CASE REPORT

Wrisberg variant of the discoid lateral meniscus with flipped meniscal fragments simulating bucket-handle tear: MRI and arthroscopic correlation

Brian W. Yue · Anil K. Gupta ·
Claude T. Moorman III · William E. Garrett ·
Clyde A. Helms

Abstract An MRI diagnosis of the Wrisberg variant discoid lateral meniscus should be considered in patients presenting with an anteriorly flipped posterior horn fragment without a definable peripheral rim. We present four cases discovered on arthroscopy that were thought to resemble bucket-handle tears on preoperative MRI. Posterior hypermobility poses a surgical challenge as excessive debridement without careful attention to underlying meniscal morphology may lead to further instability. Although this diagnosis can be difficult to make on MRI, alerting the orthopedic surgeon preoperatively may influence repair technique and meniscus conservation.

Keywords Knee · Knee injuries · Magnetic resonance imaging · Discoid lateral meniscus · Wrisberg variant · Arthroscopy

Introduction

The discoid lateral meniscus is an anatomic variant found in 1–5% of the population [1]. The Watanabe classification is the most widely used, which describes the discoid morphology as type I complete, type II incomplete, and type III meniscofemoral ligament type or Wrisberg variant [2]. The Wrisberg variant is the rarest subtype [3]. It may not have a true discoid shape, and some may retain the C-shape or have a hypertrophic posterior horn [2, 4, 5]. Anatomically, the normal lateral meniscus is stabilized posteriorly by the meniscofemoral ligament, the meniscotibial coronary ligament, and the popliteomeniscal fascicles of which there are three: anteroinferior, posterosuperior, and posteroinferior. The posteroinferior fascicle may only be variably present [6]. The Wrisberg variant is characterized by lack of the meniscotibial coronary ligament and the popliteomeniscal fascicles, with the meniscofemoral ligament of Wrisberg or Humphrey as the only posterior stabilizing structure. The absence of normal posterior attachments predisposes the posterior horn to hypermobility and subluxation leading to knee pain, popping, and locking [7, 8]. The classic presentation is that of the "snapping knee" in a young patient [9].

The Wrisberg variant has not received much attention in the radiology literature. Singh et al., in 2006 [1] reported a case series of two patients with surgical confirmation, a 15-year-old boy and a 62-year-old woman, who had non-visualization of normal meniscocapsular attachments and a vertically oriented posterior horn of the lateral meniscus. The lack of normal posterior attachments and/or abnormal shape of the Wrisberg variant type discoid lateral meniscus predisposes it towards hypermobility and tearing. It has been reported to subluxate, leading to locking of the knee [10, 11], and has also been associated with a foreshortened ligament of Wrisberg [12]. Complex degenerative, longitudinal, and horizontal tears have also been reported [3, 13].

To our knowledge, the Wrisberg variant discoid lateral meniscus with an anteriorly flipped posterior horn simulat-

B. W. Yue (✉) · C. A. Helms
Department of Radiology, Duke University Medical Center,
Box 3808, Durham, NC 27710, USA
e-mail: brianyue@gmail.com

C. A. Helms
e-mail: clyde.helms@duke.edu

A. K. Gupta · C. T. Moorman III · W. E. Garrett
Department of Orthopedic Surgery, Duke South Clinic,
Durham, NC 27710, USA

Present Address:
B. W. Yue
Danbury Radiological Associates, P.C.,
24 Hospital Ave, 3rd Floor Radiology,
Danbury, CT 06810, USA

ing a bucket-handle tear has not been reported. We report a case series of four surgically confirmed Wrisberg variant type discoid lateral menisci for which the initial preoperative MRI appearance mimicked large bucket-handle tears confounding the diagnosis.

Materials and methods

The study was approved by the institutional review board. As this was a retrospective study, informed consent was not necessary.

Four cases of Wrisberg variant discoid lateral menisci were identified, two by an orthopedic surgeon at our institution and two by preoperative MRI with subsequent arthroscopic confirmation by the same surgeon (Table 1). General arthroscopic criteria for the Wrisberg variant discoid lateral meniscus include hypermobility of the meniscus shown both by probing with flexion and extension during arthroscopy and by the absence of a fascicular attachment to the capsule and popliteus tendon, as well as the absence of the normal coronary ligament attachment to the tibia.

The preoperative MRI scans were retrospectively reviewed. All imaging was conducted on a 1.5-T closed magnet MR scanner (Signa HDx/Excite, GE Healthcare or Symphony, Siemens Healthcare). Imaging protocols included fast spin-echo/turbo spin-echo fat saturation proton density-weighted sagittal images (TR/TE, 1,500–2,000/20 ms; slice thickness, 4 mm; interslice gap, 0.4 mm; field of view, 14–17 cm; matrix, 256–288×192) as well as sagittal, coronal, and axial fast spin-echo/turbo spin-echo T2-weighted images with fat-saturation (TR/TE, 3,550–4,140/55–70 ms; slice thickness, 4 mm; interslice gap, 0.4 mm; field of view, 14–17 cm; matrix, 256–320×192–212).

Results

Case 1

This was a 26-year-old man presenting with lateral-sided left knee pain exacerbated by occasional locking that occurred while going up and down stairs. This problem started 5 months prior after he slipped on snow. On exam, he had lateral joint line tenderness, pain with the McMurray test, and decreased range of motion compared to the contralateral lower extremity.

MRI revealed a diffusely macerated and torn lateral meniscus with a large fragment flipped anteriorly and into the intercondylar notch (Fig. 1). The posterior attachments could not be assessed.

Arthroscopy showed a large flipped fragment of meniscus impinging into the intercondylar notch with a complex degenerative tear. As it could not be repaired, the meniscus was debrided (approximately 50%) and then reduced. However, there was no attachment of the lateral meniscus to the posterior joint capsule or tibia, consistent with a Wrisberg variant type. As the residual portion of meniscal tissue was stable to probing with flexion and extension post-debridement, it was decided not to repair it to the posterior capsule.

Case 2

This was a 25-year-old woman with persistent pain occasionally radiating anteriorly, swelling, popping, and lack of extension since twisting her right knee in a bus accident 2 years prior. On exam there was posterolateral joint line tenderness, full range of motion, pain with forced extension, and a positive McMurray test with an audible "clunk."

The MRI was interpreted as a large bucket handle tear involving the body segment and posterior horn of the lateral meniscus displaced into the intercondylar notch (Fig. 2). The posterior capsular attachments were not able to be assessed.

Arthroscopy showed an unstable complex tear of the posterior horn lateral meniscus extending into the body and anterior horn with meniscal tissue displaced medially into the notch. The meniscus was discoid in shape, and there were no posterior capsular, coronary, or popliteus attachments, which was consistent with a Wrisberg variant. Since it could not be reduced and repaired, approximately 50% of the meniscus needed to be excised. The residual meniscal tissue was stable following partial excision.

Table 1 Patient population

Age (years), sex	Knee	Clinical	History	Days to surgery
26, Male	Left	Locking going up/down stairs, nagging pain/swelling	Fell on snow 5 months prior	8
25, Female	Right	Swelling and popping	MVA 2 years prior	39
9, Male	Right	Catching and popping	Hyperextension 1 year prior	183
	Left	Catching and popping	No trauma	65

Fig. 1 A 26-year-old man with left knee locking and pain. a Sagittal T2. The posterior horn (*arrow*) is flipped anteromedially and is macerated. Full thickness cartilage loss present in the lateral femoral condyle. b Coronal T2. Meniscal tissue is flipped medially into the intercondylar notch (*arrow*). Partial thickness cartilage loss present in the lateral femoral condyle and medial tibial plateau with reactive marrow edema
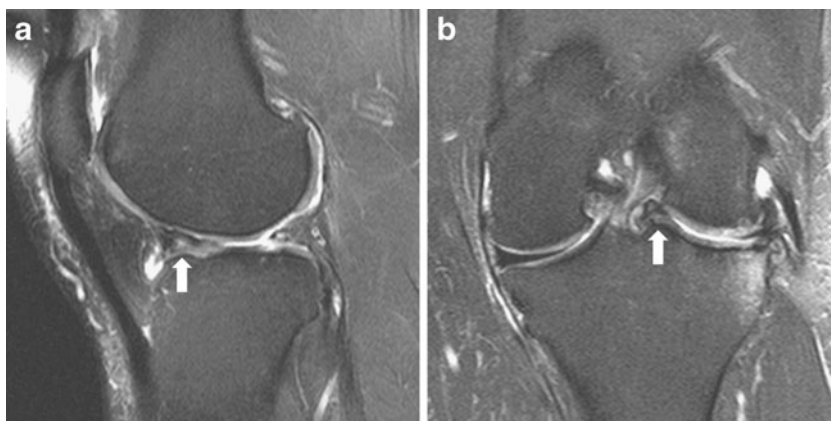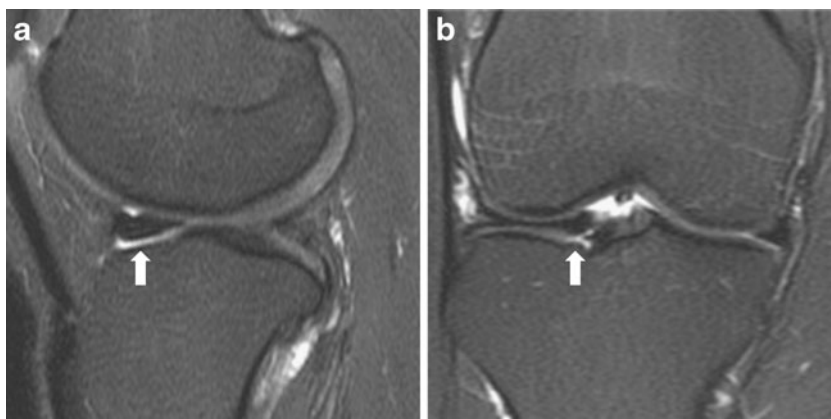

Cases 3 and 4

A 9-year-old boy presented with the complaint of long-standing painful catching and popping of both knees. One year prior he had hyperextended his right knee while playing soccer. The left knee began hurting several months later with similar pain, but there was no history of trauma. The pain was poorly localized and aggravated with activity. Examination revealed moderate peripatellar and lateral joint line tenderness, intermittent lateral joint line snapping, and pain with range of motion bilaterally.

MRI of both knees showed a double-anterior horn sign, deficiency of the body segment and posterior horn, and meniscal tissue displaced into the intercondylar notch with the simulated appearance of large bucket-handle tears (Figs. 3a and 4a, b). The posterior attachments of the menisci to the joint capsule were absent and could not be assessed. However, because of the patient's young age, the differential diagnosis of underlying bilateral Wrisberg variant menisci was offered prospectively. There was an overall appearance of too much meniscal tissue suggesting an underlying discoid morphology. This was more pronounced in the left knee lateral meniscus, which had an abnormally enlarged anterior horn with an intrameniscal cyst or degeneration.

Right knee arthroscopy demonstrated a Wrisberg variant with discoid morphology and absence of meniscocapsular, coronary, and popliteomeniscal fascicular attachments. The unstable posterior portion of the discoid meniscus was displaced into the intercondylar notch with a bulbous end adjacent to the anterior cruciate ligament (ACL), simulating a bucket handle tear (Fig. 3b, c). No peripheral meniscal tear was found. The bulbous portion was debrided and saucerized to enable reduction into the lateral compartment. Since the meniscus was unstable posteriorly following reduction, it was sutured to the posterolateral capsule using an inside-out repair technique.

Similarly, left knee arthroscopy demonstrated a complete discoid lateral meniscus with no capsular, coronary, or popliteomeniscal fascicular attachments, consistent with a Wrisberg variant. Its meniscofemoral attachment was attenuated. The medial portion was easily subluxated in and out of the intercondylar notch with a probe. The anterior horn was excessively large and this was saucerized and centrally debrided to allow reduction to an anatomic position (Fig. 4c). A longitudinal meniscal tear was noted at the junction of the body and mid-posterior horn following reduction of the displaced meniscal tissue (not shown). This was repaired and the entire meniscus stabilized to the posterolateral capsule using an inside-out repair technique (Fig. 4d).

Fig. 2 A 25-year-old woman with right knee pain on extension and an audible "clunk." a Sagittal T2. Double anterior horn sign (*arrow*) from an anteriorly flipped posterior horn fragment rather than a bucket handle tear. b Coronal T2. An inordinate amount of meniscal tissue (*arrow*) is present in the intercondylar notch suggesting discoid morphology
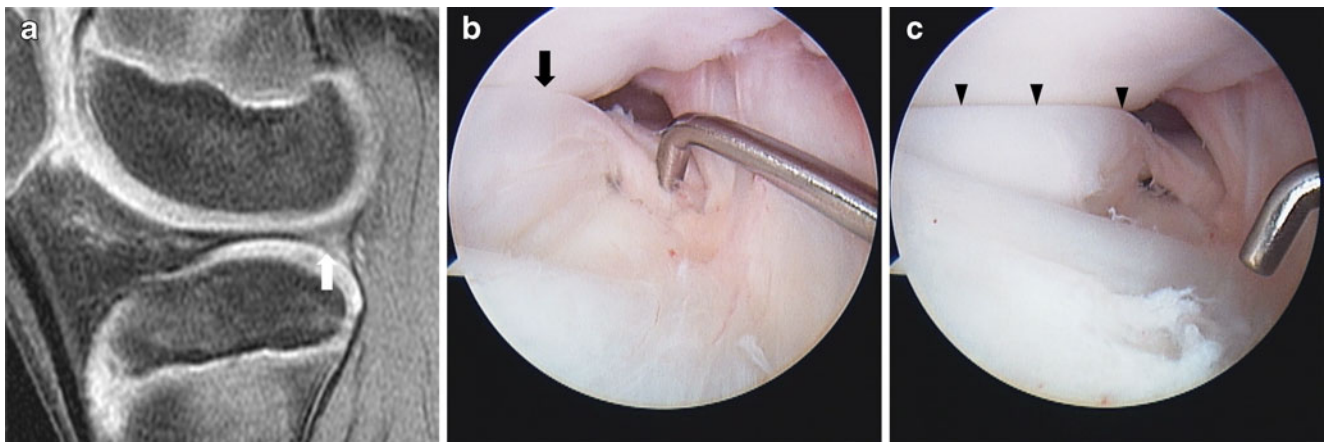
Fig. 3 A 9-year-old boy with right knee locking and catching. **a** Sagittal T2 image showing an absent posterior horn (*arrow*). **b** Discoid meniscal tissue (*arrow*) flipped adjacent to the ACL (*probe*). **c** The smooth margin suggests that this is not a peripheral bucket handle tear (*arrowheads*)

Discussion

All four knees showed findings of the Wrisberg variant discoid lateral meniscus on arthroscopy. All four knees also showed anteriorly flipped posterior meniscal fragments, which simulated the appearance of large bucket handle tears on preoperative MRI. The characteristic absence of the popliteomeniscal fascicles and meniscotibial coronary ligament could not be assessed (Fig. 5) because the posterior horn was flipped, which therefore confounded the MRI diagnosis of the Wrisberg variant meniscus.

There is one case reported in the literature of a 12-year-old boy who could voluntarily lock and unlock his knee, whose MRI showed an anteriorly flipped posterior horn lateral meniscus in the locked-knee position [14]. An MRI performed in the unlocked-knee position showed the lateral meniscus reduced in anatomic position. It was called a Wrisberg variant after dynamic demonstration of posterior horn hypermobility, in contrast to our case for which a preoperative diagnosis was suggested on a single MRI.

In our series, the correct diagnosis of bilateral Wrisberg variant menisci was suggested prospectively in a 9-year-old

Fig. 4 A 9-year-old boy with left knee locking and no trauma. **a** Sagittal T2 image showing a discoid lateral meniscus with cystic degeneration in an enlarged anterior horn (*arrow*). **b** Coronal T2 image showing medially displaced lateral meniscal tissue with cystic degeneration (*arrow*). **c** Arthroscopy photos depict saucerization and central debridement (*arrowheads*) of the discoid lateral meniscus after anatomic reduction. Lateral femoral condyle (*asterisk*). **d** Completed meniscal repair and stabilization to the posterolateral joint capsule with inside-out technique
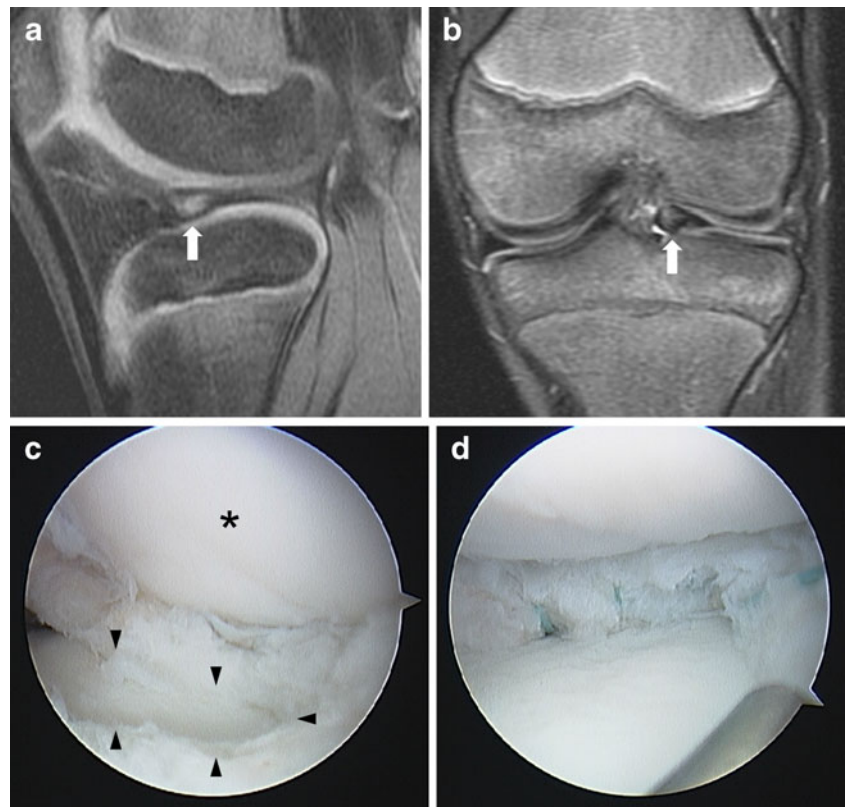
Fig. 5 A 12-year-old boy. Sagittal and coronal T2 images in this arthroscopically proven Wrisberg variant discoid lateral meniscus demonstrating absent struts of the popliteomeniscal fascicles (*arrows*), which has been reported as a key MRI finding in the nontorn, nonsubluxated Wrisberg variant meniscus

boy. The primary basis was the patient's young age at presentation with a painful snapping knee without trauma history. The increased overall amount of meniscal tissue also suggested a discoid morphology.

The other two patients in our series had an atypical presentation at an older age (26-year-old male, 25-year-old female) with history of remote trauma. Also, both patients had complex tears of the menisci that could not be repaired, requiring partial meniscectomy. Complex tears have been described in the nonsubluxated Wrisberg variant menisci [13].

In contrast to our experience with the nonsubluxated variety, we have found it difficult to diagnose a displaced Wrisberg variant meniscus on preoperative MRI apart from the classic presentation. The diagnosis can be missed, even in retrospect. However, the surgical team was able to distinguish the flipped posterior horn of the Wrisberg variant from a bucket-handle tear by identifying a smooth posterior margin with no residual peripheral rim of meniscal tissue.

Some authors have questioned whether trauma to the popliteomeniscal fascicles or meniscotibial coronary ligament could lead to an unstable meniscus reminiscent of a Wrisberg variant discoid lateral meniscus, a so-called post-traumatic Wrisberg variant [7]. It has also been observed that up to 28% of discoid lateral menisci demonstrate some degree of peripheral instability, usually at the anterior third or posterior third capsular attachment [15]. Arthroscopic criteria have not been described that would distinguish a true Wrisberg variant meniscus from a traumatic injury to the posterior capsule, coronary ligament, and fascicles, which could both lead to an unstable posterior horn.

Simonian et al. [7] reported three patients with isolated disruption of the popliteomeniscal fascicles found on arthroscopy. However, none had displaced posterior horns, and in retrospect the struts of the popliteomeniscal fascicles, although torn, could still be seen on MRI. In our study, no popliteomeniscal fascicles could be identified on MRI or by arthroscopy. Woods and Whelan [16] described three patients with isolated tears of the posterior capsule and one patient with partial capsule tear with an intact meniscotibial coronary ligament, none of which had displaced posterior horns. The evidence would suggest that isolated tears of the fascicles or posterior capsule, although contributing to peripheral instability, may not enable the posterior horn to flip anteriorly if the coronary ligament is intact.

The MRI appearance of coronary ligament tears as a "floating meniscus" have been reported, with the largest case series of 21 patients, but these are almost always associated with acute severe trauma and multiligamentous injury such as knee dislocation [17]. Isolated tear of the lateral meniscus coronary ligament is rare [18].

While in theory, simultaneous tears of the popliteomeniscal fascicles and coronary ligaments may mimic an unstable Wrisberg variant discoid lateral meniscus subluxated in a bucket-handle fashion, it would be exceedingly rare for this to occur without other associated injuries from trauma.

Surgical intervention is indicated for symptomatic unstable discoid meniscal variants. The goal with surgical intervention for Wrisberg variant discoid lateral menisci is to preserve healthy meniscal tissue and provide stabilization. This may require repair of an associated tear (if present) and suture stabilization to the posterior capsule due to the lack of coronary or popliteomeniscal fascicular attachments. In skeletally immature patients, meniscal preservation via saucerization is recommended for long-term cartilage preservation [16, 19]. Associated meniscal tears are managed with partial meniscectomy or repair [20, 21] if the tear is amenable to repair and located in the peripheral "red-red" vascular zone. In the young adult population, relative indications for meniscal repair include a tear that is longitudinal, vertical, nondegenerative, within 3 mm of the periphery (vascular zone), and less than 3 cm in length. Most tears in the adult population, however, are degenerative cleavage tears outside of the vascular zone and therefore not amenable to repair. [22, 23].

For unstable Wrisberg variants, peripheral stabilization may be added if the residual meniscus demonstrates subluxation into or outside of the joint [8, 14, 16, 21]. Total meniscectomy is avoided in skeletally immature patients unless the residual meniscus is not amenable to stabilization [24]. Capsular stabilization via an inside-out technique may be attempted if there is enough residual

meniscal tissue to allow for suture fixation to the posterior capsule following debridement. In the setting of acute posterior horn avulsions of the medial meniscus, trans-osseus stabilization is an alternative form of stabilization that can be performed and has demonstrated success in reducing peak joint contact forces in a cadaveric model [25]. A transosseous procedure for the lateral meniscus has not yet been described.

In conclusion, the Wrisberg variant is a rare cause of hypermobile lateral meniscus with an MRI diagnosis suggested by absent popliteomeniscal fascicles and coronary ligaments. Anterior displacement of the posterior horn can mimic a large bucket handle tear and impede evaluation of the posterior attachments, therefore hindering the preoperative diagnosis of the Wrisberg variant even in retrospect. A high level of suspicion is helpful. A young patient presenting with no history of trauma is a classic presentation. It is important to alert the surgeon preoperatively, as careful debridement and/or peripheral stabilization is necessary for optimal treatment of this condition.

Conflict of interest   None.

References

1. Singh K, Helms CA, Jacobs MT, Higgins LD. MRI Appearance of Wrisberg Variant of Discoid Lateral Meniscus. AJR 2006; 187:384–387
2. Watanabe M, Takeda S. Arthroscopy of the knee joint. In: Helfet AJ, editor. Disorders of the knee. Philadelphia: Lippincott; 1974. p. 45.
3. Kim YG, Ihn JC, Park SK, Kyung HS. An arthroscopic analysis of lateral meniscal variants and a comparison with MRI findings. Knee Surg Sports Traumatol Arthrosc. 2006;14(1):20–6.
4. Kaplan EB. Discoid lateral meniscus of the knee joint: nature, mechanism, and operative treatment. J Bone Joint Surg Am. 1957;39:77–87.
5. Kocher MS, Micheli LJ. The pediatric knee: evaluation and treatment. In: Insall JN, Scott WN, editors. Surgery of the knee, vol 2, 3rd ed. New York: Churchill Livingstone; 2001. p.1356–1397.
6. Peduto AJ, Nguyen A, Trudell DJ, Resnick DL. Popliteomeniscal fascicles: anatomic considerations using MR arthrography in cadavers. AJR Am J Roentgenol. 2008;190(2):442–8.
7. Simonian PT, Sussmann PS, Wickiewicz TL, et al. Popliteomeniscal fasciculi and the unstable lateral meniscus: clinical correlation and MRI diagnosis. Arthroscopy. 1997;13:590–6.
8. Neuschwander DC, Drez Jr D, Finney TP. Lateral meniscal variant with absence of the posterior coronary ligament. J Bone Joint Surg Am. 1992;74(8):1186–90.
9. Dickhaut SC, DeLee JC. The discoid lateral-meniscus syndrome. J Bone Joint Surg Am. 1982;64(7):1068–73.
10. Garofalo R, Kombot C, Borens O, Djahangiri A, Mouhsine E. Locking knee caused by subluxation of the posterior horn of the lateral meniscus. Knee Surg Sports Traumatol Arthrosc. 2005;13 (7):569–71.
11. George M, Wall EJ. Locked knee caused by meniscal subluxation: magnetic resonance imaging and arthroscopic verification. Arthroscopy. 2003;19(8):885–8.
12. Rupp S, Seil R, Kohn D. Meniscus lesions. Orthopade. 2002;31:812–31.
13. Atay OA, Doral MN, Leblebicioğlu G, Tetik O, Aydingöz U. Management of discoid lateral meniscus tears: observations in 34 knees. Arthroscopy. 2003;19(4):346–52.
14. Moser MW, Dugas J, Hartzell J, Thornton DD. A hypermobile Wrisberg variant lateral discoid meniscus seen on MRI. Clin Orthop Relat Res. 2007;456:264–7.
15. 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.
16. Woods GW, Whelan JM. Discoid meniscus. Clin Sports Med. 1990;9(3):695–706.
17. Bikkina RS, Tujo CA, Schraner AB, Major NM. The "floating" meniscus: MRI in knee trauma and implications for surgery. AJR Am J Roentgenol. 2005;184(1):200–4.
18. El-Khoury GY, Usta HY, Berger RA. Meniscotibial (coronary) ligament tears. Skeletal Radiol. 1984;11(3):191–6.
19. Gicquel P, Sorriaux G, Clavert JM, Bonnomet F. Discoid menisci in children: clinical patterns and treatment in eighteen knees. Rev Chir Orthop Reparatrice Appar Mot. 2005;91(5):457–64.
20. Ikeuchi H. Arthroscopic treatment of the discoid lateral meniscus. Technique and long-term results. Clin Orthop Relat Res. 1982;167:19–28.
21. Rosenberg TD, Paulos LE, Parker RD, Harner CD, Gurley WD. Discoid lateral meniscus: case report of arthroscopic attachment of a symptomatic Wrisberg-ligament type. Arthroscopy. 1987;3 (4):277–82.
22. Fu F, Baratz ME. Meniscal injuries. In: DeLee J, Drez D, editors. Orthopaedic sports medicine: principles and practice, vol 2. Philadelphia: WB Saunders; 1994. p. 1146–1162
23. Weiss CB, Lundberg M, Hamberg P, DeHaven KE, Gillquist J. Non-operative treatment of meniscal tears. J Bone Joint Surg Am. 1989;71:811–22.
24. Aglietti P, Bertini FA, Buzzi R, Beraldi R. Arthroscopic meniscectomy for discoid lateral meniscus in children and adolescents: 10-year follow-up. Am J Knee Surg. 1999;12(2):83–87
25. Marzo JM, Gurske-DePerio J. Effects of medial meniscus posterior horn avulsion and repair on tibiofemoral contact area and peak contact pressure with clinical implications. Am J Sports Med. 2009;37(1):124–9.