

# Functional and Radiographic Outcome of Juvenile Osteochondritis Dissecans of the Knee Treated with Transarticular Arthroscopic Drilling\*

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## ABSTRACT

Management of juvenile osteochondritis dissecans is controversial. The purpose of this study was to evaluate the functional and radiographic outcomes of transarticular arthroscopic drilling for isolated stable, juvenile osteochondritis dissecans lesions of the medial femoral condyle with an intact articular surface after 6 months of nonoperative management had failed. We reviewed 30 affected knees in 23 skeletally immature patients (mean age, 12.3 years, range, 8.5 to 16.1) at an average follow-up of 3.9 years (range, 2.0 to 7.2). Functional outcome was determined using the Lysholm score and radiographic outcome was determined using lesion size, and the radiographic score of Rodegertts and Gleissner. There was significant improvement in the mean Lysholm score (from 58 to 93). There was significant improvement in the mean lesion size on anteroposterior (4.5 ± 5.8 mm decrease) and lateral (8.4 ± 8.1 mm decrease) radiographs. There was also significant improvement in the mean radiographic score (from 3.0 to 1.9). Radiographic healing was achieved in all patients at an average of 4.4 months after drilling (range, 1 to 11 months). Linear regression analysis revealed that younger age was an independent, multivariate predictor of Lysholm score improvement. There were no apparent surgical complications.

Given the low morbidity of drilling and the associated improvement in functional and radiographic outcomes, we advocate arthroscopic transarticular drilling for patients with juvenile osteochondritis dissecans of the medial femoral condyle with an intact articular surface who have had failure of initial nonoperative management.

Osteochondritis dissecans is a condition that affects subchondral bone and manifests as a pathologic spectrum that includes softening of the overlying articular cartilage with an intact articular surface, early articular cartilage separation, partial detachment of an articular lesion, and osteochondral separation with loose bodies.<sup>9,26</sup> The etiologic basis of osteochondritis dissecans remains a source of speculation; however, repetitive microtrauma is commonly associated with it.<sup>9,10,26</sup> Osteochondritis dissecans of the knee has been classified based on anatomic location,<sup>2,10,12,21</sup> surgical appearance,<sup>11</sup> scintigraphic findings,<sup>19</sup> and age.<sup>27</sup> It is often subcategorized into a juvenile form and an adult form, depending on the status of the distal femoral physis. Patients with juvenile osteochondritis dissecans have a better prognosis than those with adult osteochondritis dissecans; more than 50% of juvenile cases demonstrate healing with 6 to 18 months of nonoperative treatment.<sup>11,18,20,30,34</sup> Adult osteochondritis dissecans, on the other hand, infrequently heals without operative intervention.<sup>11</sup> Adult osteochondritis dissecans and juvenile osteochondritis dissecans that does not heal both have the potential for later sequelae, including osteoarthritis.<sup>24,34</sup>

The management of juvenile osteochondritis dissecans is controversial. Given the potential for healing as indi-

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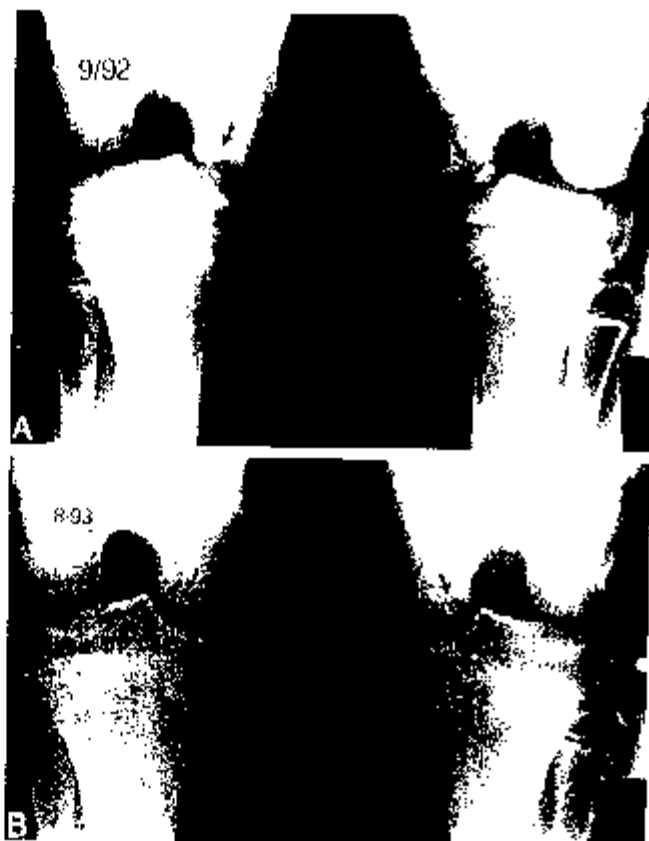
cated by normal subsequent function and radiographs, nonoperative initial management is indicated for stable lesions in skeletally immature patients.<sup>9,11,14,15</sup> Nonoperative treatment options range from "watchful waiting" and activity modification to nonweightbearing and immobilization with trials lasting from 6 to 18 months. Operative treatment is indicated for detached or unstable lesions, a patient approaching epiphyseal closure, and failure of nonoperative management.<sup>9</sup> Surgical options depend on the lesions involved and include drilling (anterograde transarticular or retrograde through the distal femoral epiphysis), curettage, bone grafting, internal fixation, open or arthroscopic reduction of a loose fragment with internal fixation, fragment removal, autologous or allogenic osteochondral grafting, and autologous chondrocyte implantation.<sup>1,3,9,10,16,19,22,23,32</sup>

The purpose of this study was to evaluate the functional and radiographic outcomes of transarticular arthroscopic drilling for isolated, stable juvenile osteochondritis dissecans lesions of the medial femoral condyle with an intact articular surface in cases where there was failure of initial nonoperative management.

## MATERIALS AND METHODS

The records of patients with osteochondritis dissecans of the knee who were seen at the sports medicine clinic of Boston Children's Hospital between 1989 and 1996 were reviewed. Inclusion criteria included skeletal immaturity with an open distal femoral physis and radiographic evidence of osteochondritis dissecans of the lateral aspect of the medial femoral condyle. All patients included in the study had persistent symptoms and radiographic evidence of osteochondritis dissecans despite 6 months of nonoperative management consisting of activity modification with periods of protected weightbearing (Figs. 1 and 2). Patients with bilateral involvement underwent protected weightbearing of the more symptomatic side. All of the patients included in the study had a stable lesion with an intact articular surface but with cartilage softening, as was found by arthroscopic visualization and probing. Thus, all lesions were grade 1 lesions as classified by Ewing and Voto<sup>11</sup> (grade 1, intact lesion; grade 2, early cartilage separation; grade 3, partially attached lesion; and grade 4, crater lesion with loose body). Only isolated osteochondritis dissecans lesions were included in this series; patients with concomitant intraarticular injuries such as meniscal tears or ligament injuries were excluded. Other exclusion criteria included prior surgery for osteochondritis dissecans, loose bodies, unstable lesions, or lesions with a disrupted articular surface (grade 2 to 4 lesions).

All patients underwent arthroscopic surgery under general anesthesia by the senior author (LJM). The affected area of the medial femoral condyle was probed to assess the size, character, and stability of the affected chondral surface. Arthroscopic drilling was performed using a 1.6-mm Kirshner wire through the affected articular surface into the subepiphyseal bone of the distal femoral epiphysis. The number of perforations varied with the size of

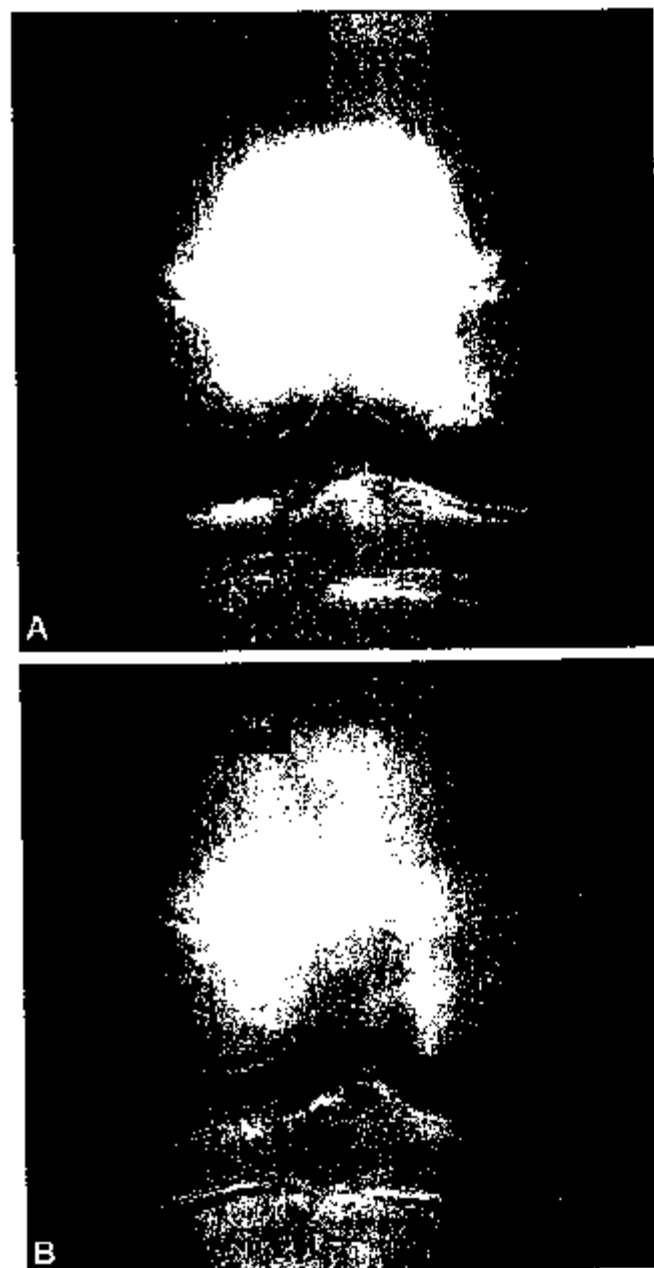


**Figure 1.** A, bilateral AP notch view radiograph in a 13-year-old boy with osteochondritis dissecans of both medial femoral condyles (arrows). These lesions remained symptomatic despite 1 year of nonoperative management including activity restriction and 2 months of protected weightbearing with splinting. B, bilateral AP notch view radiograph 12 months after transarticular drilling of the left knee and 9 months after transarticular drilling of the right knee, demonstrating healing of both lesions (arrows).

the lesion, ranging from 6 to 10 perforations. Efflux of blood or fat from the drilled hole served as evidence of adequate depth of penetration.

Postoperatively, patients were maintained nonweightbearing for 4 weeks with range of motion limited to 0° to 40° with the use of a hinged knee brace. Physical therapy was initiated at 4 weeks, with discontinuation of the brace and restoration of full motion and closed kinetic chain exercises. Weightbearing was allowed 4 weeks after surgery, and the patients progressed from partial to full weightbearing as tolerated over a 1-week period. Return to activities was permitted after a minimum of 12 weeks if there was evidence of radiographic healing and resolution of symptoms. Patients with bilateral involvement underwent staged arthroscopic drilling, with the second operation performed 2 to 6 months after treatment of the contralateral knee. These patients underwent the same postoperative therapy regimen after the second operation.

Functional outcome was determined using the Lysholm score as modified by Tegner and Lysholm.<sup>11</sup> Scores were



**Figure 2.** A, AP radiograph in a 12-year-old boy with osteochondritis dissecans of the medial femoral condyle (arrow) that remained symptomatic despite 6 months of nonoperative management including activity restriction and 2 months of partial weightbearing. B, AP radiograph 4 months after trans-articular drilling, demonstrating healing of the lesion (arrow).

obtained preoperatively and at the time of final follow-up. Radiographic outcome was determined using size of the lesion and the radiographic osteochondritis dissecans score of Itdeggerdt and Gleissner<sup>22</sup> (Table 1) as described by Schneider et al.<sup>20</sup> and Kocher et al.<sup>23</sup> Lesion size and radiographic scores were determined on preoperative and follow-up AP and lateral radiographs by a pediatric radiologist who was blinded to the details of this study. Ra-

**TABLE 1**  
Radiographic Osteochondritis Dissecans Score<sup>23</sup>

Grade	Description
I	Potentially depressed osteochondral fracture (sleeping phase)
II	Demarcation without sclerotic rim
III	Demarcation with sclerotic rim
IV	Partly detached fragment, nondisplaced
V	Displaced fragment (loose body)

diographic healing was identified as resolution of radiolucent demarcation on both the AP and lateral views (Figs. 1 and 2). Time to radiographic healing was determined based on serial postoperative radiographs.

Preoperative, follow-up, and improvement data are expressed in terms of the mean  $\pm$  standard deviation. Outcome variables were tested for normality using the Wilk-Shapiro goodness-of-fit test, which revealed no significant departures from normality and no violations of homogeneity of variance. Therefore, differences between preoperative and follow-up Lysholm and radiographic scores were evaluated using paired *t*-tests. Multiple linear regression analysis was performed to determine independent, multivariate predictors of improvement in the Lysholm score using a backward stepwise method with  $P < 0.05$  for variables to be retained in the model. The coefficient of determination (adjusted  $R^2$ ) was used to measure model fit and to express the proportion of variance in Lysholm score improvement accounted for by the set of predictors in the final model. A two-tailed alpha level of 0.05 was used as the criterion for statistical significance for all comparisons.<sup>23</sup> Data analysis was conducted using the SAS software package (version 6.12, SAS Institute, Cary, North Carolina).

## RESULTS

There were 113 patients with osteochondritis dissecans of the knee seen during the study period. Thirty patients fulfilled the inclusion criteria, 23 of whom returned for follow-up (77% follow-up). There were 30 involved knees in these 23 patients (16 with unilateral involvement and 7 with bilateral involvement). The mean age at surgery was 12.3 years (range, 8.5 to 16.1). There were 15 boys and 8 girls. The average follow-up was 3.9 years (range, 2 to 7.2). There were no apparent surgical complications associated with arthroscopic antegrade drilling.

There was a significant improvement in Lysholm scores ( $P < 0.001$ ) from a mean preoperative score of 58.8 to a mean follow-up score of 92.8 (Table 2). All 30 knees had an improvement in Lysholm scores.

There was a significant decrease in the radiographic size of the lesion on both the AP ( $P = 0.013$ ) and lateral radiographs ( $P = 0.009$ ) (Table 2). The mean decrease on AP radiographs was 4.5 mm (range, 0 to 20). Nineteen knees (63%) demonstrated a decrease in lesion size on AP radiographs, 11 knees (37%) demonstrated no change, and no knees demonstrated increased lesion size. The mean decrease in lesion size on the lateral radiographs was 8.3

TABLE 2  
Results of Antegrade Arthroscopic Drilling

Outcome measure	Preoperative	Follow-up	Change	P value
	Mean $\pm$ SD (range)	Mean $\pm$ SD (range)	Mean $\pm$ SD (range)	
Lysholm score (0-100)	58.6 $\pm$ 22 (17-100)	92.8 $\pm$ 10 (58-100)	34.2 $\pm$ 20 (5-83)	<0.001
Lesion size (mm) AP radiograph	15.7 $\pm$ 4.1 (9-20)	11.2 $\pm$ 6.3 (0-18)	4.5 $\pm$ 5.8 (0-20)	0.013
Lateral radiograph	20.4 $\pm$ 5.6 (8-30)	12.0 $\pm$ 9.4 (0-22)	8.4 $\pm$ 8.1 (0-30)	0.009
Radiographic score	3.0 $\pm$ 1.0 (1-4)	1.9 $\pm$ 1.0 (0-3)	1.1 $\pm$ 1.0 (-2-3)	<0.001

mm (range, 0 to 30). Twenty-four knees (80%) demonstrated a decrease in lesion size on lateral radiographs, 6 knees (20%) demonstrated no change, and no knees demonstrated increased lesion size.

There was a significant improvement of 1.1 (range, -2 to 3) in the radiographic scores ( $P < 0.001$ ) (Table 2). Twenty knees (67%) demonstrated an improvement in radiographic score, 7 knees (23%) demonstrated no change in score, and 3 knees (10%) demonstrated a worsening in score. Radiographic healing was achieved in all patients at an average of 4.4 months after drilling (range, 1 to 11 months).

The stepwise multiple linear regression model identified younger age as the only independent, multivariate predictor of Lysholm score improvement ( $P = 0.004$ , adjusted  $R^2 = 0.48$ ). Sex, involved side, bilaterality, presence or absence of sclerosis, presence or absence of fragmentation, radiographic lesion size on both the AP and lateral views, and radiographic score were not significant multivariate predictors of Lysholm score improvement ( $P > 0.20$  in each case).

## DISCUSSION

The etiologic and natural history of osteochondritis dissecans of the knee is not well understood, and management is controversial. Initial nonoperative management of stable, juvenile osteochondritis dissecans lesions is warranted, given the potential for healing with subsequent normal function and radiographs in skeletally immature patients.<sup>11, 18, 20, 30, 34</sup> However, despite a better prognosis for juvenile osteochondritis dissecans than for adult osteochondritis dissecans, not all lesions in skeletally immature knees heal. Cahill and colleagues<sup>11</sup> reported a 43% failure rate in 92 knees of 76 skeletally immature patients treated with 10 to 18 months of activity modification and occasional crutch use to maintain symptom free levels. In addition, traditional nonoperative management that includes prolonged immobilization or nonweightbearing may result in stiffness, atrophy, and further chondral degeneration.<sup>21</sup> Furthermore, compliance with prolonged activity restriction in these often very active and competitive patients is often problematic.

There is a role for operative management of juvenile

osteochondritis dissecans lesions in patients with detached or unstable lesions, those approaching epiphyseal closure, and those whose lesions have been unresponsive to nonoperative management.<sup>9</sup> Surgical options include drilling (antegrade transarticular or retrograde through the distal femoral epiphysis), curettage, bone grafting, internal fixation, open or arthroscopic reduction of a loose fragment with internal fixation, fragment removal, autologous or allogenic osteochondral grafting, and autologous chondrocyte implantation.<sup>1, 2, 9, 10, 16, 19, 22, 26, 32</sup> For patients with a stable lesion and an intact articular surface, arthroscopic drilling theoretically offers the potential to create channels for revascularization and healing. Drilling can be performed antegrade transarticular or retrograde through the epiphysis. Transarticular drilling is accurate and technically straightforward; however, it creates channels within articular cartilage, which heal with fibrocartilage.<sup>5</sup> Retrograde drilling avoids violation of the articular surface; however, in our experience it may be associated with technical difficulty, inaccuracy, and inadequate depth of penetration.

In this series of patients with juvenile osteochondritis dissecans of the medial femoral condyle who had an intact articular surface and failure of nonoperative management, arthroscopic transarticular drilling was associated with significant improvement in functional outcome as measured by the Lysholm score and radiographic outcome as measured by lesion size and the radiographic score of Rodegertts and Gleissner.<sup>28</sup> Radiographic healing occurred in all patients at an average of 4.4 months after drilling. There were no apparent complications. Although all the patients were skeletally immature, younger age was identified as an independent, multivariate predictor of improvement in Lysholm score.

Other investigators have also found arthroscopic transarticular drilling to be efficacious in skeletally immature patients with osteochondritis dissecans who have failure of initial nonoperative management. Bradley and Dandy<sup>2</sup> reviewed 11 affected knees in 10 children at a minimum of 1 year after transarticular arthroscopic drilling for stable osteochondritis dissecans lesions of the medial femoral condyle with an intact articular surface. All patients had had persistent pain lasting more than 6 months without clinical improvement or radiographic healing. Nine of the

11 knees were pain-free and demonstrated radiographic healing within 12 months after the operation. One knee took 2 years to unite and one knee did not heal, resulting in a subsequent loose body. Aglietti and colleagues<sup>1</sup> reviewed 16 knees in 14 children whose prolonged activity restriction had failed. At an average of 4.7 years after transarticular arthroscopic drilling for stable osteochondritis dissecans lesions of the medial femoral condyle with an intact articular surface, all lesions had progressed to radiographic healing and the patients were asymptomatic. Anderson and coworkers<sup>7</sup> reviewed 24 knees in 21 patients at an average of 5 years after antegrade arthroscopic drilling for stable osteochondritis dissecans lesions with an intact articular surface or partial detachment. All patients had had failure of at least 3 months of nonoperative management including activity restriction and non-weightbearing before surgery. Eighteen of 20 lesions in skeletally immature patients healed, whereas only 2 of 4 lesions in skeletally mature patients healed.

Limitations of this study include the lack of a control group with prolonged nonoperative management to determine whether arthroscopic transarticular drilling resulted in comparatively greater healing, improved functional and radiographic outcome, and quicker return to symptom-free activities. It is our practice to continue initial nonoperative management of stable juvenile osteochondritis dissecans lesions for 6 months. Our treatment consists of activity restriction and occasional protected weightbearing with sequential radiographic monitoring. Some slow-healing lesions may progress to healing between 6 and 18 months of nonoperative management. However, we have found patient compliance with such prolonged activity restriction to be problematic, and we have found prolonged immobilization or activity restriction to result in detrimental functional sequelae. Furthermore, excessive delay in operative intervention may allow some adolescents to approach skeletal maturity, thus giving them a more guarded prognosis for healing and eventual outcome. Indeed, in this study, even among skeletally immature patients, older age was an independent, multivariate predictor of less improvement in Lysholm score. Thus, we do not delay operative treatment until the approach of skeletal maturity, as is advocated by traditional doctrine.<sup>18</sup>

In conclusion, given the low morbidity of drilling and the associated improvement in functional and radiographic outcome, we advocate arthroscopic antegrade drilling for patients with juvenile osteochondritis dissecans of the medial femoral condyle with an intact articular surface who have had failure of initial nonoperative management.

## REFERENCES

- Aglietti P, Buzzi R, Bassi PB, et al: Arthroscopic drilling in juvenile osteochondritis dissecans of the medial femoral condyle. *Arthroscopy* 10:250-251, 1994
- Aichroth P: Osteochondritis dissecans of the knee: A clinical survey. *J Bone Joint Surg* 53B:440-447, 1971
- Anderson AF, Lipscomb AB, Coulton C: Antegrade curettement, bone grafting and pinning of osteochondritis dissecans in the skeletally mature knee. *Am J Sports Med* 18:254-261, 1990
- Anderson AF, Pagnani MJ: Osteochondritis dissecans of the femoral condyles: Long-term results of excision of the fragment. *Am J Sports Med* 25:830-834, 1997
- Anderson AF, Richards DB, Pagnani MJ, et al: Antegrade drilling for osteochondritis dissecans of the knee. *Arthroscopy* 13:319-324, 1997
- Berlet GC, Mascia A, Miniac A: Treatment of unstable osteochondritis dissecans lesions of the knee using autogenous osteochondral grafts (mosaicplasty) [case report]. *Arthroscopy* 15:312-316, 1999
- Brinley J, Dandy DJ: Results of drilling osteochondritis dissecans before skeletal maturity. *J Bone Joint Surg* 71B:642-644, 1989
- Brittberg M, Lindahl A, Nilsson A, et al: Treatment of deep cartilage defects in the knee with autologous chondrocyte transplantation. *N Engl J Med* 331:889-895, 1994
- Cahill BR: Osteochondritis dissecans of the knee: Treatment of juvenile and adult forms. *J Am Acad Orthop Surg* 3:237-247, 1995
- Cahill BR, Berg BC: <sup>99m</sup>Tc-methionine phosphatide compound joint scintigraphy in the management of juvenile osteochondritis dissecans of the femoral condyles. *Am J Sports Med* 11:320-335, 1983
- Cahill BR, Phillips MR, Navarro R: The results of conservative management of juvenile osteochondritis dissecans using joint scintigraphy: A prospective study. *Am J Sports Med* 17:601-606, 1989
- Clanton TO, DeLee JC: Osteochondritis dissecans: History, pathophysiology and current treatment concepts. *Clin Orthop* 167:50-64, 1982
- Dervin GF, Keene GCR, Chissell HP: Biodegradable rods in adult osteochondritis dissecans of the knee. *Clin Orthop* 356:213-221, 1998
- De Smet AA, Ilahi OA, Graf BK: Untreated osteochondritis dissecans of the femoral condyles: Prediction of patient outcome using radiographs and MR findings. *Skeletal Radiol* 26:463-467, 1997
- Ewing JW, Voto SJ: Arthroscopic surgical management of osteochondritis dissecans of the knee. *Arthroscopy* 4:37-40, 1988
- Gillespie HS, Day B: Bone peg fixation in the treatment of osteochondritis dissecans of the knee joint. *Clin Orthop* 143:125-130, 1979
- Glaney GL: Juvenile osteochondritis dissecans. *Am J Knee Surg* 12:120-124, 1989
- Green WT, Banks HH: Osteochondritis dissecans in children. *J Bone Joint Surg* 35A:26-47, 64, 1953
- Guhl JF: Arthroscopic treatment of osteochondritis dissecans. *Clin Orthop* 167:65-74, 1982
- Hettl F, Beguristan J, Kreuspe R, et al: Osteochondritis dissecans: A multicenter study of the European Pediatric Orthopedic Society. *J Pediatr Orthop B* 231-245, 1998
- Hughston JC, Hergenroeder PT, Courteney BG: Osteochondritis dissecans of the femoral condyles. *J Bone Joint Surg* 66A:1340-1348, 1984
- Johnson U, Utting G, Austin MD, et al: Osteochondritis dissecans of the knee: Arthroscopic compression screw fixation. *Arthroscopy* 6:179-180, 1990
- Koch S, Kampen WJ, Laprell H: Cartilage and bone morphology in osteochondritis dissecans. *Knee Surg Sports Traumatol Arthrosc* 5:42-45, 1997
- Linden B: Osteochondritis dissecans of the femoral condyles: A long-term follow-up study. *J Bone Joint Surg* 59A:709-776, 1977
- Linden B: The incidence of osteochondritis dissecans in the condyles of the femur. *Acta Orthop Scand* 47:664-667, 1976
- Mancacci M, Kim C, Zaffagnini S, et al: Use of autologous grafts for reconstruction of osteochondral defects of the knee. *Orthopedics* 27:595-600, 1999
- Pappas A: Osteochondritis dissecans. *Clin Orthop* 158:59-69, 1981
- Rodegerds U, Gleissner B: Langzeitbetreuung mit der operativen Therapie der Osteochondritis dissecans des Kniegelenkes. *Orthop Praxis* 8:612-622, 1978
- Schneider T, Fink B, Jerosch J, et al: The value of magnetic resonance imaging as postoperative control after arthroscopic treatment of osteochondritis dissecans. *Arch Orthop Trauma Surg* 117:235-239, 1998
- Smile IS: Treatment of osteochondritis dissecans. *J Bone Joint Surg* 39D:248-260, 1957
- Togner Y, Lysholm J: Rating system in the evaluation of knee ligament injuries. *Clin Orthop* 198:43-49, 1985
- Tomford WW, Springfield DS, Mankin HJ: Fresh and frozen articular cartilage allografts. *Orthopedics* 15:1180-1180, 1992
- Twyman HS, Ueda K, Achrol PM: Osteochondritis of the knee: A long-term study. *J Bone Joint Surg* 73B:461-464, 1991
- Van Dermark HE: Osteochondritis dissecans with spontaneous healing. *J Bone Joint Surg* 34A:143-148, 1952
- Zar JH: *Biostatistical Analysis*. Third edition. Upper Saddle River, NJ: Prentice-Hall, 1996, pp 413-418