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Research Article

Retrospective Study of Surgical Treatment on Pediatric Knee Osteochondritis Dissecans

Daniel Roadman[2], Roger Lyon[1,2], Scott Van Valin[1,2], Kenneth Berg[1,2] and Xue-Cheng Liu[1,2]*

[1]*Department of Orthopaedic Surgery, Children's Wisconsin, WI, USA*

[2]*Medical College of Wisconsin, Milwaukee, WI, USA*

***Corresponding Author:** Xue-Cheng Liu, Department of Orthopaedic Surgery, Children's Wisconsin and Medical College of Wisconsin, Milwaukee, WI, USA.

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Abstract

Background: Osteochondritis Dissecans (OCD) is an alteration of subchondral bone and adjacent articular cartilage. The goal of treatment is to allow patients to return to activities pain free and to avoid progression to osteoarthritis. Radiographic healing helps determine return to activities. The goal of this study was to compare sizes and time to healing of OCD lesions between surgical and non-surgical treatments from 0-24 months follow-up using serial anterior-posterior (AP) and intercondylar notch radiographs and to identify differences in Lysholm activity scores between stable and unstable lesions.

Hypothesis: 1. Stable OCD lesions will have improved healing rates as compared to unstable OCD lesions. 2. Surgical treatment of OCD will have increased healing rates as compared to non-surgical intervention. 3. Stable OCD lesions will have improved Lysholm knee activity scores compared to unstable OCD lesions. 4. Surgical treatment of OCD will have improved Lysholm knee activity scores as compared to non-surgical intervention.

Study Design: Retrospective cohort.

Level of Evidence: Level 4.

Methods: A Retrospective chart review conducted on patients diagnosed with OCD at Children's Hospital of Wisconsin from 2004 to 2016. This study evaluates patients who had surgical intervention of both stable and unstable lesions as compared to non-surgical treatment based on demographics, lesion location, lesion size, gender, age, and treatment course.

Results: In total, 625 patients had an OCD diagnosis, of which 116 lesions on 107 knees in 100 patients fit our inclusion criteria. Mean patient age was 11.5 ± 2.5 years and the mean length of follow-up was 2.3 ± 1.2 years. Unstable OCD lesions had significantly improved Lysholm knee scores at 24-months compared to stable lesions ($p = 0.0009$). Surgical treatment of larger lesions produced relatively rapid healing; the overall defect area decreased sharply, and, despite an initially larger original defect area, there was no significant difference by 12- or 24-months.

Conclusion: This study demonstrates that surgical intervention of unstable and larger OCD lesions leads to a significant increased radiographic healing rate and significantly improved functional activity scores compared to stable and nonoperatively treated lesions.

Clinical Relevance: OCD lesion healing rate varies between surgical and non-surgically treated lesions when accounting for stability and overall lesion area.

Keywords: *Osteochondritis Dissecans; Knee; Pediatric; Stable Lesions; Unstable Lesions; Surgery*

Abbreviations

ROCK: Research in Osteochondritis Dissecans of the Knee; OCD: Osteochondritis Dissecans; CT: Computerized Tomography; MRI: Magnetic Resonance Imaging; PACS: Picture Archiving and Communication System; ANOVA: Analysis of Variance; VAS: Visual Analog Scale

Introduction

The Research in Osteochondritis dissecans of the knee (ROCK) group defines osteochondritis dissecans (OCD) as an alteration of subchondral bone with risk for instability and disruption of adjacent articular cartilage [17]. Although the exact prevalence of OCD has not been determined, it is reported between 15 - 29 per 100,000 individuals [13]. OCD can affect any joint; however, the most commonly affected joint is the knee, specifically the femoral condyles, with approximately three-quarters of these lesions occurring on the medial femoral condyle [2,7,11,14].

OCD lesions are classified as juvenile or adult based on skeletal maturity [4,5]. They are further classified as stable or unstable based on radiographs, computerized tomography (CT) or magnetic resonance imaging (MRI) determination of the integrity of the articular cartilage [7,8,18]. The course of treatment varies considerably based on the classification, with most adult and unstable lesions benefiting from surgical intervention, and most juvenile or stable lesions healing successfully without surgical treatment [9,12].

Non-operative treatment for OCD lesions typically requires activity modification, inclusive of partial or complete weightbearing limitation and occasionally adjunctive brace immobilization to allow healing of the subchondral bone [9]. Optimal non-operative treatment duration has not been definitively determined, but typically is 3 - 6 months at the low end and more than 12 months at the high end. Although many patients do heal their OCD lesions with initial non-operative treatment, those who remain unhealed or have worsening symptoms, or are approaching epiphyseal closure often benefit from surgical management [5]. Initial surgical technique involves drilling (either transarticular or retroarticular) for stable lesions which has a high rate of OCD healing [7].

With more children and adolescents participating in competitive sports, with roughly 38 million participating in organized sports annually in the United States, knee injuries have become more common and are occurring at younger ages [19]. Regardless of patient age or lesion stability, the goal of treatment is to allow patients to return to their daily activities pain free and to avoid progression to osteoarthritis. Thus, identifying parameters that can reduce secondary complications is of importance. Defining when a patient is fully healed from an OCD lesion is multifactorial and can be difficult to determine. Across studies, definitions of healing range from lack of pain to complete radiographic resolution, with few studies using patient-oriented outcome instruments to validate healing [10].

Objective of the Study

The primary objective of this study was to compare sizes and time to healing of OCD lesions between surgical and non-surgical treatment from 0 - 24 months follow-up using serial knee radiographs and to identify differences in Lysholm knee activity scores between stable and unstable lesions [16].

Materials and Methods

An institutional review board approved retrospective chart review was performed on a cohort of juvenile patient who suffered OCD lesions at a single institution from 2004 to 2016. The patients were seen at the Children's Hospital of Wisconsin by either pediatric orthopedic surgeons or pediatric sports medicine physicians. Within this cohort of patients, those who had a diagnosis of OCD lesion of the knee were identified.

Patients were then evaluated for the following inclusion criteria: 1) OCD lesion of medial or lateral femoral condyle; 2) up to and including 18 year olds; 3) no previous knee surgeries; 4) no other bone or joint disorders; 5) no sickle cell disease; 6) no chronic steroid use; 7) follow-up duration minimum 1 year.

Demographic information, treatment course both non-operative and/or operative, operative technique, activity level, lesion size, and postoperative variables were identified in patients to determine risk factors that contributed to the healing of OCD lesions. Radiographic

measurements of lesion size were performed in PACS (picture archiving and communication system) for each visit for 24-months post treatment. Clinical functional activity scores were calculated using Lysholm Knee Activity scores at the 12- and 24-month post treatment.

The cohort of patients was then evaluated between surgical (transarticular and retroarticular drilling, including both stable and unstable lesions) as compared to non-surgical for differences in radiographic healing based on greatest measured area of the lesion over time and Lysholm knee scores. Statistical analysis was completed using IBM SPSS Statistics Version 24. A p-value of < 0.05 was considered significant. Univariate analyses were performed on perioperative variables and their correlation with OCD lesion healing and Lysholm activity scores. All proportional data are presented as percentages and were analyzed using chi-square tests. All continuous data are presented as mean ± standard deviation and were compared using two-tailed, unpaired student's t-tests and analysis of variance (ANOVA).

Results and Discussion

A total of 625 patients had a clinical diagnosis of OCD at our institution during our study period. Of those patients, 116 lesions on 107 knees in 100 patients fit our inclusion criteria. We had 85 male knees and 31 female knees included in the study. The mean patient age was 11.5 ± 2.5 years old at diagnosis (7 - 17 years old) and the mean length of follow-up was 2.3 ± 1.2 years (1.0 - 6.5 years). The initial mean lesion area at presentation was 145.76 mm^2. Within the affected knees, we had 62 lesions treated non-surgically and 54 lesions treated surgically. Of those lesions, 96 were identified as stable and 20 were unstable. Thirty-four were the stable lesions that had surgery declared non-healing or prolonged healing.

Overall, we found that younger patients, 10.4 ± 1.9 years versus 12.8 ± 2.6 years ($p < 0.01$), were more likely to undergo non-surgical treatment with no significant difference in gender, initial presenting visual analog scale (VAS) for pain (0 - 10), Lysholm knee score, lesion location, or active range of motion regardless of surgical versus non-surgical treatment (Table 1).

Variable	Surgical (n = 54) n (%) or mean ± (SD)	Non-surgical (n = 62) n (%) or mean ± (SD)	p-value
Age	12.8 ± 2.6	10.4 ± 1.9	<0.01*
Gender- Male	40 (74%)	45 (73%)	0.86
Medial Femoral Condyle	45 (83%)	46 (74%)	0.23
Pain 24-month Visit (0-10)	1.0 ± 1.7	1.3 ± 1.5	0.42
Initial active range of motion	136.0 ± 15.1	134.3 ± 14.2	0.52
Length of Follow-up (days)	822.5 ± 474.9	851.3 ± 374.7	0.72
Lysholm Score Initial	69.2 ± 11.6	71.5 ± 10.7	0.27
Lysholm Score 12-month	94.3 ± 9.6	96.4 ± 7.3	0.19
Lysholm Score 24-month	96.2 ± 9.4	95.8 ± 4.8	0.83

Table 1: *Univariate analysis of patient demographics and clinical symptoms throughout visits of surgical and non-surgically treated OCD lesions (chi-square and two-tailed, unpaired student's t-tests).*

**Indicates statistical significance ($p < 0.05$).*

In comparison of stable and unstable lesions, we found that younger patients were more likely to have stable lesions 10.9 ± 2.1 years versus 14.4 ± 2.4 years ($p < 0.01$) and unstable lesions presented initially with significantly lower Lysholm knee activity scores 64.3 ± 12.4 versus 71.8 ± 10.4 ($p < 0.01$). Again, we found no significant difference in gender, initial VAS score, lesion location, or active range of motion (Table 2). However, when analyzing from the initial Lysholm knee activity score, by 24-months patients with unstable OCD lesions

treated surgically had significantly improved functionally from baseline compared to those that had stable OCD lesions that were treated both operatively and nonoperatively ($p < 0.01$) (Table 3).

Variable	Stable (n = 96)n (%) or mean ± (SD)	Unstable (n = 20) n (%) or mean ± (SD)	p-value
Age	10.9 ± 2.1	14.4 ± 2.4	<0.01*
Gender- Male	72 (75%)	13 (65%)	0.36
Medial Femoral Condyle	75 (78%)	16 (80%)	0.85
Pain 24-month Visit (0-10)	1.2 ± 1.6	0.9 ± 1.5	0.42
Initial active range of motion	135.9 ± 12.1	131.3 ± 23.2	0.39
Length of Follow-up (days)	835.9 ± 409.2	847.5 ± 493.8	0.91
Lysholm Score Initial	71.5 ± 10.5	64.3 ± 12.4	<0.01*
Lysholm Score 12-month	95.5 ± 8.8	95.1 ± 6.9	0.83
Lysholm Score 24-month	95.5 ± 7.3	98.9 ± 2.2	0.17

Table 2: *Univariate analysis of patient demographics and clinical symptoms throughout visits of stable and unstable OCD lesions (chi-square and two-tailed, unpaired student's t-tests).*

**Indicates statistical significance ($p < 0.05$).*

Time (months)	Stable mean ± (SD)	Unstable mean ± (SD)	p-value
0	71.5 ± 10.5	64.3 ± 12.4	
24	95.5 ± 7.3	98.9 ± 2.2	<0.01*

Table 3: *Lysholm knee activity score comparing functional outcomes between stable and unstable knee lesions from 0-100 (analysis of variance).*

**Indicates Statistical significance ($p < 0.05$).*

Radiographically, we found that patients who underwent surgery had an initial presenting lesion area significantly larger than those who underwent non operative treatment at 149.2 ± 171.7 mm^2 versus 62.7 ± 57.1 mm^2 ($p < 0.01$). However, by 12-months, there was no longer a significant difference in lesion area between the two treatment groups, with surgical treatment of OCD lesions producing relatively more rapid healing, and greater reduction of lesion size compared to non-surgical treatment (Table 4).

Mean Lesion Area (mm^2)	Surgical mean ± (SD)	Non-surgical mean ± (SD)	p-value
0-Month	149.2 ± 171.7	62.7 ± 57.1	<0.01*
3-Month	109.4 ± 107.5	42.1 ± 57.8	<0.01*
6-Month	81.4 ± 88.1	34.4 ± 61.0	<0.01*
9-Month	44.5 ± 55.5	21.5 ± 46.1	0.04*
12-Month	25.3 ± 63.5	12.4 ± 24.3	0.17
24-Month	3.9 ± 12.5	10.9 ± 39.8	0.36

Table 4: *Univariate analysis of mean lesion area from 0-24-months between surgical and non-surgically treated OCD lesions (two-tailed, unpaired student's t-tests).*

**Indicates statistical significance ($p < 0.05$).*

Radiographically, we found that patients who presented with unstable lesions had significantly larger area than those who presented with stable lesions 192.7 ± 241.7 mm^2 versus 84.2 ± 84.2 mm^2 ($p < 0.01$). By 9-months, there was no longer a significant difference in lesion area between the two treatment groups. However, by 24-months, there was once again a significant difference in lesion size with unstable lesions showing greater lesion area at 12.1 ± 74.1 mm^2 versus 4.7 ± 24.7 mm^2 for stable lesion ($p = 0.03$) (Table 5).

Mean Lesion Area (mm^2)	Stable mean ± (SD)	Unstable mean ± (SD)	p-value
0-Month	84.2 ± 84.2	192.7 ± 241.7	<0.01*
3-Month	62.3 ± 74.7	138.69 ± 132.2	0.02*
6-Month	45.8 ± 107.5	59.5 ± 122.9	0.046*
9-Month	23.5 ± 29.8	72.3 ± 93.9	0.06
12-Month	16.4 ± 29.5	43.9 ± 62.3	0.29
24-Month	4.7 ± 25.7	12.1 ± 74.1	0.03*

Table 5: *Univariate analysis of mean lesion area from 0-24-months between stable and unstable OCD lesions (two-tailed, unpaired student's t-tests).*

**Indicates statistical significance ($p < 0.05$).*

Identifying patients early in the treatment course who are at higher risk for non-healing is of utmost importance for patient outcome, satisfaction, education, and expectations. In this study, we evaluated patients using both radiographic healing and a functional activity score to determine clinical improvement.

Our aim was to identify factors that lead to improved patient outcomes from the initial presentation. We found that patients with significantly lower initial Lysholm knee scores at presentation and larger initial lesion area were more likely to be unstable lesions. Additionally, those patients who initially had unstable OCD lesions likewise had significantly improved Lysholm knee activity scores at 24-months post-surgical treatment as compared to stable lesions. On the other hand, we cannot deny that the unstable lesions had a lower initial Lysholm score than the stable lesions. There was, however, no significant difference in final Lysholm scores at 24-months, with both lesions showing much improved outcomes. Several authors have noted improved Lysholm score after drilling of juvenile osteochondral lesions of the knee in both retroarticular and transarticular approaches [3,15]. However, in both of these studies, they were limited in sample size, with a collective total of 37 patients, and only included operative treatment of stable lesions. Our study expands upon this data, providing a larger cohort of patients from a single institution all with a diagnosis of OCD. In addition, we explored the change in scores for non-operative approaches, and those who initially presented with unstable lesions. We found that in comparison to stable lesions, unstable lesions began at a lower Lysholm score 64.3 ± 12.4 versus 71.8 ± 10.4 and showed a greater change in score by 24-months only if treated surgically. At 24-months though, there was no significant difference between final scores between stable and unstable and operative versus non-operative treatments, with both achieving significant improvement in symptoms. We interestingly did not find a significantly decreased VAS pain score between surgical and non-surgically treated patients nor stable and unstable lesions at 24-months follow-up. While pain is often used in the treatment algorithm of these lesions, our study found that the use of pain scores was not significantly indicative of patient's healing and resolution of symptoms [1]. While pain is an important variable to account for when encountering a patient, based on our findings, using a validated activity score such as the Lysholm Knee Score may offer more insight into the patients' clinical improvements.

Additionally, we found radiographically that surgical intervention on significantly larger OCD lesions and unstable lesions lead to faster radiographic healing rate compared to stable and nonoperatively treated lesions. We defined this as resolution of boundary between

fragment and bone. Few studies previously considered the effect of lesion size on recovery. Edmonds., *et al.* identified a significant difference in the rate of healing between small (< 320 mm^2) and large (> 320 mm^2) OCD lesions in surgically treated patients [6]. In our study, we analyzed lesion area as a continuous variable, and by 12-month follow-up, there was no longer a significant difference in lesion size between surgical and non-surgically treated lesions, despite the initial discrepancy, with both groups presenting with smaller lesions. In contrast, with unstable lesions, the overall area decreased sharply and was no longer significantly different by 12-months. However, at 24-months there was again a significant difference in lesion size, with two patients returning without resolution of their injury, progressing to requiring a second surgery within the 24-month period. This emphasizes the importance of early detection of healing and preventing a stable lesion from becoming unstable to improve length of treatment and overall outcomes.

In the adolescent patient population, furthering the knowledge of OCD of the knee lesions presents an opportunity to not only prevent future secondary complications, but also an opportunity to allow these patients to return to their daily activities. We provide a comprehensive review at the effects of various treatment options on these lesions incorporating both operative, non-operative, lesion stability, lesion size, the length of time before returning to activity, and the effect on functional outcome. Additional research evaluating functional outcomes while controlling for lesion size, stability type, initial length of non-operative treatment and definitive treatment method could help further develop a standardized protocol for treatment, return to activities and prevention of the progression of non-healing lesions.

Limitations of this study include the retrospective nature of this single-center chart review and thus is subject to errors within the electronic medical record, and the data is limited to information collected during clinic visits. There is no control group and low number of providers. While our study focuses on 24 months follow-up, and represents a limited study size for OCD lesions, asymptomatic patients may have followed up for less than 1-year and thus some patients who healed rapidly may have been excluded and underrepresented.

Conclusion

This study demonstrates that surgical intervention of unstable and larger OCD lesions leads to significantly improved functional activity scores and a significant radiographic healing rate compared to stable and nonoperatively treated lesions.

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Conflict of Interest

There is no conflict of interest.

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