

Rare Variant Double-Layered Lateral Meniscus Detected During Arthroscopy in a Young Gymnast After a Hyperextension Knee Injury

A Case Report

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Abstract

Case: A 15-year-old high-level gymnast sustained a hyperextension knee injury and was diagnosed with a lateral meniscus tear on advanced imaging. During arthroscopy, a redundant meniscus was encountered overlying an otherwise normal, intact lateral meniscus, consistent with a double-layer lateral meniscus. The redundant meniscus was resected, and the patient was able to return to gymnastics at her previous high level of competition.

Conclusions: Abnormalities of the lateral meniscus may be poorly characterized or undetected on preoperative imaging studies. When the decision is made to proceed with surgery, a vigilant diagnostic arthroscopic examination can facilitate the detection and treatment of unanticipated pathology.

The incidence of anatomic meniscal variants is unknown¹. Many are initially discovered incidentally². Of the known variants, discoid meniscus is the most prevalent and widely

studied³ but even these are relatively rare. The estimated incidence of discoid lateral meniscus ranges from 0.4% to 17%^{4,5}, accounting for roughly 38% of known meniscal variants³. By contrast, the



Fig. 1
Anteroposterior and lateral plain-film views of the right knee.

Disclosure: The **Disclosure of Potential Conflicts of Interest** forms are provided with the online version of the article (<http://links.lww.com/JBJS/B202>).

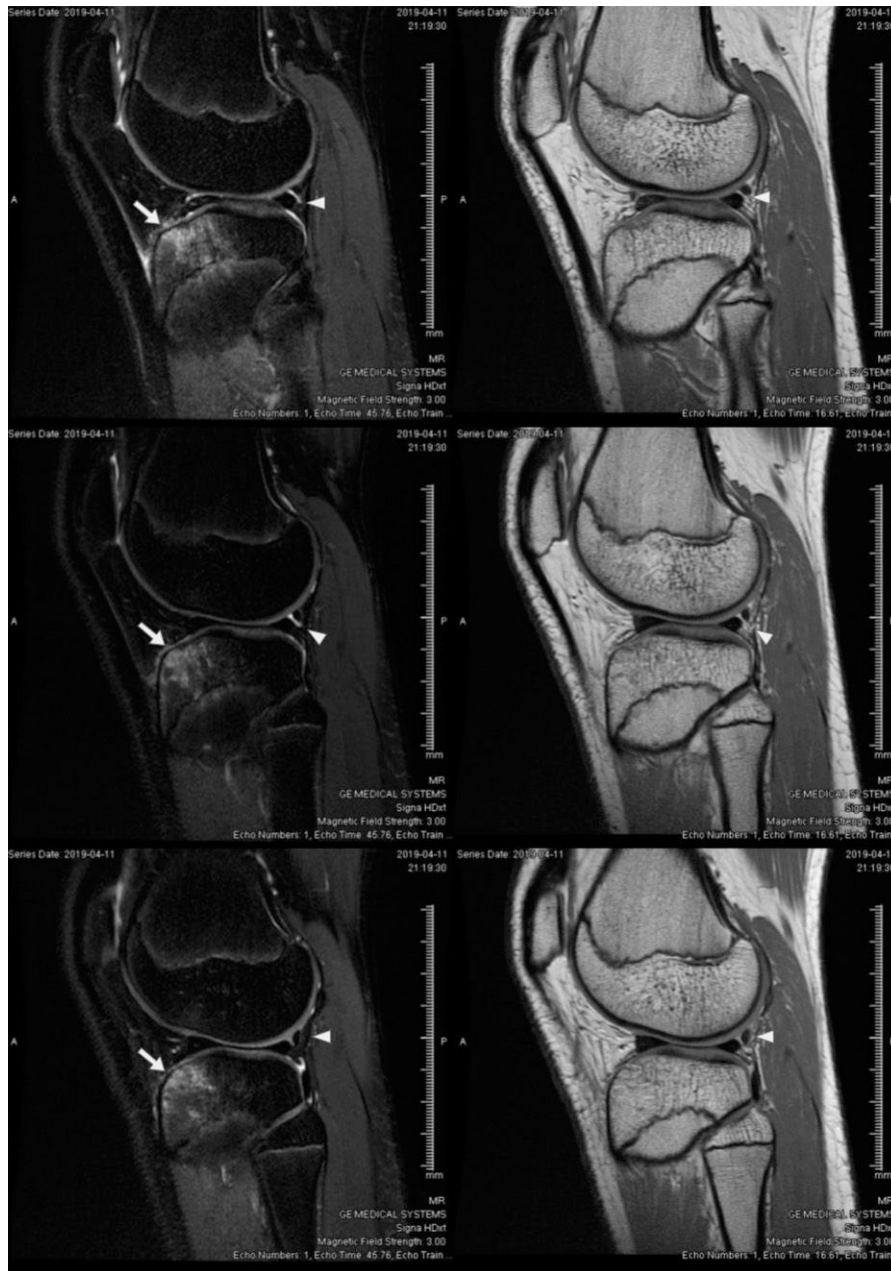


Fig. 2

Short tau inversion recovery sequence magnetic resonance imaging of the right knee showing 3 successive sagittal plane cuts through the lateral compartment. Fat-suppressed images are on the left. Bony edema on the anterior plateau (white arrow) is consistent with hyperextension injury. A linear defect is seen in the posterior horn of the lateral meniscus (white arrowhead).

double-layered lateral meniscus is believed to represent less than 1% of all known variants^{3,6}. Congenital meniscal anomalies occur at a higher rate in individuals of Asian heritage⁶⁻⁸. Variants that do not significantly alter joint function or biomechanics are clinically silent, although they likely predispose affected individuals to certain injuries and may become symptomatic with tears or meniscocapsular separation⁹. Such patients often presented with a history of atrau-

matic, knee pain and clicking and a positive McMurray test on examination¹. Other patients may simply present with chronic knee pain and effusions worsened by repetitive functional loading. These atypical presentations can be difficult to discern on imaging and even at the time of arthroscopy⁹.

We report a case of a double-layered lateral meniscus in a high-level youth gymnast with baseline knee hyperextension

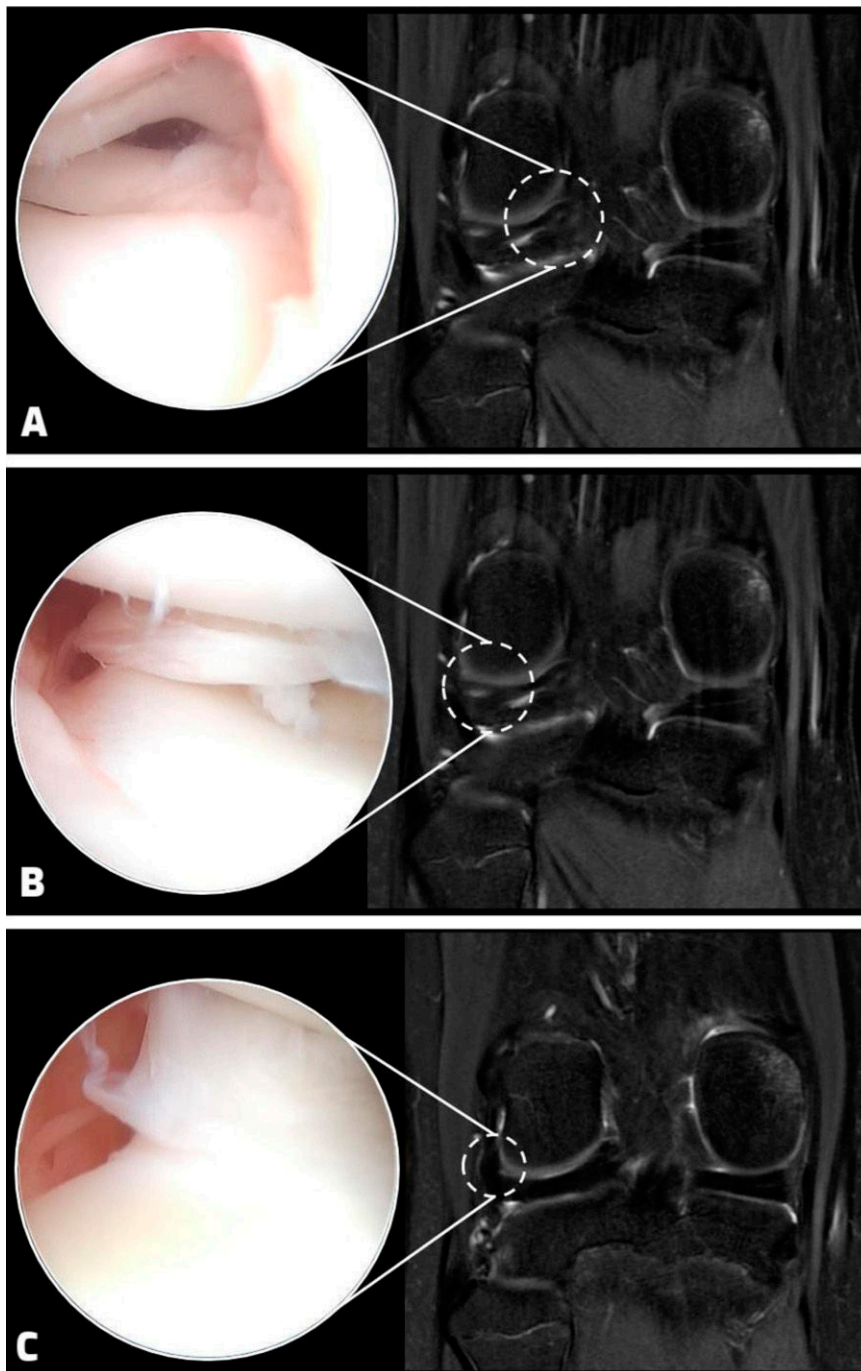


Fig. 3

Arthroscopic findings in the lateral compartment correlated with coronal fat-suppressed short tau inversion recovery coronal magnetic resonance imaging. A large meniscal flap is visible extending toward the notch medially (**Fig. 3-A**) and body laterally (**Figs. 3-B and 3-C**), raising concern for a large posterior bucket-handle tear.

which illustrates the importance of performing a detailed, thorough arthroscopic assessment to guide intraoperative decision-making.

The patient and her parents were informed that data concerning the case would be submitted for publication, and they provided consent.

Case Report

A 15-year-old female gymnast sustained a hyperextension right knee injury during a gymnastics meet. She attempted to resume the competition but had to forfeit because of pain and significant swelling. She continued to experience posterolateral

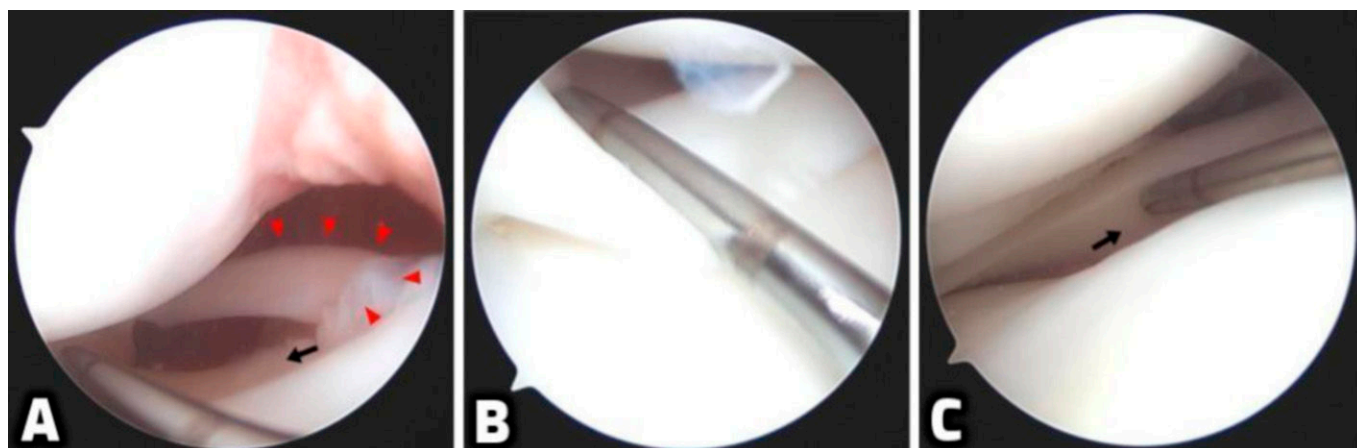


Fig. 4

Diagnostic arthroscopic examination of the lateral compartment. Redundant meniscal tissue (red arrowheads) cranial to normal-appearing meniscus (black arrow) (**Fig. 4-A**). The redundant tissue was highly mobile, devoid of meniscocapsular attachments, and was easily drawn into the weight-bearing portion of the joint on probing (**Fig. 4-B**). The inferior meniscus was intact and stable to probing (**Fig. 4-C**).

knee pain with effusions as well as catching and clicking symptoms. She was initially evaluated in a nonoperative sports medicine clinic and diagnosed with a low-grade posterolateral corner injury and possible lateral meniscus tear. Radiographs were unremarkable (**Fig. 1**). Magnetic resonance imaging (MRI) demonstrated edema in the anterior tibial plateau consistent with hyperextension injury-pattern bone bruising and an oblique tear of the posterior superior horn of the lateral meniscus extending to the body (**Fig. 2**). She was referred to the surgical orthopaedic sports medicine clinic for further evaluation.

Seven weeks out from her injury, she was persistently symptomatic and unable to return to gymnastics. Examination revealed a trace effusion, lateral joint line tenderness, vague posterolateral tenderness, and a stable ligamentous examination. Pain and discomfort were reproduced with McMurray test. Range of motion was intact and notable for over 10° of hyperextension bilaterally. Given the chronicity of her symptoms and findings on imaging and physical examination, the patient and her family elected to proceed with surgical intervention in the form of diagnostic arthroscopy and lateral meniscus repair versus partial meniscectomy.

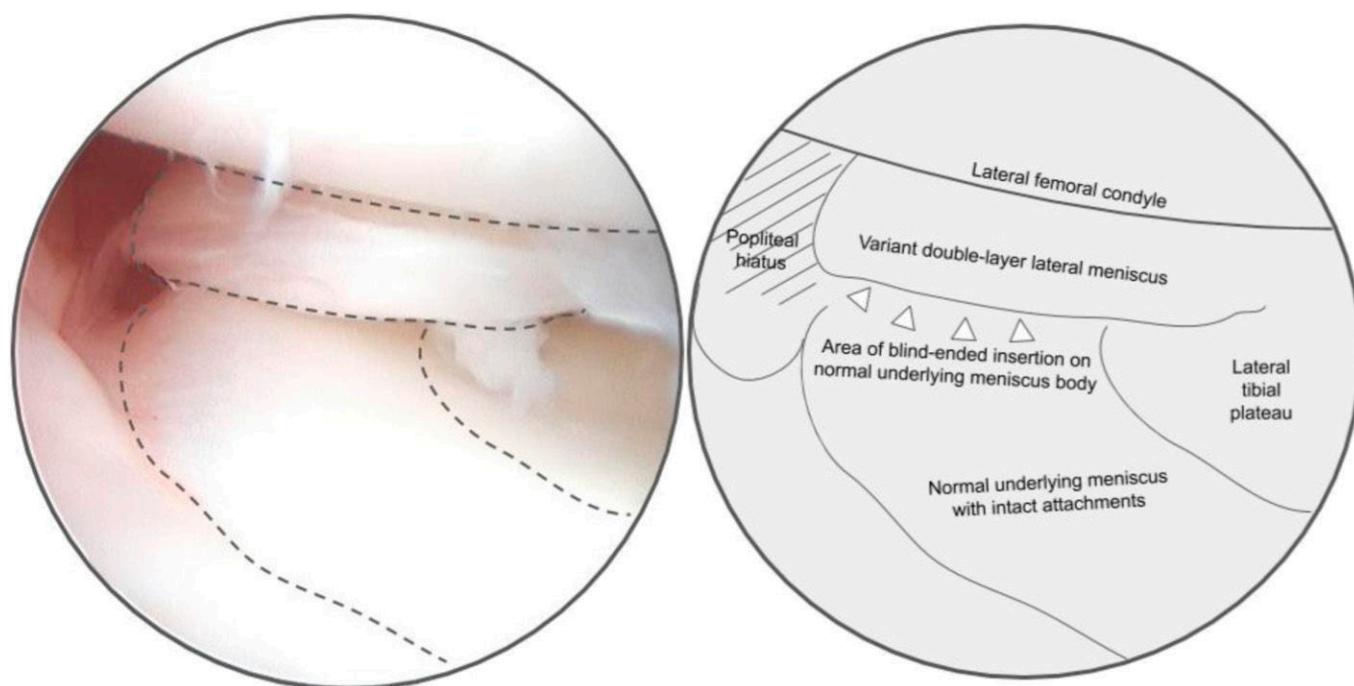


Fig. 5

Diagrammed arthroscopic image and labeled schematic of the redundant meniscal tissue inserting on the underlying lateral meniscus body.

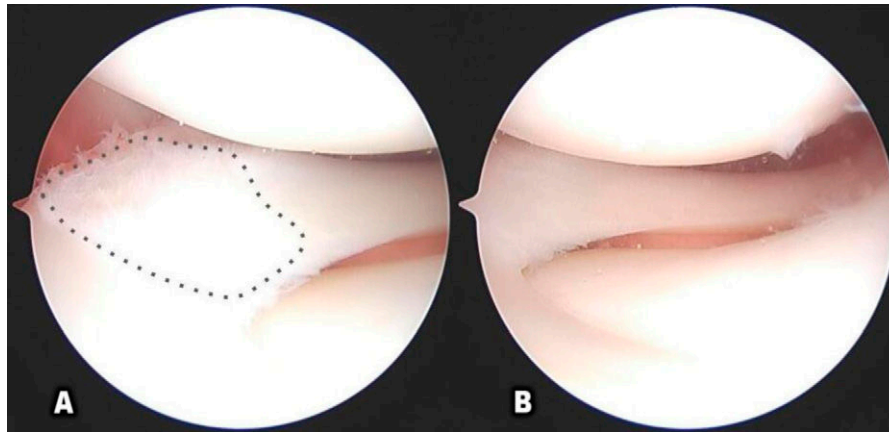


Fig. 6

Arthroscopic images after resection of the redundant meniscal tissue illustrating the area on the lateral body (**Fig. 6-A**) where the redundant tissue inserted, and the normal appearance of the meniscus following resection (**Fig. 6-B**).

Diagnostic arthroscopy of the suprapatellar, patellofemoral, medial, and intercondylar compartments did not detect any pathology or abnormalities. The medial meniscus was morphologically normal and intact. The cruciate ligaments were intact and stable to probing.

In the lateral compartment, a large meniscal flap was visible overlying an apparently otherwise intact lateral meniscus, which seemed to correlate with the findings on the MRI (Fig. 3-A). The flap seemed to remain attached posteriorly near the root and anteriorly at the body but was otherwise circumferentially detached from the capsule (Fig. 4-A) and easily drawn into the joint on probing (Fig. 4-B). Anteriorly, on close inspection, the flap seemed to turn 90° and end blindly in the body of the lower lateral meniscus (Figs. 3-B and 3-C), with features of redundant tissue (Fig. 5). Apart from the popliteal hiatus, the inferior lateral meniscus was circumferentially intact and stable to probing. Disregarding the superior mobile fragment, the inferior intact segment resembled a complete, otherwise normal meniscus (Fig. 4-C).

Collectively, these findings seemed consistent with a meniscal variant rather as opposed to a traumatic, repairable tear. Therefore, the entire redundant flap was resected with a combination of arthroscopic biters and shaver. The underlying meniscus was debrided and inspected. It did resemble an otherwise morphologically normal meniscus and was without any visible tearing (Fig. 6). It was again probed, and all the normal meniscocapsular attachments remained intact. All visible loose bodies were removed from the knee with the shaver, and the joint was lavaged to cleanse it of any remaining debris.

The patient was discharged home following the procedure and was permitted to weight bear as tolerated without a brace or crutches. At her 2-week follow-up, she reported complete resolution of symptoms. At 6 weeks, she returned to gymnastics and was asymptomatic with no complaints. She returned for subsequent evaluations at 3, 6 months, and 1 year and remained completely asymptomatic. She had completely returned to gymnastics at her previous high level of competition by her 6-month follow-up.

Discussion

The lateral meniscus exhibits anatomic variants more commonly than the medial meniscus. Approximately 38% of these variants are discoid in nature, with ring-shaped and double-layered structures comprising less than 1% each of reported variants^{3,10}. Additional lateral meniscus variations previously described include incomplete discoid meniscus¹⁰, Wrisberg meniscus¹⁰, accessory meniscus¹¹, accessory discoid meniscus¹², partial deficiency of the meniscus¹³, abnormal band formation^{14,15}, hypoplasia¹⁶, congenital absence^{16,17}, and congenital separation menisci¹⁸. The Wrisberg variant presents arthroscopically as a hypermobile, lateral discoid meniscus with no posterior meniscotibial attachment¹⁹. The only posterior attachment is the meniscofemoral ligament of Wrisberg, which may have a hypertrophied appearance; therefore, the posterior aspect is easily drawn into the joint on probing²⁰. Accessory lateral menisci are typically found overlying the normal meniscus and resemble meniscal tissue on arthroscopic examination¹². Although the discoid meniscus was first described in 1889²¹, the earliest reported case of the much rarer double lateral or double-layer meniscus was described by Bailey and Blundell in 1974²². To date, 17 cases of the double-layered meniscus variant have been reported in 14 individuals. Most recently, Ahn et al. described a case with treatment and outcome similar to our findings¹. However, we believed that the radiographic and arthroscopic correlations in our figures and diagrams would be a valuable contribution to the literature, illustrating the subtlety of these findings and the need for a thorough diagnostic arthroscopic assessment. These cases are summarized in Table I. Of these cases, half of meniscal anomalies occurred in adolescents with an incidence 6 times greater in men versus women. Although most occurrences were unilateral in nature, 3 cases reported bilateral meniscal abnormalities.

Unlike Ahn et al.¹, we did not immobilize our patient or restrict weight-bearing or motion postoperatively. This decision to proceed with postoperative protocols similar to routine meniscectomy was based on our arthroscopic assessment in which the remaining lateral meniscus seemed morphologically

TABLE I Summary of Previously Reported Cases of Double-Layer Lateral Meniscus Variants *

Author	Year	Sex	Age†	Ethnicity	Laterality	Presentation			Type‡	Additional/Associated Pathology
						Injury	Symptoms	Duration		
Ahn et al. ¹	2018	M	11	NR	Left	No	Lateral pain, mild swelling, clicking	4 mo	Separated	Ring-shaped LM
Araki et al. ²³	2016	M	8	NR	Left	No	Lateral pain, effusion	1 wk	Connected	None
Fukuda et al. ⁹	2015	M	19	Japanese	Right	Yes	Lateral pain, clicking, locking	2 yrs	Connected	Meniscocapsular separation
Lee and Min ¹⁴	2000	M	22	Korean	Right	No	Lateral pain	6 mo	Separated	None
Wang et al. ²⁴	2011	F	46	Chinese	Left	No	Lateral pain, clicking	1 mo	Connected	MFC OCD
Checa ²⁵	2011	M	12	NR	Left	No	Effusion	NR	NR	Discoid LM
Takayama et al. ²⁶	2009	M	19	Japanese	Bilateral	No	Lateral pain	2 yrs	Connected	Bucket-handle LM tear
Takayama et al. ²⁶	2009	M	13	Japanese	Bilateral	No	Lateral pain, clicking	8 mo	Connected	None
Karataglis et al. ²⁷	2006	M	57	Indian	Left	No	Lateral pain, clicking, giving way	1 yr	Separated	Patellar subluxation
Okahashi et al. ²	2005	M	53	Japanese	Left	Yes	Lateral pain	15 yrs	Separated	LTP fracture
Kim et al. ⁶	1998	M	50	Korean	Right	Yes	Lateral pain, clicking, giving way	3 yrs	NR	Discoid LM, LFC OCD
Kang et al. ²⁸	1996	M	39	Korean	Right	No	Lateral pain, swelling	7 mo	Connected	MM and LM tears
Suzuki et al. ²⁹	1991	M	14	Japanese	Bilateral	Yes	Lateral pain, clicking, giving way	13 mo	Connected	None
Suzuki et al. ²⁹	1991	F	16	Japanese	Left	Yes	Lateral pain, clicking, giving way, locking	3 yrs	Separated	None

*F = female, LFC = lateral femoral condyle, LTP = lateral tibial plateau, LM = lateral meniscus, M = male; MFC = medial femoral condyle, MM = medial meniscus, NR = not reported, and OCD = osteochondritis dissecans. †At presentation (yrs). ‡Refers to connected or separated meniscus morphology. In the former, the upper accessory meniscus is connected with the lower normal meniscus; in the latter, the upper accessory meniscus is not connected to the lower normal meniscus.

normal and intact, and no additional concomitant pathology was appreciated. Furthermore, examination under anesthesia did not demonstrate any evidence of instability.

Lateral meniscal aberrations are believed to arise in the early fetal period with an 8-year-old boy being the youngest reported incident²³. The growth of these abnormalities has been proposed to be multifactorial including congenital and developmental components²⁶. The epidemiology is yet unclear, but the predilection toward the Asian population certainly points toward ethnic variations. Undoubtedly, numerous asymptomatic cases are unreported and untreated due to variable presentation.

Fukuda et al. divides double-layer meniscal variants into either connected or separated morphological types with connected being almost threefold more prevalent than separated⁹. In the connected variant, the upper abnormal meniscus is connected to the lower

normal meniscus, usually at the anterior and posterior edges with an unconnected periphery^{2,25,29}. In the separated type, the 2 menisci do not connect. One author reported the abnormal meniscus under the normal meniscus²³. In our patient, the abnormal duplicated meniscus was above the normal meniscus, as described in the majority of reported cases, and was of the connected type.

In previously reported cases, clinical presentation often included a history of subjective, lateral knee pain ranging from 1 week to 15 years with an average of 27 months. Clicking, locking, effusion, and giving away were commonly described. A positive McMurray test was reported in almost half of the reviewed cases. Our patient presented with all these findings. Most likely, the abnormal meniscus causes improper biomechanics leading to chronic pain, although further research is warranted as to the pathological process of this anomaly.

On MRI, the duplicate meniscus may be mistaken for a bucket-handle or horizontal tear. Lee et al. proposes that a “butterfly” appearance on MRI may suggest the presence of a double-layer meniscus¹⁴. Even so, the double-layer lateral meniscus has proven notoriously difficult to conclusively identify with imaging alone and is so rare that most surgeons who encounter them at the time of arthroscopy may not have been aware that the entity existed. Furthermore, pathology can be hard to detect on MRI in the posterior and root regions of the lateral meniscus, which can confuse the decision of whether to proceed with an arthroscopic intervention¹⁰.

Additional concomitant pathologies that have been reported with a double-layer meniscus include meniscocapsular separation⁹, cartilage injury^{7,24}, patellar subluxation²⁷, tibial plateau fracture², and midportion tear of the lateral meniscus²⁸. The low number of cases available makes it difficult to discern the degree to which the presence of a double-layered meniscus variant may have contributed to these additional injuries, if at all; however, meniscocapsular separation of the abnormal meniscal duplicate does offer a plausible explanation as to why the variant may become symptomatic after an injury. In addition, the lack of concomitant pathology in the setting of the separated variant could be related to its greater mobility, similar to the way in which the less mobile medial meniscus is believed to be more prone to injury. This would suggest that a higher index of suspicion is warranted when the connected variant is encountered.

Congenital meniscal abnormalities may be mistaken for a meniscal injury both on imaging and examination. Performing a careful, detailed, and thorough diagnostic arthroscopic examination may reveal findings that differ substantially from the conclusions drawn from preoperative advanced imaging. In the rare case that a double-layer lateral meniscus variant is encountered at the time of arthroscopy, resection of the redundant tissue seems to result in elimination of symptoms with a full recovery and return to sport. ■

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