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Flag Sign: A Case Report of an Unusual Magnetic Resonance Imaging Finding of a Medial Meniscal Root Fragment in an Adolescent Water Polo Player

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Learning Point of the Article:

This case undermines that imaging signs described in the literature can fail at times and careful consideration of the lesion along with clinical correlation must be paired in a case-by-case series in order to reach a safe diagnosis, while for difficult cases, arthroscopy is the golden standard.

Abstract

Introduction: A meniscus tear ranks among the most common sports-related injuries, especially among athletes. Sudden, twisting movements, such as pivoting to catch a ball, usually in contact sports, and can tear the meniscus. Magnetic resonance imaging (MRI) technology is extensively utilized for identifying meniscal tears. A flag sign on an MRI typically indicates a partial or complete meniscal root tear. We present a case where a "flag sign" was attributed to a medial meniscal root fragment in an adolescent water polo player.

Case Report: A 15-year-old male patient suffered a knee injury (mild swelling and pain) while playing as a goalkeeper in water polo. A physical examination revealed negative Lachman and positive medial McMurray tests. MRI images showed a typical flag sign, without any other concomitant injuries. An arthroscopic medial meniscectomy was performed. 8 months post-operatively the injuries were well healed. In this instance, the flag sign caused interference with the MRI evaluation of an anterior cruciate ligament (ACL) injury

Conclusion: This case highlights the importance for clinicians to meticulously assess both the morphological changes in the meniscus and its relationship with the femoral condyle before arriving at a definitive diagnosis even in the athletes of non-contact sports. The meniscal "flag sign" mimics the ACL signal on MRI.

Keywords: Meniscus, tear, knee, arthroscopy, flag sign, injury.

Introduction

A meniscus tear ranks among the most common sports-related injuries, frequently necessitating surgery due to knee pain and dysfunction [1]. The estimated incidence of meniscal tears are approximately 60/100,000 population, with the frequency of meniscal-related injuries on the rise [2]. This increase can be attributed to heightened sports participation and advancements in diagnostic tools [3]. The primary categories of meniscus tears encompass vertical tears, such as longitudinal tears (including bucket handles), radial tears (including flap tears), and posterolateral root tears [4].

Magnetic resonance imaging (MRI) is a useful pre-operative tool with a high accuracy for discriminating meniscus tears and other pathologies [5]. MRI has a high sensitivity and specificity for detecting injuries of the knee [6]. The diagnosis of meniscal injuries through MRI primarily relies on the assessment of morphological and signal changes in the meniscus. However, in some cases, a displaced meniscus can lead to diagnostic confusion. Should an arthroscopy be required, the usefulness of MRI might be questioned [4]. A flag sign seen on MRI typically

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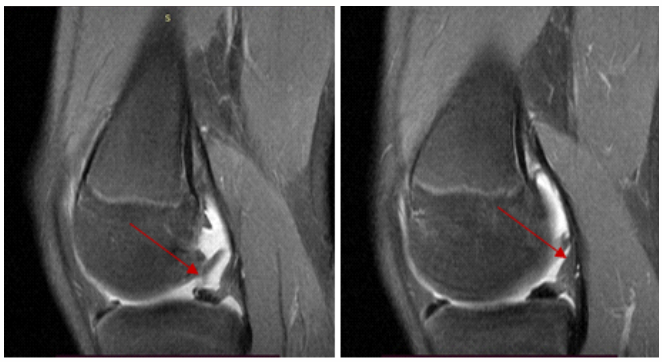

Figure 1: Sagittal magnetic resonance image shows the "flag sign," a meniscal fragment (arrow).

indicates a meniscal root tear. However, we present a case where a "flag sign" was observed due to a medial meniscal root fragment hidden at the back of the posterior cruciate ligament (PCL), mimicking the signal of the anterior cruciate ligament (ACL) on MRI.

Case Report

The study protocol received approval from the General University Hospital ethics committee, and the patient provided written informed consent for the disclosure of his information in this report. The patient, a 15-year-old man, sustained an injury while playing water polo. As a goalkeeper in a water polo game, he twisted his right knee 15 days before the presentation. On September 04, 2023, he was referred to the sports medicine center of the local university hospital due to swelling and pain. Clinical examination revealed a negative anterior drawer test, negative Lachman test, positive McMurray test, positive Apley compression test, negative posterior drawer test, and symmetric pivot shift test compared to the contralateral knee. Routine laboratory tests showed no abnormalities. Subsequently, the patient underwent knee MRI using a Siemens 3.0-T system with scanning parameters of TR = 3137 ms and TE = 104 ms. The MRI revealed the "flag sign" on the sagittal view (Fig. 1). Simultaneously, a structure resembling the ACL tissue was observed on the coronal view, creating confusion for both the radiologist and the surgeons. This signal bore similarity to a flag connecting the femur and tibia. A flag sign typically indicates meniscal root tears. Further, investigation suggested that the signal was a meniscal fragment displaced into the intercondylar notch (Fig. 2a), distinguishable from the normal ACL connection to the femoral condyle (Fig. 1b) on coronal MRI. Failure to effectively differentiate the flag sign could lead to misdiagnosis of an intact ACL, potentially delaying treatment for ACL injury.

In the sagittal view, there was no "absent bow tie sign." During arthroscopy, it was revealed that a free fragment of the medial meniscus posterior root had migrated to the intercondylar eminence, explaining the observed "flag sign" (Fig. 2). Importantly, the ACL was found to be normal, with no tears or other visible pathology in the remainder of the meniscus. Arthroscopic medial partial meniscectomy was performed (Fig. 2). The remaining medial meniscal root was well attached to the posterior tibial condyle so there was no need for root fixation (Fig. 3).

The treatment and rehabilitation following the partial meniscectomy were categorized into immediate post-operative care, early rehabilitation, intermediate rehabilitation, and late rehabilitation phases. Each phase has specific goals and protocols to ensure proper healing and return to function for our athletes.

1. Immediate post-operative care (0–1 week)

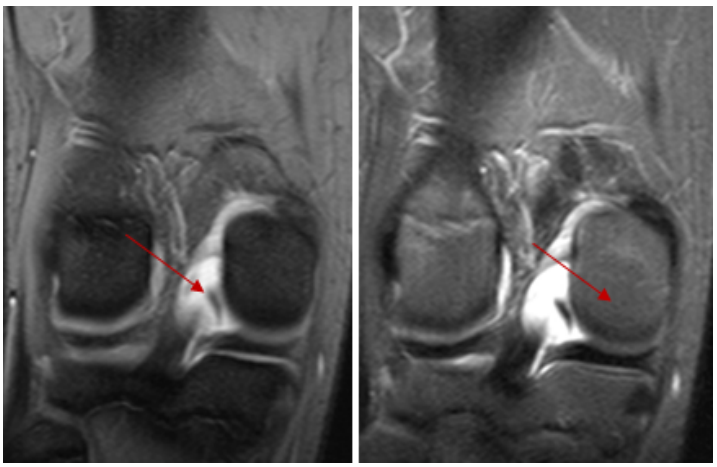

Figure 2: A meniscal fragment (arrow) has been displaced into the intercondylar notch and resembles the anterior cruciate ligament on a coronal magnetic resonance imaging.

Goals

- Manage pain and swelling
- Protect the surgical site
- Begin gentle range of motion (ROM) exercises.

Protocols

- Pain management: Use prescribed medications (paracetamol 1000 mg 3 times/day, etoricoxib 90 mg 1 time/day for 5 days)
- Swelling control: Apply ice packs 10 min every hour, elevate the leg above heart level, and use compression bandages
- Weight-bearing: Use crutches to limit weight bearing (often partial weight bearing)
- ROM: Begin gentle passive ROM exercises (e.g., heel slides) within pain tolerance.

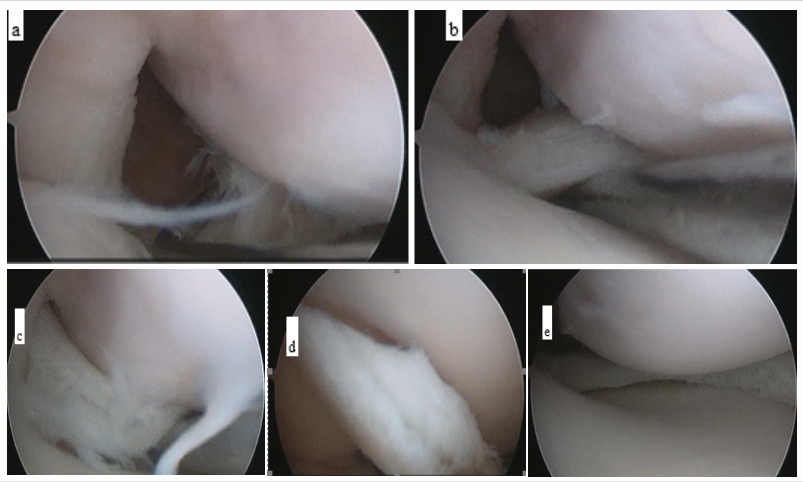

Figure 3: Arthroscopy. (a, b, c) A free fragment of the medial meniscus posterior root has moved to the intercondylar eminence and resembles a "flag sign." (d) Resetting the medial meniscus. (e) The repaired lateral meniscus.

1. Early rehabilitation phase (1–3 weeks).

Goal

- Improve ROM
- Initiate muscle strengthening
- Continue swelling management.

Protocols

- ROM exercises: Progress to active ROM exercises, such as seated knee extensions and flexion stretches
- Strengthening exercises: Begin isometric quadriceps and hamstring exercises, straight leg raises
- Swelling control: Continue the use of ice and elevation as needed
- Weight-bearing: Gradually increase weight bearing as tolerated and wean off crutches as advised by the surgeon

2. Intermediate rehabilitation phase (3–6 weeks).

Goals

- Restore full ROM
- Enhance muscle strength
- Improve neuromuscular control

Protocols

- ROM exercises: Full ROM exercises, including cycling on a stationary bike
- Strengthening exercises: Progress to closed kinetic chain exercises (e.g., mini-squats and leg presses) and resistance band exercises.
- Proprioception exercises: Balance exercises on stable surfaces progressing to unstable surfaces
- Functional activities: Begin low-impact activities such as swimming or an elliptical trainer.

3. Late rehabilitation phase (6 + weeks).

Goals

- Return to pre-injury level of activity
- Enhance functional strength and stability
- Prepare for sport-specific activities.

Protocols

- Strengthening exercises: Continue the progression of strengthening exercises with increased resistance and complexity
- Plyometric exercises: Introduce plyometric exercises (e.g., hopping and jumping drills) if appropriate
- Sport-specific drills: Begin sport-specific drills and functional activities tailored to the individual's sport, swimming with a ball, passing, and shooting during swimming
- Cardiovascular training: Engage in cardiovascular training that mimics the demands of the individual's sport, we introduce swimming with resistance.

At the 8-month post-operative follow-up, the patient's knee joint was stable, and the meniscus had healed well. The patient showed full active and passive knee ROM with a Lysholm score of 91 and a Tegner activity scale score of 10.

Discussion

The menisci play a crucial role in distributing the load across the articular cartilage, providing shock absorption, and serving as secondary stabilizers of the knee joint [7]. This stability and function are attributed to the menisci's wedge shape, their biochemical composition, and their attachments to the tibia. Each meniscus is crescent shaped, with the medial meniscus resembling a "C" shape and the lateral meniscus resembling a "U" shape [8].

The meniscus primarily consists of type 1 and type 2 collagen [9]. Its blood supply originates from the medial and lateral middle geniculate arteries [10]. Conventionally, the meniscus is divided into three zones based on vascularization, the inner third, known as the white–white zone, lacks blood vessels and relies almost entirely on diffusion through synovial fluid for nutrition [11]. The middle third is the red-white zone, while the

outer third is the red-red zone [11]. The outer red-red zone of the meniscus is the only area with a direct blood supply, a factor that is important when deciding between repair and meniscectomy options [11].

MRI is a useful pre-operative tool with a high accuracy for discriminating meniscus tears and other pathologies including cartilage and ligament injuries [5]. MRI has a high sensitivity and specificity for detecting injuries of the knee [6]. Diagnosis of meniscal injuries through MRI primarily relies on assessing morphological and signal changes in the meniscus. Meniscal injury is a prevalent condition in sports medicine, and a flag sign on an MRI typically indicates a meniscal root tear. However, we present a case where a "flag sign" was attributed to a free medial meniscal fragment, mimicking the ACL signal on MRI. This case underscores the importance for clinicians to meticulously identify morphological changes in the meniscus and its relationship with the femoral condyle before reaching a final diagnosis.

According to Kim et al., pre-operative MRI could be used as a diagnostic tool to identify meniscus tears, but it is not capable of classifying the type and location of meniscus tears [12]. In addition, variations in the type and location of meniscus tears were observed between patients with ACL injuries and those with intact ACLs; therefore, careful attention is required during the arthroscopic evaluation of patients with ACL injuries [12].

Numerous well-known MRI findings of meniscal tears have been documented in the literature, including the "absent bow tie sign," "ghost sign," "double ACL sign," "double PCL sign," and "double anterior horn sign" [13]. The "reversed" double PCL sign results from a displaced meniscal fragment moving to the posterior region of the PCL [14].

In our case, a displaced medial meniscal fragment was identified in the intercondylar notch on the coronal MRI view, resembling the appearance of the ACL. However, a key distinction was observed: The meniscal fragment lacked a connection to the femoral condyle, instead resembling a flag-like structure. This distinct appearance led to its designation as the "flag sign."

Another case reported in the literature describes a "flag sign" resulting from a free lateral meniscal fragment, which mimicked the ACL signal on MRI [15]. The MRI images displayed both an ACL injury and the flag sign, leading to a diagnosis of ACL tear and lateral meniscal injury [15]. This case illustrates that clinicians should carefully identify the morphological changes in the meniscus and the relationship of the meniscus with the femoral condyle before reaching a final diagnosis [15].

Conclusion

A significant finding, in this case, was the resemblance of a free medial meniscal fragment on MRI, presenting as a "flag sign." Clinicians must meticulously assess morphological changes in the meniscus and its relationship with the femoral condyle before reaching a conclusive diagnosis to determine the most suitable treatment approach. Pre-operative MRI serves as a valuable diagnostic tool for identifying meniscus tears. However, it may not always accurately classify the type and location of these tears. When an arthroscopy is required, the usefulness of an MRI might be questioned.

Clinical Message

This case undermines that imaging signs described in the literature can fail at times and careful consideration of the lesion along with clinical correlation must be paired in a case-by-case series to reach a safe diagnosis, while for difficult cases, arthroscopy is the golden standard.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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