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CASE REPORT

Symptomatic bilateral complete discoid medial menisci of the knee in a child: A case report

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ABSTRACT

Bilateral complete discoid medial menisci are extremely rare congenital anatomic variants of the knee. Currently, arthroscopic partial meniscectomy with or without peripheral suture repair is performed for symptomatic discoid meniscus. However, most of the outcomes are short-term. In this article, we present a pediatric case of symptomatic bilateral complete discoid medial menisci and highlight the effectiveness of arthroscopic partial meniscectomy with or without peripheral suture on symptomatic complete discoid medial menisci based on 60-month excellent clinical and functional results.

Keywords: Alignment, bilateral, discoid medial menisci, histology, meniscectomy, suture.

More than a century ago, a discoid lateral meniscus was first described in the literature.[1] The case of discoid medial meniscus was first described by Jones[2] in 1930. In 1941, Cave and Staples[3] reported two cases of the pathology. The incidence of discoid medial menisci was reported to be 0.1 to 0.3%, which was extremely rare, compared to that of discoid lateral menisci (1.4 to 15.5%).[4] To date, around 70 cases of discoid medial menisci have been reported in the literature.[5,6] Furthermore, bilateral complete discoid medial menisci are extremely uncommon congenital anatomic variants of the knee, ranging from 0.03 to 0.3%, since Murdoc[7] reported the first case in 1956.

The main symptoms of discoid menisci are locking and giving way in both knees. Magnetic resonance imaging (MRI) is useful option to confirm the bilateral discoid menisci. Currently, arthroscopic partial meniscectomy (saucerization) and/or peripheral suture repair is performed for the surgical treatment.[8] Its postoperative clinical outcomes are satisfactory.[6,9] However, most of the outcomes are short-term. Few reports exist on bilateral complete discoid medial menisci in children, whose lower extremity alignment should be taken into account along with growth. Although a few reports have focused on the histology of the discoid lateral menisci,[10,11] there is no study evaluating the histology of discoid medial meniscus.

In this article, we describe a rare case of symptomatic bilateral complete discoid medial menisci in a child. Fortunately, our surgical treatment was proven to be successful in a 60-month follow-up.

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CASE REPORT

A 10-year-old male patient without any past medical and trauma history had complaints of bilateral knee pain and occasional locking and giving way of both knees for two years during daily living activities and sports activities such as running and swimming. Physical examination of both knees revealed no swelling or red flare. However, tenderness was noted in the bilateral medial femorotibial joints. Bilateral medial painful click with the McMurray test was obviously found to be positive. No anteroposterior (AP), valgus and varus instabilities were observed. Restriction of range of knee motion was slightly observed, with an extension of 0° and a flexion of 130°.

Standing AP plain radiographs showed a widened medial joint space in both knees (Figure 1a-c). No medial tibial plateau cupping or femoral condyle squaring was observed.[5] A standing full-length lower limb AP radiograph showed mild valgus knees (Table I) (Figure 1a). Hip-knee-ankle (HKA) angle was 3.0° and 2.2° in the right and left lower limbs, respectively. Joint-line convergence angle (JLCA) showed a medial opening. The MRI scans showed typical bilateral discoid medial menisci



FIGURE 1. Pre- and postoperative (60-months) plane radiographs and plane magnetic resonance imaging (MRIs) (bilateral knees). **(a)** Preoperative whole-leg standing view and **(b, c)** standing anteroposterior view **(b: Right, c: Left)**. **(d-g)** Preoperative bilateral knee MRI with discoid of medial meniscus **(d-g: Right, h-k: Left)**. **(d, e)** Horizontal rupture was observed in mid to posterior portion; coronal view. **(f, g)** Sagittal view of right medial meniscus. **(h, i)** Coronal view and **(j, k)** sagittal view. **(l)** Postoperative whole-leg standing view and **(m, n)** standing anteroposterior view **(m: right, n: Left)**. **(o-v)** Postoperative bilateral knee MRI **(o-r: Right, c-v: Left)**. **(o, p, s, t)** coronal view and **(q, r, u, v)** sagittal view. **(d, f, h, j, o, q, s, u)**: T2WI. **(e, g, i, k, p, r, t, v)**: Fat-suppressed proton density (FSPD).

TABLE I
Pre- and postoperative radiographic measurements of plane radiographs of bilateral knee

Measurement	Extremity	Preoperation	Final follow-up (60 months postoperatively)
Hip-knee-ankle angle (°)	Right side	3.0	1.9
	Left side	2.2	1.0
Femorotibial angle (°)	Right side	171.4	173.9
	Left side	172.5	175.8
Mechanical lateral distal femoral angle (°)	Right side	87.3	86.0
	Left side	87.9	87.3
Medial proximal tibial angle (°)	Right side	87.5	86.8
	Left side	88.0	87.0
Joint-line convergence angle (°)	Right side	-2.5	-0.5
	Left side	-1.7	0
Mechanical axis (°)	Right side	57.9	51.7
	Left side	57.8	40.3

with horizontal cleavage and longitudinal tears in the middle and posterior portion of the right medial meniscus, and small horizontal tears in the posterior portion of the left medial meniscus (Figure 1d-k). The medial menisci were thicker than the lateral menisci. The anterior horn of the medial menisci had no anomalies, and the lateral menisci were normal.

Three weeks after the first visit to our hospital, the patient was operated based on his symptom. Under general anesthesia, arthroscopy of both knees using standard parapatellar portals revealed the complete type of bilateral discoid medial meniscus (Figure 2a, c). Horizontal cleavage and peripheral longitudinal tears in its mid to posterior portion accompanied with its thickening tears were found in the right knee. Horizontal cleavage tear was also found in the left knee. Partial medial meniscectomy for resecting central portion of the discoid meniscus resection and reshaping were performed bilaterally using an excision technique in one piece (Figure 2b, d, 3a, k), as reported by Kim et al.[12] Peripheral longitudinal tears in the mid and posterior portion of the right discoid meniscus were repaired with the inside-out stack suture technique using a specific device (Henning Meniscal Suture Kit; Stryker Corp., MI, USA).

The knee was immobilized with a soft knee brace for a week followed by full weight bearing and flexion limitation to 90° for two additional weeks. Flexion limitation to 120° was applied at four weeks from the operation and free range of motion was allowed postoperatively after six weeks.

The histology of the discoid medial menisci was different from the normal menisci. Histological examination showed proteoglycan enriched tissue

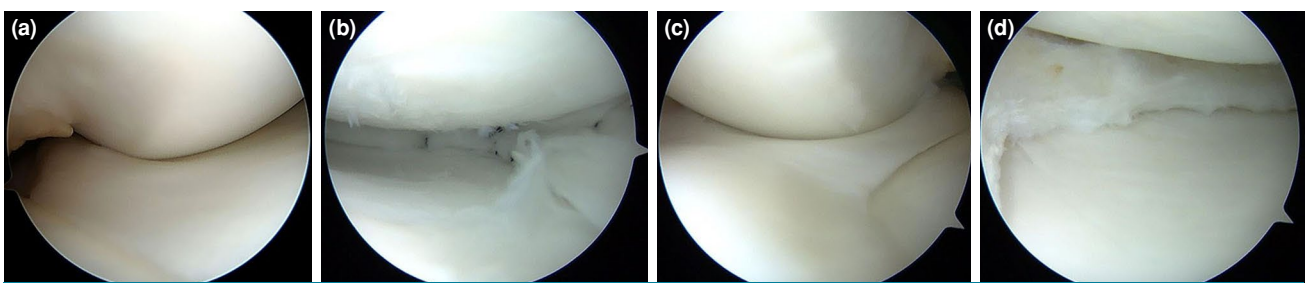


FIGURE 2. Intraoperative arthroscopic view of bilateral knees. Bilateral complete thickened discoid with thickening in medial menisci were observed. **(a, b)** Right knee: After saucerization, longitudinal rupture in mid to posterior portion of medial meniscus was found. Inside out suture repair was performed **(b)**. **(c, d)** Left knee: Saucerization was performed.

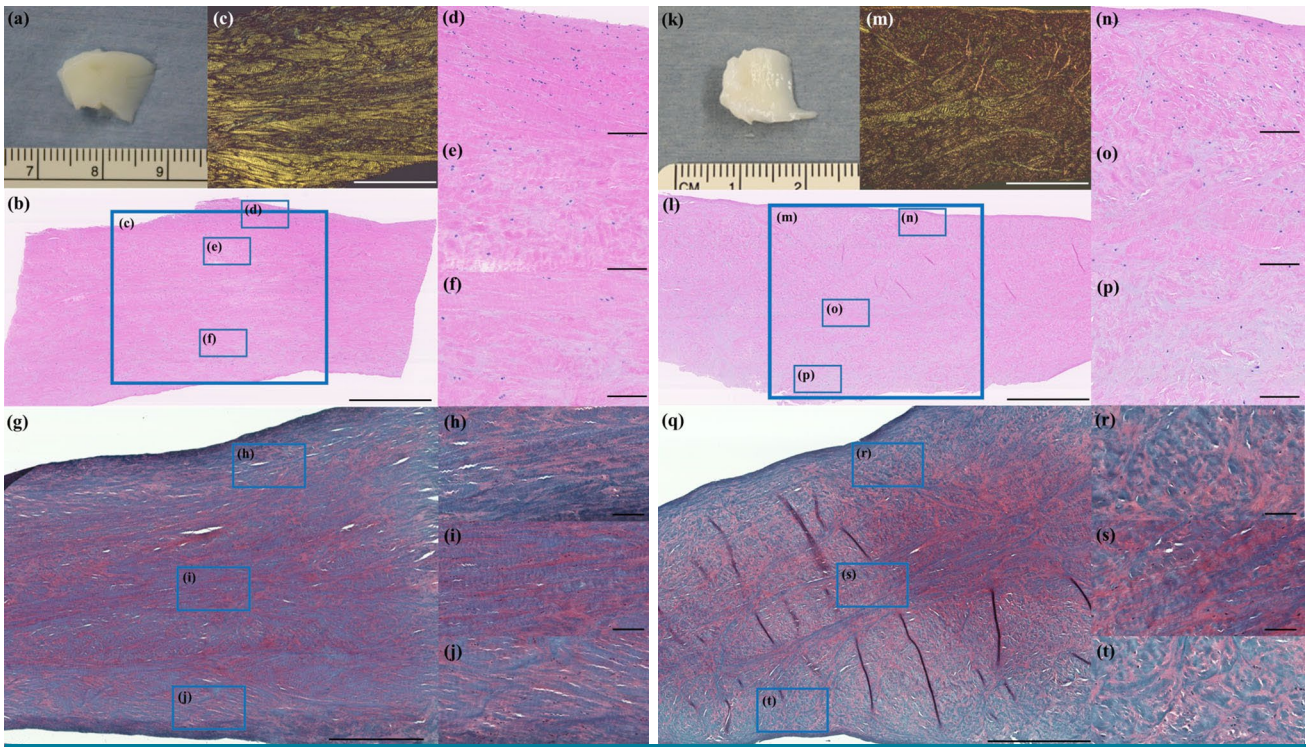


FIGURE 3. Histological evaluation of bilateral meniscus **(a-j: right, k-t: Left)**. **(a, k)** Gross examination of the resected the central portion of the discoid medial meniscus. (B,D-F,L,N-P) Hematoxylin and eosin-stained section, **(g-j, q-t)** Safranin O-stained section and **(c, m)** observation by polarizing microscope. **(c, m)** Cells are randomly scattered, the collagen fibers are irregularly represented. **(d, n)** Meniscal surface cells have a more flattened, fusiform morphology. **(e, f, o, p)** Degenerated extracellular matrix with disorganized and less-dense collagen fibers. **(g-j, q-t)** Proteoglycan-enriched cells are observed. Scale bar: **(b, c, g, l, m, q)** 1 mm, **(d-f, h-j, n-p, r-t)** 100 µm.

and woven arrangement in the inner part of the collagen fibers, while a large tight network was observed in the peripheral parts (Figure 3). Denatured extracellular matrix with disorganized collagen fibers was detected in the central area of discoid meniscus. Flattened and fusiform morphology cells were observed in both meniscal surfaces. In contrast, cells in the central portion were rounded. Large round cells with a relatively round in cytoplasm were sparsely scattered throughout the extracellular

TABLE II
Pre- and postoperative functional test scores and pain scores

Score	Preoperation	Final follow-up (60 months postoperatively)
JOA score (points)	75	100
Lysholm score (points)	56	100
KOOS (points)		
Pain	33	90
Symptoms	39	79
Activities of daily living	49	100
Function in sport and recreation	20	90
Knee-related quality of life	13	81
Tegner activity score (level)	6	6
VAS	7	0

JOA: Japanese Orthopaedic Association maximum score; 100 points. KOOS: Knee Injury and Osteoarthritis Outcome Score; VAS: Visual Analog Scale for pain (0-10 [worst pain]).

matrix. No vascular supply was observed. Both in the meniscofemoral and meniscotibial side, scattered cells and the irregular collagen fibers were detected.

No bilateral knee pain and locking were observed postoperatively. The patient was free from pain in both knees at six months of follow-up. At 60 months of follow-up, he had no recurrence of symptoms. He was able to return to sports activities. Physical examination revealed no tenderness with negative McMurray test result, and had a full range of motions. The lower limb alignment was changed from valgus to normal position in a postoperative plain full-length standing radiograph. The HKA angle and mechanical axis were slightly decreased after surgery, and the femorotibial angle (FTA) and JLCA were increased compared to preoperative values (Table I) (Figure 1l-n). In the follow-up MRI at 60 months, the size of menisci was reduced and no signs of chondral degeneration was observed. Fat-suppressed proton density-weighted MRI showed an intrameniscal hypersignal of the posterior portion of the medial meniscus (Figure 1o-v). The functional test scores and pain scores as assessed by the Japanese Orthopaedic Association (JOA), Knee Injury and Osteoarthritis Outcome Score (KOOS), and Visual Analog Scale (VAS) for pain improved postoperatively (Table II).[13]

DISCUSSION

In this article, we report a 10-year-old boy with symptomatic bilateral complete discoid medial menisci. Partial medial meniscectomy resecting the central portion of the discoid meniscus and reshaping was performed bilaterally. At 60 months of follow-up, clinical outcomes were favorable.

Discoid meniscus is a rare anatomical malformation of the meniscus, and its population increases in Asians (20%) than Caucasians (0.5%).[14] Most of the previous studies have reported a male preponderance, particularly in bilateral cases.[15] Lateral discoid is more frequent than the medial one, and bilateralism is extremely rare. As most of the cases are asymptomatic, the incidence of the pathology and its bilateral presence may be underestimated. One of the most symptomatic patients are usually adolescents, and patients in many of the case reports are in this age range.[4] Although rare, some authors reported pediatric cases. To the best of our knowledge, no previous report has evaluated the surgical influence on lower limb alignment change after surgical treatment and the histology of the discoid medial meniscus.

Regarding the etiology of a discoid meniscus, there is still some controversy. In 1948, Smillie[16] reported that the normal meniscus shape in the developing embryo was in discoid shape, and that failing of absorption of the central portion, leading to its remaining during the fetal stage, resulted in formation of congenital discoid meniscus. Weiner and Rosenberg[17] also described that the causes of discoid menisci were congenital changes in the tibia. Watanabe and Ikeuchi[18] advocated the classification regarding the discoid lateral meniscus: complete (full disk which covers the whole tibial plateau), incomplete (larger meniscus than normal ones), and the Wrisberg ligament type. There are some associated anomalies with discoid medial menisci; tibial plateau depression, abnormal attachment of the anterior horn to the anterior cruciate ligament (ACL), pathological plica in medial patella, meniscal cyst, and discoid lateral meniscus, on the same knee.[5] Flouzat-Lachaniette et al.[9] reported that there were three forms in anterior horn insertion: (A) normal, (B) defective anterior horn attachment to the tibia and continuity of the anterior horn, and (C) anterior horn continuity with the ACL. This particular case exhibited a complete type of discoid menisci with normal insertion of the anterior horn.

Inner circular collagen fibers, which disperse the hoop stresses on the menisci, exists in the normal menisci. Radially oriented collagen fibers are formed on the outer surface. Both of them are able to protect the longitudinal collagen fibers from tearing apart and fix them to the joint capsule.[10] There are four collagen fiber networks which have been reported previously.[19] Radially arranged collagen fibers exists along the surfaces of the meniscus, resisting to shear loads. The main portion of the meniscus tissue consists of the inner circumferential collagen fiber network, and disperse the hoop stresses on the meniscus complex during weight bearing. Two accessory collagen fiber networks which consist of superficial fibrils and oblique connective fibers fixing the circumferential collagens have been reported. The intact collagen network plays major roles to keep the glycosaminoglycans. Bisicchia et al.[20] found the disorganization of the collagen fibers and avascularity in the inner part of discoid lateral meniscus in children and adolescent cases. Inoue et al.[21] reported that vascularity in the intercondylar part of complete discoid lateral meniscus was observed in six patients. Papadopoulos et al.[11] compared the discoid lateral meniscus with the normal meniscus, and found the disorganization of the circular collagen network with a heterogeneous course of the circumferentially

arranged collagen fibers in the pathology. Atay et al.[10] also reported that the collagen fibers in the discoid meniscus were disoriented and their number decreased compared to the number of normal meniscus. These changes in collagen fiber and the stress distribution caused by increased meniscal thickness are factors of vulnerability.[22] The main strength of this report, however, was that we performed an *en bloc* resection of the central portion of the discoid meniscus, which may have affected the histology. Histological examination showed disorganization of the collagen fibers with hypocellularity similar to discoid lateral meniscus in previous studies.[20]

Due to the biomechanics and morphology of the medial tibiofemoral joint, discoid medial meniscus is incongruous for load bearing.[23] The medial meniscus is fix-positioned to the medial tibial plateau, resulting in its tear under the low impact trauma. Stable discoid meniscus is usually asymptomatic and it can be symptomatic in the occurrence of a tear. Total meniscectomy has been previously performed for symptomatic torn discoid meniscus. However, total meniscectomy increases the risk of osteoarthritis development than partial meniscectomy with a stable peripheral rim.[24] Hasegawa et al.[25] reported clinical outcomes comparing total resection and partial resection for discoid lateral meniscus. The mean follow-up period was 11 years and the mean age of patients was 12 years. Both procedure groups showed good clinical results, but total resection group showed a higher prevalence of osteoarthritic changes compared to the partial resection group. Therefore, partial resection is a more preferable option in the treatment of discoid meniscus. Currently, surgical management, such as arthroscopic partial meniscectomy excising the central anomalous discoid meniscus and preserving the stable peripheral rim, and peripheral suture repair for associated meniscus tears are performed on symptomatic discoid medial meniscus, with favorable short-term results.[26] Cho[27] reported a case of bilateral discoid menisci with unilateral symptoms. They treated the case with partial meniscectomy and all-inside meniscal repair. In the majority of case reports, only short-term results are reported. In our case, the patient had no symptom with favorable objective and subjective clinical outcomes after surgical treatment at 60 months of follow-up.

It is well known that meniscus has the critical function of load-distribution and the failure of its function leads to progression of knee osteoarthritis.[28] Surgical treatment for discoid meniscus should consider the changes in lower extremity alignment, particularly in children. Habata et al.[29] reported that the long-term clinical results (range, 10 to 22 years) were satisfactory after total meniscectomy for discoid lateral meniscus, and that the degrative changes were relatively mild, if the age was under 40 years. However, a careful follow-up for arthritis development is needed, if patients are aged over 19 years with valgus deformities, since the knees become more valgus after the surgical intervention. Concerning static considerations, with normal alignment, approximately 70% of the load is shared in the medial compartment of the knee in single-leg stance.[30] Regarding dynamic considerations, Shelbourne et al.[31] reported joint-contact forces at the knee during walking using computer modeling and simulation methods. Compressive force, which acts in tibiofemoral joint in the medial compartment, was greater than that in the lateral compartment during the whole stance phase, as the resultant ground-reaction force passed medial to the knee throughout stance phase. In another study, a knee adduction moment was induced by the medially directed ground-reaction force.[32] Therefore, lower limb alignment change may be greater in meniscectomy of the discoid medial meniscus than in meniscectomy of the discoid lateral meniscus. In our case, growth plates remained open, but there is no report on the effect of surgical treatment for future growth, particularly on lower limb alignment changes. At 60 months after partial meniscectomy, lower limb alignment changed from valgus to normal position without chondral degeneration. Washington et al.[33] reported that one-third of the cases showed mild degenerative changes. In contrast, there were no knee which had advanced osteoarthritic changes. Räber et al.[34] found that there was narrowing of the joint space in 18% and both of them to more advanced degrees in 36%. Aglietti et al.[35] showed that there were minor osteophytes in 53% of the cases, while narrowing of the joint space no more than 50% was found in 73% of them. Some of the reports concerning late osteoarthritic changes after total meniscectomy, including discoid lateral meniscus, documented that 9 to 36% of the cases had narrowing of the joint space in no less than 16 years of follow-up.[36] In our case, although narrowing of the joint space was observed, early osteoarthritic changes were not observed 60 months after surgery. However, MRI scans showed mild signal changes of the treated discoid medial meniscus. Wasser et al.[24] reported clinical and MRI results after arthroscopic treatment of discoid lateral meniscus in children. Thirty percent of the cases had a high signal intensity change in T2-weighted MRI at a mean of 28 months

postoperatively. They considered that this fact was the natural course of the healing process in sutured discoid meniscus. No relationship between the hypersignal and clinical results was observed. Therefore, further follow-up is mandatory to evaluate the effects on knee stability and the long-term survival of meniscal function objectively.

In conclusion, this extremely uncommon case of symptomatic bilateral complete discoid medial menisci in a child highlights[37] the effectiveness of arthroscopic partial meniscectomy on symptomatic complete discoid medial menisci based on the 60-month excellent clinical and functional results. After arthroscopic partial meniscectomy of both menisci, the lower limb alignments were changed from valgus to a normal position, and histological examination showed disorganization of the collagen fibers with hypocellularity and no vascularity.

Patient Consent for Publication: A written informed consent was obtained from the parents and/or legal guardians of the patients.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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