



Surgical Repair of Symptomatic Wrisberg Variant Discoid Lateral Meniscus with Pull-Out Repair and Capsulodesis

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Abstract: Wrisberg variant discoid lateral meniscus (DLM) is a congenital anatomic variation of the meniscus in the knee joint, which is an uncommon type of the DLM. We present a surgical technique in a case of symptomatic Wrisberg variant DLM. To improve the instability due to the lack of the posterior attachment of meniscotibial ligament, the posterior portion of DLM was attached to the insertion site of normal LM posterior root using pull-out repair technique. In addition, a longitudinal tear from the anterior to the middle portion of DLM was repaired with outside-in and inside-out techniques. Finally, a capsulodesis using knotless anchors was performed from outside of the joint to prevent the meniscus extrusion after the surgery. Knee symptoms such as pain, catching, and ROM restriction disappeared at 3 months after the surgery. Postoperative magnetic resonance imaging showed a slightly sharpened shape of the DLM, and the attachment of the posterior portion of the DLM was observed. Longitudinal tear of the DLM was healed without cleavage. This procedure is useful to improve the symptoms of the knee joint with Wrisberg variant DLM and to preserve the function of the meniscus.

Introduction

Discoid lateral meniscus (DLM) is a congenital anatomic variation of the meniscus in the knee joint. The prevalence of DLM is higher in the Asian populations (1.5% to 38%)¹⁻⁴ rather than in the Western populations (1.5 to 5%).^{5,6} DLM is classified into three types based on the morphologic features and presence of the meniscotibial ligament⁷: complete DLM (type I) covers the entire tibial plateau, incomplete

DLM (type II) covers more of the tibial plateau than is normal, and Wrisberg variant (type III) lacks the posterior capsular attachment, with the exception of the posterior meniscofemoral ligament (Wrisberg ligament).

A stable DLM is asymptomatic, and no treatment is necessary. When knee symptoms, including pain, effusion, catching, locking, and limitation of range of motion (ROM) occur associated with an injured DLM,⁸ a surgical procedure should be considered. Previously, total or subtotal meniscectomy had been performed, and satisfactory results were obtained just after the surgery.⁹ However, contact pressure on the lateral compartment dramatically increased, and degeneration of articular cartilage and/or osteochondritis dissecans has emerged,¹⁰ leading to secondary osteoarthritis.⁹ A systematic review has shown that more degenerative change occurs after subtotal or total meniscectomy.¹¹ From the viewpoint of preserving the meniscus function, a saucerization with suture repair has been performed,¹² and satisfactory clinical results were obtained. However, a possible concern is that DLM appears extruded after surgery,^{13,14} and function of the meniscus might not be maintained properly.

For the surgical procedure of the Wrisberg variant DLM, only a small number of reports have been

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reported.¹⁵⁻¹⁷ Neuschwander reported one case of meniscectomy and 6 cases of stabilization of the meniscus to the posterior capsule.¹⁵ Yue reported two cases of partial resection and two cases of inside-out repair of DLM to the posterolateral capsule.¹⁶ Almost good clinical results were obtained; however, a surgical option that can definitely eliminate the instability of the Wrisberg variant DLM has not been established.

Here, we present a surgical technique for treatment of symptomatic Wrisberg variant DLM. To improve the instability due to the lack of the posterior attachment of meniscotibial ligament, posterior portion of DLM is attached to the insertion site of normal LM posterior root using pull-out repair technique. In addition, a longitudinal tear from the anterior to the middle portion of DLM is repaired with outside-in and inside-out techniques. Finally, a capsulodesis using knotless anchors is performed from outside of the

joint to prevent the meniscus extrusion after the surgery.

Indications, Preoperative Patient Evaluation, and Imaging

This technique is indicated for patients with Wrisberg variant DLM, who have symptoms, such as knee pain, effusion, catching, locking, and limitation of ROM. Preoperative magnetic resonance imaging (MRI) is necessary to evaluate the classification, tear pattern, and the shift of the DLM.¹⁸ It is sometimes difficult to accurately diagnose Wrisberg variant DLM on preoperative MRI; in such cases, arthroscopic evaluation is necessary for conclusive diagnosis. For preoperative patient evaluation, a physical examination should be performed for effusion, joint line tenderness at the lateral side of the knee, limitation of knee range of motion, and McMurray test. Preoperative MRI shows a

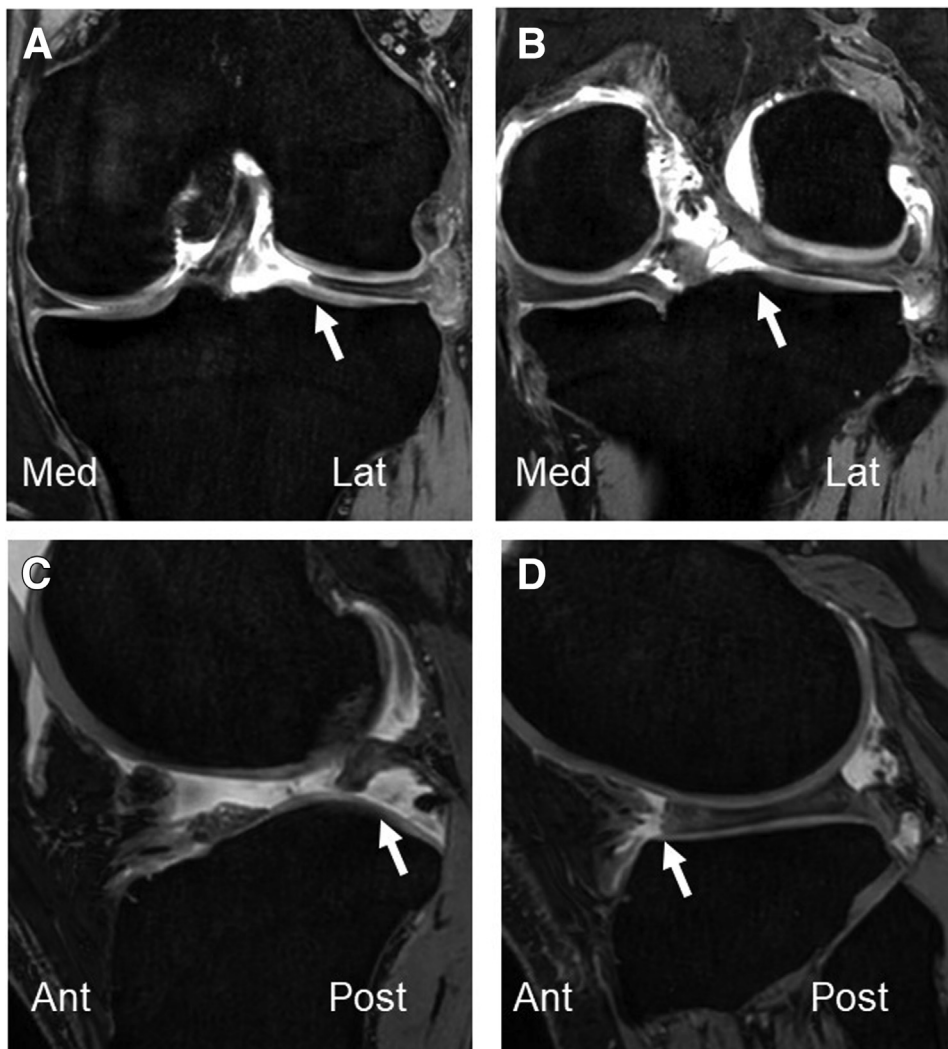


Fig 1. Preoperative MRI of a left knee joint (A and B: coronal planes; C and D: sagittal planes). (A) Discoid lateral meniscus (DLM) covered the most area of the lateral tibial plateau (arrow). (B) No tibial attachment of posterior DLM was observed (arrow). (C) DLM lacked the posterior tibial attachment (arrow). (D) Longitudinal tear was observed at the anterior part of the LM (arrow).

large size of the LM, which covered most of the area of the lateral tibial plateau (Fig 1A). The posterior horn of the LM lacks a bony attachment to the tibia in both coronal and sagittal planes (Fig 1, B and C). Longitudinal tear is observed at the anterior part of the LM (Fig 1D). From these findings, it is diagnosed as the injury of the Wrisberg variant DLM.

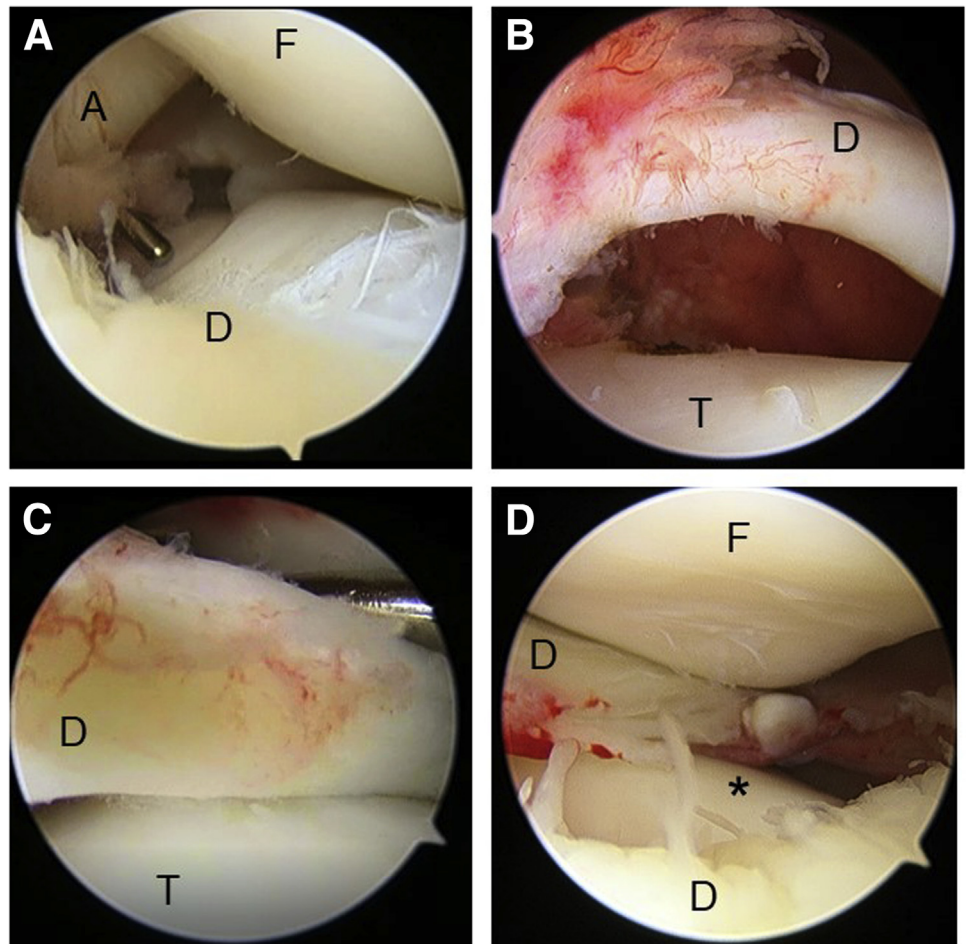
Surgical Technique (With Video Illustration)

The patient is positioned supine on a standard operating table. An anteromedial and anterolateral portals are used for the standard arthroscopic examination (Video 1). Arthroscopic view from the anterolateral portal reveals that the lateral tibial plateau is almost covered with the DLM (Fig 2A). At first, an inside-out suture is addressed for DLM, and the meniscus body is pulled to the lateral peripheral side to better visualize the lateral compartment and to proceed with the surgical procedure. There is no bony attachment of the posterior horn of the DLM (Fig 2B), and the posterior part of the DLM is pulled anteriorly by probing in spite of no obvious tear (Fig 2C). A complete longitudinal

tear is observed in the white-red zone extended from the anterior to the middle part of the DLM (Fig 2D).

For the elimination of the meniscus instability, a bone tunnel is created to attach the posterior portion of the DLM to the tibia. A 2.4-mm guide wire (Arthrex, Naples, FL) is inserted into the insertion site of normal LM posterior root from the anteromedial aspect of the proximal tibia using ACUFEX Director Tip Aimer (Smith & Nephew Endoscopy, Andover, MA) (Fig 3, A and B), and the 6-mm-diameter tunnel is created. Subchondral bone at the lateral side of the tunnel outlet is exposed by a curettage to enhance the healing of the meniscus attachment. A Knee Scorpion Suture Passer (Arthrex, Naples, FL), preloaded with 2-0 FiberWire (Arthrex) is inserted through the anterolateral portal, creating a mattress suture at the posterior horn (Fig 3C). The suture post is placed in front, and the tined suture is left uncut, so this suture can be pulled into the tunnel, as well as work as a locking suture against SutureTapes applied later. Then, 2 SutureTapes (Arthrex) are passed just lateral to the mattress suture using the Knee Scorpion, applying racking hitch knot.

Fig 2. Arthroscopic images of Wrisberg variant discoid lateral meniscus (DLM) in a left knee joint (viewing from an anteromedial portal). (A) DLM covered the most area of the lateral tibial plateau. (B) Posterior portion of the DLM had no tibial attachment and was floated from the tibia. (C) Posterior part of the DLM was displaced anteriorly by probing. (D) Longitudinal tear from the anterior to the middle portion of the DLM was observed with the gap at the tear site and the exposed lateral tibial plateau (asterisk). A denotes anterior cruciate ligament; D denotes DLM; F denotes lateral femoral condyle; and T denotes lateral tibial plateau.



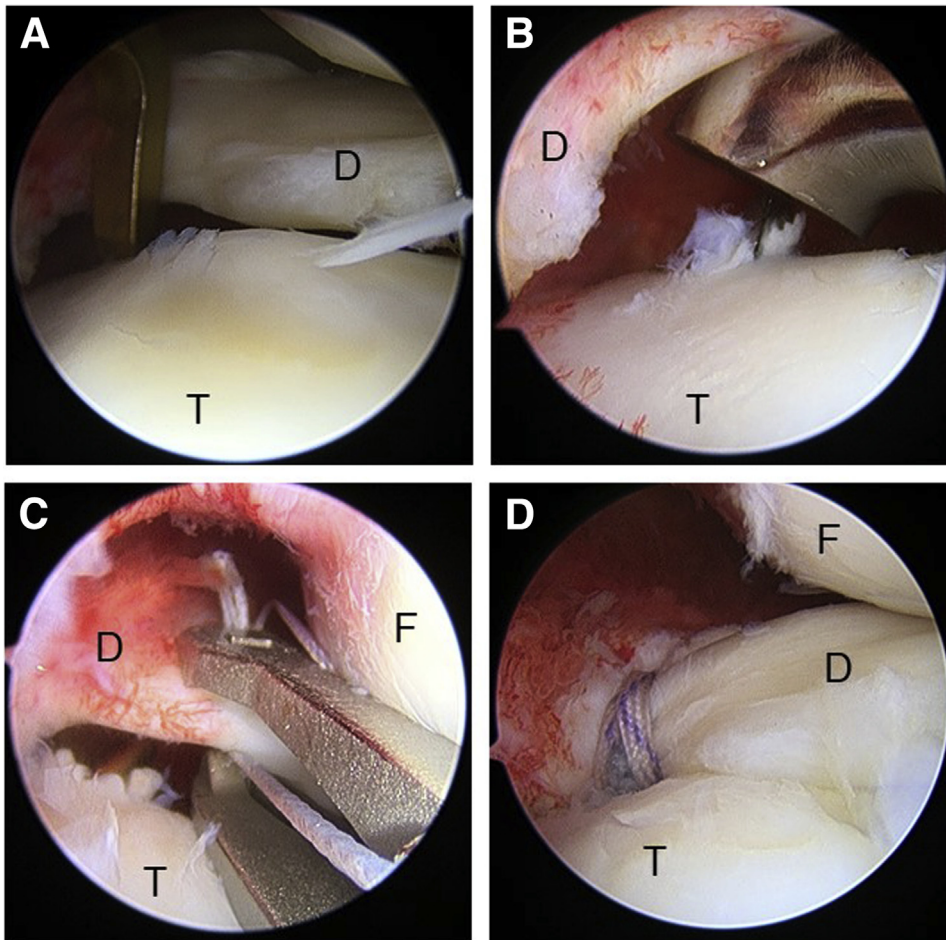


Fig 3. Surgical procedure of creating an attachment of the posterior portion of discoid lateral meniscus (DLM) in a left knee joint. (A) Viewing from an anterolateral portal. (B-D) View from an anteromedial portal. (A) A guide was positioned at the anatomical insertion site of the normal LM posterior root (viewing from an anterolateral portal). (B) A 2.4-mm guidewire was inserted. (C) Subchondral bone at the lateral side of the tunnel outlet was exposed by a curettage. (D) Sutures were secured at the posterior portion of the DLM and pulled into the tunnel. D denotes DLM; F denotes the lateral femoral condyle; T denotes the lateral tibial plateau.

Sutures are shuttled through the bone tunnel to the anteromedial aspect of the proximal tibia without final fixation (Fig 3D).

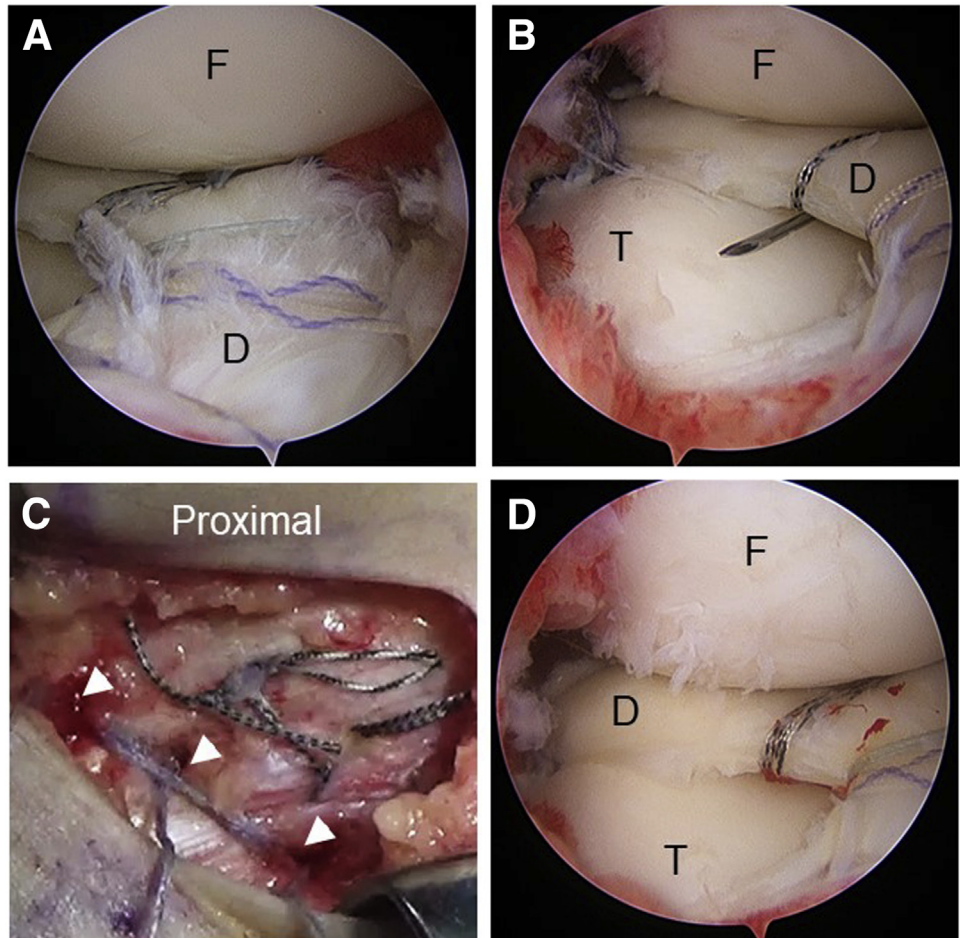
To repair the anterior portion of the longitudinal tear, outside-in technique is performed using a Micro SutureLasso Small Curve with Nitinol Wire Loop (Arthrex). A 2-cm horizontal skin incision is made at the level of the LM to expose a joint capsule. An Ultrablade is passed through both the femoral and tibial sides of the anterior portion of the DLM, and the knot is tied on the capsule. For the repair of the anterior part, 5 sutures are required. To repair the middle portion of the longitudinal tear, inside-out technique is performed using Henning meniscal suture kit (Stryker, Kalamazoo, MI). A 2.5-cm longitudinal skin incision is made under the level of the LM to expose a joint capsule. For the repair of the middle part, a total of 2 inside-out sutures are required (Fig 4A).

Next, for the prevention of the meniscus extrusion, a capsulodesis is performed from the outside of the joint using 1.8-mm Knotless FiberTak Soft Anchors (Arthrex). For the appropriate anchor placement, a

spinal needle (23G) is inserted beneath the meniscus from the outside of the joint (Fig 4B). From the skin incision of the inside-out technique, the anchor is inserted at the edge of the tibial plateau. A total of 3 anchors are inserted at an interval of 1 cm. The repair suture from the second anchor is inserted into the shuttling suture loop from the first anchor, and the shuttling suture of the first anchor is gently pulled to pass the repair suture through the first anchor. The repair suture of the second anchor is tightened. In the same manner, the repair suture from the third anchor is inserted into the shuttling suture loop from the second anchor, and the shuttling suture of the second anchor is gently pulled to pass the repair suture through the second anchor. The repair suture of the third anchor is also tightened. At this time, the capsule is substantially stabilized (Fig 4C); therefore, the repair suture of the first anchor is dismissed.

Finally, the sutures for the posterior portion of the DLM are fixed using TensionLoc (Arthrex) at the anteromedial aspect of the proximal tibia. With arthroscopic viewing from the anteromedial portal, the

Fig 4. Surgical procedure of repair of the DLM in a left knee joint (viewing from an antero-medial portal). (A) Longitudinal tear from the anterior to the middle portion of DLM was repaired with outside-in and inside-out techniques. (B) A spinal needle was inserted beneath the meniscus for the appropriate anchor placement of a capsulodesis. (C) Capsulodesis was performed from the outside of the joint using 1.8-mm Knotless FiberTak Soft Anchors (Arthrex) for the prevention of the meniscus extrusion. Three anchors were inserted at the edge of the tibial plateau and tensioned with the next anchor, respectively (arrowheads). The capsule was substantially stabilized. (D) The sutures for the posterior portion of the DLM were fixed with arthroscopic viewing from the anterolateral portal. Final arthroscopic examination showed the properly exposed tibial cartilage with repaired DLM. D denotes DLM; F, lateral femoral condyle; T, lateral tibial plateau.



suture ends for the DLM are tied under adequate tension. Final arthroscopic examination shows the properly exposed tibial cartilage with repaired DLM (Fig 4D). Throughout the procedure, meniscectomy is not necessary. The tips and pitfalls of this technique are described in Table 1.

Postoperative Course

After the surgery, a routine postoperative protocol for meniscus repair, including range of motion exercises

and partial weight bearing with a knee immobilizer and crutches, is applied. Walking without knee immobilizer is permitted at 4 weeks postoperatively, and full weight bearing is permitted at 6 weeks. After the confirmation of healing in MRI at 3 months, (Figs 5-7), deep squatting at more than 90° is allowed.

Discussion

We have introduced a surgical repair of symptomatic Wrisberg variant DLM, which consists of three main

Table 1. Tips and Pitfalls

Tips	Pitfalls
<ul style="list-style-type: none"> • At first, place an inside-out suture for DLM and pull it to the lateral peripheral side. This enables you to better visualize the lateral compartment and easily proceed with the surgical procedure. • Position the transtibial tunnel properly at the anatomical insertion site of the normal LM posterior root. • For a capsulodesis, insert anchors at the edge of the lateral tibial plateau, but not into the articular cartilage. Guidance of a spinal needle just beneath the LM indicates the appropriate position. 	<ul style="list-style-type: none"> • Surgical instruments such as the tibial tunnel guide and suture passer should be handled carefully to avoid chondral damage. • Care should be taken not to damage the inside-out sutures during the procedure of capsulodesis.

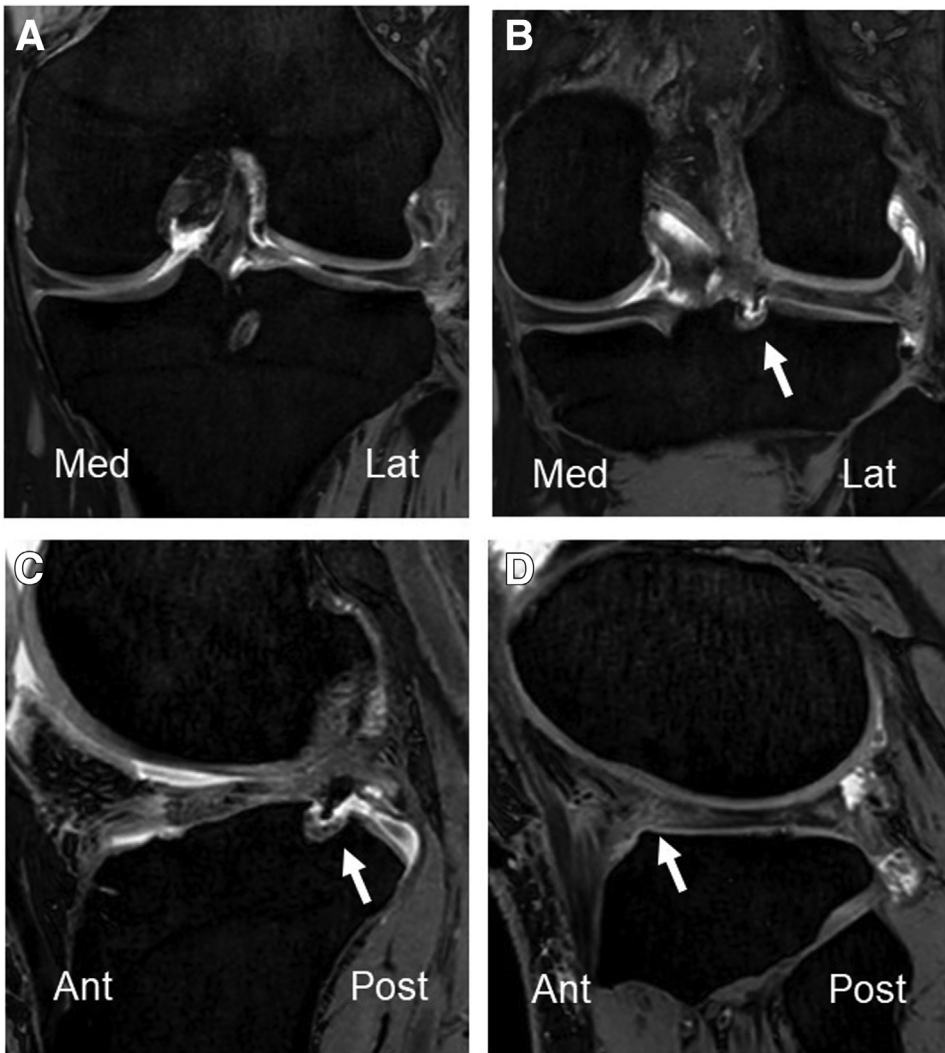


Fig 5. Postoperative magnetic resonance image of a left knee joint at 3 months after surgery (A and B: coronal planes; C and D: sagittal planes). (A) A sharpened shape of the DLM. (B) Created attachment of the posterior portion of the DLM (arrow). (C) The attachment of the posterior portion of the DLM (arrow). (D) Repaired longitudinal tear of the DLM was healed without cleavage (arrow).

procedures: creating an attachment of the posterior portion of DLM through a bone tunnel, repair of a longitudinal tear from the anterior to the middle portion of DLM using outside-in and inside-out techniques, and a capsulodesis using knotless anchors from outside of the joint to prevent the meniscus extrusion after the surgery.

To improve the instability of the Wrisberg variant DLM due to the lack of the posterior attachment of meniscotibial ligament, previous reports showed inside-out technique to stabilize the DLM to the posterior capsule.¹⁶ However, it is difficult to obtain enough stability using inside-out technique from an anteromedial portal because the penetrating angle of meniscal repair devices was too shallow to repair the posterior portion of LM. Of course, the all-inside technique for LM from an anterolateral

portal has a considerable risk to induce the neurovascular injury. Therefore, it would be best to create a bony attachment of the Wrisberg variant DLM using pull-out repair technique to obtain enough stability of the posterior portion of the DLM, as well as to mimic anatomical insertion site of the normal LM.

In addition to the meniscal repair techniques, a capsulodesis was performed using knotless anchors from outside of the joint. Previous reports showed that meniscal repair would induce transposition of the medial meniscus,^{19,20} and the meniscus extrusion after surgery increased as the number of sutures required for repair increased.²¹ In this surgical procedure, a number of sutures are necessary for meniscal repair, which has a possibility to induce the meniscal extrusion. Moreover, extrusion of the



Fig 6. Postoperative magnetic resonance imaging of a left knee joint at 3 months after surgery (sagittal planes). Holes of suture anchors were observed at the edge of the lateral tibial plateau (arrowheads).

and discoid menisci have less hoop stress functionality.²³ Therefore, we performed the capsulodesis to prevent the meniscus extrusion.^{24,25}

The tips of this procedure are listed in [Table 1](#). At first, we placed an inside-out suture for DLM²⁶ and pull it to the lateral peripheral side. It enabled better visualization of the lateral compartment to proceed with the surgical procedure with the DLM. To create a bony attachment of the posterior portion of DLM, the transtibial tunnel should be properly placed at the anatomical insertion site of the normal LM posterior root because a wrong position would result in a biomechanical property of the LM different from the normal one. In addition, the anchors for capsulodesis should be inserted at the edge of the lateral tibial plateau, but not into the articular cartilage. Guidance of a spinal needle just beneath the LM is useful for the appropriate position.

The pitfalls of this procedure are as follows: surgical instruments, such as the tibial tunnel guide and suture passer, should be handled carefully to avoid chondral damage. Care should be taken not to damage the inside-out sutures, while the procedure of capsulodesis ([Table 1](#)).

Fig 7. Three-dimensional MRI of a left knee joint using Vincent. (A) Preoperative image showed no attachment of DLM (arrow). (B) Postoperative image showed a substantial posterior attachment of the DLM (arrow).

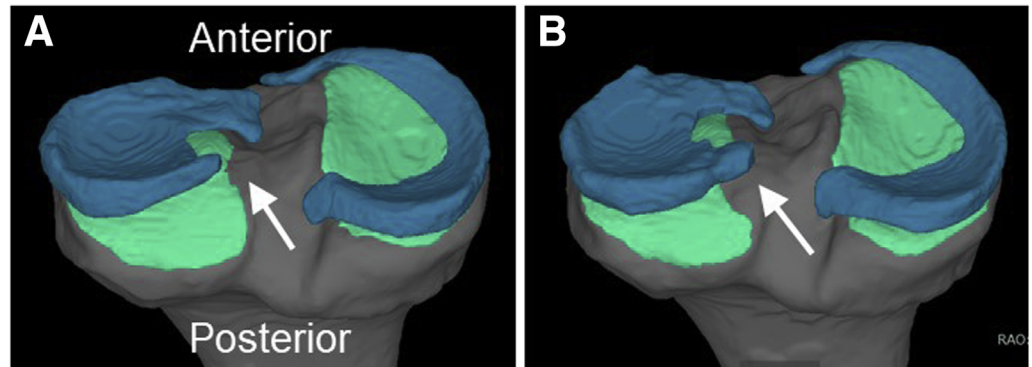


Table 2. Advantages and Limitations of this Technique

Advantages	Limitations
<ul style="list-style-type: none"> • Pullout suture fixation of posterior portion of the DLM provides the definite stabilization of the Wrisberg variant DLM. • Meniscus extrusion after repair is prevented by capsulodesis, which leads to maintaining the function of the meniscus. 	<ul style="list-style-type: none"> • To complete the procedure is technically demanding. • There is a risk to limit the normal motion of LM during knee extension-flexion.

DLM, discoid lateral meniscus; LM, lateral meniscus.

meniscus can occur after surgery of the DLM, even in cases in which a sufficient margin of the discoid meniscus has been preserved,²² probably because collagen fibers in the discoid meniscus are disoriented

The critical advantages of this surgical technique are pullout suture fixation of posterior portion of the DLM provides the definite stabilization of the Wrisberg variant DLM, and the capsulodesis prevents the

meniscus extrusion after repair of longitudinal meniscus tear of the DLM (Table 2). It improves the clinical symptoms and maintains the proper function of the meniscus.

The main disadvantages of this technique are that this procedure is technically demanding, and there is a risk of limiting the normal motion of LM during knee extension-flexion (Table 2).

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References

- Kim SJ, Kim DW, Min BH. Discoid lateral meniscus associated with anomalous insertion of the medial meniscus. *Clin Orthop Relat Res* 1995;234-237.
- Kim SJ, Lee YT, Kim DW. Intraarticular anatomic variants associated with discoid meniscus in Koreans. *Clin Orthop Relat Res* 1998;202-207.
- Fukuta S, Masaki K, Korai F. Prevalence of abnormal findings in magnetic resonance images of asymptomatic knees. *J Orthop Sci* 2002;7:287-291.
- 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;23:15-19.
- Dickason JM, Del Pizzo W, Blazina ME, Fox JM, Friedman MJ, Snyder SJ. A series of ten discoid medial menisci. *Clin Orthop Relat Res* 1982;(168):75-79.
- Dickhaut SC, DeLee JC. The discoid lateral-meniscus syndrome. *J Bone Joint Surg Am* 1982;64:1068-1073.
- Watanabe M, ST, HI. *Atlas of arthroscopy*. Tokyo, Japan: Springer-Verlag, 1979.
- Yamaguchi N, Chosa E, Tajima T, Morita Y, Yokoe T. Symptomatic discoid lateral meniscus shows a relationship between types and tear patterns, and between causes of clinical symptom onset and the age distribution. *Knee Surg Sports Traumatol Arthrosc*. In press.
- Washington ER 3rd, Root L, Liener UC. Discoid lateral meniscus in children. Long-term follow-up after excision. *J Bone Joint Surg Am* 1995;77:1357-1361.
- Mochizuki T, Tanifuji O, Sato T, Watanabe S, Endo N. Predictive factors for developing osteochondritis dissecans after surgery for discoid lateral meniscus are younger age and shorter meniscal width. *Knee Surg Sports Traumatol Arthrosc* 2019;29:100-108.
- Lee YS, Teo SH, Ahn JH, Lee OS, Lee SH, Lee JH. Systematic review of the long-term surgical outcomes of discoid lateral meniscus. *Arthroscopy* 2017;33:1884-1895.
- Wasser L, Knorr J, Accadbled F, Abid A, Sales De Gauzy J. Arthroscopic treatment of discoid meniscus in children: clinical and MRI results. *Orthop Traumatol Surg Res* 2011;97:297-303.
- Matsuo T, Kinugasa K, Sakata K, Ohori T, Mae T, Hamada M. Post-operative deformation and extrusion of the discoid lateral meniscus following a partial meniscectomy with repair. *Knee Surg Sports Traumatol Arthrosc* 2017;25:390-396.
- Yamasaki S, Hashimoto Y, Takigami J, Terai S, Takahashi S, Nakamura H. Risk factors associated with knee joint degeneration after arthroscopic reshaping for juvenile discoid lateral meniscus. *Am J Sports Med* 2017;45:570-577.
- Neuschwander DC, Drez D Jr, Finney TP. Lateral meniscal variant with absence of the posterior coronary ligament. *J Bone Joint Surg Am* 1992;74:1186-1190.
- Yue BW, Gupta AK, Moorman CT 3rd, Garrett WE, Helms CA. Wrisberg variant of the discoid lateral meniscus with flipped meniscal fragments simulating bucket-handle tear: MRI and arthroscopic correlation. *Skeletal Radiol* 2011;40:1089-1094.
- Moser MW, Dugas J, Hartzell J, Thornton DD. A hypermobile Wrisberg variant lateral discoid meniscus seen on MRI. *Clin Orthop Relat Res* 2007;456:264-267.
- Ahn JH, Lee YS, Ha HC, Shim JS, Lim KS. A novel magnetic resonance imaging classification of discoid lateral meniscus based on peripheral attachment. *Am J Sports Med* 2009;37:1564-1569.
- Furumatsu T, Miyazawa S, Tanaka T, Okada Y, Fujii M, Ozaki T. Postoperative change in medial meniscal length in concurrent all-inside meniscus repair with anterior cruciate ligament reconstruction. *Int Orthop* 2014;38:1393-1399.
- Zhang Z, Shang XK, Mao BN, Li J, Chen G. Torn discoid lateral meniscus is associated with increased medial meniscal extrusion and worse articular cartilage status in older patients. *Knee Surg Sports Traumatol Arthrosc* 2019;27:2624-2631.
- Katagiri H, Miyatake K, Nakagawa Y, et al. The effect of a longitudinal tear of the medial meniscus on medial meniscal extrusion in anterior cruciate ligament injury patients. *Knee* 2019;26:1292-1298.
- Choi NH. Radial displacement of lateral meniscus after partial meniscectomy. *Arthroscopy* 2006;22(575):e571-e574.
- 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;35:475-478.
- Koga H, Muneta T, Yagishita K, et al. Arthroscopic centralization of an extruded lateral meniscus. *Arthroscopy Techniques* 2012;1:e209-e212.
- Koga H, Muneta T, Watanabe T, et al. Two-year outcomes after arthroscopic lateral meniscus centralization. *Arthroscopy* 2016;32:2000-2008.
- Perkins CA, Busch MT, Christino MA, Willimon SC. Saucerization and repair of discoid lateral menisci with peripheral rim instability: Intermediate-term outcomes in children and adolescents. *J Pediatr Orthop* 2021;41:23-27.