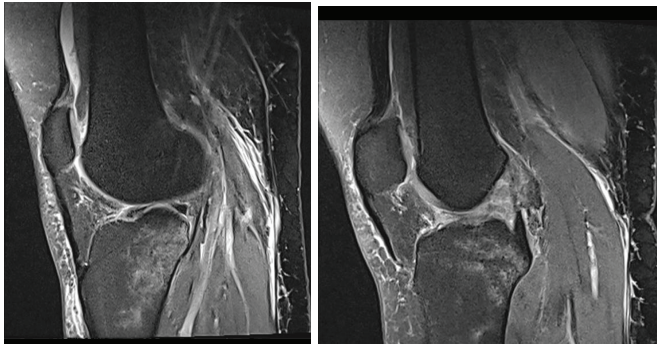


Figure 1 (ACL Tear): PD sagittal MR image in a 28-year-old male sprint runner shows rupture of ACL with marrow edema in proximal tibial, joint effusion and subcutaneous edema.

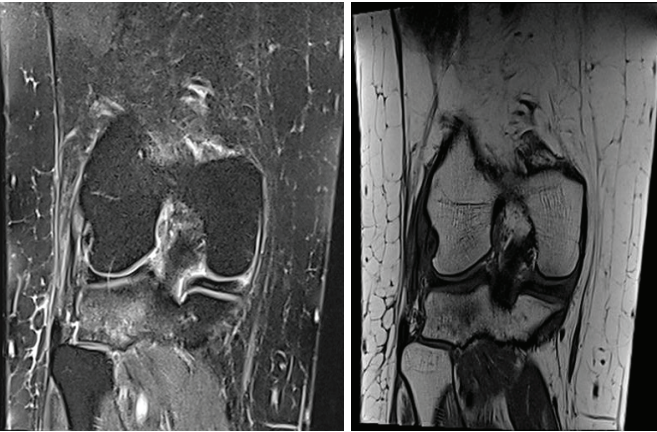


Figure 2 (LCL Tear): PD Cor & T1 Cor MR image in a 30-year-old male football player shows a partial tear in the upper part of LCL and marrow edema in the lateral tibial plateau.

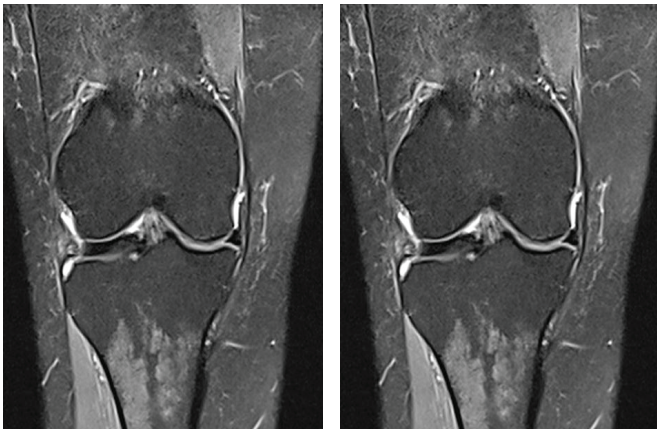


Figure 3 (Discoid lateral meniscus with longitudinal tear): PD Coronal MR image in a 34-year-old female badminton player shows discoid lateral meniscus with a longitudinal tear in anterior horn and adjacent part of the body with marrow edema in proximal tibia.

numerical data were calculated. Bar diagrams and Pie charts were used to display various frequency distributions.

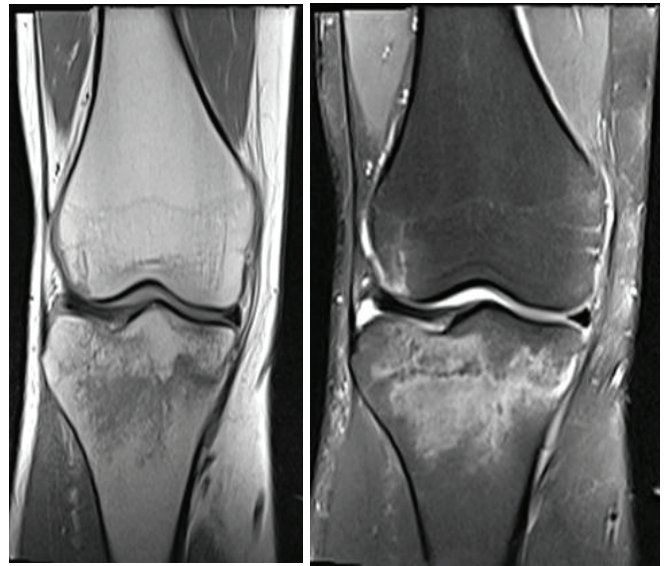


Figure 4 (Osseous Injury): PD Cor & T1 Cor MR image in a 23-year-old male Basketball player shows a non-displaced fracture of medial tibial plateau with significant marrow edema and minimal marrow edema at lateral femoral condyle with small joint effusion.

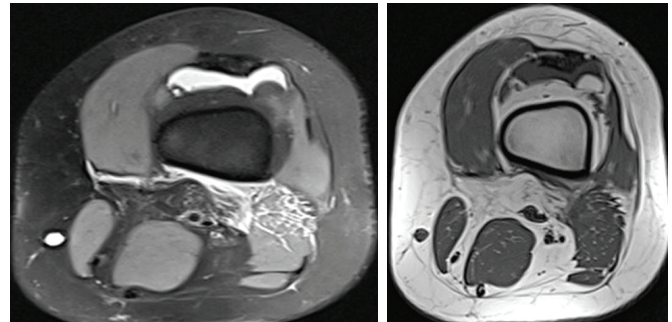


Figure 5 (Biceps femoris muscle injury): PD axial & T1 axial MR image in a 19-year-old male football player shows edema in biceps femoris muscle with fluid collection in suprapatellar recess.

RESULTS

We included a total of 55 patients who presented with knee injuries related to sports during the study period. The findings of this study are outlined in the tables.

Table 1: Age Distribution

Sl. No.	Ag	No. of patients	Percent
1	18 to 25	15	27.3
2	26 to 35	26	47.2
3	36 to 45	14	25.5

Table 1 presents that the maximum number of patients were in the age group between 26-35 years

46.3% (n = 26) followed by the age group 18-25 years 27.3% (n = 15) and least in 36 to 45 years age group i.e., 25% (14). The mean age was 30.45 ± 7.66 years.

Table 2: Gender Distribution.

Sl. No.	Gender	No. of patients	Percent
1	Male	32	58.2
2	Female	23	41.8

In the study majority were males 58% (n = 32). The male-to-female ratio was 1.4:1.

Table 3: Type of Sports.

Sl. No.	Type of Sports	No. of patients	Percentage
1	Athletics	12	21.8
2	Badminton	7	12.7
3	Basketball	7	12.7
4	Cricket	8	14.5
5	Football	10	18.2
6	Kabaddi	6	10.9
7	Volleyball	5	9.2

Table 3 displays sports-wise distribution of knee injuries, in which athletics (22%) was the most common, while volleyball was the least common (9%) sport.

Table 4: Injury Mechanism.

Sl. No.	Injury Mechanism	No. of patients	Percent
1	Contact	10	18.2
2	Non-Contact	45	81.8

Table 4 displays distribution of study pattern on the basis of mechanism of injury. Out of 55, Contact injury was reported in 18.2% of participants while the rest 81.8% were non-contact injuries.

Table 5: Cruciate Ligament Tear

S. No	Cruciate ligament tear	Anterior		Posterior	
		No. of patients	Percent (%)	No. of patients	Percent (%)
1	Complete	3	5.4	0	0.0
2	Partial	14	25.5	5	9.1
3	Avulsion	1	1.8	0	0.0
4	Normal	37	67.3	50	90.9

Anterior cruciate ligament tear was noted in 33% (n=18) of the patients with partial tears being more common 25.5% (n=14) and posterior cruciate ligament tear was noted only in 9.1% (n= 5) of the patients with partial tear being more common seen in 9.1% (n= 5).

Table 6: Collateral Ligament Tear

Sl. No.	Collateral Ligament Tear	Medial		Lateral	
		No. of patients	Percent (%)	No. of patients	Percent (%)
1	Grade I	1	1.8	0	0.0
2	Grade II	4	7.3	4	7.3
3	Grade III	1	1.8	0	0.0
4	Normal	49	89.1	51	92.7

Lateral collateral ligament tear was noted in 7.3% (n= 4) of the patients with grade II tear being the most common 7.3% (n= 4).

In the study medial collateral ligament tear was noted in 10.9% (n= 6) of the patients with grade II tear being most common 7.3% each (n= 4).

Table 7: Medial Meniscal Tear- Location

Sl. No.	Medial Meniscal tear	No. of patients	Percent
1	Single Location		
a	Body	2	3.6
b	Posterior Horn	5	9.1
c	Anterior Horn	3	5.5
2	Multiple locations		
a	Body/ Anterior Horn	1	1.8
b	Posterior Horn/ Body	1	1.8
c	Body/ Anterior Horn/ Posterior Horn	6	10.9
3	No tear	37	67.3

Multiple locations of medial meniscal tear were more common than a single location.

Table 8: Medial Meniscal Tear- Type

Sl. No.	Medial Meniscal tear-Type	No. of patients	Percent (%)
1	Radial	2	3.6
2	Complex	4	7.3
3	Longitudinal	12	21.8
4	Horizontal	0	0
5	Normal	37	67.3

Medial meniscus tear was noted in 32.7% (n= 18) of the patients with Longitudinal tear being the most common 21.8% (n= 12), followed by complex tear seen in 7.3%.⁴

Table 9: Lateral Meniscal Tear-Location.

Sl. No.	Lateral Meniscal tear	No. of patients	Percent
1	Single Location		
a	Body	3	5.5
b	Anterior Horn	2	3.6
c	Posterior Horn	3	5.5
2	Multiple locations		
a	Body/ Posterior Horn	4	7.3
b	Anterior Horn/ Posterior Horn	1	1.8
c	Body/ Anterior Horn/ Posterior Horn	1	1.8
3	No tear	41	74.5

Single location of lateral meniscal tear was more common than multiple locations, in which body and posterior horn involvement were most common.

Table 10: Lateral Meniscal Tear-type

Sl. No.	Lateral Meniscal tear-Type	No. of patients	Percent
1	Radial	1	1.8
2	Complex	1	1.8
3	Longitudinal	7	12.7
4	Horizontal	5	9.2
5	Normal	41	74.5

Lateral meniscus tear was noted in 25.5% (n= 14) of the patients with longitudinal tear being the most common 12.7% each (n= 7).

Table 11: Other Variables

Sl. No	Other Variables	No. of patients	Percent
1	Osseous injuries	32	58.2
2	Muscle & Tendon injuries	12	21.8
3	Joint Effusion	40	72.7

In the study joint effusion was found in 72.7 % (n= 40) of the patients followed by osseous injuries i.e. 58.2 % (n= 32) and muscle injuries were the least common finding, seen in 21.8% (n=12) of patients.

Table 12: Grading of Muscle Tendon Injury

Sl. No	Muscle tendon injury	No. of patients	Percent
1	Grade 0	43	78.2
2	Grade 1	8	14.5
3	Grade 2	4	7.3

In the study Muscle tendon injuries were noted in 21.8 % (n=12) of the patients with Grade I injury being more common 14.5% (n=8).

DISCUSSION

Sports-related knee injuries is a serious health concern, especially for young, active people. For prompt medical intervention, a precise diagnosis is essential, including an assessment of the type and severity of the injury. The knee can be examined using a variety of imaging techniques, including radiography, ultrasound, bone scintigraphy, CT scans, arthroscopy, and MRI.¹⁶ Since the 1990s, MRI has emerged as the preferred method for diagnosing internal knee joint issues.¹⁷ In 18% of cases, it significantly impacted on the therapeutic strategy, enabling earlier surgical interventions based on precise diagnoses.^{18,19} This study, titled "Spectrum of MRI findings in sports-related knee injuries" was conducted at a tertiary care center. It aimed to evaluate various MRI-detected osseous, cartilaginous, ligamentous, meniscal and muscular injuries resulting from sports-related trauma in patients with knee injuries referred from the Orthopedic Department for Investigation at the Department of Radiodiagnosis.

SOCIO-DEMOGRAPHIC VARIABLES

Age is recognized as a significant risk factor for knee injuries; with such injuries showing notable association with increasing age.

In this study, the age range of patient spanned from 18 to 45 years, as observed from the analysis of the patient demographics. The second-largest patient group, those between the ages of 18 and 25, was followed by the largest group, those between the ages of 26 and 35. This distribution of ages was consistent with a few earlier research,²⁰⁻²² which found that the mean age range was between 23 and 37 years. This age range usually coincides with the timeline when people participate actively in physically demanding activities or sports.

Our study had an above-average percentage of male patients (58%), compared to female patients (42%), yielding a male-to-female ratio of 1.4:1. Similar gender ratios were found in other research.²³⁻²⁶ This finding was in line with earlier research that suggested that men are more likely to sustain knee injuries, possibly as a result of varying levels of physical activity, involvement in high-risk sports, and variations in biomechanics.

Athletics was the most frequent sport associated with knee injuries in our study, representing 21.8% of injuries (n=12), followed by football, which accounted for 18.2% (n=10) of injuries. Following these were basketball (n = 7), badminton (n = 7), volleyball (n = 5), kabaddi, a popular rural Indian sport (n = 6), and cricket (n = 8).

Here, non-contact injuries were the most common type of injury seen, constituting 81.8% of cases (n = 45), while contact injuries constitute 18% of cases (n = 10). 78.2% of the participants in the study were amateur athletes (n = 43), while the remaining 21.8% were professional athletes (n = 12). These findings closely resemble those of a study carried out by R. John *et al.*²⁷

CRUCIATE LIGAMENTS

In our study, the anterior cruciate ligament (ACL) (Figure 1), which was injured in 18 out of 55 patients (33%), emerged as the ligament that was injured the most frequently. According to one study,²³ which included 173 patients and reported ACL tears in

45.08% of cases, incidents of ACL tears surpassed those of other ligamentous injuries. This finding was consistent with the study's findings. Our research found that partial ACL tears were more frequent than complete ones (5.5% vs. 25.5%). It is in line with earlier studies where partial ACL tears occurred in 66.60 and 90.0% of ACL tear cases, respectively.^{23,28} Another related study involving 69 patients discovered that while 46.93% of ACL tears were complete, 53.06% of ACL tears were partial.²⁹ These results concurred with other researchers, who found that various ACL injuries were present in 60% of cases.¹⁴ They disagree with another study,³⁰ which found that only 25.4% of knee injuries were due to ACL tears. The increased severity of injuries from various sports may be to blame for the higher incidence of ACL tears in our study.

In our study, posterior cruciate ligament (PCL) injuries occurred in only 5 patients (9.1%), which was comparatively less frequent. All five patients had intrasubstance hyperintense signals and partial tears. Our findings were consistent with Josey Verghese *et al.*,²⁹ who found posterior cruciate ligament injuries in only 10.15% of cases. In our study, partial PCL tears were the most prevalent PCL pathology. These findings were consistent with those of Hetta and Niazi,¹⁴ who found that 8% of cases had PCL injuries.

COLLATERAL LIGAMENTS

We discovered that medial collateral ligament (MCL) tears were more frequent than lateral collateral ligament (LCL) tears (Figure 2) occurring in 10.6% of cases compared to 7.3% of patients. This MCL tear incidence was consistent with the findings of Adil I N,³¹ who discovered MCL tears in 18% of the 50 patients included in their study group. Our findings concur with Josey Verghese *et al.*²⁹ that 13% of patients had MCL tears. According to the findings of our study, MCL tears occurred more frequently than LCL tears (7.3% vs. 10.6%), which was in line with Saurabh Chaudhuri *et al.*,³² which found that MCL injuries were more common (15%) than LCL injuries (12%).

We also noted O'Donoghue's triad in one patient, which includes medial meniscus and MCL tears as well as an anterior cruciate ligament (ACL) tear.

MENISCAL LESIONS

In the present study, medial meniscal tears were more common than lateral meniscal tears, with a prevalence of 32.7% versus 25.5%. Singh JP *et al.* studied 173 cases and found that 38.23% of patients had medial meniscal tears and 29.41% had lateral meniscal tears.²³ This observation was in line with La Prade *et al.*,²⁰ who noted that medial meniscal tears were twice as common as lateral meniscal tears and reported similar findings (Figure 3).

Multiple medial meniscal tears occurred more frequently than single ones in our study. Injury to the posterior horn of the medial and lateral meniscus was more common among single-location tears than to the anterior horn, consistent with Jee *et al.*,³³ who found that 56% of cases had torn posterior horns of the medial meniscus. Comparable to the study by De Smet,³⁴ where the anterior horn of the medial meniscus was involved in 2% of cases, our study found anterior horn tears in 5% of cases. According to studies by Nasir³¹ and previously published literature,³⁵ tears involving the posterior horn of the medial meniscus were more frequent.

Out of the 32 meniscal tears in our study (18 involving the medial meniscus and 14 involving the lateral meniscus), 19 were longitudinal tears (12 involving the medial meniscus and 7 involving the lateral meniscus), 5 were horizontal, 5 were complex, and 3 were radial. These results were consistent with a study by Berquist *et al.*³⁶ that revealed longitudinal tears to be the most frequent meniscal tear type. The most typical type of meniscal tear was a horizontal tear.³⁷

JOINT EFFUSION

Joint effusion (Figures 2 and 5) was the most prevalent finding in our study, affecting 72.7% of the study group, consistent with Miller *et al.*,³⁸ where 79% of participants had effusion. Mehta and colleagues³⁹ reported similar findings, with joint effusion being found in 74% of cases.

OSTEOCHONDRAL AND OSSEOUS INJURIES

In our study, 38 patients (58.2%) had osseous lesions

(Figure 4). The majority of these lesions were bony contusions involving the femoral and tibial condyles, consistent with other studies,^{39,40} which found that bone injuries occurred in 62 and 53.3% of cases, respectively.

INJURY TO MUSCLES AND TENDONS

Muscle and tendon injuries (Figure 5) were seen in 12 patients (21.8%). In 8 patients (14.5%), grade I injuries made up the majority of these injuries with a pattern resembling the study by Medhat *et al.*,⁴⁰ which revealed that 10% of cases involved muscle and tendon injuries.

MRI AS A DECISION-MAKING TOOL FOR RETURN TO SPORTS

Athletes who compete in various sports frequently worry about knee injuries, which can seriously hinder their ability to resume their previous level of athletic activity. MRI is crucial in determining the extent and seriousness of knee injuries, giving clinicians important information to choose the right conditions and window of opportunity for athletes to return to sports. This discussion examines how MRI results can be used in informed decision-making regarding a return to sports and focuses on variables that affect this crucial choice.

There are several benefits to using an MRI when deciding whether to return to sports. It provides a non-invasive thorough evaluation of knee injuries, enabling a better understanding of the severity and risk factors involved. Designing individualized rehabilitation protocols is made easier with the help of the detailed anatomical information provided by MRI. To enable timely adjustments to the rehabilitation plan, a series of MRI evaluations help track healing progress and identify potential complications. Furthermore, MRI results help athletes and their support staff set reasonable expectations, ensuring a safe and gradual return to sports activity.

CONCLUSION

The current study emphasizes how well magnetic resonance imaging (MRI) can diagnose various

internal knee injuries incurred during athletic activity. MRI is excellent at identifying and precisely localizing the injuries, describing their nature, and assessing the degree of severity. This confirms MRI's crucial role in thoroughly evaluating internal knee structures impacted by sports-related injuries.

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