Case Report

Ring-shaped lateral meniscus combined with an accessory meniscus: A rare anatomical variant

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Abstract
A ring-shaped meniscus is a very rare anatomical variant among all meniscal abnormalities. Additionally, an accessory meniscus is extremely rare, and only a few cases have been reported. We herein report a case involving the combination of these two features in a single lateral meniscus. These abnormalities were found during arthroscopic surgery for removal of an osteochondral fragment that had detached from the patellar bone and plication of the medial patellofemoral ligament in a patient with acute patellar dislocation. To our knowledge, each variant is extremely rare and the combination of the two variants has not been reported.

Keywords
anatomical variant, accessory meniscus, lateral meniscus, ring-shaped meniscus

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Introduction
Various types of meniscal anomalies have been reported. Anomalies of the lateral meniscus are more frequently found than those of the medial meniscus. Among them, a discoid meniscus is the most common anomaly; other anomalies are rarely reported. Other anomalies of the lateral meniscus include a double-layered meniscus, accessory meniscus, and ring-shaped meniscus. Although a few cases of these anomalies have been reported separately,¹⁻⁴ combinations of these aberrations are extremely rare. To our knowledge, no reports have described the combination of a ring-shaped aberration and accessory meniscus in a single joint. We herein describe a patient with a ring-shaped lateral meniscus combined with an accessory meniscus.

Case report
A 16-year-old boy presented with sudden-onset knee pain and joint swelling after the patella was briefly hit during recreational Korean wrestling. There was no direct trauma and no previous knee joint symptoms such as catching, effusion, locking, or giving way. The patient’s medical history was unremarkable, but unrecognized joint laxity was found on physical examination. Additionally, the range of motion of the knee joint was restricted to 0°–60°, with the patella positioned laterally, and ecchymosis and tenderness were present on the medial side of the patella. Radiological examination revealed lateral subluxation of the patella with a displaced fragment (Figure 1). Magnetic resonance imaging (MRI) showed a discoid lateral meniscus with a small cystic alteration under the anterior root of the lateral meniscus along with a portion of meniscal tissue at the medial portion of the lateral compartment with the

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regular border adjacent to the tibial spine (Figure 2). These findings suggested a combined alteration of the lateral meniscus, bucket handle tear, and anterior root tear of the lateral meniscus.

We decided to perform an arthroscopic procedure. First, we performed osteochondral fragment removal and imbrication of the medial patellar retinaculum as an arthroscopic all-inside technique as described by Halbrecht⁵ (Figure 3). However, under arthroscopic examination of the lateral compartment, we found a normally inserted and stable ring-shaped lateral meniscus without injury. Its insertion to the anterior and posterior horn was firmly attached. The inner portion of the meniscus was not mobilized when pulled with a probe. We considered the patient to have an aberration of the lateral meniscus. Additionally, we found an accessory structure under the lateral meniscus; this structure was exposed by pulling the anterior horn of the lateral meniscus anteriorly. It appeared as a cartilage structure that arose from the anterolateral portion of the lateral tibial plateau and inserted at the inner portion of the ring-shaped lateral meniscus. Its shape resembled a comma. The texture of the accessory meniscus felt normal under examination with a probe. No tears or injuries of the accessory meniscus

Figure 1. (a) Plain radiograph showing patellar subluxation and a displaced fragment (white arrow) on the medial side of the patella. (b) A loose body (osteochondral fragment, black arrow) is seen on a coronal magnetic resonance image.

Figure 2. (a) Focal scalloping of the lateral tibial plateau adjacent to the medial inferior portion of the cyst (white arrow). (b) Width of the midbody of the lateral meniscus (double-headed arrow) indicates a discoid meniscus. (c) Redundant meniscal tissue (arrowhead) on the medial aspect of the lateral meniscus mimics a bucket handle tear.

Figure 3. Arthroscopic findings. (a) Osteochondral fracture of the patella (white arrow). (b) Removal of osteochondral fragment using a forceps. (c) Sutures are placed along the medial retinaculum for arthroscopic all-inside medial imbrication.
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dence of about 16.6%

The lateral meniscus is more morphologically variable than
the medial meniscus, and the most common lateral menis-
cal aberration is the discoid meniscus. In the sagittal plane of MRI, "central
tear has an irregular or degenerative inner margin
that is not tapered and sharp. In the present case, the ring-
shaped lateral meniscus was characterized by the presence of a
bridge between the two horns of the meniscus, and the inner portion of the
ring-shaped lateral meniscus is the mirror image or reflec-
tion of the normal appearing body of the meniscus.\textsuperscript{8}

A double-layered meniscus is extremely uncommon and
one of the forms of accessory meniscus. In all cases
reported in the literature, it was overlying the normal lateral
meniscus. Its clinical features remain unclear, however
mechanical obstruction of the hypermobile components
of the accessory meniscus may have often been associated
with symptoms including pain and mechanical symptoms
such as clicking, locking, and giving way.\textsuperscript{4,9} A review of the
literature showed that the symptoms were significantly
improved by resection of the hypermobile upper accessory
meniscus. However, all reported double-layered lateral
menisci have no specific radiological finding, thus careful
arthroscopic examination is needed to reveal this uncom-
ononormal abnormality and achieve a clinical improvement.

An accessory meniscus arising from the tibial plateau is
extremely rare, with only two cases having been published
in the literature.\textsuperscript{1,10} One of them has clinical symptoms,
pain and mild swelling, but the other has no clinical symp-
tom associated with a lateral accessory meniscus. They
have no abnormality on plain radiograph and MRI. Such
aberrations are considered to result from a congenital rather
than developmental process, although the clinical presenta-
tions, pathology, and epidemiology of these variations are
still unclear.\textsuperscript{9,11}

In the arthroscopic findings, a ring-shaped meniscus is
apt to be misinterpreted as a bucket handle tear of a normal
C-shaped lateral meniscus or a central tear of a discoid
meniscus. However, a ring-shaped meniscus has some dif-
ferences from a bucket handle tear or a central tear. The
displaced medial portion of the bucket handle tear is usu-
ally movable and reducible into the lateral portion of the
meniscus, and detachment from the torn edge is observed.
A central tear has an irregular or degenerative inner margin
that is not tapered and sharp. In the present case, the ring-
shaped meniscus was characterized by the presence of a
bridge between the two horns of the meniscus, and the inner portion of the ring-shaped meniscus was not mo-
bilized when we tried to move it laterally within the inter-
condylar notch using a probe. It also had the same
appearance as that of a normal meniscus, with a sharp and
tapering inner margin.

\textbf{Discussion}

The lateral meniscus is more morphologically variable than
the medial meniscus, and the most common lateral menis-
cal aberration is the discoid meniscus. Its incidence is very
low, except in Asian populations, in which it has an inci-
dence of about 16.6%. In contrast, it occurs in less than 5%
of the Caucasian population.\textsuperscript{6,7} Other anomalies, such as a
ring-shaped meniscus, double-layered meniscus, and
accessory meniscus, are relatively rare. In a large cadaver
study, Ryu et al.\textsuperscript{5} reported that the prevalence of a ring-
shaped meniscus was 0.9% and that of a double-layered
meniscus was 0.5%.

A ring-shaped meniscus previously reported is almost
on the lateral side and usually asymptomatic. It has a firm
structure and is connected to the surrounding soft tissue.
This may contribute to the lack of clinical symptoms. MRI has been reported to be a valuable diagnostic tool to detect
the lateral meniscal variants, but it is important to bear in
mind the possibility of a ring-shaped meniscus in the dif-
ferential diagnosis of a bucket handle tear or a central tear
of a discoid meniscus. In the sagittal plane of MRI, “central
bow tie sign” is useful in detecting the normal meniscal
tissue onto the inner portion of the lateral compartment of
the knee.\textsuperscript{8} In the coronal plane, the inner portion of the
lateral meniscus is in the medial portion of the lateral com-
partment and not in the intercondylar notch, and the pres-
ence of the “mirror sign” in which the inner portion of the

\begin{center}
\textbf{Figure 4.} Arthroscopic findings of the lateral compartment of the right knee. (a) Ring-shaped lateral meniscus with an inter-horn bridge (white star). (b) Stabilized inner portion of the ring-shaped meniscus. (c) Exposed comma-shaped accessory meniscus. (d) The accessory meniscus arises from the lateral tibial plateau with no injury. (e) Lateral, anterior, and posterior portions of the ring-shaped lateral meniscus with a smooth margin (arrows), and no evidence of tear. LFC: lateral femoral condyle; ACL: anterior cruciate ligament.
\end{center}
Additionally, the combined accessory meniscus in our case arose from the anterolateral portion of the lateral tibial plateau and inserted jointly with the inner portion of the ring-shaped meniscus; however, no anomaly such as a tear or degenerative change was found. The patient’s presenting symptoms before the surgery were caused by patellar dislocation, and the aberrations of the lateral meniscus were found incidentally during arthroscopy. We believe that these aberrations were probably a congenital anomaly. We also found no clear evidence of a relationship between the symptoms and the morphological anomalies. Thus, we decided to leave these malformations untouched. Their true role in producing clinically significant knee symptoms requires further research and long-term follow-up.

Conclusion
To the best of our knowledge, the present case is the first description of a combined ring-shaped meniscus with an accessory meniscus of the lateral side with no other anomalies. A diagnosis of rare aberrations, as ring-shaped or accessory menisci, should be carefully made after thorough probing to differentiate them from other anomalies. Usually, ring-shaped and accessory menisci are asymptomatic and found incidentally. Preoperative history taking and assessment of symptoms of the knee joint are essential to determine whether to treat the aberration.

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References
1. Karahan M and Erol B. Accessory lateral meniscus: a case report. Am J Sports Med 2004; 32(8): 1973–1976.
2. Ryu K, Iriuchishima T, Oshida M, et al. Evaluation of the morphological variations of the meniscus: a cadaver study. Knee Surg Sports Traumatol Arthrosc 2015; 23(1): 15–19.
3. Choi NH. A ring-shaped lateral meniscus. Am J Knee Surg 1999; 12(2): 109–110.
4. Wang Q, Liu XM, Liu SB, et al. Double-layered lateral meniscus. Knee Surg Sports Traumatol Arthrosc 2011; 19(12): 2050–2051.
5. Halbrecht JL. Arthroscopic patella realignment: an all-inside technique. Arthroscopy 2001; 17(9): 940–945.
6. Ikeuchi H. Arthroscopic treatment of the discoid lateral meniscus. Technique and long-term results. Clin Orthop Relat Res 1982; 167: 19–28.
7. Papadopoulos A, Karathanasis A, Kirkos JM, et al. Epidemiologic, clinical and arthroscopic study of the discoid meniscus variant in Greek population. Knee Surg Sprots Traumatol Arthrosc 2009; 17(6): 600–606.
8. Esteves C, Castro R, Cadilha R, et al. Ring-shaped lateral meniscus with hypoplastic anterior cruciate ligament. Skeletal Radiol 2015; 44(12): 1813–1818.
9. Suzuki S, Mita F, and Ogishima H. Double-layered lateral meniscus: a newly found anomaly. Arthroscopy 1991; 7(3): 267–271.
10. Saygi B, Yildirim Y, Senturk S, et al. Accessory lateral discoid meniscus. Knee Surg Sports Traumatol Arthrosc 2006; 14(12): 1278–1280.
11. Soren A. On the etiology of congenital malformation of the meniscus. Arch Orthop Trauma Surg 1985; 104(5): 283–288.