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Discoid lateral meniscal repair without saucerization for adolescents with peripheral longitudinal tear

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ABSTRACT

Recently, successful clinical outcomes for symptomatic discoid lateral meniscus (DLM) have been reported following partial meniscectomy (saucerization) with repair. In contrast, some studies using radiography and magnetic resonance imaging (MRI) have suggested that function of load transmission might not be appropriately maintained after saucerization with repair. Therefore, in pursuit to uphold load transmission after surgery for DLM, this study tried to preserve the DLM shape to keep the original DLM function. Discoid lateral meniscus repair without saucerization was indicated, with strict criteria, for those who had a painful peripheral longitudinal tear with purely intact body caused after a single traumatic incidence. The repair was performed without saucerization for four adolescents (two males, two females; mean age 16.2 years; three complete types of DLM, and one incomplete type of DLM). Postoperatively, the following were evaluated with radiography and MRI at six, 12, and 24 months after surgery: clinical outcomes, degenerative changes, and morphology of repaired DLM. They all showed good clinical outcomes. Furthermore, no degeneration, deformation, nor extrusion was observed at the two-year follow-up after surgery. For limited cases of DLM, as mentioned above, DLM repair without saucerization can be one treatment option.

1. Introduction

A discoid lateral meniscus (DLM) is a morphologically abnormal variant of the crescent-shape meniscus; it was first reported by Young in 1889 [1]. The incidence of this variant in several clinical studies ranges from 0.4–17%, and is slightly higher in Asian populations [2–6]. Discoid lateral meniscus is clinically important because it may be susceptible to tears and degeneration. This susceptibility to tears and degeneration is known to be associated with the differences between the DLM and normal lateral meniscus. These differences are that the DLM is larger and thicker than a normal meniscus; ultra-structurally, DLM has a decrease in the number of collagen fibers in the matrix; and DLM has both discontinuity and homogeneity of a circumferential collagen net-

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work [7–15]. Generally, conservative treatment is selected as the first treatment for symptomatic DLM. For patients with symptomatic DLM and for whom conservative treatment failed, surgical treatment should be considered.

Although the accepted treatment for symptomatic discoid lateral meniscus in the past has been total or subtotal meniscectomy [3,16–19], based on the accumulated knowledge of meniscal function, current treatment recommendations favor meniscal reshaping through partial meniscectomy (saucerization) without repair or with repair if peripheral instability exists [20,21–24]. However, it is doubtful whether the function of the postoperative DLM after partial meniscectomy with repair is maintained. In both short-term and long-term observations using magnetic resonance imaging (MRI) or radiography, morphological deformation, extrusion and radiographic degenerative changes have been observed after saucerization with repair [23,25,26]. These results indicated that the function of load transmission might not be appropriately maintained after partial meniscectomy with repair [25]. Accordingly, the limitation of preservation of load transmission in the saucerization procedure has become apparent in current practice. Therefore, in pursuit of upholding load transmission after surgery for DLM, attempts were made to preserve DLM shape to keep the original DLM function, as partially resected DLM that mimic normal meniscus might be insufficient to keep the original DLM function, due to the unique femur-DLM-tibia complex. Nevertheless, while taking into consideration the DLM characteristic of susceptibility to tears and degenerations, DLM repair without saucerization was indicated under strict criteria for only those who had painful peripheral longitudinal tear with a purely intact body caused after a single traumatic incidence. This study performed DLM repair without saucerization on four adolescents with a peripheral longitudinal tear, and evaluated clinical outcome, degenerative change, and morphology of repaired DLM with radiography and MRI at six, 12, and 24 months after surgery.

2. Materials and methods

2.1. Patients

From January 2001 to December 2015, 141 operations were performed for patients with a symptomatic discoid lateral meniscus that did not respond to conservative treatment. Of these patients, four adolescent patients (2.8%) underwent a discoid shape preserved repair (DLM repair without saucerization) followed by radiographic and MRI evaluation of their repaired meniscus at six, 12, and 24 months after surgery.

Inclusion criteria were adolescents with painful meniscal symptoms after a single incident, including catching, snapping, and locking. The DLM was meticulously evaluated through both MRI and arthroscopy. Only cases with peripheral instability that was caused by a single longitudinal tear located only on the peripheral and intact DLM body without degeneration or morphological deformation were included. The following were excluded: asymptomatic patients or patients with meniscal symptoms without pain, including catching and snapping; cases in which the body of DLM had horizontal tears, degeneration, and deformation; cases with other than a peripheral longitudinal tear; and cases with hard to reduce meniscus due to a long period of time in a locked state. Patients included two males and two females, with the mean age of 16.2 years (range, 15–17) at time of surgery.

2.2. Evaluation of discoid lateral meniscus: Shifting meniscus morphology and site of tear

Pre-operatively, shifting meniscus morphologies on sagittal and coronal MRI images were evaluated, as Ahn et al. reported (antero-central shift type, postero-central shift type, central shift type, no shift type) [22]. Intraoperatively, DLM morphology was evaluated according to the classification by Watanabe et al. (Complete type, Incomplete type, Wrisberg type) and the location of tear according to Ahn et al. (meniscocapsular junction, anterior horn type; meniscocapsular junction, posterior type; and posterolateral corner loss type) [22,27].

2.3. Surgical procedure

Discoid lateral meniscus repair without saucerization was performed arthroscopically, while the patient was under general anesthesia, using an anteromedial and anterolateral portal. An additional far anteromedial portal was made to increase visibility of the DLM. The peripheral tears in the middle to posterior segments were repaired with an inside-out technique using Henning's instrument (Stryker, Kalamazoo, MI, USA) [28]. Regarding the upper side of the DLM, peripheral tears were repaired by placing vertical sutures at five-millimeter intervals, as performed for normal meniscal repair. Although there is less visibility on the bottom side, in order to add the fixation strength, vertical sutures were performed as far as visibility allowed. At that time, the lateral portal was used as the portal for lifting up the DLM using a hook. The other two portals were interchangeably used as viewing and working portals. When the tear site could be approached with Henning's instrument, stacked sutures were performed. To enhance healing of the meniscus, a fibrin clot was prepared from 20 ml of peripheral blood from the patient [29,30]. The fibrin clot was introduced into the tear site and fixed by fastening the sutures outside the joint. The tear in the anterior to middle segment was repaired using zone-specific cannula (Linvatec, Largo, FL, USA) with #00 Fiberwire (Arthrex Japan, Tokyo, Japan) and Henning's instruments, as mentioned above. Of four patients, one peripheral tear was located in the anterior to middle segment and three were in the middle to posterior segment. A mean of 11.3 (10–13) non-absorbable sutures were used to fix the torn meniscus to the capsule.

2.4. Postoperative rehabilitation

All patients were prescribed the same rehabilitation menu. After brace immobilization for two weeks, range-of-motion exercise was started. Partial weight bearing was allowed at three weeks, followed by full weight bearing at four weeks. Jogging was allowed at three months, while return to strenuous sports activities was permitted at six months.

2.5. Postoperative evaluations: clinical outcome, radiographic and MRI evaluation

Regarding clinical evaluation, each patient underwent clinical examination, including measurement of range of motion, assessment of effusion, and the McMurray test. The clinical outcomes were evaluated with the Ikeuchi grading scale [3] and Tegner activity level [31].

All patients underwent radiographic evaluation in the pre-operative phase and postoperatively at six, 12, and 24 months. Lateral joint space widening was evaluated with posteroanterior 45° flexed weightbearing view [32]. In addition to joint space widening, osteophyte formation and subchondral bone sclerosis were meticulously evaluated.

Furthermore, in order to evaluate the repaired DLM, an MRI evaluation was performed two weeks after surgery (before weight bearing was permitted) and again at six, 12, and 24 months after surgery using a 1.5-Tesla MRI scanner (EXCELART Vantage; Toshiba, Tochigi, Japan). Postoperative deformation and extrusion of the repaired DLM was evaluated according to Matuso et al. [25]

3. Case summary

Regarding clinical outcome at 24 months, there were no patients with pain, loss of range of motion, effusion, tenderness, snapping, or positive McMurray test. According to Ikeuchi [3], all patients were graded as excellent. The mean Tegner activity level at the pre-operative phase and 24 months was 3.5 and 3.3, respectively.

The lateral joint space widening evaluated with radiography did not change throughout the postoperative phase, and no osteophyte formation and subchondral bone sclerosis were evaluated within two years. There was no radiographic evidence of degenerate change within two years. Furthermore, the discoid shape evaluated with MRI was preserved without deformation and no extrusion was found postoperatively within two years.

This study summarized the patients' demographics, findings, and clinical data for each case in Table 1. The images of arthroscopic operative procedure are shown for Case 1 and Case 4 in Fig. 1. The radiographic findings over time are shown for Case 2 in Fig. 2. The MRI findings over time are shown for Case 3 in Fig. 3.

4. Discussion

The most important findings of this study are as follows: 1) DLM repair without saucerization was performed for four adolescents who only had a painful peripheral longitudinal tear with purely intact body caused after a single traumatic incidence, and they showed good clinical outcomes at two years after operation; 2) A 45° flexion weightbearing view using radiography showed that the joint space was preserved without degeneration; 3) MRI showed that the discoid shape was preserved without deformation and extrusion within two years.

Regarding DLM, historically, the early treatment of choice for a symptomatic DLM was total or sub-total meniscectomy [3,16–19]; However, previous studies have reported that total or subtotal meniscectomy leads to a high rate of early osteoarthritic changes [20,23,33,34]. Then, based on accumulated knowledge on the importance of meniscal function, total or subtotal meniscectomy is currently avoided as much as possible. Therefore, current treatment recommendations favor meniscal reshaping through partial meniscectomy with or without repair [20–24]. Recently, successful clinical outcomes have been reported following partial meniscetomy with repair in both short-term and long-term studies using objective scoring systems, and it was suggested that symptomatic discoid meniscus are best treated with saucerization and repair [23,24,35,36].

On the other hand, it remains unclear whether the function of the postoperative DLM after partial meniscectomy with repair is maintained. Ahn et al. reported that, although partial meniscectomy with repair was associated with less progression of degenerative changes compared with subtotal meniscectomy, degenerative changes were observed in 39% of cases treated with partial

Table 1
Patients' demographics, findings, and clinical results.
M, male; F, female; R, right; L, left; Pre, pre-operative phase; Post, postoperative phase; MC-A, meniscocapsular junction anterior horn type; MC-P, meniscocapsular junction posterior horn type.

Case	Age/Sex	Side	Tegnar score [30] (pre/post)	Symptom	Discoid type [26]	MRI classification [22]	Arthroscopic findings [22]	Suture number	Fibrin clot	Clinical result [3]
1	15/M	L	3/3	Painful snapping	Incomplete	No shift	MC-A	10	+	Excellent
2	17/F	R	3/3	Temporary locking	Complete	No shift	MC-P	10	+	Excellent
3	17/M	L	5/4	Persistent locking	Complete	Antero-central	MC-A + P	12	+	Excellent
4	16/F	L	3/3	Painful snapping	Complete	No shift	MC-P	13	+	Excellent

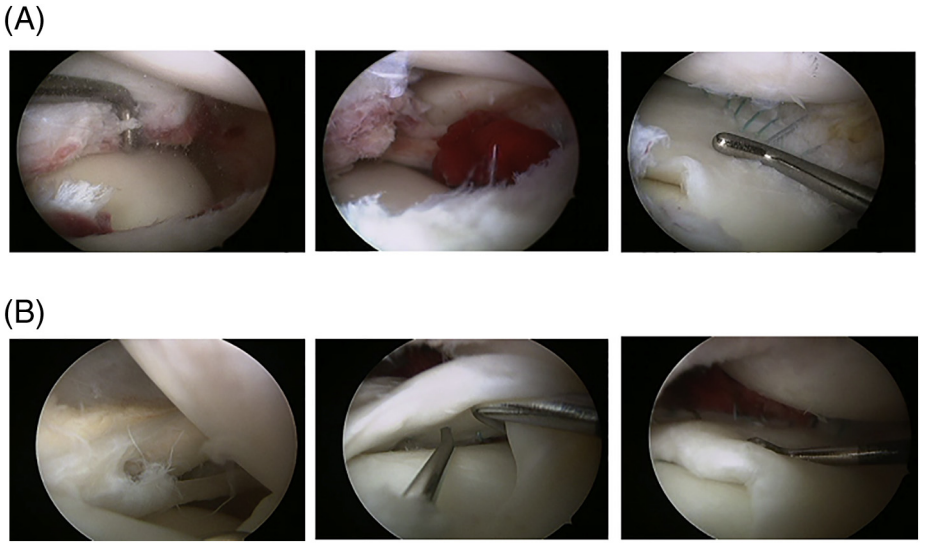

Fig. 1. An arthroscopic view of the repaired lateral discoid meniscus. (A) Case 1: The incomplete DLM that had neither deformation nor degeneration in the body. There was a single longitudinal tear limited to the peripheral area of the anterior horn. After rasping the synovial tissue around the longitudinal tear, the fibrin clot was put inside the tear, and meniscal repair was performed with inside-out technique using zone-specific cannula and Henning instrument, and used 10 stiches. Finally, it was confirmed that there was no instability. (B) Case 4: The DLM was completely discoid with a single longitudinal tear located in the peripheral area of the posterior horn. No apparent degeneration or deformation was confirmed. After rasping the synovial tissue around the longitudinal tear, the fibrin clot was put inside the tear and the meniscus was repaired with an inside-out technique using Henning instrument, and 13 stiches. Finally, it was confirmed that there was no instability.

meniscectomy with repair after a mean follow-up of 10.1 years [23]. Furthermore, Matsuo et al. using MRI showed that the discoid lateral meniscus exhibited deformation and extrusion from two weeks to six months after partial meniscectomy with repair [25]. They concluded that in spite of good clinical outcomes, the function of load transmission might not be maintained appropriately after surgery. Accordingly, although a partial meniscectomy with repair might be considered as a more favorable treatment than a subtotal meniscectomy, there is still some controversy regarding the restoration of load transmission after partial meniscectomy with repair.

Moreover, there are a few studies in which the peripheral lesion of a symptomatic DLM was repaired without saucerization to restore the natural DLM function as much as possible. Woods and Whelan et al. reported that they treated for patients with Wrisberg ligament type by open surgical reattachment for posterior capsular disruptions, and showed that three patients had excellent results at 37.5 months following surgery [37]. Coagarea et al. also reported the case of an open repair for a bucket-handle tear of a complete DLM incarcerated in posterolateral compartment without clinical outcome [38]. These two reports did not examine the postoperative state in detail, such as by using radiography and MRI. In this report, not only good clinical outcomes, but also preservation of both joint space and DLM shape for as long as two years after surgery were shown with radiography and MRI. This report is the first report that evaluated both clinical and image outcomes after arthroscopic DLM repair without saucerization.

Comparing DLM repair with saucerization and without saucerization, although an almost equivalent clinical outcome was shown, there were some discrepancies between these procedures. First, degenerative changes using radiography were reported after DLM repair with saucerization [23,26]. However, no joint space narrowing with degeneration was found within two years after surgery in the current study. Repaired DLM without saucerization might maintain the function of load transmission compared with DLM repair with

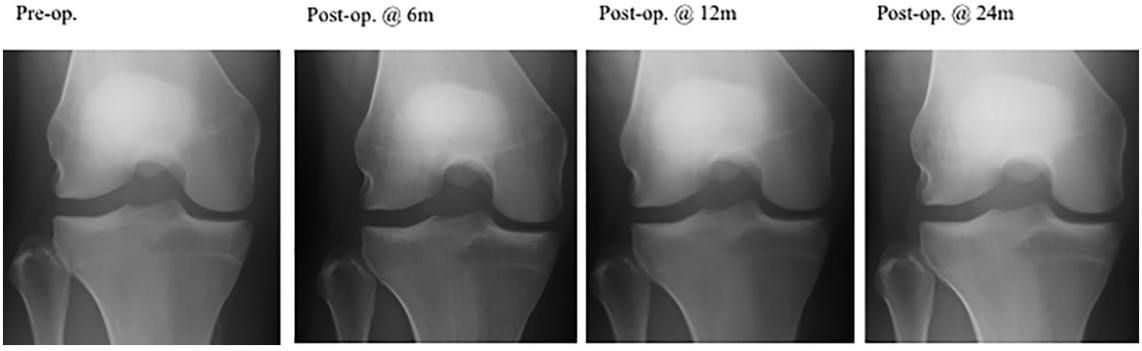

Fig. 2. The radiographic findings with posteroanterior 45° flexed weightbearing view for Case 2 pre-operatively and postoperatively at six, 12, and 24 months. There was no change in lateral joint space, no osteophyte formation, and no subchondral bone sclerosis. Pre-op. = preoperative; Postop. = postoperative; m = month.

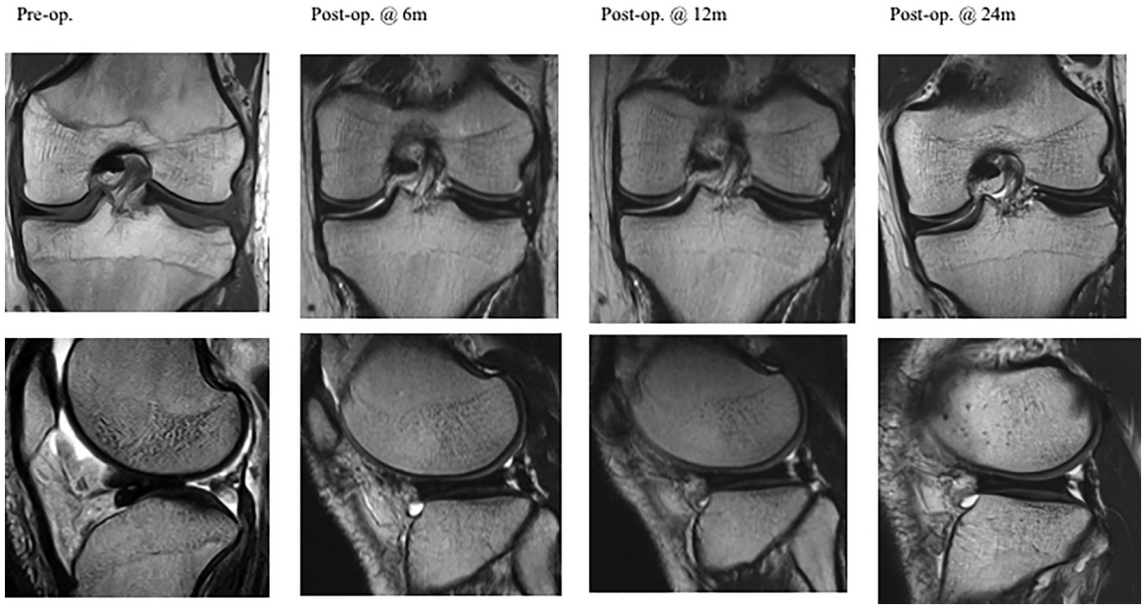

Fig. 3. The MRI findings for Case 3 pre-operatively and postoperatively at six, 12, and 24 months. In MRI at pre-operative phase, it was confirmed that posterior portion of DLM overturned onto the anteromedial portion and caused locking. (Antero-central shift type according to Ahn et al.) In MRI at postoperative phase, DLM was reduced to the normal position and observed to have a discoid shape morphology. The discoid shape was preserved and neither deformation nor extrusion was found postoperatively within 2 years. Pre-op. = preoperative; Postop. = Postoperative; m = month.

saucerization. Second, regarding MRI findings, Matsuo et al. showed the morphological change and extrusion after DLM repair with saucerization [25]. However, the current study observed no morphological change and extrusion. The central portion of the DLM removed by saucerization might have the function to prevent extrusion by contracting against the expanding force. Histologically, a previous study showed this central portion of DLM consists of a unique irregularly arranged fibril pattern, while the peripheral site of the DLM peripheral site consists of circumferential fibrils suited for resisting hoop stress similar to a normal meniscus [39]. This unique fibril pattern might play a connective role in preventing DLM extrusion. Therefore, considering preservation of DLM function, this report suggested that DLM repair without saucerization would be superior to DLM repair with saucerization. Nonetheless, worldwide current treatment recommendations favor meniscal reshaping through partial meniscectomy (saucerization) with repair if peripheral instability exists [23,24,35,36]. Owing to good clinical outcomes, as previously reported, this procedure should be performed from now on. However, based on the concept that DLM has the original load transmission function, including DLM center due to the unique femur-DLM-tibia-complex, for limited cases of DLM with only peripheral instability, preserving the DLM body without saucerization as performed in this series, can be one of the treatment options.

This study had some limitations. First, not all patients with DLM who had meniscal symptoms had DLM repair without saucerization. In this series, as the inclusion criteria was very narrow and strict, as mentioned above, this procedure could not be performed for all DLM patients. Second, four cases (2.4%) were included in this series. Due to strict inclusion criteria, this number was the maximum number of cases. These patients matching current indication criteria should be followed with patience until more patients are gathered. Third, they were followed for two years after surgery. Since DLM is known to have tears and degeneration because of the structural difference with a normal meniscus, these patients should be followed from now on with great attention. Furthermore, future clinical trials may elucidate the exact patients who will benefit from DLM repair without saucerization.

5. Conclusion

In this case report, DLM repair without saucerization was performed on four adolescents who had a painful peripheral longitudinal tear with an intact body caused after a single traumatic incidence. For two years after surgery, good clinical outcomes were shown, and both the joint space and discoid shape were preserved without deformation and extrusion.

Conflict of interest

No benefits in any form were received or will be received from a commercial party related directly or indirectly to the subject of this article. None of the authors have any conflicting interest related to the outcomes of this study.

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