Research

Ring-Shaped Lateral Meniscus – Rise Awareness and Avoid Unnecessary Surgery: A Case Report

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Abstract:
There are numerous meniscal anatomical variants, particularly prevalent in the East Asian population. These variants typically involve the lateral meniscus and are often asymptomatic. The ring-shaped meniscus is a relatively rare variant, with an incidence of 0.9 to 2.4% in the Asian populations. Magnetic resonance imaging (MRI) has a pivotal role in diagnosing meniscal and ligament injuries of the knee. Still, it has been difficult to distinguish a ring-shaped meniscus from a bucket-handle tear of a lateral meniscus or a central tear of a discoid lateral meniscus.
The subject was a woman in her 20s, reporting pain in her left knee after a mild sprain. The first MRI showed a small mediopatellar plica with a fissure of lateral femoral cartilage posteriorly and a massive bucket-handle rupture of the lateral meniscus with intercondylar incarceration of the fragment. During arthroscopic knee surgery, an intercondylar lateral meniscus fragment was visualized. The fragment could not be reponed due to a massive fibrous band attaching it to the joint capsule posteromedially. A congenital condition was suspected. Later, a follow-up bilateral MRI was performed, showing a symmetrical condition and confirming the presence of bilateral ring-shaped lateral menisci. The radiologist, however, still interpreted the finding as a bilateral incarcerated bucket-handle lateral meniscus tear.
Our case highlights the importance of knowing the plethora of meniscal variants to avoid unnecessary surgery.

Keywords: Ring-shaped meniscus; Lateral meniscus; Knee arthroscopy; Magnetic resonance imaging

1. Introduction

The menisci are fibrocartilages interposed between the femoral condyles and tibial plateau. In cross-section, they appear triangular and are fundamental for tibiofemoral congruence, playing an essential role in the kinetics of the knee (Faruch-Bilfeld et al., 2016). The medial meniscus is shaped like an open "C" and is attached to the medial capsule through the coronary ligaments. In contrast, the lateral meniscus is an incomplete, oval-shaped structure that lacks capsular attachments, making it more mobile than the medial meniscus (Iqbal et al., 2020).

There are numerous meniscal anatomical variants, and they are particularly prevalent in the East Asian population. These variants typically involve the lateral meniscus and are often asymptomatic (Tyler et al., 2010). The commonest of the variants is the discoid meniscus, with an incidence of about 16.6% in Asian populations and less than 5% in the Caucasian population (Lee et al., 2020). Other less common variants include the ring-shaped meniscus (RSM), abnormal bands of the lateral meniscus and double-layered meniscus. The RSM is relatively rare, with an incidence of 0.9 to 2.4% in the Asian populations (Kim et al., 2006). Noble (1975) was the first to document a ring-shaped lateral meniscus as an incidental finding during autopsy. Monllau et al. (1998) further described it as a meniscus with the anterior and posterior horns connected by an inter-horn meniscal bridge. While meniscal malformations are generally considered congenital, some cases may result from meniscal regeneration following knee operations (Nagashima et al., 2019). Magnetic resonance imaging (MRI) has a pivotal role in diagnosing meniscal and ligament injuries of the knee (Faruch-Bilfeld et al., 2016). However, certain anatomical variants can be confused with pathological conditions, such as a displaced bucked-handle tear (Kim et al., 2006). Diagnosing a ring-shaped lateral meniscus on MRI is particularly challenging because its appearance, with a centrally located fragment, often resembles a displaced meniscal tear (Atay et al., 2002).

This case report aims to raise awareness among healthcare professionals about possible rare congenital conditions affecting the lateral meniscus, which could help prevent unnecessary surgical interventions.

2. Case presentation

A woman in her 20s was referred to our outpatient clinic complaining of pain in her left knee. She reported a mild sprain of the knee. Previous major trauma to the knee was not reported. Magnetic resonance imaging (MRI) revealed a small mediopatellar plica with fissure of lateral femoral cartilage posteriorly and a massive bucket-handle rupture of the lateral meniscus with intercondylar incarceration of the fragment. The medial meniscus, anterior and posterior cruciate ligament, collateral ligaments, patellar ligament and quadriceps tendon showed no pathology.

On physical examination, the knee range of motion was preserved, and no instability of the knee joint was observed. Pain was occasional. The patient reported pain on palpation on the lateral femorotibial joint line and directly on the patellar ligament. Due to minimal clinical symptoms, a senior surgeon was consulted to discuss the indications for possible treatment strategies due to a low-symptomatic clinical presentation of a suspected bucket-handle tear. A knee arthroscopy was recommended. Awaiting the surgery, reduction and modification of physical activity was advised.

3. Treatment

An arthroscopic knee surgery was performed about one month after the outpatient visit. During the arthroscopic examination the intercondylar lateral meniscus fragment was visualised. As the fragment could not be reponed laterally, partial tissue resection connecting the fragment posteromedially and popliteally was attempted. As the resection was being performed, the extent of the posterior fibrous band was appreciated. Realizing that an extensive tissue resection would be needed to attempt a successful reposition of the fragment laterally, the surgeon did not carry the procedure through. Given the patient had minimal preoperative issues, it was decided not to perform a large-scale resection that could alter the patient anatomy and potentially cause difficulties.

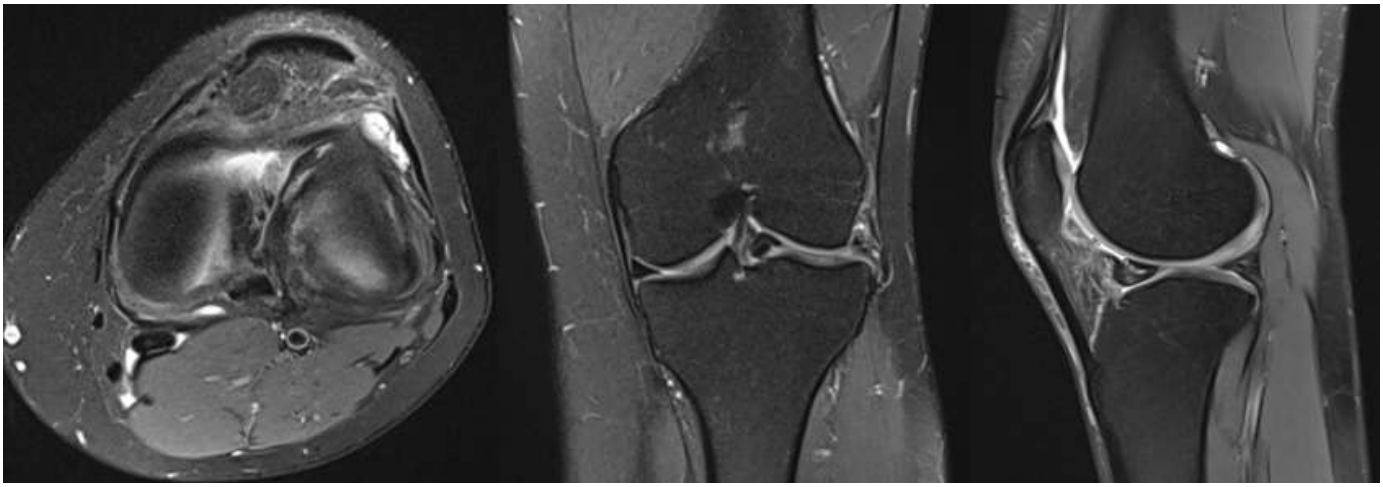

Figure 1. MRI transverse (left), coronal (centre) and saggital (rigth) plane view.

The patient recovered quickly after the arthroscopy and was discharged from the hospital the following day. She received standard analgesics and anticoagulants. Postoperative course was uneventful. Physiotherapy was suggested.

Postoperative rehabilitation focused on improving the range of motion and strengthening the thigh muscles until normalization. The patient immediately began light isometric contractions of the quadriceps muscle combined with Bioptron therapy for 2 weeks. After suture removal, she received TECAR therapy four times with additional manual lymph drainage. She was taught scar massage and self kinesiotape application for circulatory/lymphatic drainage. She used a Compex Sport Elite muscle stimulator daily for initial muscle strengthening. From week one to two, the program used was Disuse atrophy while doing isometric quadriceps femoris muscle contractions. From week three to six she advanced to Muscle growth, and six to nine to Reinforcement. Progressively, she increased the difficulty of exercises from isometric contractions to closed kinetic chain exercises, like squats. For pain management she used Modulated TENS when needed. For additional muscle strengthening, conditioning, and a gradual return to sports, she worked with a kinesiologist twice a week for two months.

4. Outcome and additional diagnostic procedures

About three months after the arthroscopy, the patient returned to the clinic for a follow-up. She reported pain during cross-leg sitting and on palpation on the anterolateral joint line and arthroscopic scars. On detailed medical history, she reported episodes of pain in both knees since childhood.

The arthroscopic view of the operated lateral meniscus (**Figure 2**) differed from the usual bucket-handle ruptured meniscus. The attachment of the meniscus to the popliteal capsule was uncommon. As well, there were only minor findings suggesting a traumatic event, therefore a congenital condition was suspected. A centrally ruptured discoid lateral meniscus seemed a possible clinical hypothesis. The patient was referred to bilateral knee MRIs. The MRI showed symmetrical condition, while reporting no previous trauma of the right knee, which was completely asymptomatic. The radiologist reported a bilateral bucket-handle tear with an intercondylar incarceration of the fragment. A ring-shaped lateral meniscus was diagnosed after conducting literature research and further consultation with radiologists.

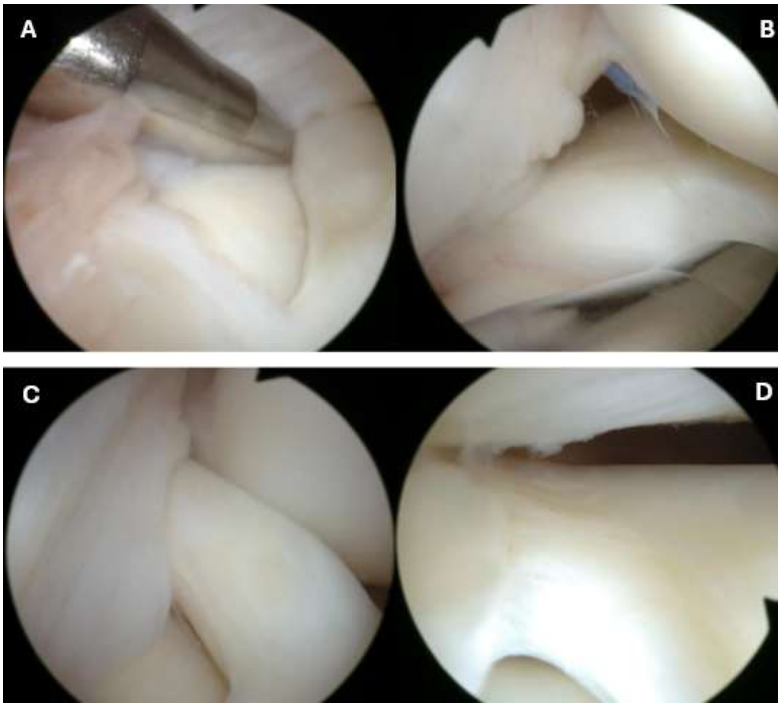

Figure 2. Arthroscopic view of the ring-shaped lateral meniscus**. A**: anterolateral view**, B:** meniscus continues posteriorly**, C:** anteromedial view, **D:** anterolateral to posterolateral view (meniscus continues medially**).**

5. Discusion

The lateral meniscus is morphologically more prone to variations, predominantly found in Asian populations (Lee et al., 2020). The most frequent meniscal variant is the discoid meniscus, classified by Watanabe & Ikeuchi (1969) into three types: complete discoid meniscus, incomplete discoid meniscus and Wrisberg type meniscus. In 1998, Monllau et al. proposed the addition of RSM as a fourth type, leading to the development of the modified Watanabe classification system.

RSM is generally considered to be a congenital variation of the lateral meniscus, since patients usually present no symptoms or history of significant trauma (Arnold & Van Kampen, 2000; Soejima et al., 2013; Tyler et al., 2010). Additionally, Le Minor (1990) also identified RSM in primates, such as gorillas, further supporting its congenital origin. However, there are reports of symptomatic RSM cases, which are usually accompanied by meniscal cysts (Atay et al., 2002; Arnold & Van Kampen, 2000; Koukoulias & Papastergiou, 2011), medial plicas (Asadullayeva et al., 2024), meniscal tears (Kim et al., 2006) or other concurrent abnormalities or malformations of the knee (Rahij et al., 2024). In our case, MRI similarly revealed a small medial plica and meniscal cyst, indicating that the symptoms were not necessarily produced by the meniscus, as a RSM was also present in the other, asymptomatic, knee.

On the other hand, we can find literature suggesting regenerative formation of RSM after partial meniscectomy (Nagashima et al., 2019), anterior cruciate ligament (ACL) reconstruction (Fujii et al., 2017), and partial resection of a discoid meniscus with ACL reconstruction (Soejima et al., 2013). Similarly, cases of regenerative formation of a discoid meniscus have been reported in children (Bisicchia & Tudisco, 2013). Although the exact mechanism of regeneration is unknown, most authors suggest it is influenced by active growth plates that promote tissue repair (Nagashima et al., 2019) or the environment after ACL reconstruction, where drilling debris may contain mesenchymal stem cells and growth factors that promote intraarticular tissue formation (Fujii et al., 2017; Soejima et al., 2013).

Lateral meniscus variants are mostly detected on MRI (Lee et al., 2020). Still, it has been difficult to distinguish a RSM from a bucket-handle tear of the normally C-shaped lateral meniscus (Kim et al., 2006) or a central tear of a discoid meniscus (Lee et al., 2020). MRI signs that could aid in the recognition of a RSM are typically the presence of "the mirror image sign" and "the central bow tie sign" (Iqbal et al., 2020).
In differential diagnosis, we should also remember that bucket-handle ruptures are more common in the medial meniscus due to its firm attachment to the capsule and consequent greater stability (Niitsu et al., 2003). As bucket-handle ruptures of the medial meniscus have a predilection of 76% (Ververidis et al., 2006), the involvement of the lateral meniscus should also raise suspition of congenital meniscal variants (Fujikawa et al., 2002).

6. Conclusions

When interpreting MRI images, it is essential to be aware of the signs mentioned previously to avoid unnecessary surgery (Asadullayeva et al., 2024). Nevertheless, a detailed history and note of trauma should be taken, as well as medical symptoms evaluated when interpreting the MRI findings (Kim et al., 2006). The final decision whether to operate should therefore not be made exclusively on the MRI.

Conflicts of Interest: The authors declare no conflict of interest.

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