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Current Concepts: Evaluation and Treatment of Discoid Meniscus in the Pediatric Athlete

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The discoid meniscus is an uncommon anatomical meniscal variant that may present with pain, snapping, motion loss, swelling, and locking of the affected knee, typically during childhood or adolescence.[1] Although the etiology of discoid meniscus is not completely understood, it is considered a congenital anomaly with a possible genetic component.[2, 3] Incidence is estimated at 0.4% to 5.2% in the Western European population but is reportedly much higher (roughly 17%) in Asian populations.[4-6], Discoid menisci, when present, are almost always in the lateral compartment, although cases of medial discoid meniscus have also been reported. The overall incidence of medial discoid meniscus has been estimated to be between 0.06% and 0.3% while that of lateral discoid meniscus, as detailed above, is significantly higher.[7-11]

ANATOMY AND MORPHOLOGY

The menisci differentiate from mesenchymal tissue early during fetal development with a clear definition by 8 weeks and a mature anatomical shape by 14 weeks in utero.[12] Interestingly, menisci never possess a discoid shape during the normal course of development.[13,14] The meniscus is fully vascularized at birth, with the central one-third becoming avascular by 9 months as the vascular supply regresses.[14] By 10 years, only the peripheral one-third maintains its vascular supply, and the menisci have adult-like characteristics with tissue composed mainly of circumferential collagen fibers.[4,14-16]

A normal meniscus is wedge-shaped in the coronal plane and crescent-shaped in the axial plane. The medial meniscus is shaped like the letter "C," is connected firmly to the joint capsule, and covers approximately 50% of the medial tibial plateau. The normal lateral meniscus covers 70% of the lateral tibial plateau and has firm

anterior and posterior attachments while the lateral portion is less securely tethered.[17] A discoid meniscus is characterized by an atypical shape—the center being partially or completely filled in (or "disc-like")—often associated with anomalous attachments to the tibia, femur, and surrounding joint capsule. In addition to an atypical morphology, the discoid meniscus may also be much thicker than normal, resulting in a "block-like" appearance. The increased thickness may be responsible for the pathognomonic snapping of the knee as it is brought passively into flexion or extension (hence, the term "snapping knee" was traditionally used to describe a symptomatic discoid lateral meniscus). While the discoid shape is relatively straightforward to address, the increased meniscal thickness may be quite difficult to correct surgically.[4-6,18]

In addition to the macromorphological differences characteristic of discoid menisci, histological differences have also been described, including differences in collagen density and disorganization of the circumferential collagen network.[19-21] Taken together, these differences may compromise the ability of the discoid meniscus to withstand normal forces placed across the knee and predispose it to tear. This is important because the normal meniscus plays a critical role in facilitating load distribution across the knee joint, in addition to assisting with functions including shock absorption, proprioception, and stabilization of the knee. Torn and/or unstable discoid menisci are unable to perform these functions adequately, which may ultimately result in degenerative joint disease and progress to end-stage osteoarthritis (OA).

CLASSIFICATION

The traditional Watanabe classification of discoid meniscus consists of 3 variants: type I, a complete discoid shape; type II, an incomplete discoid shape; and type III, the Wrisberg variant.[22] The Wrisberg variant is described as a more normal-appearing meniscus but lacks normal peripheral attachments.[5, 6, 15] This classification system was expanded by Monllau and colleagues, [23] who described a ring-type meniscus variant with normal posterior tibial attachments. Although the Watanabe classification is commonly used, its utility in assisting with clinical decision-making may be limited.

Several other classification schemes exist. Jordan and colleagues[24] described a classification scheme defining a meniscal type as complete or incomplete, also noting the presence of symptoms, tearing, and peripheral rim instability. They grouped stable types together, regardless of morphology, and then further classified them based on the presence of symptoms and tears. Similarly, the unstable types were grouped together and then subclassified in the same manner.[17,24] Klingele and colleagues[25] also described a contemporary classification scheme of discoid meniscus evaluating peripheral stability patterns that may be more clinically and surgically relevant. This classification is based on the type of discoid morphology (complete vs incomplete), the presence or absence of peripheral rim stability (stable vs unstable), and the presence or absence of a meniscal tear (torn vs untorn).[5,25]

EVALUATION

A stable discoid meniscus is often an incidental finding, seen either on advanced diagnostic imaging performed for another reason or at the time of arthroscopy to address another problem. Younger children with discoid meniscus tend to present with symptoms such as popping and snapping related to instability and the abnormal morphology of the discoid meniscus. Older patients tend to present with symptoms related to acute tears through the abnormal meniscal tissue. Although discoid menisci can become acutely symptomatic in the presence of a tear, the onset of symptoms may occur in the absence of a discrete traumatic event.[1] Alternatively, some patients will

report a clear history of injury, often a noncontact, rotational injury mechanism related to an athletic activity. Patients with torn discoid menisci may report pain, catching, locking, and/or giving way of the knee, and on examination may have limited extension, snapping, effusion, quadriceps atrophy, and joint line tenderness. Eponymous meniscal compression tests including the McMurray, Apley, and Thessaly tests, may also be performed when meniscal tear is suspected, although this may be tricky for younger children.[1]

Considering the high association of meniscal tears with ligamentous injuries, examination of knee stability is important. Plain radiographs of the knee should be taken, although the results will often be negative for osseous injury in the case of an isolated meniscal tear. Radiographs of a discoid knee may show subtle differences compared with radiographs of a non-discoid knee. A recent comparison of children with symptomatic lateral discoid menisci with age-matched controls found statistically significant increased lateral joint space, elevated fibular head, increased height of the lateral tibial spine, and increased obliquity of the tibial plateau.[26] They did not find statistically significant increased squaring of the lateral femoral condyle or cupping of the lateral tibial plateau. Radiographic signs can be subtle and may not all be present in a patient with a discoid meniscus.

Magnetic resonance imaging (MRI) is the assessment technique of choice for the diagnosis of discoid meniscus, although MRI may not reliably identify a Wrisberg variant or incomplete discoid menisci (**Figure 1**).

Gans and colleagues[27] examined preoperative MRI and clinical examination compared with pathology found during arthroscopy. Although they found that MRI and clinical examination had excellent diagnostic accuracy of 92.7% and 95.3%, respectively, the most common missed pathology on MRI later found on diagnostic arthroscopy was the presence of a lateral discoid meniscus, which occurred in 26.7% of missed diagnoses. Adult diagnostic criteria of discoid meniscus include ≥3 contiguous 5-mm sagittal cuts showing continuity between the anterior and posterior horns of the meniscus. Other criteria include a minimal meniscal width >15 mm on the coronal view or a minimum meniscal width that is >20% of the width of the maximal tibial width.[28] These criteria are often applied to children as well. Additionally, if >50% of the lateral joint space is covered by meniscal tissue, a diagnosis of discoid meniscus should be considered.[6]

TREATMENT

Management of symptomatic discoid meniscus is directed toward resolving symptoms while preserving meniscal tissue and preventing the development of OA. Incidentally found discoid menisci in asymptomatic patients should not be treated surgically and can have periodic follow-ups for detection of any functional deterioration or symptom development. Surgical treatment may be beneficial for patients with symptoms related to their discoid menisci such as pain, recurrent effusion, limited knee motion, mechanical symptoms (e.g., locking and catching), and activity restrictions.

Traditionally, surgical treatment of a symptomatic discoid meniscus consisted of subtotal (meaning nearly complete, or <3mm of peripheral rim remaining) or complete meniscectomy, often performed in an open fashion. Surgical techniques have evolved; current surgical approaches typically include diagnostic arthroscopy followed by arthroscopic saucerization (also called partial meniscectomy) of the central portion of the “disc,” leaving a peripheral rim of 6 mm to 8 mm to approximate that of the normal meniscus (**Figure 2**).[29,30] Saucerization removes the redundant central meniscal tissue in an attempt to create a more “normal” C-shaped morphology, although it does not address the increased thickness characteristic of many discoid menisci. It may be particularly difficult to “debulk” an abnormally thick discoid meniscus in the coronal plane, and there is little in the outcomes literature

to support this approach. Following partial meniscectomy, the remaining meniscal tissue should be inspected thoroughly both for the presence of instability and for residual tears. Meniscal tears should be repaired in standard fashion; commonly, this may be a combination of all-inside sutures placed into the posterior horn, inside-out sutures placed into the midbody, and outside-in sutures placed into the anterior horn. Peripheral rim instability—identified, for example, by the ability to translate the posterior horn of the meniscus fully onto the anterior tibial plateau—should be addressed by suturing the meniscus to the adjacent capsule (**Figure 2**).[25, 31] Menisci that have residual complex tears that are not amenable to repair may be treated by subtotal meniscectomy. These patients may be candidates for subsequent meniscal allograft transplantation.[32,33]

TREATMENT OUTCOMES

Performing a partial meniscectomy has consistently been shown in the laboratory to increase contact stresses proportionally to the percentage of tissue removed.[34] It follows logically that performing a subtotal or complete meniscectomy in a young patient would yield increased, abnormal contact stresses throughout the knee with resultant degenerative changes and progression to OA over time. While long-term outcome studies of subtotal or complete meniscectomy have shown somewhat variable results, the majority report the development of pain, instability, poor function, osteoarthritic changes and even the development of osteochondritis desiccans.[5,35]

In an early investigation of long-term outcomes associated with surgical resection of a discoid lateral meniscus, Räber and colleagues[36] retrospectively examined 17 knees that had undergone total meniscectomy for the lateral discoid meniscus. At a mean follow-up of 19.8 years, these authors reported that patients accounting for 10 of 17 operative knees had developed symptoms of osteoarthrosis such as pain. In addition, two-thirds of the knees that had follow-up radiographs performed (10 of 15 knees) had visible osteoarthritic changes present.

In 2011, Stilli and colleagues[37] conducted a mid-term follow-up study examining 104 knees over an average follow-up of 8.5 years, with an average age of 8 years at the time of surgery. Younger patients, 2 to 7 years, underwent subtotal meniscectomy whereas patients, 8 to 14 years, underwent arthroscopic partial meniscectomy. Patients with a Wrisberg variant underwent removal of the posterior horn. The authors of this study reported that younger patients who had undergone subtotal meniscectomy had the best outcomes (defined by self-reported questionnaire responses and clinical evaluation). However, these results should be interpreted with caution: at the time of follow-up, patients in this study would still have been in adolescence and may not yet have developed the symptomatic degenerative changes in the knee joint that are strongly associated with meniscectomy.

There are few long-term outcome studies for arthroscopic saucerization. In 2014, Ahn and colleagues[38] examined patient-reported outcomes and radiographic changes for 48 knees in pediatric patients treated arthroscopically for a symptomatic discoid meniscus. Patients were treated with partial meniscectomy (22 knees), partial meniscectomy with meniscal repair (18 knees), or subtotal meniscectomy (8 knees). Out of 48 knees evaluated, 45 knees (94%) were rated as “excellent” or “good” at an average 10-year follow-up. However, a significant percentage of patients had evidence of degenerative changes on follow-up radiographs, specifically: 88% of the subtotal meniscectomy group, 39% of the partial meniscectomy with repair group, and 23% in the partial meniscectomy-alone group. This finding suggests that the early appearance of radiographic changes suggestive of OA does not necessarily correlate with the development of knee symptoms in this cohort, although longer-term follow-up of these patients into adulthood and middle age is clearly needed.

Recently, short-term outcomes have been reported for contemporary arthroscopic saucerization of discoid menisci with peripheral rim stabilization performed as deemed necessary at the time of surgery. In 2012, Carter and

colleagues[39] examined 57 knees that underwent saucerization alone or saucerization with peripheral rim stabilization. At an average follow-up of 15 months, both patient populations had equivalent self-reported outcomes and clinical examination findings. The authors concluded that peripheral stabilization does not negatively affect short-term outcomes if instability is recognized and treated.

Yoo and colleagues[40] found equivalent results between patients undergoing saucerization, saucerization with rim stabilization, and subtotal meniscectomy for 100 pediatric knees with an average follow-up of 4.7 years. Subtotal meniscectomy was defined as <3 mm of peripheral rim remaining and was performed when there was severe degeneration or complex tearing of the remnant rim following arthroscopic saucerization. Taken together, these data seem to suggest that short- and mid-term outcomes for pediatric patients treated surgically are generally good in terms of reported clinical function and development of OA, although long-term follow-up studies will be essential for understanding the true impact of surgical interventions.

Shieh and colleagues[41,42] investigated risk factors for failed meniscal surgery in 324 menisci from 2008 to 2012, including in 46 discoid saucerization procedures with or without stabilization. At a mean of 40 months, 15% of the discoid saucerization cohort required a revision procedure, with increased odds of revision surgeries in patients who had undergone meniscal tear repair. The most frequent indication of revision surgery was sustaining a meniscal tear during intense physical activity in the first year after the index procedure, and patients underwent either debridement or repair for their revision procedure.

SUMMARY

Discoid meniscus is a rare anatomical meniscal variant characterized by an abnormal “O-like” shape, increased meniscal thickness, disorganization of collagen fibers, and variable absence of peripheral attachments. These morphological changes predispose patients with discoid menisci to increased rates of symptomatic meniscal instability and tearing. An MRI remains the most sensitive imaging modality for the diagnosis of a discoid meniscus, with ≥3 contiguous 5-mm sagittal cuts showing continuity between the anterior and posterior horns indicative of a discoid variant. Surgical treatment for symptomatic discoid menisci has evolved from subtotal meniscectomy to contemporary arthroscopic saucerization techniques with repair of meniscal tears and peripheral stabilization performed as needed. Long-term outcome studies for patients who undergo subtotal or complete meniscectomy reveal an association with osteoarthritic changes of the knee. Short- and mid-term outcome studies for patients who undergo arthroscopic saucerization with or without repair and/or peripheral stabilization are generally good, although reoperation rates have been estimated at 15% in the first 3 to 4 years. Longer-term follow-up, with the inclusion of validated functional outcomes measures, will be essential for understanding the true impact of various surgical interventions over time.

Key Info

Key Info:

Take-Home Points

- The discoid meniscus is a congenital variant that is present from birth and may or not become symptomatic as a child matures.

- MRI may be used to make the diagnosis of discoid lateral meniscus, defined as 3 or more consecutive sagittal 5-mm cuts demonstrating contiguity of the anterior and posterior horns.
- A useful classification system for discoid meniscus describes the shape of the meniscus (complete or partial disc), whether it is torn (torn or intact), and whether it has peripheral instability (stable or unstable).
- Surgical treatment of symptomatic discoid lateral meniscus is aimed at restoring normal morphology and stability to the abnormal meniscus.
- Short- and mid-term outcomes following partial meniscectomy with repair and/or stabilization as needed are generally good; long-term outcomes following subtotal or complete meniscectomy are poor, demonstrating progression to early arthritis.

Figures/Tables

Figures / Tables:

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References

References

1. Yaniv M, Blumberg N. The discoid meniscus. J Child Orthop. 2007;1(2):89-96. doi: 10.1007/s11832-007-0029-1.

2. Gebhardt M, Rosenthal R. Bilateral lateral discoid meniscus in identical twins. J Bone Joint Surg Am. 1979;61(7):1110-1111. doi: 10.2106/00004623-197961070-00027.
3. Dashefsky JH. Discoid lateral meniscus in three members of a family. J Bone Joint Surg, (Am.). 1971;53(6):1208-1210. doi: 10.2106/00004623-197153060-00018.
4. Francavilla ML, Restrepo R, Zamora KW, Sarode V, Swirsky SM, Mintz D. Meniscal pathology in children: differences and similarities with the adult meniscus. Pediatr Radiol. 2014;44(8):910-925. doi: 10.1007/s00247-014-3022-0.
5. Kushare I, Klingele K, Samora W. Discoid meniscus: diagnosis and management. Orthop Clin North Am. 2015;46(4):533-540. doi: 10.1016/j.ocl.2015.06.007.
6. McKay S, Chen C, Rosenfeld S. Orthopedic perspective on selected pediatric and adolescent knee conditions. Pediatr Radiol. 2013;43(1):99-106. doi: 10.1007/s00247-012-2587-8.
7. Greis PE, Bardana DD, Holmstrom MC, Burks RT. Meniscal injury: I. Basic science and evaluation. J Am Acad Orthop Surg. 2002;10(3):168-176. doi: 10.5435/00124635-200205000-00003.
8. Ikeuchi H. Arthroscopic treatment of the discoid lateral meniscus. Technique and long-term results. Clin Orthop Relat Res. 1982;167(167):19-28.
9. Nathan PA, Cole SC. 12 Discoid meniscus: a clinical and pathologic study. Clin Orthop Relat Res: SC: Cole. 1969;64:107-113.
10. Jeannopoulos CL. Observations on discoid menisci. J Bone Joint Surg, (Am.). 1950;32(3):649-652. doi: 10.2106/00004623-195032030-00019.
11. Dickason J, Del WP, Blazina ME, Fox JM, Friedman MJ, Snyder SJ. A series of ten discoid medial menisci. Clin Orthop Relat Res. 1982;168:75-79. doi: 10.1097/00003086-198208000-00014
12. Andrish JT. Meniscal injuries in children and adolescents: diagnosis and management. J Am Acad Orthop Surg. 1996;4(5):231-237. doi: 10.5435/00124635-199609000-00001.
13. Kaplan E. The embryology of the menisci of the knee joint. Bull Hosp Joint Dis. 1955;16(2):111-124.
14. Clark C, Ogden J. Development of the menisci of the human knee joint. Morphological changes and their potential role in childhood meniscal injury. J Bone Joint Surg, (Am.). 1983;65(4):538-547 doi: 10.2106/00004623-198365040-00018.
15. Carter CW, Kocher MS. Meniscus repair in children. Clin Sports Med. 2012;31(1):135-154. doi: 10.1016/j.csm.2011.09.002.
16. Shieh A, Bastrom T, Roocroft J, Edmonds EW, Pennock AT. Meniscus tear patterns in relation to skeletal immaturity: children versus adolescents. Am J Sports Med. 2013;41(12):2779-2783. doi: 10.1177/0363546513504286.
17. Jordan MR. Lateral meniscal variants: evaluation and treatment. J Am Acad Orthopsurg. 1996;4(4):191-200. doi: 10.5435/00124635-199607000-00003.
18. Flouzat-Lachaniette C, Pujol N, Boisrenoult P, Beaufils P. Discoid medial meniscus: report of four cases and literature review. Orthop Traumatol Surg Res. 2011;97(8):826-832. doi: 10.1016/j.otsr.2011.07.011.
19. Choi Y-H, Seo Y-J, Ha JM, Jung KH, Kim J, Song SY. Collagenous ultrastructure of the discoid meniscus: A Transmission Electron Microscopy Study. Am J Sports Med. 2017;45(3):598-603. doi: 10.1177/0363546516674181.
20. Atay OA, Pekmezci M, Doral MN, Sargon MF, Ayvaz M, Johnson DL. Discoid meniscus: an ultrastructural study with transmission electron microscopy. Am J Sports Med. 2007;35(3):475-478. doi: 10.1177/0363546506294678.
21. Papadopoulos A, Kirkos JM, Kapetanos GA. Histomorphologic study of discoid meniscus. Arthroscopy. 2009;25(3):262-268. doi: 10.1016/j.arthro.2008.10.006.
22. Watanabe M, Takeda S, Ikeuchi H. Atlas of Arthroscopy. Tokyo: Igaku-Shoin Ltd; 1969.
23. Monllau JC, León A, Cugat R, Ballester J. Ring-shaped lateral meniscus. Arthroscopy. 1998;14(5):502-504. doi: 10.1016/S0749-8063(98)70079-9.

24. Jordan M, Duncan J, Bertrand S. Discoid lateral meniscus: a review. S Orthop J. 1993;2(4):239-253.
25. Klingele KE, Kocher MS, Hresko MT, Gerbino P, Micheli LJ. Discoid lateral meniscus: prevalence of peripheral rim instability. J Pediatr Orthop. 2004;24(1):79-82. doi: 10.1097/01241398-200401000-00015.
26. Choi SH, Ahn JH, Kim KI, et al. Do the radiographic findings of symptomatic discoid lateral meniscus in children differ from normal control subjects? Knee Surg Sports Traumatol Arthrosc. 2015;23(4):1128-1134. doi: 10.1007/s00167-014-2924-6.
27. Gans I, Bedoya MA, Ho-Fung V, Ganley TJ. Diagnostic performance of magnetic resonance imaging and pre-surgical evaluation in the assessment of traumatic intra-articular knee disorders in children and adolescents: what conditions still pose diagnostic challenges? Pediatr Radiol. 2015;45(2):194-202. doi: 10.1007/s00247-014-3127-5.
28. Samoto N, Kozuma M, Tokuhisa T, Kobayashi K. Diagnosis of discoid lateral meniscus of the knee on MR imaging. Magn Reson Imaging. 2002;20(1):59-64. doi: 10.1016/S0730-725X(02)00473-3.
29. Hayashi LK, Yamaga H, Ida K, Miura T. Arthroscopic meniscectomy for discoid lateral meniscus in children. J Bone Joint Surg, (Am.). 1988;70(10):1495-1500. doi: 10.2106/00004623-198870100-00009.
30. Kim S-J, Kim D-W, Min B-H. Discoid lateral meniscus associated with anomalous insertion of the medial meniscus. Clin Orthop Rel Res. 1995;315(315):234-237 doi: 10.1097/00003086-199506000-00026.
31. Adachi N, Ochi M, Uchio Y, Kuriwaka M, Shinomiya R. Torn discoid lateral meniscus treated using partial central meniscectomy and suture of the peripheral tear. Arthroscopy. 2004;20(5):536-542. doi: 10.1016/j.arthro.2004.01.028.
32. Kim J-M, Bin S-I. Meniscal allograft transplantation after total meniscectomy of torn discoid lateral meniscus. Arthroscopy. 2006;22(12):1344-1350.e1. doi: 10.1016/j.arthro.2006.07.048.
33. Ramme AJ, Strauss EJ, Jazrawi L, Gold HT. Cost effectiveness of meniscal allograft for torn discoid lateral meniscus in young women. Phys Sportsmed. 2016;44(3):278-282. doi: 10.1080/00913847.2016.1197762.
34. Baratz ME, Fu FH, Mengato R. Meniscal tears: the effect of meniscectomy and of repair on intraarticular contact areas and stress in the human knee: a preliminary report. Am J Sports Med. 1986;14(4):270-275. doi: 10.1177/036354658601400405.
35. Wroble RR, Henderson RC, Campion ER, el-Khoury GY, Albright JP. Meniscectomy in children and adolescents. A long-term follow-up study. Clin Orthop Relat Res. 1992;279(279):180-189.
36. Räber D, Friederich N, Hefti F. Discoid lateral meniscus in children. Long-term follow-up after total meniscectomy. J Bone Joint Surg, (Am.). 1998;80(11):1579-1586. doi: 10.2106/00004623-199811000-00003.
37. Stilli S, Reggiani LM, Muccioli GMM, Cappella M, Donzelli O. Arthroscopic treatment for symptomatic discoid lateral meniscus during childhood. Knee Surg Sports Traumatol Arthrosc. 2011;19(8):1337-1342. doi: 10.1007/s00167-011-1440-1.
38. Ahn JH, Kim KI, Wang JH, Jeon JW, Cho YC, Lee SH. Long-term results of arthroscopic reshaping for symptomatic discoid lateral meniscus in children. Arthroscopy. 2015;31(5):867-873. doi: 10.1016/j.arthro.2014.12.012.
39. Carter CW, Hoellwarth J, Weiss JM. Clinical outcomes as a function of meniscal stability in the discoid meniscus: a preliminary report. J Pediatr Orthop. 2012;32(1):9-14. doi: 10.1097/BPO.0b013e31823d8338.
40. Yoo WJ, Jang WY, Park MS, et al. Arthroscopic treatment for symptomatic discoid meniscus in children: midterm outcomes and prognostic factors. Arthroscopy. 2015;31(12):2327-2334. doi: 10.1016/j.arthro.2015.06.032.
41. Shieh A, Edmonds EW, Pennock AT. Revision meniscus surgery in children and adolescents: the effect of skeletal immaturity. Orthop J Sports Med. 2015;3(7):S00075:2325967115. doi: 10.1177/2325967115S00075.
42. Shieh AK, Edmonds EW, Pennock AT. Revision meniscal surgery in children and adolescents: risk factors and mechanisms for failure and subsequent management. Am J Sports Med. 2016;44(4):838-843.

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