Technical Note

Simultaneous Meniscal Repair and Temporary Guided Growth Using a Tension Band Plate to Correct Alignment in Pediatric Discoid Lateral Meniscus Patients With Valgus Knee

Yusuke Hashimoto, M.D., Ph.D., Keisuke Nakagawa, M.D., Ph.D., Kazuya Nishino, M.D., Ph.D., Tomohiro Tomihara, M.D., Daichi Takahashi, M.D., Hiroaki Nakamura, M.D., Ph.D., and Hiroshi Katsuda, M.D.

Abstract: Meniscal stabilization with saucerization has recently been recommended for discoid lateral meniscus (DLM) to preserve the meniscus shape and prevent the progression of osteoarthritis. However, axial alignment of the lower limb causes a significant valgus change after arthroscopic partial meniscectomy and can lead to progressive lateral osteoarthritic changes. Thus, valgus knees in patients with DLM are a suspected predictive factor for poor outcomes after DLM surgery. Valgus malalignment in pediatric patients can be corrected by temporarily tethering one side of the open physis using implant-mediated guided growth to generate differential growth in the coronal plane. This Technical Note describes simultaneous arthroscopic meniscal surgery and temporary hemiepiphysiodesis to treat DLM with valgus deformities to reduce the risk of future chondral damage to the lateral knee compartment.

Discoid lateral meniscus (DLM) of the knee represents an abnormal morphologic variation of the meniscus, which typically covers a larger-than-usual area of the tibial plateau. Arthroscopic surgical repair of a torn DLM in children has favorable clinical outcomes in short- and long-term assessments with the restoration of motion and significant improvements in multiple patient-reported outcome scores.[1,2] However, reports[1,3,4] have described degenerative sequelae, including meniscal retears, lateral compartment osteoarthritis, and postoperative osteochondritis dissecans (OCD), as complications after DLM surgery. Partial meniscectomy and saucerization with repair of knees with a torn DLM sometimes progresses to valgus alignment and lateral compartment degeneration.[5,6] Therefore, surgeons need to consider valgus knee correction and meniscal surgery in patients with DLM and valgus knees.

A coronal plane angular deformity can be corrected with less-invasive surgical techniques in pediatric patients by using implant-mediated guided growth. By temporarily tethering one side of an open physis to generate differential growth, osseous correction can be achieved with a low complication rate.[7] This Technical Note describes simultaneous meniscal repair and temporally guided growth of a torn DLM in valgus knees to maintain adequate alignment.

Surgical Technique

This technique is indicated for DLM with valgus knee (Fig 1A), which sometimes involves peripheral tears or OCD with an open physis (Fig 1 B-D). With the patient in the supine position, a nonsterile tourniquet is applied to the proximal thigh of the operated leg. The usual arthroscopic evaluation is performed using anteromedial and anterolateral portals (Fig 2 A-C, Video 1).

From the Department of Health and Sport Management, Osaka University of Health and Sports Science, Osaka, Japan (Y.H.); Department of Orthopaedic Surgery, Osaka Metropolitan University Graduate School of Medicine, Osaka, Japan (Ke.N., Ka.N., H.N.); and Department of Orthopaedic Surgery, Shimada Hospital, Osaka, Japan (T.T., D.T., H.K.).

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Address correspondence to Yusuke Hashimoto, M.D., Ph.D., Department of Health and Sport Management, Osaka University of Health and Sports Science, 1-1, Asashirodai, Kumatori-cho, Sennan-gun, Osaka, 590-0496, Japan. E-mail: hussyyomu@omu.ac.jp

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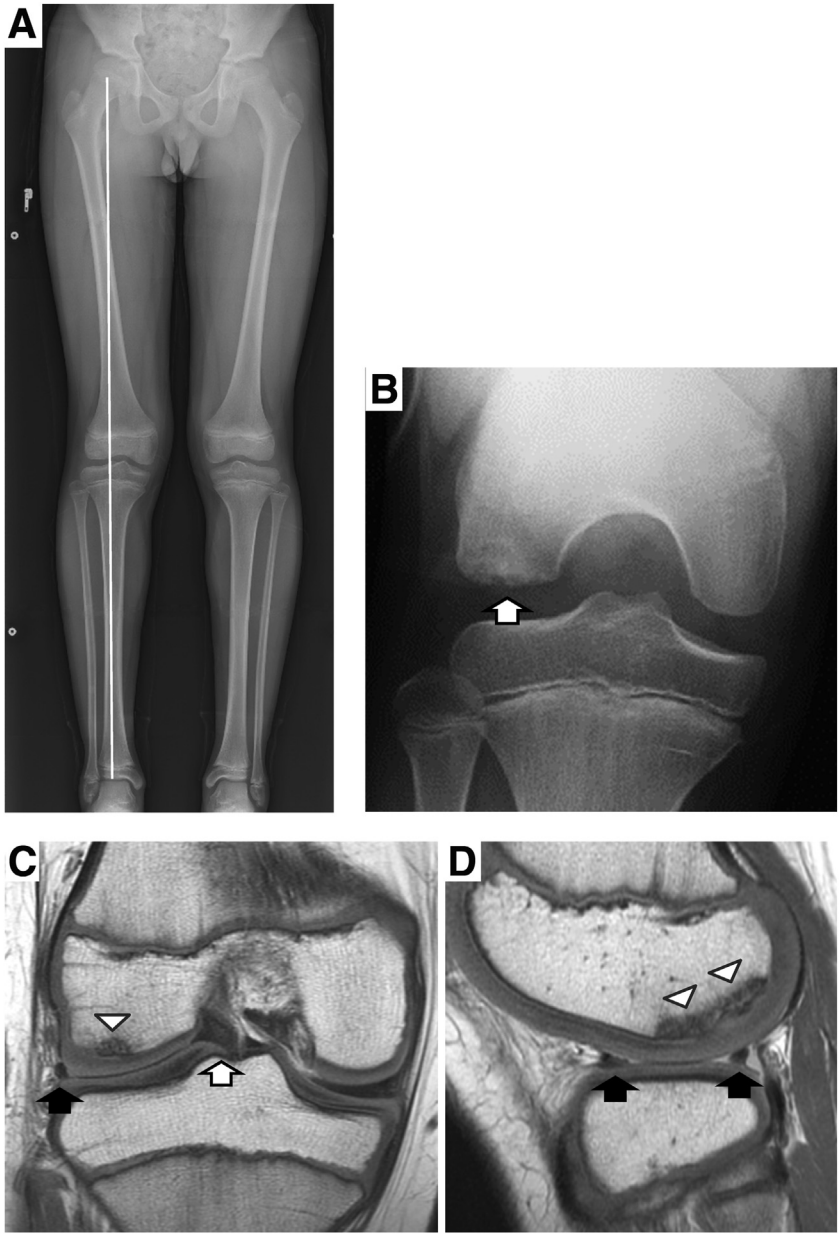

Fig 1. Preoperative images of the right knee of a 12-year-old boy. (A) The whole-leg standing radiograph. The preoperative alignment parameters are 60% in weight-bearing line ratio (white line; Mikulicz's line), valgus 2.4° in the hip-knee-ankle angle, 88° in the medial proximal tibial angle, and 83° in the lateral distal femoral angle. (B) The Rosenberg view. Translucent areas of the lateral femoral condyle are visible in this view (white arrow). (C-D) Magnetic resonance images of the locked meniscus to the intercondylar notch and OCD lesion in (C) the coronal view and (D) the sagittal view. The meniscus is entirely displaced centrally toward the intercondylar notch (C; white arrow). and the amount of residual meniscus on the peripheral site is small (C and D; black arrows). Signal change in the subchondral bone without clear lesion margins is visible on the coronal and sagittal images (C and D; white arrow heads).

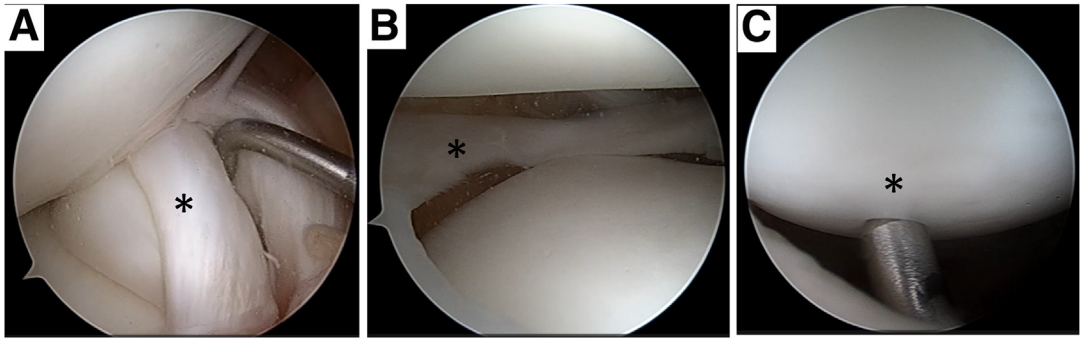

Fig 2. Arthroscopic findings of the right knee viewed from the anterolateral portal in the "figure 4" position. (A) The meniscus is entirely displaced centrally toward the intercondylar notch (black asterisk). (B) The small amount of the peripheral rim (black asterisk) bridging to the locked meniscus is confirmed. (C) A probe confirms softening of the cartilage surface without fissuring of the lateral femoral condyle (black asterisk).

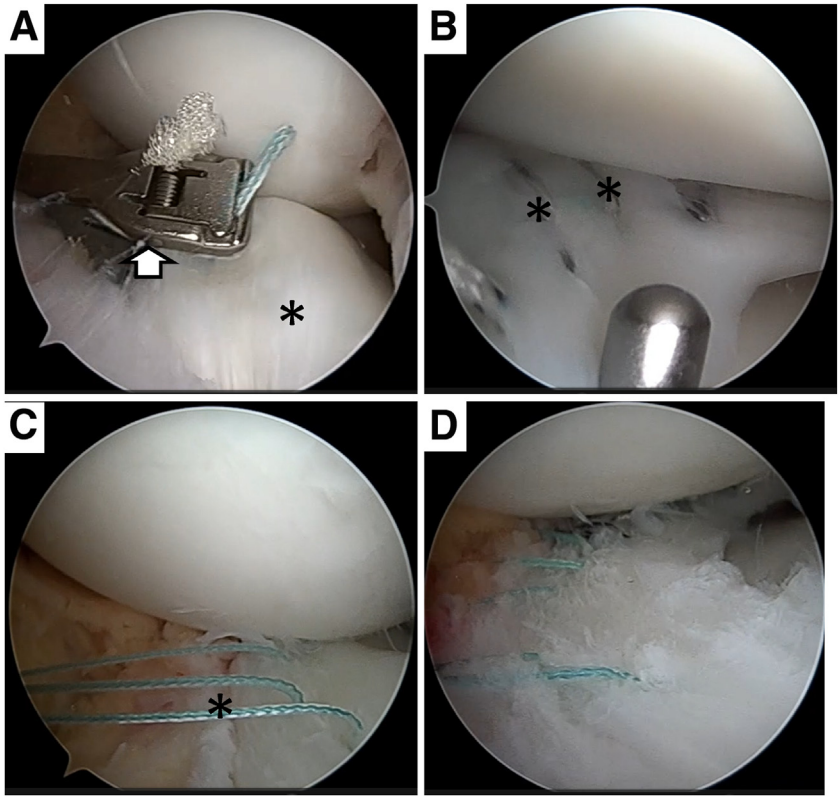

Fig 3. Reduction and fixation for the shifted meniscus of the right knee in the "figure-4" position. (A) Reduction suture with Scorpion suture passer (Arthrex; white arrow) is passed with the anterior meniscus (black asterisk) through anterolateral portal, viewed from the anteromedial portal. (B) The dual meniscal repair needles loaded with 2-0 braided polyester sutures (black asterisk) penetrate the unstable portion of the meniscus through a cannula positioned in the anteromedial portal, viewed from the anterolateral portal. (C) Sutures with 2-0 FiberWire (black asterisk) are passed through the anterior horn by using a Scorpion suture passer and suture hook through anterolateral portal, viewed from the anteromedial portal. (D) Arthroscopic view from the anteromedial portal after reducing and fixing the meniscus to its anatomic position.

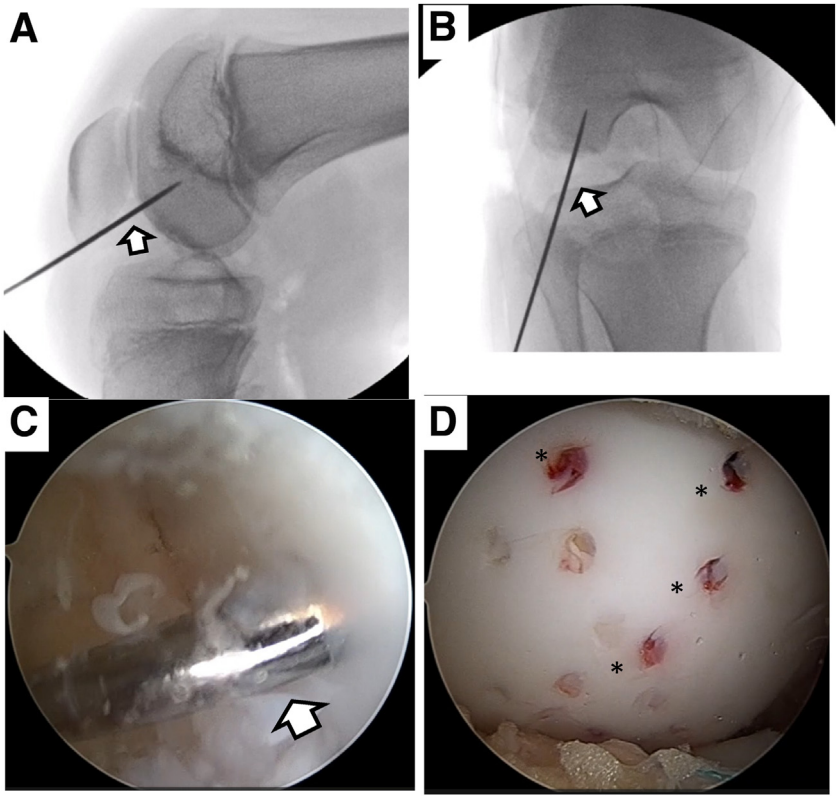

Fig 4. Drilling the OCD lesion under fluoroscopy of the right knee. To avoid perforating the physis, the location of OCD is confirmed by using a 1.5-mm Kirschner wire (white arrow) through the anterolateral portal with fluoroscopy. (A) The lateral view. (B) The A-P view. (C) Under arthroscopy viewed from the anteromedial portal, a Kirschner wire (white arrow) is inserted from the anterolateral portal. Intra-articular drilling is applied to the OCD lesion at 3-mm intervals. (D) Blood flow from bone marrow (black asterisk) is confirmed under arthroscopy viewed from the anterolateral portal. (A-P, anteroposterior; OCD, osteochondritis dissecans.)

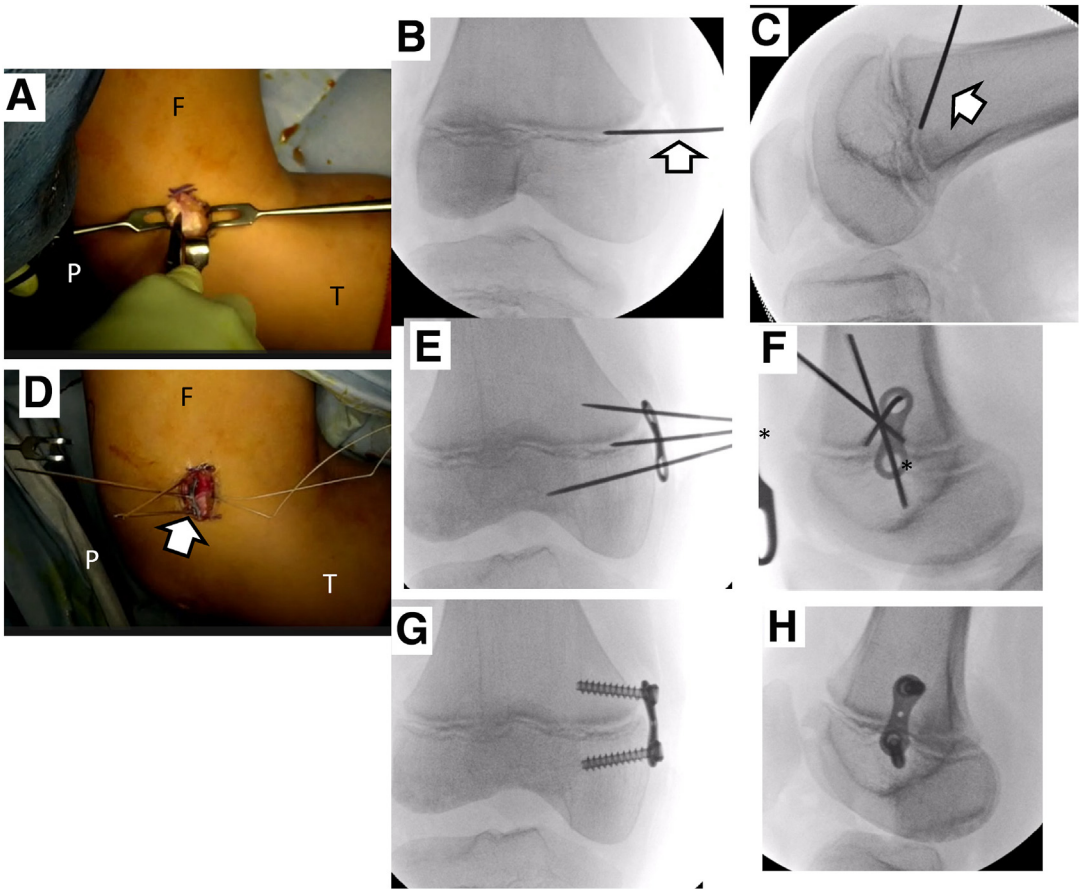

Fig 5. Extra periosteal plating with 2 nonlocking screws under fluoroscopic guidance of the right knee. (A) A 2-cm surgical incision of the medial femoral side is created in the longitudinal direction. (B) A 1.5-mm K-wire (white arrow) is inserted into the medial extent of the physis under A-P fluoroscopy. (C) Under the lateral fluoroscopic view, the center of the growth plate is positioned. (D) A 2-hole guided growth plate (white arrow) is placed over the centering K-wire. (E and F) After 2 K-wires are placed on the proximal and distal holes, the final placement of the plate and the direction of screws are confirmed under the C-arm in the A-P view (E) and lateral view (F); the plate is in the center of the lateral view to avoid any iatrogenic sagittal plane deformities. (G and H) Solid screws (4.5 mm) are inserted and provisionally tightened down to the plate in the metaphysis and epiphysis in the A-P view (G) and in the lateral view (H). (A-P, anteroposterior; F, femoral side; P, patella T, tibial side.)

Reduction sutures are applied using a Scorpion suture passer (Arthrex, Naples, FL) through the anterolateral portal (Fig 3A). Inside-out sutures are used to reduce and fix the meniscus to its anatomic position (Fig 3B). For the anterior segment of the lateral meniscus, transportal transcapsular sutures[8] are applied by using the Scorpion passer and suture hook (CONMED Linvatec, Largo, FL) (Fig 3 C and D, Video 1). After treating the OCD lesion (Fig 4 A-D, Video 1), extraperiosteal plating is subsequently performed with 2 nonlocking screws under fluoroscopic guidance.[7] Under a tourniquet, a 2-cm longitudinal incision is centered over the medial extent of the physis and oriented along the anatomic axis of the femur (Fig 5A). After soft-tissue dissection, a 1.5-mm K-wire is inserted into the medial extent of the physis in the coronal and sagittal planes to guide the positioning of the center of the growth plate under fluoroscopic guidance (Fig 5 B and C, Video 1). A 2-hole guided growth plate (eight-Plate; Orthofix, Lewisville, TX) is contoured and passed over the wire. The final placement of the plate and screws is confirmed extraperiosteally under the C-arm in the anteroposterior and lateral views, with the plate in the center of the lateral view to avoid any iatrogenic sagittal plane deformities. After drilling, 4.5-mm cannulated screws are then inserted and provisionally tightened down to the plate in the metaphysis and epiphysis (Fig 5D).

Postoperative Management

Patients are immobilized for 1 week using a brace, limited to a knee range of motion of 0° to 90° for 3 weeks and then allowed partial weight-bearing for 8 weeks. Patients may return to sports at 6 months after the procedure.

Table 1. Advantages and Limitations of the Procedure

Advantages	Limitations
• Allows for the correction of the valgus knee for juvenile DLM with this plate. • Compared with traditional osteotomy, this procedure is technically easy to perform, minimally invasive, and associated with less morbidity and fewer complications. • Effective for OCD lesion of the lateral condyle. • It can be used to treat a meniscal repair at the same time. • A surgeon needs only standard meniscal repair skills and plating skills.	• Need to use a specific plate. • Only applicable for open physis. • An additional skin incision is needed to put the plate. • The plate needs to be removed after correcting the deformity. • Possibility of rebound phenomenon. • Possibility of reinjury after meniscal stabilization.

DLM, discoid lateral meniscus; OCD, osteochondritis dissecans.

Discussion

Discoid saucerization procedures with or without repair have similar Lysholm scores and International Knee Documentation Committee scores as nondiscoid repair procedures and revision rates as those of nondiscoid repair procedures.[2,9] However, total meniscectomy and partial meniscectomy for DLM can change the lower-limb alignment to valgus (1°-3°) after surgery.[10] Cho et al.[6] reported that arthroscopic surgery for adult DLM resulted in progression to valgus alignment and lateral compartment degeneration, compared with nonoperative treatment and arthroscopic surgery for adult non-DLM. In general, valgus malalignment increases the risk of knee osteoarthritis radiographic progression.[11] Thus, DLM with valgus knees should be considered and treated. Takigami et al.[12] report that the central meniscal shift of the DLM was a predictive factor for OCD of the lateral femoral condyle and that disappearance of the peripheral part of the meniscus, which indicates loss of meniscal load transmission, may be the main cause of OCD. Thus, preserving the peripheral rim of the meniscal repair is necessary to suppress the progression of valgus knees and heal OCD.

For valgus alignment, correcting lower-limb malalignment is necessary to improve the load environment in the lateral compartment. Temporary-guided growth using a tension band plate is a fixed bridging the physis using a plate and 2 screws. The interface between the screw heads and plate enables angular motion of the screws, which allows continued growth of the rest of the physis, thereby correcting angular deformities in a growing child. Compared with traditional osteotomy, this technique is technically easy, minimally invasive, and associated with less morbidity and fewer complications.[13]

Martay et al.[14] described that a weight-bearing line ratio of 60% tibial width (3° valgus) causes minimal halved lateral compartment stress, and a weight-bearing line ratio of 50% tibial width (0° varus/valgus) causes minimal changes to lateral stress levels. Kumar et al.[15] reported that the rate of deformity correction was the lateral distal femoral angle changed at 0.87°/month in patients younger than 10 years old. Ko et al.[16] reported that the use of plates and faster correction speed were positively associated with the rebound phenomenon. Therefore, we recommend this technique during adolescence to prevent overcorrection or the rebound phenomenon.

This report is preliminary. Further follow-up assessments of clinical and radiologic outcomes are necessary to investigate the long-term effects of this technique. Nevertheless, this technique should be defined as the ideal method to preserve the meniscus and to correct knee deformity in patients with valgus DLM. This method maintains the meniscal status and decreases the pressure on the lateral compartment to prevent the progression of osteoarthritis. The advantages and limitations of our technique, as well as its advantages and disadvantages, are summarized in Tables 1 and 2, respectively.

Table 2. Pearls and Pitfalls of the Procedure

Pearls	Pitfalls
• Careful evaluation of intraoperative plating. • In the sagittal plane, the K-wire should be inserted into the center of the growth plate under fluoroscopic guidance. • In the coronal plane, screws should be inserted into the metaphysis and epiphysis. • For the meniscus, a reduction suture with Scorpion is needed. • Firm stabilization is needed for the meniscus. • Careful drilling is necessary to avoid perforating the physis for a stable OCD lesion.	• Arthroscopy sometimes does not detect a stable OCD lesion. • Fluoroscopic guidance is important for the drilling. • Careful stabilization is needed between the meniscal body and capsule without gap. • Anteriorization is avoided, which can lead to sagittal plane deformity (i.e., recurvatum). • Careful observation for correcting deformity and adequate periods to remove the plate must be determined.

OCD, osteochondritis dissecans.

Disclosures

H.N. reports a relationship with Department of Orthopaedic Surgery, Osaka Metropolitan University. All other authors (Y.H., Ke.N., Ka.N., T.T., D.T., and H.K.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. 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.
2. Diao YD, Vivekanantha P, Cohen D, Hoshino Y, Nagai K, de Sa D. Patients with discoid menisci have similar clinical outcomes to those without discoid menisci when undergoing surgical intervention: A systematic review. *Knee Surg Sports Traumatol Arthrosc* 2023;31:3369-3380.
3. Hashimoto Y, Nishino K, Reid JB 3rd, et al. Factors related to postoperative osteochondritis dissecans of the lateral femoral condyle after meniscal surgery in juvenile patients with a discoid lateral meniscus. *J Pediatr Orthop* 2020;40:e853-e859.
4. Campbell AL, Pace JL, Mandelbaum BR. Discoid lateral meniscus. Short-term effects of discoid lateral meniscectomy on the axial alignment of the lower limb in adolescents. *Curr Rev Musculoskelet Med* 2023;16:154-161.
5. Wang J, Xiong J, Xu Z, Shi H, Dai J, Jiang Q. Short-term effects of discoid lateral meniscectomy on the axial alignment of the lower limb in adolescents. *J Bone Joint Surg Am* 2015;97:201-207.
6. Cho JH, Nam HS, Park SY, Ho JPY, Lee YS. Arthroscopic meniscal repair and meniscectomy for adult discoid lateral meniscus result in progression to valgus alignment and lateral compartment degeneration compared with nonoperative treatment and nondiscoid lateral meniscus. *Arthroscopy* 2024;40:1223-1233.
7. Artioli E, Mazzotti A, Ramacci V, et al. Indications and timing in isolated medial femoral hemiepiphysiodesis for idiopathic genu valgum: A systematic review. *Knee* 2023;40:52-62.
8. Hashimoto Y, Yamasaki S, Guttmann D, et al. Surgical management of discoid lateral meniscus with anterior peripheral instability: Retaining an adequate residual meniscus volume. *Arthrosc Tech* 2022;11:e1141-e1147.
9. Su L, Bennett A, Combs K, et al. Arthroscopic treatment of symptomatic discoid lateral meniscus and nondiscoid meniscus in adolescent patients. *Am J Sports Med* 2022;50:3805-3811.
10. Zhang P, Zhao Q, Shang X, Wang Y. Effect of arthroscopic resection for discoid lateral meniscus on axial alignment of the lower limb. *Int Orthop* 2018;42:1897-1903.
11. Felson DT, Niu J, Gross KD, et al. Valgus malalignment is a risk factor for lateral knee osteoarthritis incidence and progression: Findings from the Multicenter Osteoarthritis Study and the Osteoarthritis Initiative. *Arthritis Rheum* 2013;65:355-362.
12. Takigami J, Hashimoto Y, Tomihara T, et al. Predictive factors for osteochondritis dissecans of the lateral femoral condyle concurrent with a discoid lateral meniscus. *Knee Surg Sports Traumatol Arthrosc* 2018;26:799-805.
13. Masquijo JJ, Artigas C, de Pablos J. Growth modulation with tension-band plates for the correction of paediatric lower limb angular deformity: Current concepts and indications for a rational use. *EFORT Open Rev* 2021;6:658-668.
14. Martay JL, Palmer AJ, Bangerter NK, et al. A preliminary modeling investigation into the safe correction zone for high tibial osteotomy. *Knee* 2018;25:286-295.
15. Kumar S, Sonanis SV. Growth modulation for coronal deformity correction by using Eight Plates—Systematic review. *J Orthop* 2018;15:168-172.
16. Ko KR, Shim JS, Shin TS, Jang MC. Factors affecting rebound phenomenon after temporary hemiepiphysiodesis and implant removal for idiopathic genu valgum in adolescent patients. *J Pediatr Orthop* 2022;42:e336-e342.