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Original Research

Age as a Prognostic Factor in Arthroscopic Drilling of Juvenile Osteochondritis Dissecans of the Knee: A National Database Review

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Abstract

Background: Juvenile Osteochondritis Dissecans (JOCD) is a common knee condition that can cause significant morbidity if the lesion does not heal. Arthroscopic drilling is a common surgical treatment for low-grade intact lesions, but its success rate and complications have not been well defined in a large series.

Purpose: This study seeks to determine the reoperation rate and the incidence of major complications following arthroscopic drilling of JOCD lesions of the knee.

Methods: A query of patients in the Pediatric Health Information System (PHIS) database from 2013 to 2018 was performed for the diagnosis and billing codes specific for arthroscopic drilling of an intact JOCD lesion. Subsequent surgical procedures on ipsilateral and contralateral knees were then analyzed for evidence of additional surgical procedures related to non-healing of the lesion.

Results: We identified 1027 patients, 6-17 years of age, who underwent arthroscopic drilling as their initial surgical treatment for a diagnosis of JOCD of the knee. Within 6 months of the original surgery, 27 patients (3%) had a secondary surgery on the ipsilateral knee, and 27 patients (3%) had surgery on the contralateral knee. By 2 years, 84 patients (8%) had a secondary surgery on the ipsilateral knee and 38 patients (4%) had surgery on the contralateral knee. Patient age was a significant factor in both the frequency and distribution of secondary surgeries, with older patients requiring repeat procedures and tending to have more invasive procedures more

frequently. Less than 1% of patients underwent another surgical procedure of the knee not specifically to treat the JOCD lesion.

Conclusions: The 2-year reoperation rate following drilling of an intact juvenile OCD lesion was 8%. Younger patients (<13 years old) were less likely to undergo a subsequent procedure compared to older patients. In addition, if they did require a second procedure, the majority of older patients required a salvage-type cartilage procedure. The rate of complications requiring additional knee surgeries was less than 1%.

Level of Evidence: Level III, Prognostic Study

Key Concepts

- Arthroscopic drilling in the treatment of juvenile OCD of the knee is very effective, and only 3% of patients require a second surgery in the first 6 months and 8% in the first 2 years.
- Younger patients were not as likely to require subsequent arthroscopic drilling for osteochondritis dissecans of the knee.
- Intact lesions with low rates of anticipated healing may lead to favorable outcomes if treated sooner.

Introduction

Juvenile Osteochondritis Dissecans, or JOCD, is a pathologic lesion of the subchondral bone in skeletally immature adolescents.[1] Approximately 75% of JOCD lesions are found in the knee, most commonly in the medial and lateral femoral condyles.[1,2] JOCD is a relatively rare condition, with an overall incidence of 9.5 per 100,000.[3] It is usually found in adolescent patients, with higher incidence between the ages of 12 to 19 years old.[3] Previous literature suggests a 2-5:1 male-to-female ratio.[1,3,4]

The exact etiology is controversial, but it is likely from an ischemic event within the subchondral epiphyseal region of the bone, either directly caused by or exacerbated by repetitive trauma, such as from sports.[2,5-9] Most afflicted patients are involved in athletics,[1] but genetic factors have been implicated as well.[2,5,6,10] It typically presents as pain in the joint with occasional swelling that is worsened by activity. If the overlying cartilage is compromised because of insufficient subchondral support, the joint may develop mechanical symptoms and locking.[11]

For stable JOCD lesions with intact overlying articular cartilage, non-operative treatment, such as immobilization and activity modification, is usually recommended as the initial treatment.[2,12,13] This approach has been reported to have an approximately 50% success rate within 6 to 18 months.[6,12-14] Surgical treatment is another option that may be employed. The most common approach for lesions with intact articular cartilage involves drilling multiple small tracks across the lesion and into the surrounding healthy bone with fine guidewires via a transarticular or retroarticular approach.[1,4,6,12,15] There is some evidence that this procedure has a higher rate of radiographic healing than nonoperative treatment, with rates in smaller series ranging from 70% to 100%,[16,17] although no large series have been reported. It is also a procedure with low perceived morbidity.[6,13,18] However, there is little data specifically examining the rate of major complications leading to additional surgical procedures following this procedure.

As the success rate and the risk for associated complications often figure into the decision-making

process for this condition, knowing these rates may help clinicians and their families decide what treatment course is better for their situation. Because the prior literature along these lines has mostly been smaller case series, our study aimed to examine the outcomes of arthroscopic drilling for JOCD lesions using a pediatric multi-center database cohort. We sought to identify secondary procedures after drilling of an intact lesion to ascertain rates of reoperation for the JOCD as well as any other major complications requiring reoperation. Specifically, we wanted to evaluate the role of age on the outcomes and complications.

Materials and Methods

Database. Data for this study were obtained from the Pediatric Health Information System (PHIS), an administrative database that contains inpatient, emergency department, ambulatory surgery, and observation encounter-level data from over 49 not-for-profit, tertiary care pediatric hospitals in the United States. These hospitals are affiliated with the Children's Hospital Association (Lenexa, KS). Data quality and reliability are assured through a joint effort between the Children's Hospital Association and participating hospitals. Portions of the data submission and data quality processes for the PHIS database are managed by Truven Health Analytics (Ann Arbor, MI). For the purposes of external benchmarking, participating hospitals provide discharge/encounter data including demographics, diagnoses, and procedures. Nearly all of these hospitals also submit resource utilization data (e.g., pharmaceuticals, imaging, and laboratory) into PHIS. Data are de-identified at the time of data submission, and data are subjected to several reliability and validity checks before being included in the database. For this study, data from 48 hospitals were included.

Cohort identification. We performed a query of PHIS from 2013 to 2018. Patients that underwent arthroscopic drilling of a JOCD lesion were identified using ICD 9 and 10 codes for knee JOCD and the CPT code for arthroscopic drilling of an intact JOCD lesion (29886). All non-surgical or non-knee related JOCD cases were excluded. For identified patients, secondary surgeries were identified as repeat encounters on a different date, relevant to JOCD of the knee. The secondary surgeries were categorized into six distinct groups based on CPT Codes: repeat arthroscopic drilling of intact lesion, arthroscopic drilling with internal fixation, open treatment with bone grafting or internal fixation, cartilage resurfacing procedures, removal of loose bodies, and other surgical procedures not otherwise listed (Table 1). When multiple surgical procedures occurred in the same surgery, the procedure was classified based on the treatment aimed to address a JOCD lesion at the most advanced stage. Secondary surgeries were also categorized based on the side, ipsilateral, or contralateral. Bilateral cases

Table 1. Surgical Categories

	Surgery Type				
	Arthroscopic Drilling of Intact Lesion	Arthroscopic Drilling with Internal Fixation	Open Treatment with Bone Grafting or Internal Fixation	Cartilage Resurfacing Procedure	Removal of Loose Bodies
CPT Codes	29886	29885 29887	27355 27356 27357 27358 27472 27514 27519 27524 27535	27355 27356 27357 27360 27412 27415 27416 29866 29867	29874 27331 29879

Breakdown of the CPT codes used to categorize the surgical procedures in the cohort.

were only marked as such if the opposing laterality was specifically stated. Otherwise, in situations where there was no laterality stated in the primary or readmit procedures, laterality was assumed to be on the same leg. For situations where there were multiple readmits within the same patient, each readmit was counted as a separate case for the purposes of the statistical analysis.

Statistical Analysis. We created two cohorts based on time to readmit surgery from the initial procedure, with horizons at 6 months and 2 years. The breakdown of procedure type for readmit surgeries was determined via standard descriptive summaries. We also looked at age-related differences in readmit surgery incidence and surgery type. When examining differences of surgery type, the five original surgical categories were combined into three categories based on the degree of invasiveness of the surgical procedure as follows: drilling (arthroscopic drilling of intact lesion), fixation (arthroscopic drilling with internal fixation and open treatment with bone grafting or internal fixation), and salvage procedure (cartilage resurfacing procedure and removal of loose bodies). These groups were compared in two age cohorts: 5 to less than 13 years old (late childhood) and 13 years old to 17 years old (adolescence). Chi-squared test was used to examine age-related effects for surgical incidence and Fisher's exact test and chi-squared tests were used to examine age-related effects for surgery type.

Results

Demographics

We identified 1027 patients that had arthroscopic drilling as the initial surgical treatment for a JOCD of the knee. Of those patients, 682 were male, and 345 were female—a 2:1 ratio. For the overall cohort, the average age at the time of the original surgery was 12.5 years, but the ages ranged from 6 to 17 years of age. Female patients were slightly younger than male patients, with an average age of 12.0 years old versus an average age of 12.8 for males (Figure 1).

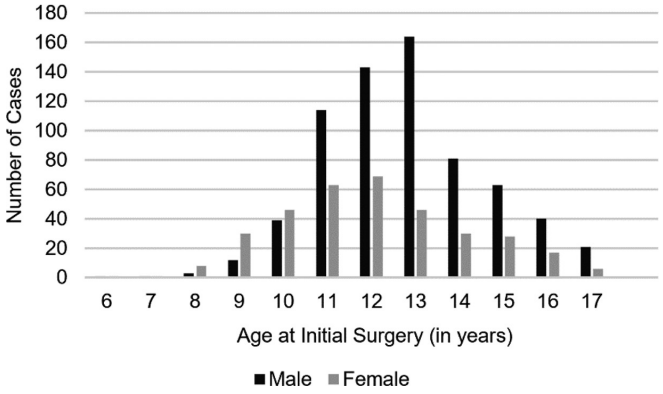

Figure 1*. Distribution of patient age at initial surgery by gender. Most patients were between 9 and 16 years of age, with a large increase in ages 11 to 13. Starting at age 11, males had consistently higher numbers than females.*

Additional Surgical Procedures Within 6 Months

Within 6 months of the original drilling procedure, 27 patients (2.63% of total patients; 18 Male, 9 Female) had an additional 27 surgeries for treatment of JOCD of the knee. For these secondary surgeries (Table 2), 13 (48.15% of ipsilateral secondary surgeries) were another arthroscopic drilling of intact lesion, 4 (14.81%) were arthroscopic drilling with internal fixation, 5 (18.52%) were cartilage resurfacing procedures, 4 (14.81%) were removal of loose body procedures, and 1 (3.70%) was not in our coding guidelines (removal of implant procedure). There were also 27 (2.63% of total patients; 18 Male, 9 Female) patients that had 27 surgeries for a contralateral knee lesion. For those surgeries on the other knee (Table 2), 23 (85.19% of the contralateral knee surgeries) were arthroscopic drilling of an intact lesion, and 4 (14.81%) were arthroscopic drilling with internal fixation. There were no contralateral cases requiring open reduction or a cartilage resurfacing procedure.

There was a significant effect of age on the distribution of secondary surgical treatments on the ipsilateral knee ($p=0.0077$) (Figure 2). In the older patient cohort (13-17 years old), 6/16 repeat surgeries were drilling, compared to 7/9 in the younger patient cohort (6-12 years). The remaining were fixation or salvage procedures. This observation of an age effect on repeat surgery distribution was noted in the contralateral knee as well

Table 2. Additional Surgeries

		Surgery					
		Arthroscopic Drilling of Intact Lesion	Arthroscopic Drilling with Internal Fixation	Open Treatment with Bone Grafting or Internal Fixation	Cartilage Resurfacing Procedure	Removal of Loose Bodies	Other Surgery Not Otherwise Specified
Six Months Post-Op	Ipsilateral	13	4	0	5	4	1
	Contralateral	23	4	0	0	0	0
Two Years Post-Op	Ipsilateral	26	23	0	11	8	24
	Contralateral	31	6	0	0	1	0

Breakdown of repeat surgeries at 6 months and 2 years after the initial drilling operation for both the ipsilateral and contralateral knee.

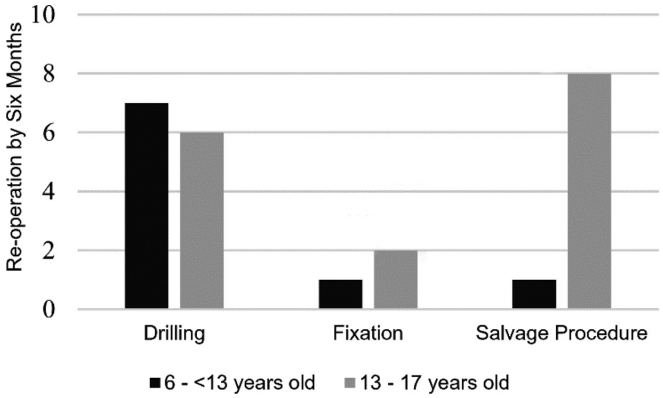

***Figure 2**. Secondary surgeries on the ipsilateral knee within 6 months after index surgery. Distribution of surgical treatments grouped into drilling, fixation, and salvage procedures by age cohort.*

($p<0.001$). In the older patient cohort, 6/17 surgeries on the contralateral knee were drilling, compared to 17/18 in the younger patient cohort. There was no significant difference across age groups in the proportion of any specific secondary procedure in the ipsilateral knee. However, when all secondary surgeries (ipsilateral and contralateral knee) were compared, arthroscopic drilling surgeries occurred at a lower rate ($p=0.0024$) and salvage procedures at a higher rate ($p=0.0112$) in older patients.

Additional Surgical procedures Within 2 Years

Within 2 years of the original drilling procedure, 84 patients (8.18% of total patients; 53 Male, 31 Female) had an additional 92 surgeries for treatment related to JOCD of the knee. For these secondary surgeries, 26 (28.26% of ipsilateral secondary surgeries) were another arthroscopic drilling of an intact lesion, 23 (25.00%) were arthroscopic drilling with internal fixation, 11 (11.96%) were a cartilage resurfacing procedure, 8 (8.70%) were removal of loose body procedures, and 24 (26.09%) were not specifically directed at a JOCD lesion (Table 3). There were also 38 patients (3.70% of total patients; 26 Male, 12 Female) that had 38 surgeries on a contralateral knee JOCD lesion. For those surgeries on the other knee (Table 2), 31 (81.58% of the contralateral knee surgeries) were arthroscopic drilling of an intact lesion, 6 (15.79%) were arthroscopic drilling with internal fixation, and 1 (2.63%) was a removal of loose body procedure. There were no contralateral cases requiring open reduction or a cartilage resurfacing procedure.

Similar to the associations noted at the 6-month mark, there were significant effects of age on both the incidence and distribution of secondary surgical treatments on the ipsilateral knee at 2 years postop. Older patients underwent secondary surgeries more frequently than younger patients ($p=0.019$). In addition, the distribution of repeat surgeries in older patients was statistically different relative to the younger patients ($p=0.030$)

Table 3. Additional Surgeries Not Specifically Directed at a JOCD Lesion

	Additional Surgeries Not Specifically Directed at a JOCD Lesion					
	Arthroscopic evaluation, synovectomy, or chondroplasty without additional treatment to the subchondral bony portion of the JOCD	Arthrocentesis	Osteotomy or guided growth procedure of the knee	Open soft tissue bursectomy	Removal of implants	Unlisted procedure
CPT Codes	29870, 29875, 29877	20610	27418, 27485	27340	20670, 20680	29999
Count	6	1	2	1	13	1

Breakdown of repeat surgeries at two years after the initial drilling operation for the ipsilateral knee that did not fit into our initial coding guidelines. There were two cases where CPT Codes of 29877 and 20680 occurred in the same encounter and one case where CPT codes of 20610 and 20680 occurred in the same encounter. In all three instances, the non-implant removal CPT code was used to categorize the case into the above categories.

(Figure 3). 12/42 secondary surgeries were drilling in the older patient cohort compared to 15/28 in the younger patients. Again, for procedures on the contralateral knee, older patients had a different distribution of repeat surgeries ($p<0.001$), with 11/16 repeat surgeries being drilling compared to 20/22 in the younger cohort. Similar to 6-month data, when all secondary procedures were compared, drilling procedures occurred at a lower rate ($p=0.0031$) and salvage procedures at a higher rate ($p=0.0042$) in older patients.

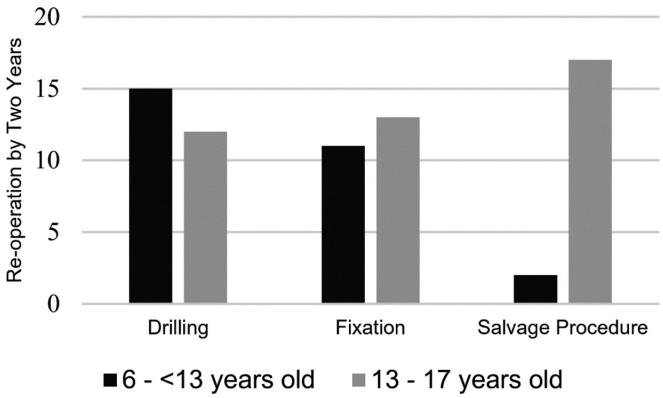

***Figure 3**. Secondary surgeries on the ipsilateral knee by 2 years after index surgery. Distribution of surgical treatments grouped into drilling, fixation, and salvage procedures by age cohort.*

Discussion

This report of 1027 patients represents one of the largest cohorts of patients treated with arthroscopic drilling of JOCD of the knee. Our findings support the notion that this surgical procedure is relatively effective, with a low rate of repeat surgery up to two years following the procedure. There were only about 3% of patients (27/1027 patients) undergoing another JOCD related surgery on the same knee within 6 months and about 8% (84/1027 patients) requiring another surgery on the same knee by 2 years. Finally, our findings also support the observation that this procedure may be more effective in younger patients, as older patients were more likely to require additional procedures and tended to have more invasive procedures.

We assessed the success of the procedure by noting the need for another procedure on the same knee for a diagnosis of JOCD. Our analysis noted that 8% of the patients underwent a repeat procedure to address JOCD pathology on the same knee within 2 years of the initial drilling. Thus, at best, this would equate to an estimated success rate of up to 92% with the initial surgical procedure. This success rate is in line with the reports by Edmonds et al., which noted 87% of surgeries

were successfully treated without a repeat procedure[19] and Adachi et al., which noted 95% of surgeries were successful.[20] However, this is much higher than the report by Louisa et al., which noted only 70.6% of drilling procedures leading to excellent outcomes in skeletally immature patients.[6] The discrepancy in outcomes may be due to the longer follow-up time in the Louisa et al. study, which averaged 11.75 years.

We also attempted to evaluate this cohort for complications related to drilling of JOCD that required a repeat surgical procedure. Within 2 years of the index drilling, we were only able to identify 9 patients that underwent a surgical procedure for a diagnosis or a procedure that may have suggested a complication. These included 1 diagnostic arthroscopic procedure, 6 arthroscopic surgeries for synovectomy or chondroplasty without direct additional treatment applied to the subchondral bony portion of the JOCD, 1 arthrocentesis, and 1 open soft tissue bursectomy around the knee. If all these procedures were actually complications related to the arthroscopic drilling procedure, this would equate to a major complication rate of 0.9% (9/1041 patients). While no prior reports have specifically evaluated for complications following an arthroscopic drilling, these findings are in line with prior reports that have noted the complication rate to be very low.[21]

As younger patients often have a greater healing potential than older patients, we hypothesized that older patients may need more secondary surgeries. Indeed, we found an age-related effect on secondary surgeries on the ipsilateral knee, with the older patients having both a higher incidence of repeat surgeries and a higher tendency for more invasive repeat surgeries, compared to the younger cohort at 2 years following the index procedure. These findings are in line with the multicenter results reported by Hefti et al. who noted that overall treatment results were better for younger patients than they were for older patients.[5]

Bilateral lesions have been reported to be present in 2.7% to 29% of patients with JOCD of the knee,[6,19] In our database, only ~4% of the patients underwent surgical treatment for a JOCD on the contralateral knee in the 2 years following drilling in the first knee. Interestingly, all cases where bilateral knee surgeries were performed were also staged, with the minimum time between surgical procedures being 21 days and the median being 128 days (~4.25 months). While the incidence and timing of bilateral surgery are not well described in the literature, this report supports the notion that the need for bilateral surgery is relatively rare. However, it should be noted that these rates only reflect the need for bilateral surgery for those patients whose initial surgery was an arthroscopic drilling of an intact lesion. The incidence of bilateral treatment may be different for JOCD patients treated at different stages of their lesion.

There are several limitations to this paper. While the most common surgical treatment for stable JOCD lesions is arthroscopic drilling, because the database simply classifies cases based on the CPT code, we cannot definitively say that the lesion being treated was an intact lesion or that the treatment rendered was simply a drilling. It is possible that coding errors in the database included cases which required more invasive procedures but were simply coded as drilling of an intact lesion. However, if this was the case, it would only serve to contaminate the pool of intact lesions with more unstable lesions and thus be expected to make the rates of additional procedures appear greater. Another limitation in the database is that we cannot be entirely certain that all the subsequent procedures were in the same knee as the index procedure in circumstances where no laterality was specifically noted. Thus, if anything, the rates of subsequent surgery may be a bit lower and the rates of contralateral surgery a bit higher than reported. Furthermore, as the PHIS database draws from tertiary care pediatric hospitals in the United States, the patient population may not be truly representative of the national pediatric population with this condition, who may be treated in outpatient facilities. However, as the largest patient cohort from the greatest number of treating institutions to date, the generalizability of this study should be better than any currently available data.

In conclusion, this is one of the largest studies examining arthroscopic drilling of JOCD lesions. It provides support that arthroscopic drilling is associated with low rates of secondary surgery and low rates of major surgical complications. Furthermore, it confirms the commonly held assumption that younger patients (<13 years of age) have a higher healing potential and are less likely to require a second surgery compared to older patients. Thus, while the risks and benefits of surgery must be carefully weighed, lesions with a predicted high risk of failure of nonoperative treatment based on age, skeletal maturity, size of the lesion, and other factors, performing an arthroscopic drilling sooner rather than later may lead to better outcomes.

Disclaimer

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