Functional and Radiographic Outcomes of Unstable Juvenile Osteochondritis Dissecans of the Knee Treated With Lesion Fixation Using Bioabsorbable Pins

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Background: The purpose of this study was to evaluate the functional and radiographic outcome of fixation of unstable juvenile osteochondritis dissecans lesions of the knee after a minimum of 2 years of follow-up.

Methods: A total of 33 unstable juvenile osteochondritis dissecans lesions in 30 patients underwent fixation using bioabsorbable pins through arthrotomy or under arthroscopy. The patients consisted of 23 males and 7 females, and the average age at the time of operation was 14.4 years (range, 11 to 17 y). The functional outcomes were evaluated using the Lysholm score and Hughston's criteria at a mean follow-up of 3.3 years (range, 2.1 to 6.3 y). Healing of the osteochondritis dissecans lesions were confirmed by plain radiographs and magnetic resonance imaging.

Results: The Lysholm score improved significantly at 3 months after the surgery, and was maintained until the final follow-up. Radiographically, 32 of 33 lesions healed after fixation of the lesion (healing rate was 97.0%). Healing was achieved at an average of 2.4 months on plain radiographs and 4.2 months on magnetic resonance imaging. According to Hughston's criteria, 25 patients were graded as excellent, 4 as good, and 1 as poor at the final follow-up.

Conclusions: The fixation of the unstable juvenile osteochondritis dissecans lesions with bioabsorbable pins demonstrated improved clinical outcomes and radiographic high healing rates at a mean of 3.3 years of follow-up. We advocate this procedure for patients with unstable juvenile osteochondritis dissecans lesions of sufficient quality to enable fixation which will preserve the normal contour of the distal femur.

Level of Evidence: Level IV—retrospective case series.

Key Words: osteochondritis dissecans, knee, fixation, bioabsorbable pin

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Osteochondritis dissecans (OCD) of the knee is an osteochondral lesion which usually occurs in adolescent or young adults, causing limitation of their daily or sports activities due to knee pain. Although definite etiologies have not been well accepted, several theories have been reported, such as repetitive minor trauma, ischemia, or genetic factors.[1–4] Sometimes OCD progresses leading to a partial or total separation of an articular cartilage with its underlying subchondral bone. Therefore, early diagnosis and appropriate treatment are important to avoid secondary osteoarthritis. OCD is often subcategorized in to a "juvenile" and "adult" type depending on the status of the physis of the femoral condyle. There have been several treatment options for juvenile OCD of the knee including conservative treatments, drilling,[5–9] fixation of the lesion,[10–22] osteochondral graft,[23,24] or more recently autologous chondrocyte implantation.[25–27] Although stable juvenile OCD usually respond well to nonoperative treatments, operative treatments are usually indicated for unstable OCD lesions, even if they are juvenile type. Adequate operative treatment for unstable OCD lesions should be determined according to the patient's age, size, stage, or condition of the OCD lesion, or status of the subchondral bone.

If the unstable osteochondral fragment or loose bodies of OCD lesions are left in the joint with adequate conditions for fixation, internal fixation should be the preferred method of treatment, as it preserves the natural contour of the distal femur. After Bandi and Allgower first demonstrated fixation of the OCD lesion using autogenous bone pegs through arthrotomy, good results of fixation of the OCD lesion were reported.[11–22] There have been several surgical fixation methods using different devices such as bone pegs, metal screws, bioabsorbable pins, and recently, osteochondral plugs.[28,29] Those fixations can be performed through arthrotomy or under arthroscopy, depending on the status of the OCD lesions.

The purposes of this retrospective study were to evaluate the functional and radiographic outcome of fixation of unstable juvenile OCD lesions of the knee after a minimum of 2 years of follow-up and clarify the factors affecting the final clinical scores. The hypothesis was that fixation of unstable juvenile OCD lesions of the knee would improve the functional and radiographic outcomes for patients with such lesions.

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METHODS

The institutional review board approved the use of human subjects for this study. Written informed consent was obtained from all patients before their participation and the rights of the patients were protected.

Between February 2002 and October 2010, we surgically treated 101 patients with juvenile OCD of the knee with open physis in our institution. Among them, 40 patients underwent fixation of the OCD lesion as a primary procedure. We excluded 5 patients due to insufficient clinical data, loss of follow-up, and additional surgical procedures such as osteochondral graft. Finally, 33 unstable OCD lesions in 30 patients who underwent fixation through arthrotomy or under arthroscopy and were followed up over 2 years were included in this study (follow-up rate was 87.5%). The subjects consisted of 23 males and 7 females, and the average age at the time of operation was 14.4 years (range, 11 to 17 y). The duration of symptoms varied widely, averaging 10.5 months (range, 1 mo to 5.7 y). The average follow-up period was 3.3 years (range, 2.1 to 6.3 y). Sixteen OCD lesions were located in the medial femoral condyle, 11 in the lateral femoral condyle, 4 in the patella, and 2 in the patellar groove. The size of the lesion on the radiograph varied from 15×10 mm to 30×25 mm (average, $427.9 \pm 197.2\ mm^2$).

Preoperatively, all OCD lesions on the magnetic resonance imaging (MRI) were graded according to Nelson's classification[30]: grade 0: normal; grade 1: intact cartilage with signal changes; grade 2: a high signal breach of the cartilage; grade 3: a thin, high signal rim extending behind the osteochondral fragment indicating synovial fluid around the fragment; and grade 4: mixed-signal or low-signal loose body in the center of the lesion or free within the joint. On the 1.5-T MR unit, proton density and T2-weighted sagittal and coronal images were obtained. We regarded the high-intensity rim around the fragment as the important sign for lesion instability on MRI, as described by Nelson et al[30] or De Smet et al.[31] At the final follow-up, the clinical results were assessed according to Hughston's criteria[32] and the Lysholm score.[33] Briefly, Hughston's criteria are: excellent: no limitation of activity, no symptoms, examination normal, radiographs normal; good: mild aching with strenuous activity, examination normal, radiographs show healed defect, or residual sclerosis; fair: mild aching and swelling with strenuous activity, examination normal, radiographs show flattening of the condyle but normal joint space; poor: pain and swelling with mild activity, tenderness, loss of 20 degrees of motion, 0 to 2.5 cm of thigh atrophy, radiographs show irregularity of condyle, and narrowed joint space; and failure: pain and swelling with no activity, tenderness, loss of motion of >20 degrees, >2.5 cm of thigh atrophy, radiographs show absent joint space. Bone union was confirmed with anteroposterior tunnel view and lateral view of the radiographs and sagittal and coronal images of the MRI. Radiographic healing was defined as resolution of the radiolucent area on both anteroposterior and lateral views of plain radiographs and the disappearance of the abnormal signal intensity area of the lesions on MRI. Radiographic and MRI evaluations were performed by one of the authors who had no information about the patients. Functional, radiographic, and MRI evaluations were carried out at least every 3 months until 1 year after the fixation of the OCD lesions. After 1 year, those evaluations were performed every 6 months.

Operative Technique

Ordinary arthroscopic intra-articular inspection was done through the lateral and medial infrapatellar portal with a 30-degree oblique arthroscope. The knee was flexed 90 degrees or more according to the site of the lesion, to obtain the optimal visualization of the OCD lesions. The extent, instability, and cartilaginous congruity of the lesions were evaluated. Fixation of the OCD lesion was indicated for patients with unstable OCD of the knee arthroscopically, in which the surgeons had determined that the lesion had enough quality to be fixed. The fixation of the OCD lesions was performed using bioabsorbable pins through arthrotomy or under arthroscopy. In this study, the indication for the fixation through arthrotomy or under arthroscopy was determined according to the arthroscopic or MRI findings of the OCD lesion. If the patient had a lesion separated from the underlying base, and it could not be reduced anatomically under arthroscopy, fixation through arthrotomy was indicated. Fixation under arthroscopy was indicated for patients who had an unstable lesion that was not separated from the base or if separated, it could be reduced anatomically under arthroscopy. The lesion fixation under arthroscopy was performed in 15 lesions, and through arthrotomy in 18 lesions. Thirteen of 15 lesions which were fixed under arthroscopy were not separated from the base arthroscopically.

For patients with unstable OCD lesions arthroscopically, the fibrous tissue between the OCD lesion and its base usually was gently debrided. We did not hesitate to perform the fixation of the lesions through arthrotomy, when it was difficult to refresh the fibrous tissue between the fragment and its subchondral bone or to have anatomic reduction of the lesions arthroscopically. Bone graft was not necessary, because lesion recession was minimal in all cases. All unstable OCD lesions were osteochondral lesions and not chondral lesions. While reducing the OCD lesion anatomically, multiple bioabsorbable pins (NEOFIX; Gunze, Kyoto, Japan) were used for fixation. Multiple pins were placed 2 mm under the articular surface in diverging directions for good stability, because the pins were not threaded. Care was taken not to damage the epiphyseal line in skeletally immature patients, by measuring the distance between the cartilage surface and the epiphyseal line on MRI preoperatively and using the pins with appropriate length. The number of bioabsorbable pins was determined according to the lesion size and instability (1 to 9, average = 3.4, 15 to 30 mm in length) (Figs. 1–4).

In conjunction with the fixation of the OCD lesion, 7 patients with the inferocentral type of OCD lesions on the discoid lateral meniscus underwent a central partial meniscectomy regardless of their meniscal symptoms or

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FIGURE 1. Preoperative Rosenberg's view of 15-year-old boy. Radiolucent area in left lateral femoral condyle is observed (A: coronal view, B: lateral view).

whether or not they had a meniscal tear. Two patients with the inferocentral type of OCD lesions had undergone partial meniscectomy for discoid lateral meniscus in the previous hospital.

Postoperatively, after all patients were immobilized for 1 week with a soft knee brace, range-of-motion exercise using a continuous passive motion device was started. Partial weight-bearing was permitted after 3 weeks, and full weight-bearing was allowed 5 to 6 weeks postoperatively. Sports activities were recommended 3 to 6 months postoperatively according to the patients' symptoms and bone union of the lesion on radiographs and MRI.

Statistical Analysis

The Wilcoxon signed rank test and Mann-Whitney *U* test was used for paired and unpaired comparison between 2 groups. Differences in parameters among the 3 groups were analyzed using 1-way analysis of variance. If a statistical difference existed, Fisher post hoc test was used. For correlation between the final Lysholm score and several factors, such as age of the patients, size of the lesion, preoperative periods, Spearman correlation coefficient by rank was used. A *P*-value of <0.05 was regarded as statistically significant. All statistical analyses were conducted on Statview 5.0 (SAS Institute, Cary, NC).

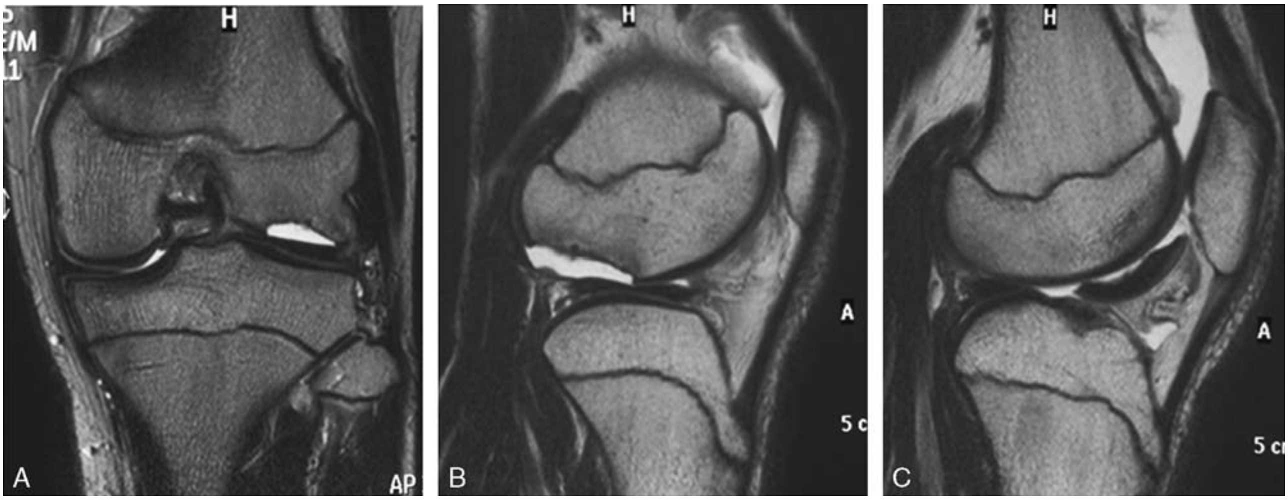

FIGURE 2. T2-weighted magnetic resonance imaging of left knee joint reveals large bone defect in the lateral femoral condyle and loose body in the intercondylar area (A: coronal view, B and C: sagittal view).

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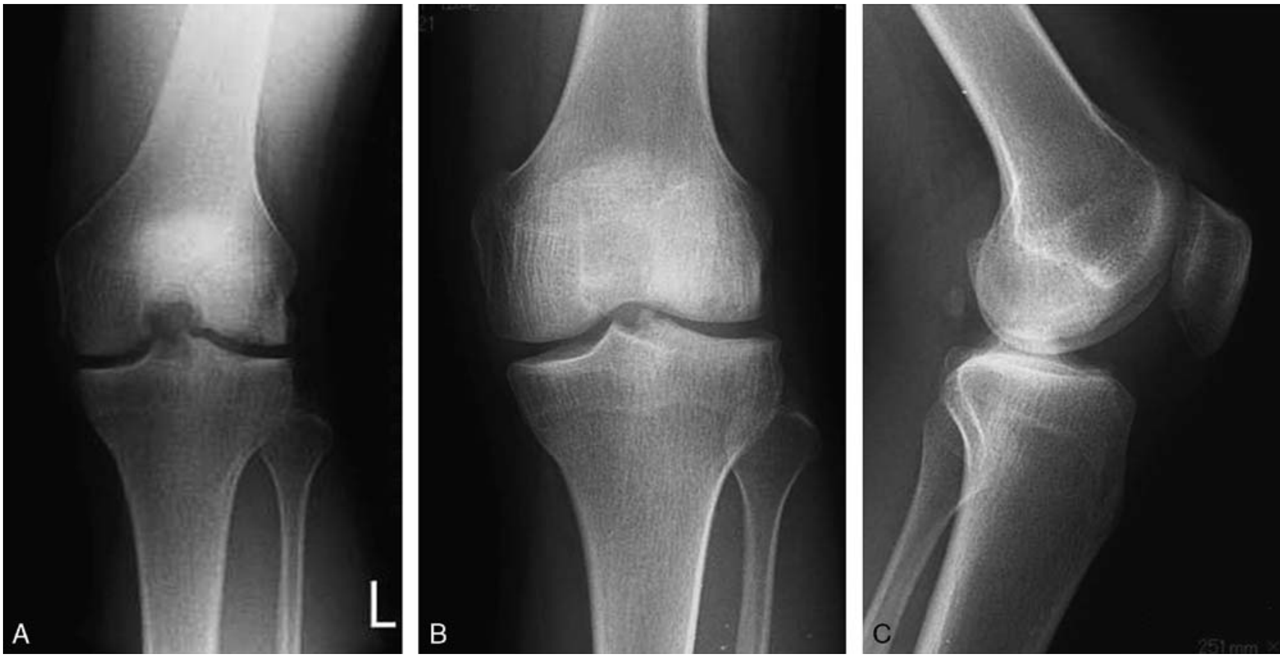

FIGURE 3. Plain radiographs at final follow-up of 3 years after surgery (A: Rosenberg's view, B: coronal view, C: lateral view).

RESULTS

The OCD lesion characteristics and surgical procedure were summarized in Table 1. The preoperative MRI showed that 17 of the lesions were classified as grade 3 and 16 as grade 4, indicating lesion instability. The preoperative Lysholm score improved significantly at 3 months after the surgery, and was maintained until final follow-up (Fig. 3). Although we have attempted to investigate the factors affecting the final clinical scores, there were no significant correlations between the final clinical scores and age of the patients, size of the lesion, and preoperative periods. There was also no significant difference between the scores of the patients with medial condyle, lateral condyle, or other locations. The number

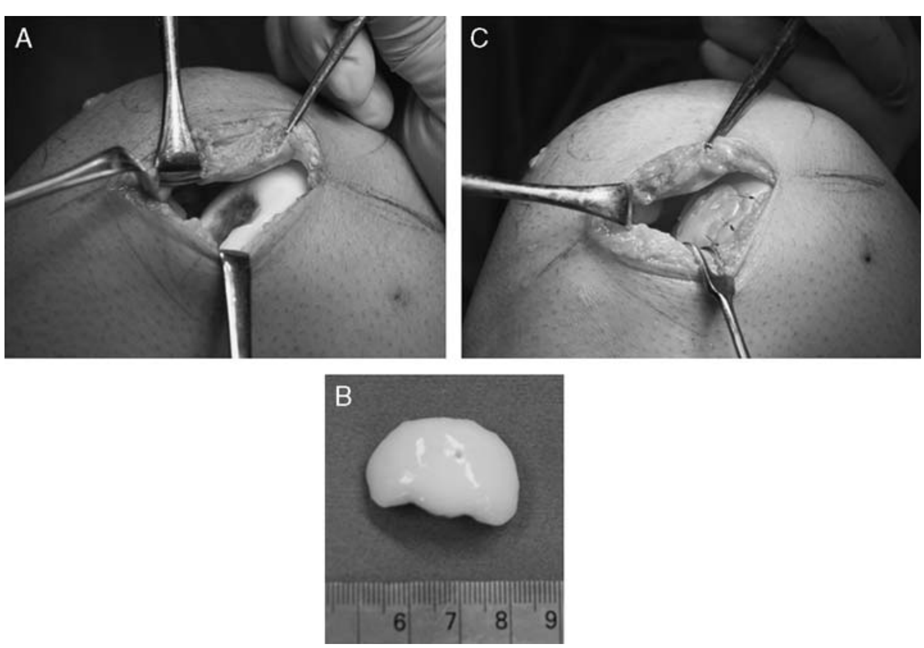

FIGURE 4. Operative findings. A, Large bone defect (2 × 3 cm) was observed in the lateral femoral condyle. B, Loose body. C, The osteochondritis dissecans loose body is fixed with 4 poly L-lactic acid pins and suture of the peripheral rim of the fragment using 5-0 nylon.

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TABLE 1. Characteristics of the Osteochondritis Dissecans Lesions and Surgical Procedure

Location of the lesion	
Medial femoral condyle	16
Lateral femoral condyle	11
Patella	4
Patella groove	2
Size of the lesion (mean ± SD) (mm^2)	427.9 ± 197.2
Fixation of the lesion	
Open	18
Arthroscopic	15
No. bioabsorbable pins [mean (range)]	3.4 (1-9)

of pins used for fixation was correlated with the size of the lesions. Radiographically, 32 of 33 lesions healed after fixation of the lesion at an average of 2.4 months (range, 1.5 to 4.5 mo) on plain radiographs and 4.2 months (range, 3 to 6 mo) on MRI. The overall healing rate was 97.0%. According to Hughston's criteria, 25 patients were graded as excellent, 4 as good, and 1 as poor at the final follow-up. The single patient who was graded as poor involved in a case in which bone union was not achieved. Twenty-five of 28 patients who had been involved in sports activities returned to their previous activities without reduction of their activity levels within 6 months after the operation.

In this series, there were no infections, synovitis, deep thrombosis, or nerve or arterial involvement. As for the range of motion, all patients acquired normal range of motion. There were also no apparent surgical complications associated with the fixation of the OCD lesions using bioabsorbable pins or those additional procedures.

DISCUSSION

This study clearly demonstrated that fixation of the unstable juvenile OCD lesions with bioabsorbable pins was an effective treatment option, as supported by their functional and radiographic improvement at a mean of 3.3 years of follow-up. The patients achieved a high healing rate of the OCD lesions, high incidence of returning back to previous sports activities, or low complication rates. There were no significant correlations between the final scores and age of the patients, size of the lesion, and preoperative periods. There was also no significant difference between the scores of the patients according to the locations of the lesions.

Fixation of the OCD lesion is indicated when the unstable OCD fragment is well preserved. Because this procedure can preserve the natural contour of the distal femur, it has the best opportunity for the restoration of normal anatomy and function, while hopefully decreases the chance of secondary osteoarthritis. Fixation of the OCD lesion not only stabilizes the lesion but may have drilling effect to the fragment and the subchondral bone. Fixation of the OCD lesion using bone pegs was first reported by Bandi and Allgower in 1959.[10] They described 1 case of OCD in the knee treated by drilling and bone peg fixation and stated that the fragment was united to the base 1 year later and hence an excellent result was achieved. After this report, other good results of OCD lesion fixation followed, using not only bone pegs but also metal screws, bioabsorbable pins, or more recently autogenous osteochondral grafts.[11–22,28,29] Although the fixation of the OCD lesions has been performed frequently through arthrotomy, thanks to the development of arthroscopic operative techniques in knee surgery, this procedure can now be performed under arthroscopy for less invasive surgery.

In this study, we used the bioabsorbable pins made of poly L-lactic acid for the fixation of the OCD lesions. It has been reported that the advantages of using bioabsorbable pins compared with bone pegs or metal screws are that (1) they do not require harvest of healthy tissue; (2) they do not require a second operation to remove the implant; (3) there is no interference on the postoperative MRI scan; and (4) there is a potentially lower incidence of prominent hardware. In contrast, the potential disadvantages of using bioabsorbable pins are (1) the dropping out of pins due to lack of thread; (2) a lack of compressive force; and (3) an inflammatory reaction causing synovitis. In the case series, we have not experienced any major complications attributable to the bioabsorbable pins.

We had a relatively high rate of patients with unstable OCD lesions in their lateral femoral condyle compared with previous reports. In this study, 33.3% (11/33) of the patients' lesions were located in the lateral femoral condyle. A total of 63.6% (7/11) of these patients also had a discoid lateral meniscus. There have been several reports investigating the relationship between OCD in the lateral femoral condyle and discoid lateral meniscus. Mizuta et al[34] reported 6 patients in whom OCD in the lateral femoral condyle had developed after total resection of the torn discoid lateral meniscus. Mitsuoka et al[35] reported a case of OCD in the lateral femoral condyle with an intact discoid lateral meniscus. Although they treated patients with a partial meniscectomy of the meniscus without any treatment of the OCD lesion, the OCD lesion had healed 1 year after the surgery. Deie et al[4] also evaluated the relationship between the location of the OCD lesion in the lateral femoral condyle and the complete and incomplete discoid meniscus, suggesting that mechanical stress caused

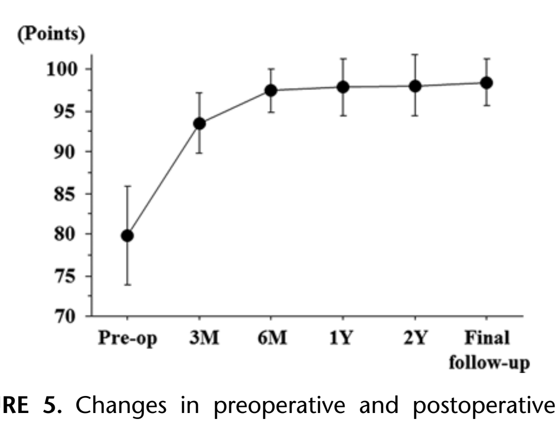

FIGURE 5. Changes in preoperative and postoperative Lysholm score.

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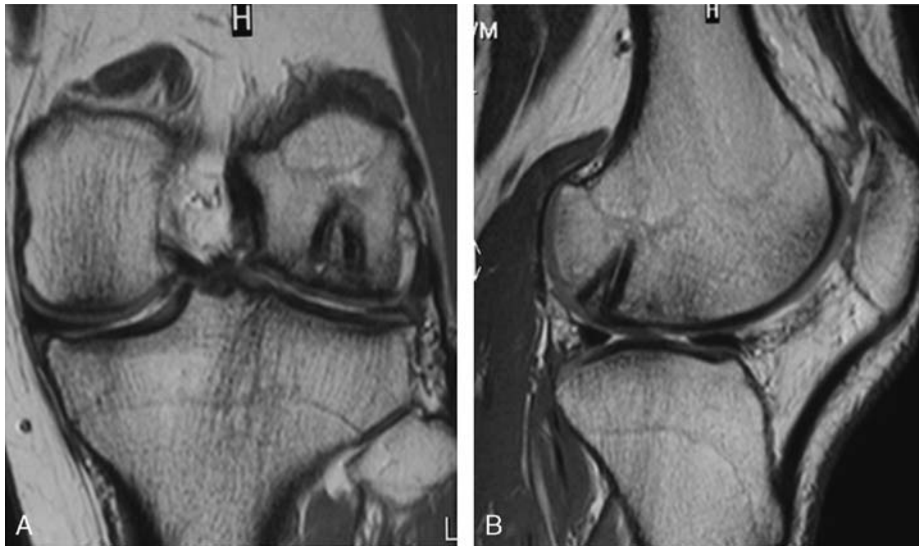

FIGURE 6. Magnetic resonance imaging at final follow-up of 3 years after surgery. Healing of the osteochondritis dissecans lesion is confirmed, although PLLA pins used for fixation are still visible.

by the discoid meniscus can be a cause of OCD in the lateral femoral condyle. These studies suggested that abnormal stress applied to an articular surface of the lateral femoral condyle by a discoid lateral meniscus, its tear, or a meniscectomy can comprise the pathogenesis of OCD in the lateral femoral condyle. The high incidence of OCD in the lateral femoral condyle in this study was probably because of the frequent presence of a discoid lateral meniscus in the Asian population. We performed a partial central meniscectomy on patients with unstable OCD of the lateral femoral condyle in conjunction with discoid lateral meniscus regardless of the existence of meniscal symptoms and even if they did not have meniscal tears. Further studies will be necessary to determine categorically if we need additional meniscal surgery for intact or asymptomatic discoid lateral meniscus accompanied by unstable OCD lesions. Therefore, we should be very careful for performing the additional meniscal surgery at this moment.

We recognize several limitations of this study. Firstly, this study was not a prospective comparative study. Therefore, we cannot conclude the superiority of the fixation of the unstable OCD lesions using bioabsorbable pins over other treatment procedures or other fixation methods. The follow-up period is not long enough to evaluate secondary osteoarthritis, degeneration of repaired tissue, or deterioration of clinical scores. Additional comparative studies with a larger number of patients and a longer follow-up, including second-look arthroscopy will be required to clarify the issue. Secondly, although radiographic evaluations were carried out by an author who did not know any clinical data of the patients, summary of the clinical scores was not performed in a blinded manner, which can cause a degree of bias for evaluations. It was also difficult to determine the healing of the OCD lesion on radiography and MRI.

CONCLUSIONS

The fixation of the unstable juvenile osteochondritis dissecans lesions with bioabsorbable pins demonstrated improved clinical outcomes and radiographic high healing rates at a mean of 3.3 years of follow-up. We advocate this procedure for patients with unstable juvenile osteochondritis dissecans lesions of sufficient quality to enable fixation which will preserve the normal contour of the distal femur (Figs. 4–6).

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