

Clinical Outcome of Internal Fixation of Unstable Juvenile Osteochondritis Dissecans Lesions of the Knee

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abstract

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Juvenile osteochondritis dissecans (OCD) lesions of the knee are a common cause of knee pain in skeletally immature patients. The authors sought to determine lesion healing rates, the risk factors associated with failure to heal, and the clinical outcomes for patients who underwent internal fixation for unstable OCD lesions. A retrospective review was conducted of all patients who underwent internal fixation of OCD lesions from 1999 to 2009. Using validated scoring systems, clinical outcome and functional activity were evaluated at the follow-up. The study group comprised 19 patients (20 knees). Mean patient age was 14.5 years (range, 12-17 years). Mean clinical follow-up was 7 years (range, 2-13 years). Mean radiographic follow-up was 2.5 years (range, 0.5-9 years). Fourteen (70%) lesions were grade 3 and 6 (30%) were grade 4. Eleven knees had lateral condyle lesions and 9 had medial lesions. Bioabsorbable fixation was used in 13 knees, metal fixation was used in 5 knees, and 2 knees were fixed with a combination of methods. Osseous integration was evident in 15 (75%) of 20 knees at final follow-up. The 5 unhealed lesions were lateral condylar lesions. Mean Tegner activity scores improved from 3.3 preoperatively to 5.6 at final follow-up. Mean Lysholm and International Knee Documentation Committee scores were 86.8 and 88.7, respectively, at final follow-up. Further operative intervention was required in 11 knees, with 50% of patients undergoing removal of hardware and 15% requiring subsequent osteochondral allograft transplantation. The authors recommend bioabsorbable fixation for symptomatic stable lesions and metal compression screws with staged removal for unstable lesions.



Figure: Preoperative lateral magnetic resonance image of the medial condyle of the knee showing the large osteochondritis dissecans lesion.

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Juvenile osteochondritis dissecans (OCD) lesions of the knee are a common cause of knee pain in skeletally immature patients. The incidence of OCD lesions has been previously reported to be 15 to 29 in 100,000, with a higher proportion of males affected.^{1,2} Many authors report having observed an increased incidence of these lesions because the rate of involvement in highly competitive sports has increased in the juvenile, or skeletally immature, population.^{1,2}

The etiology of OCD lesions is not fully understood, and much controversy has existed over the past few decades. Various etiologies that have been postulated are a hereditary or genetic predisposition, local ischemia, nonunited secondary ossification centers, inflammatory processes, and repetitive trauma.²⁻⁴ Despite the controversy, the pathologic nature of the lesion has been well studied. Yonetani et al⁵ examined core specimens from OCD lesions and found no degenerative changes or bone necrosis. However, they found underlying instability of the deeper layers of articular cartilage and poor areas of healing at areas of separation.

The clinical dilemma is how to effectively treat OCD lesions. The literature has shown that nonoperative treatment of stable lesions in the juvenile population is a viable option when compared with the outcomes in the adult population.^{1,4} However, only 50% of skeletally immature patients with stable lesions are treated successfully with nonoperative management.¹ Therefore, operative intervention can be considered for lesions that fail conservative management, unstable lesions, and lesions in patients who are reaching skeletal maturity.^{1,2} Unstable lesions can be diagnosed based on plain radiography for large lesions or magnetic resonance imaging (MRI) scans, which can show lesion instability. Arthroscopic and open techniques have been described for the treatment of OCD lesions, but the goal is the same: to improve the healing potential of the lesion and to potentially pro-

vide stability to the lesion depending on the size. Microfracture or drilling of the lesion has previously been described and has shown good results for small lesions and unstable lesions without detachment.⁶ However, when the lesions are large or the lesion is detached, fixation of the lesion is required if the fragment has viable bone and cartilage remaining.

Numerous internal fixation methods for the stabilization of OCD lesions in the knee have been described. Compression screw fixation provides stable fixation of lesions and good outcomes; however, many devices available require removal before initiating full weight bearing.⁷⁻¹⁰ The use of a cortical or osteochondral autograft for fixation has also shown good healing with promising short-term outcomes.¹¹ Recently, biocompatible internal fixation devices such as pins, nails, and screws have become available and show promising results.¹²⁻¹⁶

Currently, few data exist on the outcomes of these internal fixation procedures for juvenile OCD lesions.¹⁰ This is likely because of the variety of internal fixation techniques available today, the small number of cases, and the lack of consensus on the ideal construct for long-term stability and symptomatic relief with the lowest side effect or morbidity profile. The purpose of the current study was to evaluate the clinical outcomes of juvenile unstable OCD lesions in patients who underwent surgical fixation at our institution. Specifically, the authors sought to determine (1) the clinical and radiographic healing rates after fixation of these lesions, (2) the risk factors associated with failure to heal, and (3) the overall clinical and functional outcome of these patients.

MATERIALS AND METHODS

A retrospective chart review of all skeletally immature patients who underwent surgery for the diagnosis of unstable OCD of the knee between the years 1999 and 2009 was performed. An institutional review board process was conducted and

approval was given before the initiation of the study. Only patients who had undergone surgery with any form of internal fixation device (bioabsorbable or metal) were included in the study. All patients' preoperative radiography studies were assessed by the primary author (J.E.W.) and found to be immature, which was defined as the presence of an open or partially open physis. Surgical intervention was indicated because of radiographic findings, MRI findings, and/or symptoms that were suggestive of unstable lesions. All unstable lesions were confirmed at the time of surgery and graded using the Ewing and Voto classification (Figure 1). Patient charts and operative reports were reviewed. The size and location of each lesion, the type of surgery performed, the type of internal fixation used, and the need for further intervention were evaluated.^{5,17,18}

Assessment of Radiographic Healing

Healing of the treated lesion was assessed by the treating surgeon's assessment of radiographs at final follow-up. When postoperative MRI was available, De Smet criteria were used to evaluate the lesion stability.¹⁹ Magnetic resonance imaging was used in 9 cases to evaluate healing and lesion stability, whereas plain radiographs were obtained in 10 patients and a computed tomography scan in a single patient.

Assessment of Functional Outcomes

The Tegner and Lysholm validated scoring systems were used to assess each patient's functional activity and symptoms preoperatively and at final clinical follow-up.¹⁸ The long-term outcome follow-up for the cohort was conducted using a telephone questionnaire. The patients provided appropriate consent before inclusion in the long-term analysis. The telephone questionnaire determined whether the patient had undergone further surgical intervention to the affected knee. Long-term follow-up Tegner and Lysholm

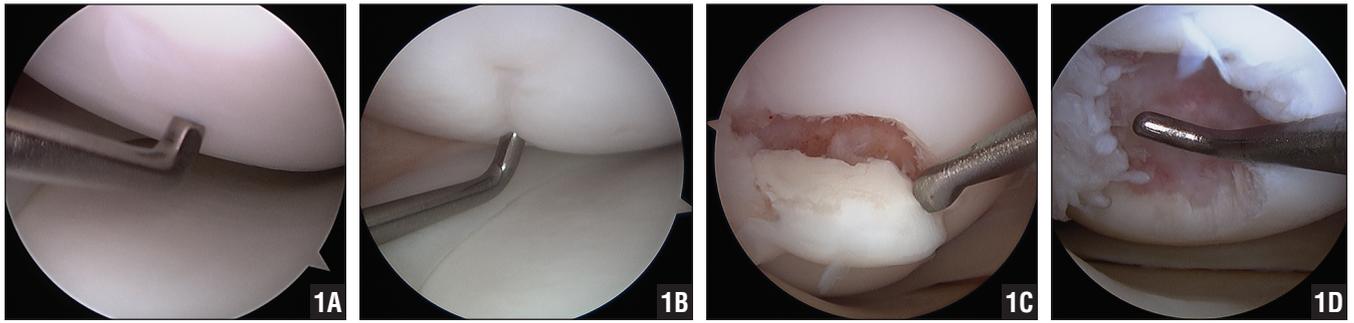


Figure 1: Arthroscopic images showing representative lesions of the Ewing and Voto classification. Grade I, intact lesion (A); grade II, lesion showing early separation (B); grade III, lesion partially attached (C); and grade IV, crater lesion with loose body (D).

scores were obtained along with an International Knee Documentation Committee score to determine their current functional activity level in regards to their knee.

Data were analyzed using JMP Statistical Discovery software for data processing (SAS Institute Inc, Cary, North Carolina). One-way analysis of variance was conducted for statistical analysis.

RESULTS

The authors initially identified 60 skeletally immature patients treated with surgery for the diagnosis of unstable OCD lesions of the knee between 1981 and 2009. From this cohort, they further identified 20 patients whose lesions were treated with internal fixation techniques between 1999 and 2009. Thirteen knees had fully open physes and 7 had closing physes. Average patient age was 14.5 years (range, 12-17 years), and the cohort consisted of 14 (70%) male and 6 (30%) female knees. Mean radiographic follow-up was 2.5 years (range, .5-9 years) (Figure 2). Mean clinical follow-up was 7 years (range, 2-13 years). Medial condylar lesions were noted in 8 of 20 knees, whereas 12 knees had lateral condylar lesions. In 6 patients, an antecedent trauma was identified preoperatively. Three patients had antecedent drilling procedures performed on the operative knee that failed.

Fourteen (70%) lesions were Ewing and Voto grade 3 and 6 (30%) were grade 4 lesions. Average size of all lesions was 545 mm². A trend existed toward a higher

grade with a larger lesion size. Grade 3 lesions were 471 mm², and grade 4 lesions were 710 mm². Average lesion size was 581 mm² in males and 467 mm² in females. Grade 4 lesions were significantly larger than grade 3 lesions ($P=.003$).

Surgical type varied depending on the decision of the surgeon. Arthroscopic-assisted internal fixation was used for 5 of 20 lesions, open debridement with internal fixation for 9 of 20 lesions, and open debridement with bone grafting and internal fixation for 6 of 20 lesions. Bioabsorbable fixation was used in 13 knees, nonbioabsorbable fixation was used in 5 knees, and a combination of implants was used in 2 knees. Bioabsorbable fixation included compression screws (3 cases), pins (5 cases), nails (6 cases), chondral darts (2 cases), and cortical pegs (1 case). Non-bioabsorbable fixation included forms of cannulated compression screws (7 cases).

Radiographic Healing

At final postoperative follow-up, osseous integration was evident in 15 (75%) of 20 knees, with the 5 unhealed lesions all located on the lateral condyle. Figure 3 shows an example of a medial condylar lesion that went on to heal clinically and radiographically.

Risk Factors for Not Healing

Lesions that did not heal or went on to require osteochondral allograft transplantation were on average over 500 mm² in size and involved the lateral femoral

condyle. Likewise, patients whose lesions did not heal required a mean of 2.6 subsequent surgical procedures compared with 0.5 in those whose lesions healed. Three (60%) of the 5 lesions that did not heal had a complication of loose or broken hardware after the initial operation.

Repeat Surgical Interventions

Further operative intervention was required in 11 (55%) of 20 knees. Hardware removal and debridement were required in 50% of knees. Three knees continued to have poor healing of their lesion with continued symptoms and subsequently went on to osteochondral allograft transplantation.

At long-term follow-up, only 2 patients required further debridement of their OCD lesions after the initial 2.5-year follow-up. None required other major procedures to their knees.

Complications

Broken or prominent hardware occurred in 4 (20%) of 20 knees, 1 knee effusion required steroid injection, and 1 patient had a sterile subcutaneous fluid collection after hardware removal. This yields an overall complication rate of 30%.

Clinical and Functional Outcome

Only 10 (50%) patients were available for long-term follow-up questionnaires. Of the 10 patients available for follow-up questionnaires, 8 had evidence of healing on the initial postoperative follow-up, 2

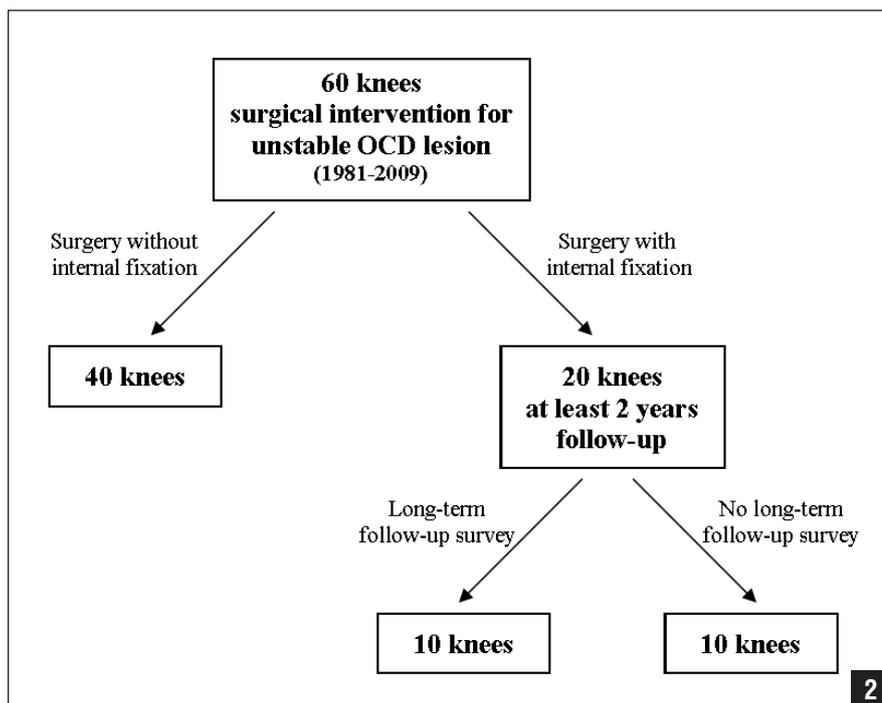


Figure 2: Flow chart showing patient movement in the study.

75%. Likewise, this study found a significant improvement in Lysholm and Tegner outcome scores and return to activity 2.5 years postoperatively. Although a mild decrease in functional activity scores existed at 7 years with the subgroup of long-term follow-up patients, their scores continue to represent functional knees with minimal symptoms and they are capable of daily and mild activities. This is also consistent with the adult literature that shows internal fixation provides stability and improved return to activity outcomes.²⁰

Like Kocher et al,¹⁰ the current authors found a high rate of reoperation was required for hardware removal, hardware failure, poor osseous integration, or, eventually, osteochondral allograft transplantation. Numerous factors likely contribute to these reoperations. For metal implants, the need for a secondary operation to remove hardware before full weight bearing is required to protect the opposing tibial articular surface. In the current study, 7 patients had nonbioabsorbable devices used and all required removal after healing. This second look also has the advantage of assessing healing of the osteochondral fragment. Some lesions fixed with metal screws are positioned near the notch of the femur, with screws opposing the tibial spines. These may not require removal if they do not articulate with tibial articular cartilage.

The use of bioabsorbable implants has gained popularity to minimize the need for the removal of hardware before weight-bearing activities. Much debate exists as to which type of bioabsorbable implants to use, including pins, nails, or compression screws. Numerous short-term studies have shown the efficacy of these products in the juvenile population in regard to lesion healing, lack of need for hardware removal, and improved ability to image with the device in situ.^{14,15} Despite the appeal of bioabsorbable devices, numerous reports exist of implant failure, either by loosening or fracture, and local inflammatory response, thus raising question to their safety.^{12,13} Millington et

had subsequently undergone osteochondral allograft procedures, and 4 required no further operative intervention after their initial procedure. Overall, Tegner activity level scores improved from 3.3 preoperatively to 5.6 at initial postoperative follow-up. At long-term follow-up, on average, Tegner scores decreased mildly to 4.7. Average Lysholm knee scores at the initial postoperative follow-up was 88.1 and at long-term follow-up was 86.8. Average International Knee Documentation Committee score 88.7 at 7-year follow-up. No significant difference existed in any postoperative score that correlated with lesion grade. The 3 patients who eventually underwent osteochondral allograft transplantation had lower average Tegner and Lysholm scores at initial follow-up (2.3 and 70.3, respectively).

DISCUSSION

Unstable OCD lesions in the knee have become more prominent in children and adolescents because more children participate in high-level sports activities.

Previous studies have shown the need for surgical treatment for unstable lesions or those that have failed nonoperative management.^{1,2,4} The goal of internal fixation techniques, as stated by Cahill,¹ should be based on the principles of fracture treatment. Fixation should provide adequate joint congruity, stability, and longevity while minimizing physeal injury, morbidity, iatrogenic joint damage, and the need for further operative interventions when possible. The current study found that larger lesions tended to be of a higher grade, meaning they were more unstable. Therefore, the adequacy of internal fixation becomes even more important for these lesions to allow for healing. In the adult population, internal fixation has been shown to provide long-term symptomatic relief and a higher rate of return to sports compared with cartilage or allograft procedures.²⁰

This study's results are similar to those of Kocher et al,¹⁰ who found an OCD lesion osseous integration rate of 84.6% compared with the current observed rate of

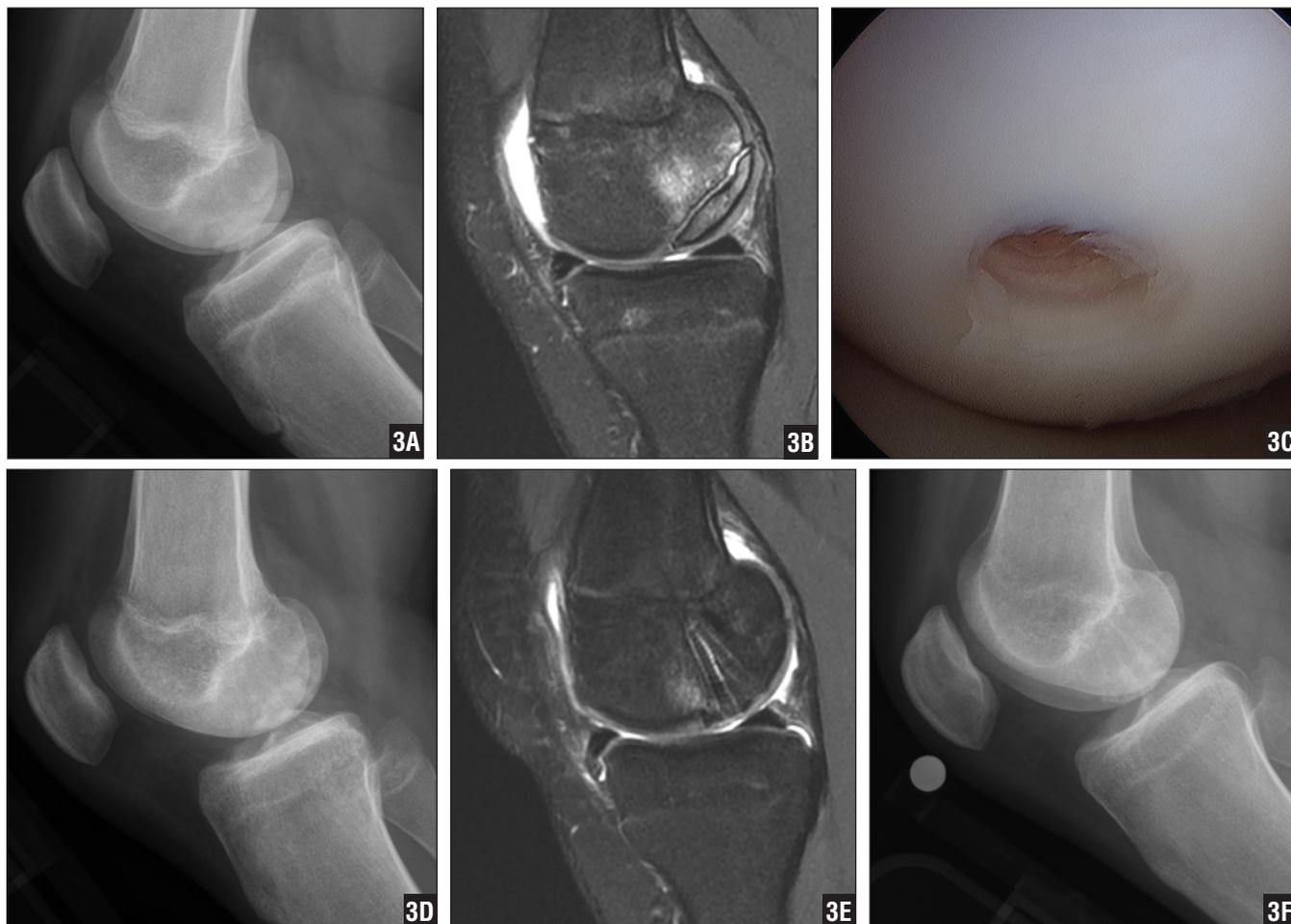


Figure 3: Preoperative lateral radiograph (A) and magnetic resonance image (B) of the medial condyle of the knee showing the large osteochondritis dissecans lesion. Intraoperative image [AQ: What kind?] of the articular surface after deployment of a Bio-Compression screw (Arthrex Inc, Naples, Florida) (C). Post-operative lateral radiograph showing fixation of the osteochondritis dissecans lesion (D). Nine-month postoperative magnetic resonance image (E) and 2-year postoperative lateral radiograph (F) showing healing of the osteochondritis dissecans lesion.

al¹⁶ showed that bioabsorbable fixation is inferior in the adult population. The current authors noted bioabsorbable implant failure in 4 patients and synovitis requiring intra-articular steroid injection in 1 patient. This represented a significant rate of failure when compared with nonbioabsorbable implants. Currently, the authors recommend using bioabsorbable fixation for symptomatic stable lesions and metal compression screws with staged hardware removal for any unstable lesions.

A higher number of lateral condylar lesions existed in the current study. This higher percentage is likely caused by the larger and more unstable nature of lateral

condylar lesions. These lesions are more likely to fail conservative or even first-line treatments, such as microfracture or drilling, and subsequently require internal fixation to heal the lesion. Another finding in this cohort was that only lateral-sided lesions failed to heal. This could be related to the lateral lesions being more centrally based on the condyle compared with medial lesions, which were more laterally based, resulting in more forces across the lesion. Also, lateral lesions are more frequently posterior on the condyle and therefore more difficult to place internal fixation implants in appropriate alignment perpendicular to the lesion surface.

This study has limitations. The main limitation is the small patient cohort. This is mainly because of the uncommonness of these types of surgical cases. Therefore, the 75% healing rate may not be generalizable to the general population. Likewise, because this was a retrospective review, the type of surgery and fixation methods were at the discretion of the treating surgeon at the time of surgery, which can add variability to the outcome data. Each surgeon also determined his or her own radiographic follow-up, which was inconsistent. However, no matter the radiographic follow-up technique, each treating surgeon physically evaluated the

patient and clinically and radiographically determined when his or her lesion healed or did not heal. These limitations are consistent with much of the literature, which has not produced large cohorts that have been able to show superior outcomes with one implant device over another.

CONCLUSION

Osteochondritis dissecans of the knee in the skeletally immature population poses an ever-increasing problem affecting children, especially those involved in sporting activities. For unstable lesions, the literature has shown the need for surgical intervention and the efficacy of internal fixation over conservative management or lesion excision techniques. This study has shown that internal fixation results in good postoperative and long-term functional outcomes with minimal symptoms. Lateral lesions were less likely to heal than medial lesions, and all lesions that went on to require osteochondral allograft were lateral lesions. However, these lesions often require multiple operations as a result of either the lesion pathology or the subsequent removal of the implant device. The desire to identify the optimum implant device that provides adequate fixation while minimizing the need for further intervention still needs to be prospectively studied. 

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