Long-Term Results of Arthroscopic Reshaping for Symptomatic Discoid Lateral Meniscus in Children

Jin Hwan Ahn, M.D., Kang-Il Kim, M.D., Joon Ho Wang, M.D., Jong Wook Jeon, M.D., Young Chu Cho, M.D., and Sang Hak Lee, M.D.

**Purpose:** To assess the long-term clinical and radiographic results of arthroscopic reshaping with or without peripheral meniscus repair for the treatment of symptomatic discoid lateral meniscus in children. **Methods:** This study included 38 children (48 knees) who underwent arthroscopic surgery for symptomatic discoid lateral meniscus. The mean age at operation was 9.9 years (range, 4 to 15 years), and the mean follow-up period was 10.1 years (range, 8 to 14 years). Arthroscopic partial meniscectomy was performed in 22 knees (group A); partial meniscectomy with repair, in 18 knees (group B); and subtotal meniscectomy, in 8 knees (group C). Clinical and radiographic results were evaluated preoperatively and at the final follow-up. **Results:** According to the scale of Ikeuchi, 94% of cases showed excellent or good results clinically. At the final follow-up, the median Tegner activity level was 7 (range, 4 to 10). The mean Lysholm knee score improved from 74.9 ± 10.6 to 97.6 ± 4.0, and the mean Hospital for Special Surgery score improved from 80.8 ± 8.9 to 97.8 ± 3.6 (P < .0001). At the final follow-up, radiographic evaluation showed the development of minor osteophytes in the lateral compartment of 18 knees and moderate joint space narrowing with spur formation in 1 knee. In addition, degenerative changes were observed in 23% of cases in group A, 39% of cases in group B, and 88% of cases in group C. Group C showed significantly greater progression of degenerative changes than group A or B. **Conclusions:** Arthroscopic reshaping for symptomatic discoid lateral meniscus in children led to satisfactory clinical outcomes after a mean of 10.1 years. However, progressive degenerative changes appeared in 40% of the patients. The subtotal meniscectomy group had significantly increased degenerative changes compared with partial meniscectomy with or without repair. **Level of Evidence:** Level IV, therapeutic case series.

Discoid lateral meniscus (DLM) has a prevalence ranging from 0.4% to 17%, occurring at a higher prevalence in Asian populations. In children, DLM is associated with a higher frequency of meniscal tears and related symptoms because these menisci are larger and thicker than normal lateral menisci. Many DLM cases have an associated tear in the DLM, resulting in symptoms such as pain, a clicking sound, or a limitation of extension, and arthroscopic treatment should be considered. If tears in the DLM are not treated appropriately, then the remnant meniscus can become unstable and preservation may not be possible.

The traditional treatment for symptomatic DLM is total meniscectomy by open or arthroscopic means. Some reports have noted favorable long-term clinical results after total meniscectomy in children, but these studies examining the long-term radiographic results after total meniscectomy in children have shown early degenerative changes in 86% to 100% of cases. Recent reports have also found that peripheral instability in DLM patients occurs at a frequency of 38% to 88%. Therefore current treatment recommendations favor meniscal reshaping through partial meniscectomy with or without repair. However, arthroscopic reshaping can be challenging to an inexperienced surgeon because visualization within the lateral joint space may...
be limited by a thickened meniscus and the small size of the pediatric knee.\textsuperscript{23,26,28}

A number of case studies have concentrated on the long-term results of arthroscopic or open total meniscectomy in children and adolescents.\textsuperscript{3,6,19,29} However, no long-term clinical studies of arthroscopic reshaping for symptomatic DLM have been undertaken in children. In 2008 we described short-term clinical results after arthroscopic partial meniscectomy in conjunction with meniscal repair for treating children with symptomatic DLM.\textsuperscript{23} Therefore we investigated the long-term clinical and radiographic results of arthroscopic reshaping with or without peripheral meniscus repair for the treatment of symptomatic DLM in children. We hypothesized that arthroscopic reshaping would yield satisfactory clinical results without serious complications. Furthermore, we hypothesized that the development of degenerative changes after arthroscopic treatment over a long-term follow-up would depend on maintaining an adequate stable rim of meniscal tissue.

Methods

Patient Demographic Data

From June 1997 to May 2004, the senior author (J.H.A.) performed arthroscopic surgery in 60 children (72 knees) with symptomatic DLM. This study included 38 of these patients (48 knees) who were able to return for the final evaluation after a minimum follow-up of 8 years (mean, 10.1 years; range, 8 to 14 years). Ten patients received bilateral operations for DLM. The mean age at operation was 9.9 years (range, 4 to 15 years); 19 knees were in children younger than 10 years, and 29 knees were in children aged 10 years or older. Of the 48 knees, 22 were left knees. There were 15 girls and 23 boys.

The surgical indication was persistent mechanical pain despite 3 months of conservative treatment. If a patient had persistent locking, a block to extension, or severe pain with a loud click, arthroscopic treatment was recommended after we obtained magnetic resonance imaging (MRI) confirmation of a torn DLM.

Evaluation

All preoperative evaluations were performed the day before surgery for each parameter, and postoperative evaluations were performed at the final follow-up. Careful recording of the nature of the pain and a physical examination were performed in each case. The mean duration of symptoms before surgery was 10.8 months (range, 3 to 60 months). An extension block was the most frequent manifestation, followed by a loud click or pain. All patients underwent preoperative radiographic evaluation, which included anteroposterior, lateral, tunnel, and Merchant views. Arthroscopic findings were analyzed as follows: By use of the classification of Watanabe et al.,\textsuperscript{30} 47 knees (98\%) were classified as type 1 (complete type) and 1 knee (2\%) was classified as type 2 (incomplete type): there were no type 3 cases (Wrisberg ligament type). The group assignments according to arthroscopic treatment are shown in Table 1. Arthroscopic partial meniscectomy was performed in 22 knees (group A); partial meniscectomy with repair, in 18 knees (group B); and subtotal meniscectomy, in 8 knees (group C). According to the previous report, the MRI findings were classified into the following 4 categories based on shifting meniscus morphologies: (1) no shift, (2) anterocentral shift, (3) posterocentral shift, or (4) central shift.\textsuperscript{24} There was a correlation between MRI classification and arthroscopic treatment group ($P = .01$, Table 2).

At final follow-up, the Tegner activity level and the grading scale of Ikeuchi\textsuperscript{26} were determined. Clinical results were evaluated with Lysholm knee scores and Hospital for Special Surgery scores preoperatively and at final follow-up. To evaluate degenerative changes radiographically, we used the classification of Burks et al.,\textsuperscript{31} which is based on the grading system of Holden et al.\textsuperscript{32} The grades were as follows: grade 0, normal radiograph; grade I, slight joint space narrowing, minimal osteophyte formation, and slight sclerosis; grade II, moderate joint space narrowing, spur formation, and sclerosis; grade III, bone-on-bone changes; and grade IV, severe sclerosis with loss of bone stock.

Surgical Technique

On the basis of the preoperative MRI findings, saucerization was planned and peripheral rim instability was expected before arthroscopic surgery.\textsuperscript{23,24} The arthroscopic partial meniscectomy technique with or without repair for symptomatic DLM has been described previously.\textsuperscript{23} Careful probing was performed

### Table 1. Groups According to Arthroscopic Treatment in 48 Discoid Lateral Menisci

<table>
<thead>
<tr>
<th>Group</th>
<th>No. of Knees (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A: partial meniscectomy</td>
<td>22 (46)</td>
</tr>
<tr>
<td>Group B: partial meniscectomy with repair</td>
<td>18 (38)</td>
</tr>
<tr>
<td>Group C: Subtotal meniscectomy</td>
<td>8 (16)</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
</tr>
</tbody>
</table>

### Table 2. MRI Classification and Arthroscopic Treatment Group

<table>
<thead>
<tr>
<th>MRI Classification</th>
<th>No. of Knees (%)</th>
<th>Operation Group (A/B/C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No shift</td>
<td>30 (63)</td>
<td>18/10/2</td>
</tr>
<tr>
<td>Anterocentral shift</td>
<td>4 (8)</td>
<td>1/2/1</td>
</tr>
<tr>
<td>Posterocentral shift</td>
<td>6 (13)</td>
<td>2/3/1</td>
</tr>
<tr>
<td>Central shift</td>
<td>8 (17)</td>
<td>1/3/4</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td></td>
</tr>
</tbody>
</table>

MRI, magnetic resonance imaging.
to identify the meniscus type and tear shape and to evaluate the stability of the peripheral rim. Peripheral rim tears at the posterior horn of the lateral meniscus were examined in the posterolateral compartment using the posterolateral portal. Partial central meniscectomy was performed to remove the central portion of the thickened meniscus and the torn unstable part and to leave a stable rim more than 6 mm from the peripheral capsular attachment. After the central portion of the meniscus was removed, the remaining peripheral rim was carefully probed to ensure that there were no additional tears and that the rim was balanced and stable. If the meniscus was shifted anteriorly or posteriorly, one suture for reduction purposes and verified meniscal morphology was placed before undertaking central partial meniscectomy. When the peripheral rim tear of the DLM was reducible with a probe, suture repair was performed. However, when the loss of the posterolateral corner of the DLM was too large and the tear was irreducible with a probe, subtotal or total meniscectomy was considered. All repairs were performed with absorbable sutures (No. 0 PDS; Ethicon, Somerville, NJ), and different suture techniques were used depending on the properties of the tear site. If a tear could not be repaired because posterolateral corner loss was more than 1 cm, arthroscopic subtotal meniscectomy was performed. Rehabilitation was performed as previously described.

Statistical Analysis
Statistical analysis of the association between degenerative changes and other factors was performed with the $\chi^2$ test or Fisher exact test, as appropriate. An exact $P$ value (2 tailed) $< .05$ with Bonferroni adjustment (threshold $P$ value is $0.05/n$, where $n$ is the number of all simultaneous independent tests) was considered statistically significant. Multivariate logistic regression analysis was used to examine the relative contribution of the selected factors to the degenerative changes in knee joints. With the exception of the Tegner activity...
Fig 2. (A) An anteroposterior view in a 7-year-old boy shows no significant abnormality in the left knee. (B) Coronal magnetic resonance imaging shows a complete-type discoid lateral meniscus. (C) Arthroscopic findings show a complete-type discoid lateral meniscus. (D) Arthroscopic partial central meniscectomy was performed. (E) An anteroposterior view shows no degenerative changes, classified as grade 0, at 12 years' follow-up. (ACL, anterior cruciate ligament; LFC, lateral femoral condyle.)
level, data were normally distributed and expressed as mean ± standard deviation. Data were analyzed with SPSS software, version 13.0 (SPSS, Chicago, IL).

Results

According to the scale of Ikeuchi,2 the result was excellent in 31 knees, good in 14 knees, and fair in 3 knees at final follow-up. Therefore 45 knees (94%) showed excellent or good clinical results. At the last follow-up, the median Tegner activity level was 7 (range, 4 to 10). The mean Lysholm knee score improved from 74.9 ± 10.6 preoperatively to 97.6 ± 4.0 at final follow-up (P < .0001), and the mean Hospital for Special Surgery score improved from 80.8 ± 8.9 preoperatively to 97.8 ± 3.6 at final follow-up (P < .0001). All knees had grade 0 degenerative changes preoperatively. At the final follow-up, 29 knees (60.4%) had grade 0 degenerative changes, 18 (37.5%) had grade I degenerative changes, and 1 knee (2%) had grade II degenerative change (Figs 1-3). Therefore 19 knees (39.5%) showed radiographic degenerative changes over a long-term follow-up period, although most of these changes were minimal. At final follow-up, degenerative changes were observed in 5 knees (22.7%) in group A, 7 knees (38.9%) in group B, and 7 knees (87.5%) in group C (Table 3).

Table 4 summarizes the factors associated with the progression of degenerative changes on the radiographs on univariate analyses. Group C showed a greater progression of degenerative changes than did the other groups. Multiple logistic regression analysis of degenerative changes showed subtotal meniscectomy (odds ratio, 13.558; P = .0278) to be a significant predictor (Table 5).

Arthroscopic re-evaluation of 3 knees (6.3%) was required at a postoperative mean of 9.7 months (range, 7 to 12 months). In 1 knee that showed pain and effusion, arthroscopic meniscus repair was performed at 7 months’ follow-up. One knee underwent arthroscopic adhesiolysis at 8 months’ follow-up because of limited range of motion. Finally, arthroscopic partial meniscectomy of the central portion was performed at 12 months’ follow-up because the patient had mild pain.36

Discussion

The most important finding of our study is that meniscal reshaping by partial meniscectomy with or without repair was associated with less progression of degenerative changes than was subtotal meniscectomy regarding long-term results. We suggest that DLM should be treated with arthroscopic partial meniscectomy with or without meniscal repair according to the presence or absence of peripheral tears. In our series 40 knees (83%) underwent meniscal reshaping through partial meniscectomy with or without repair. The advantage of this study was that all operations were performed by a single surgeon (J.H.A.) using a standardized surgical technique to minimize differences among treatment groups.

Previous long-term follow-up studies have shown satisfactory clinical results after total meniscectomy for DLM in children and adolescents.18,20,37 Washington et al. reported that 72% of 18 knees (mean age, 10.5 years) had excellent or good results after open total meniscectomy at a mean follow-up of 17 years. Raber et al.18 reported that 76% of 17 knees (mean age, 9 years) were rated normal or nearly normal after open total meniscectomy at a mean follow-up of 19.8 years. Similarly, Aglietti et al.37 found that 94% of 17 knees (mean age, 13.6 years) had excellent or good results after arthroscopic meniscectomy (partial meniscectomy in 11 knees and total meniscectomy in 6), with a mean follow-up of 10 years. However, their radiographic results were not consistent with the clinical results. Raber et al. showed that 10 of 11 knees had osteoarthritic changes, such as flattening of the lateral femoral

Fig 3. An anteroposterior view shows moderate joint space narrowing and marginal spur formation in tibial lateral margin that was classified as grade II at 12 years’ follow-up after subtotal meniscectomy.
condyle or spurring and sclerosis of the tibial plateau. Furthermore, Aglietti et al. reported that osteophytes developed in all knees and that 8 of 15 knees showed less than 50% narrowing of the lateral joint line compared with the opposite knee. These results might suggest that younger patients exhibited good results simply because they were still young during the follow-up period. In contrast to other long-term studies, most of the degenerative changes in our series were mild osteoarthritic changes, such as slight joint space narrowing, minimal osteophyte formation, and slight sclerosis.

Recent studies have focused on peripheral stability and attachment in DLM.2 The current treatment of choice for a torn DLM is meniscal preservation with or without repair based on peripheral rim instability. In children current evidence supports that meniscal repair should be attempted instead of total or near total meniscectomy in DLM with peripheral instability because of the greater healing potential of children. However, treatment by subtotal meniscectomy is inevitable if meniscus salvage is not possible because of large meniscal rim defects. In our series the meniscus repair rate was high, at 18 of 48 knees (38%), although 8 of 48 knees (17%) underwent subtotal meniscectomy. Therefore we recommend that meticulous arthroscopic assessment and repair of peripheral instability during the evaluation and treatment of DLM should be performed, particularly in patients with the complete variant and in young children, for preservation of the maximal amount of meniscal tissue.

A few reports have found that the degree of meniscus resection was associated with the progression of degenerative changes. Kim et al.12 compared the long-term radiologic outcomes of partial meniscectomy and total meniscectomy for torn DLMs with over 5 years of follow-up. Their results showed that partial meniscectomy led to better results. They concluded that the long-term prognosis after arthroscopic meniscectomy for a torn DLM was related to the volume of the meniscus removed, although the percentage of patients treated with total meniscectomy was high (64%) in their study. Our results showed that subtotal meniscectomy led to greater progression of degenerative changes than other operative techniques on univariate analyses. This result suggests that the progression of degenerative arthritis was more greatly affected by subtotal or total meniscectomy than by partial meniscectomy with or without meniscus repair.

### Limitations
This study has some limitations. First, this was a retrospective study, not a randomized study, and it lacked a control group. The knees with irreparable posterolateral gaps that were treated with subtotal or total meniscectomy in this study might somehow be fundamentally different from those that underwent repair or just partial meniscectomy so that degenerative joint disease is already more likely, regardless of the surgical intervention chosen. Second, only 48 of the initial 72 knees (66.7%) were available for follow-up. The long-term nature of this study contributed to the high rate of loss to follow-up. Third, the sample sizes were not uniform across the 3 groups. Moreover, we did not perform a power analysis to check the appropriateness of statistical power, supporting the reliability of the results from this study.

### Conclusions
Arthroscopic reshaping for symptomatic DLM in children led to satisfactory clinical outcomes after a mean of 10.1 years. However, progressive degenerative changes appeared in 40% of the patients. The subtotal meniscectomy group had significantly increased degenerative changes compared with partial meniscectomy with or without repair.

### References
3. Ogut T, Kesmezacar H, Akgun I, Cansu E. Arthroscopic meniscectomy for discoid lateral meniscus in children and

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**Table 4. Univariate Analysis for Factors Associated With Development of Degenerative Changes on Radiographs**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Grade 0 (n = 29)</th>
<th>Grade I (n = 18)</th>
<th>Grade II (n = 1)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr, mean ± SD</td>
<td>9.7 ± 3.1</td>
<td>10.4 ± 2.3</td>
<td>10.4 ± 2.3</td>
<td>.42</td>
</tr>
<tr>
<td>Sex (male/female), n</td>
<td>19/10</td>
<td>13/5</td>
<td>1/0</td>
<td>.67</td>
</tr>
<tr>
<td>Symptom duration, mo, mean ± SD</td>
<td>11.9 ± 12.0</td>
<td>9.9 ± 8.7</td>
<td>2</td>
<td>.54</td>
</tr>
<tr>
<td>Operation group, n, A/B/C</td>
<td>17/11/1</td>
<td>5/7/6</td>
<td>0/0/1</td>
<td>.03</td>
</tr>
</tbody>
</table>

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**Table 5. Multiple Logistic Regression Analysis for Evaluation of Relative Contribution of Variables to Development of Degenerative Changes on Radiographs**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Odd Ratio (95% Confidence Interval)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.21 (0.94-1.58)</td>
<td>.14</td>
</tr>
<tr>
<td>Sex, male</td>
<td>1.01 (0.99-1.01)</td>
<td>.77</td>
</tr>
<tr>
<td>Symptom duration</td>
<td>0.97 (0.91-1.04)</td>
<td>.39</td>
</tr>
<tr>
<td>Operation group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C vs A</td>
<td>13.56 (1.26-145.92)</td>
<td>.028</td>
</tr>
<tr>
<td>B vs A</td>
<td>4.26 (0.73-24.72)</td>
<td>.13</td>
</tr>
</tbody>
</table>
LONG-TERM RESULTS OF DISCOID LATERAL MENISCUS
