Published in final edited form as:
Am J Sports Med. 2009 April ; 37(4): 754–759. doi:10.1177/0363546508328119.

Does ORIF of an OCD Loose Body Result in Healing and Long Term Maintenance of Knee Function?

Robert A. Magnussen, MD, **James L. Carey, MD**, and **Kurt P. Spindler, MD**
Vanderbilt Sports Medicine Center, Nashville, Tennessee

Abstract

Background—Osteochondritis dissecans (OCD) can progress to loose body formation resulting in a Grade IV defect. The decision to fix versus excise the loose body is controversial. Published operative fixation outcomes are small case series with short follow-up.

Hypothesis—Operative fixation (ORIF) of the loose body into the grade IV defect will heal and approximate “normal” knee function at long-term follow-up.

Study Design—Case series

Methods—Twelve patients were identified who underwent ORIF of a knee OCD loose body into the Grade IV osteochondral defects ranging in size from 2.0 to 8.0 cm^2 (mean 3.5 cm^2). After 12 weeks, hardware was removed and healing was assessed. Long-term outcomes were assessed with a Knee injury and Osteoarthritis Outcome Score (KOOS) and a Marx activity score.

Results—Arthroscopy for screw removal revealed stable healing in 92% (11/12) of patients. No patients required subsequent surgery for a loose body. At an average of 9.2 years follow-up (range 3.8-15.8 years) 83 % (10/12) of patients completed the KOOS. KOOS subscale scores for pain (mean 87.8, range 67-100), other symptoms (mean 81.8, range 61-96), function in activities of daily living (mean 93.1, range 72-100), and sports and recreation function (mean 74.0, range 40-100) were not significantly lower than published age matched controls. However the KOOS subscale for knee related quality of life (mean 61.9, range 31-88) was significantly lower ($p = 0.003$).

Conclusions—Operative fixation of Grade IV OCD loose bodies results in stable fixation. At an average 9 years after surgery, patients did not have symptoms of osteoarthritis pain and had normal function in activities of daily life. However, patients reported significantly lower knee related quality of life. Operative fixation of OCD loose bodies is a better alternative to lesion excision.

Introduction

Osteochondritis dissecans (OCD) is a lesion of subchondral bone primarily affecting juveniles and young adults. Multiple hypotheses have been put forward regarding the etiology of this condition including inflammation,[55] ossification abnormalities,[20] ischemia, [24] and repetitive microtrauma. [2, 27, 28, 39] The natural history of the disease process has been studied by multiple authors using a variety of methods. These studies generally show the prognosis to be better for smaller lesions and those in the skeletally immature.[10, 27, 28]

Correspondence author: Kurt P. Spindler, MD, Vanderbilt Sports Medicine, 4200 Medical Center East, South Tower, 1215 21st Avenue South, Nashville, TN 37232-8774, Phone: (615) 343-1685, Fax: (615) 322-7126, kurt.spindler@vanderbilt.edu.

Osteochondritis dissecans lesions have been classified based on their appearance at arthroscopy.[25] Stage I defects are stable to probing. Stage II lesions show early signs of separation with intact cartilage. Stage III lesion are partially detached. Stage IV lesions are characterized by craters and the presence of loose bodies. These loose bodies consist of articular cartilage with or without attached subchondral bone. If the fragment remains in its bed, magnetic resonance imaging (MRI) has been shown to be useful in determination of lesion stability.[14]

Stable OCD lesions have long been managed by non-operative means with healing rates noted to be between 50 and 94 %.[60] Skeletal immaturity, small lesion size, and lesion location on the medial femoral condyle have been associated with higher healing rates.[10, 14, 24, 27, 28, 39, 58, 60] Three to six months of non-operative management is advised by most authors, with treatment ranging from avoidance of sports to strict immobilization and non-weightbearing.[4, 10, 16, 27, 28, 55, 60] Drilling has been shown to result in union and good clinical results in 80-90 % of lesion which failed previous non-operative management.[3, 5, 7]

Unstable lesions that remain in the defect (Stage II or III), as determined by MRI or arthroscopy are felt to require operative fixation, often in conjunction with drilling and/or local bone grafting.[12, 20, 29, 60] Reported healing rates by radiograph have been between 80 and 100% with good to excellent clinical outcomes in the majority of patients.[1, 13, 16, 21, 28, 30, 34, 40, 43, 44, 48, 54]

Proposed treatment options for lesions that have progressed to loose body formation (Grade IV) include excision of the loose body or replacement of the loose body in the defect. Results of excision of the loose body with or without drilling of the defect have been poor in up to 75 % of patients. [2, 4, 27, 61] If the lesion is excised, the defect can be treated with abrasion, microfracture, osteochondral autograft transfer, osteochondral allograft, or autologous chondrocyte implantation.

Many authors recommend fixation of loose bodies of OCD when possible.[3, 5, 8, 16, 23, 25, 31, 32, 37, 41, 42, 46, 49, 55-57, 59, 62] However, published operative fixation outcomes are small case series (10 or fewer patients) with short (less than 5 year) follow-up. These series all focus on patients with loose bodies with a large amount of bone attached. We hypothesize that operative fixation (ORIF) of a loose body into a grade IV defect will heal and approximate “normal” knee function at long-term follow-up.

MATERIALS AND METHODS

Identification of patients

A search of billing records at our institution was undertaken to identify all patients who underwent operative fixation of osteochondritis dissecans lesions by the senior author between January 1, 1991, and December 31, 2006. A search for CPT codes 29885 (Drilling for osteochondritis dissecans with bone grafting with or without internal fixation) and 29887 (Drilling for intact osteochondritis dissecans lesion with internal fixation) identified 36 patients. Medical records of these patients were reviewed and 24 patients were excluded because the lesion had not progressed to a loose body and remained in the defect (14 patients), because they underwent drilling of the lesion without fixation of the loose body (5 patients), or because the defect was purely chondral without attached subchondral bone (5 patients). The remaining 12 patients had Grade IV defects and underwent fixation of the loose body into the defect. These patients form the study group.

Operative Technique and Post-operative Protocol

A diagnostic arthroscopy was performed in each case to localize the OCD lesion and to find and assess the loose bodies. The anteromedial or anterolateral portal was then extended into a mini-arthrotomy to visualize the lesions located on the medial or lateral femoral condyles or trochlea. In two cases the lesion was located on the medial facet of the patella, requiring a larger arthrotomy and complete eversion of the patella to gain access to the lesion. In each instance the loose body was extracted from the knee and all fibrous tissue removed. The OCD defect was then drilled with a Kirschner wire and curetted to bleeding bone. The loose body was then positioned in the defect to assess its relative size. When the loose body was large than the defect, it was trimmed appropriately to fit the defect. If the defect was larger than the loose body, proximal tibial cancellous autograft was packed in the lesion until the size of the defect matched that of the loose body. The loose body was then positioned in the defect and fixed in place using one to four metal cortex screws (Synthes USA, West Chester, PA) ranging in size from 1.5 to 2.7 mm. Screws were sunk until the head was flush with the articular cartilage. Post-operatively, patients were allowed full range of motion but kept non-weightbearing status on the operative extremity for 12 weeks. Continuous passive motion (CPM) devices were not utilized.

Arthroscopy for Removal of Hardware

All patients returned to the operating room 12 weeks after the index procedure for diagnostic arthroscopy and screw removal. The repaired lesion was identified and probed arthroscopically and the stability of the replaced loose body was noted. Hardware was removed from fifteen patients arthroscopically, while the two patients with patellar defects required mini-arthrotomy for hardware removal. Lesion stability was again assessed after hardware removal. One patient with an incompletely healed lesion underwent repeat fixation with subsequent hardware removal 12 weeks later.

Follow-up

After approval by our institutional review board, attempts were made to contact the 12 patients identified above by telephone. Those patients who were located were asked if they required subsequent surgery on the operative knee and operative reports were obtained for any subsequent procedures. Additionally, the patients were asked to complete a questionnaire which allowed calculation of a Knee injury and Osteoarthritis Outcome Score (KOOS)[53] and a Marx activity score. [45]

Data Analysis

A KOOS and Marx activity score were calculated for each patient that completed the questionnaire. A mean and standard deviation was then calculated for the Marx activity score as well as the five components of the KOOS. The five KOOS components were then compared to previously published reference data[50] for patients in this age group using a t-test. Statistical analysis was performed using Medcalc (Mariakerke, Belgium).

RESULTS

Patient Demographics

The 12 patients identified above included 6 males (50 %) and ranged in age from 12 to 34 years (mean 19.2 years) at the time of surgery. Seven patients (58 %) were skeletally mature at the time of the procedure. Duration of symptoms ranged from 0.5 to 18 months (mean 4.7 months). Defects ranged in size from 2.0 to 8.0 cm^2 (mean 3.5 cm^2). Lesions were located on the medial femoral condyle (42 %), lateral femoral condyle (25 %), lateral trochlea (17

%), and medial facet of the patella (17 %). All twelve repaired loose bodies were osteochondral fragments with bone attached. These data are summarized in Table 1.

Follow-up

Twelve patients (100 %) returned to the operating room for arthroscopic hardware removal 12 weeks post-operatively. We were able to contact 11 patients (92 %) at a mean of 9.5 (range 3.8 – 15.8) years post-operative and inquire about further surgical intervention on the index knee. Our outcome questionnaire was completed and returned by 10 patients (83 %). One patient was unable to complete the questionnaire due to severe mental illness and one patient was not located.

Findings at Removal of Hardware as 12 Weeks

Each repaired defect was examined after removal of hardware at 12 weeks post-operative. Sixteen of seventeen lesions were noted to be completely healed and stable to probing. One patient with a large (8 cm^2) lesion was noted to be partially healed. Approximately 75 % of the lesion had fully healed while the remaining 25 % was noted to be loose This portion was removed, the bed was curetted to bleeding bone, and the piece was attached again with screws. At repeat arthroscopy 12 weeks later the entire lesion was noted to be healed and stable.

Repeat Surgery

The eleven patients who were contacted by telephone were asked if they had undergone any surgery on the index knee after removal of hardware. Only one patient had undergone additional surgery on the knee because of pain after a re-injury. Review of the operative report indicated that the repaired lesion was stable and grade II fibrillation of the surrounding articular cartilage was noted and debrided.

Clinical Outcome

The ten patients that completed the questionnaire had a mean Marx activity score of 4.6. KOOS subscale scores for pain (mean 87.8, range 67-100), other symptoms (mean 81.8, range 61-96), function in activities of daily living (mean 93.1, range 72-100), and sports and recreation function (mean 74.0, range 40-100) were not significantly different from published age-matched controls. However the KOOS subscale score for knee related quality of life (mean 61.9, range 31-88) was significantly different from published age-matched controls ($p = 0.003$). These data are presented in full in Table 2. No correlation was noted between Marx activity score and any KOOS subscale.

Complications

No patients experienced any perioperative complications at either the index surgery or subsequent removal of hardware. Two patients (17 %) were noted to have minor scuffing of the articular cartilage of the tibial plateau adjacent to the repaired lesion

DISCUSSION

Treatment of patients with grade IV OCD lesions is complicated by a lack of published data on the outcomes of different treatment options. Good short term results have been reported with excision of the loose body and treatment of the defect with drilling, microfracture, or abrasion. Ewing and Voto noted 79 % of patients had satisfactory results at 1 year while Denoncourt et al demonstrated the presence of fibrocartilage in the defect at 5-15 months after surgery.[15, 19] However, significantly poorer results have been noted with longer term follow-up. [2, 4, 61]

Several authors have attempted articular chondrocyte implantation (ACI) in conjunction with loose body excision for the treatment of osteochondritis dissecans. All have shown significantly worse results in these patients than patient with osteochondral defects from other etiologies, with failure rates ranging from 14 to 67 %.[38, 51, 52] One case study documented a good result when repaired the lesion with an osteochondral autograft[6] while other authors have found that results of osteochondral autograft transfer are similar in patients with osteochondritis dissecans to those with defects from other etiologies.[33]

Multiple authors have opined that when possible, replacement and fixation of the loose body in the defect provides the best opportunity for the restoration of normal anatomy and function. A review of the literature on this subject yielded 19 case reports and case series describing fixation of OCD lesions that included at least one grade IV defect. These studies are summarized in Table 3.[3, 11, 16, 22, 23, 25, 31, 32, 36, 37, 41, 42, 46, 47, 49, 55-57, 62] The results reported in these series are generally good, although incompletely reported. Many studies do not describe the number of lesions initially treated, instead reporting only the number evaluated in follow-up. Lesion size is frequently omitted and follow-up is short or of unreported duration. Outcome measures are limited to radiographic assessments of union and clinical outcomes generally described as excellent, good, fair, or poor.

The current series provides short-term arthroscopic evaluation of union as well as long-term follow-up using validated clinical outcome tools with greater than 80 % follow-up. Our data indicate that ORIF of the loose bodies in grade IV OCD results in stable union in 92 % of cases at 12 weeks. Long-term follow-up demonstrates that these patients have not required subsequent surgery on the index knee for loose bodies and are able to function at a nearly normal level in activities of daily living without significant pain or knee symptoms. However, it is clear that these patients' knees are not normal, as evidenced by the statistically significant departure from normal controls in the knee related quality of life subscale of the KOOS. This finding likely represents a true clinical difference as well, as the difference exceeds minimum perceptible change in KOOS subscale which is felt to be 10 points.[17, 53]

While no rigid KOOS score cutoff exists that defines a symptomatic knee, Englund et al attempted to develop such criteria in a series of patients followed for 16 years after partial meniscectomy.[18] They defined a "symptomatic knee" as those in which the knee related quality of life and at least 2 of the other 4 subscales exhibited a decrease in score consistent with at least half of the questions being answered with at least a 1 point decrease from the best response. By these criteria, 50 % of their patients had a "symptomatic knee." However, only half of these patients also showed radiographic evidence of osteoarthritis. Utilizing the KOOS subscale cutoffs described above, four of the ten patients in our series have a "symptomatic knee" at 8 year follow-up.

Significant limitations exist in this study. First, our utilization of a mailed questionnaire to obtain long-term follow-up exposes the study to certain biases. As was demonstrated by Kim *et al*, patients with poorer outcomes are less likely to return questionnaires and tend to take longer to return them when they do so.[35] We attempted to minimize this possible bias by being persistent in our data gathering but our failure to obtain 100 % follow-up must be considered when interpreting data from a small cohort of patients. Further, our long-term results consist only of patient reported outcomes and a determination of whether the patient required subsequent surgery on the index knee. No imaging was obtained to verify the position of the repaired loose body long-term. We believe that given the size and bony nature of the loose bodies, they would be symptomatic and require excision or repeat fixation if they were to again become loose bodies. This supposition is supported by the fact the patients initially had sufficient symptoms from these loose bodies that they required operative fixation.

Additionally, we describe one method of treatment for this patient group without inclusion of a control group or comparison with another treatment method. However, previous authors have demonstrated poor outcomes or evidence of osteoarthritis in 50 to 75 % of patients at 5-15 year follow-up.[2, 4, 27, 61] We feel this series demonstrates a viable alternative to lesion excision by operative fixation of loose bodies.

Finally, the relatively small number of patients included in the study limits the accuracy of correlations made between patient and lesion characteristics and outcome. Specifically, our study only included two patients with patellar defects and one was lost to follow-up. The patient with a patellar defect available for long-term follow-up demonstrated the lowest scores in nearly all KOOS subscales and the lowest Marx activity score. Given the relatively poor results of treatment of articular cartilage defects of the patella with multiple techniques,[9, 26] increased difficulty in treating OCD lesions in this location are not unexpected. Similarly, we were unable to demonstrate any relationship between lesion size and clinical outcome as has been previously described.[10, 28, 29] Outcome data on more patients are necessary to determine the influence of lesion size and location on clinical outcome.

CONCLUSIONS

Operative fixation of Grade IV OCD loose bodies resulted in stable fixation in 92 % of patients at 12 weeks after surgery. At an average 9 years after surgery, patients had minimal pain and exhibited normal function in activities of daily life. However, patients reported significantly lower knee related quality of life. Only prospective comparative studies can determine relative advantages of the available treatment choices for these lesions.

References

1. Aglietti P, Buzzi R, Bassi PB, Fioriti M. Arthroscopic drilling of osteochondritis dissecans of the medial femoral condyle. Arthroscopy. 1994; 10(3):286–291. [PubMed: 8086022]
2. Aichroth P. Osteochondritis dissecans of the knee. J Bone Joint Surg Br. 1971; 53-B(3):440–447. [PubMed: 5562371]
3. Anderson AF, Lipscomb AB, Coulam C. Antegrade curettement, bone grafting and pinning of osteochondritis dissecans in the skeletally mature knee. Am J Sports Med. 1990; 18(3):254–261. [PubMed: 2372074]
4. Anderson AF, Pagnani MJ. Osteochondritis dissecans of the femoral condyles: long-term results of excision of the fragment. Am J Sports Med. 1997; 25(6):830–834. [PubMed: 9397273]
5. Anderson AF, Richards DB, Pagnani MJ, Hovis JD. Antegrade drilling for osteochondritis dissecans of the knee. Arthroscopy. 1997; 13(3):319–324. [PubMed: 9195028]
6. Berlet GC, Mascia A, Miniaci AM. Treatment of unstable osteochondritis dissecans lesions of the knee using autogenous osteochondral grafts (mosaicplasty). Arthroscopy. 1999; 15(3):312–316. [PubMed: 10231112]
7. Bradley J, Dandy DJ. Results of drilling ostochondritis dissecans before skeletal maturity. J Bone Joint Surg Br. 1989; 71-B(4):642–644. [PubMed: 2768313]
8. Braune C, Rehart S, Kerschbaumer E, Jager A. Resorbable pin refixation of an osteochondral fracture of the lateral femoral condyle due to traumatic patellar dislocation: case management, follow-up and strategy in adolescents. Z Orthop Ihre Grenzgeb. 2004; 142(1):103–108. [PubMed: 14968393]
9. Brittberg M, Lindahl A, Nilsson A, Ohlsson C, Isaksson O, Peterson L. Treatment of deep cartilage defects in the knee with autologous chondrocyte transplantation. N Engl J Med. Oct 6; 1994 331(14):889–895. [PubMed: 8078550]

10. Cahill BR, Phillips MR, N R. The results of conservative management of juvenile osteochondritis dissecans using joint scintography. A prospective study. Am J Sports Med. 1989; 17(5):601–605. [PubMed: 2610273]
11. Cetik O, Turker M, Uslu M. Bilateral osteochondritis dissecans of lateral femoral condyle. Knee Surg Sports Traumatol Arthrosc. Sep; 2005 13(6):468–471. [PubMed: 16170582]
12. Crawford DC, Safran MR. Osteochondritis dissecans of the knee. J Am Acad Orthop Surg. 2006; 14(2):90–100. [PubMed: 16467184]
13. Cugat R, Garcia M, Cusco X, et al. Osteochondritis dissecans: a historical review and its treatment with cannulated screws. Arthroscopy. 1993; 9(6):675–684. [PubMed: 8305105]
14. de Smet AA, Fisher DR, Graf BK, Lange RH. Osteochondritis dissecans of the knee: value of MR imaging in determining lesion stability and the presence of articular cartilage defects. Am J Roentgen. 1990; 155(3):549–553.
15. Denoncourt PM, Patel D, Dimakopoulos P. Treatment of osteochondritis dissecans of the knee by arthroscopic curettage, follow-up study. Orthopedic Review. 1986; 15(10):652–657.
16. Dervin GF, Keene GCR, Chissell HR. Biodegradable rods in adult osteochondritis dissecans of the knee. Clin Orthop Relat Res. 1998; 356:213–221. [PubMed: 9917687]
17. Ehrich EW, Davies GM, Watson DJ, Bolognese JA, Seidenberg BC, Bellamy N. Minimal perceptible clinical improvement with the Western Ontario and McMaster Universities osteoarthritis index questionnaire and global assessments in patients with osteoarthritis. J Rheumatol. Nov; 2000 27(11):2635–2641. [PubMed: 11093446]
18. Englund M, Roos EM, Lohmander LS. Impact of type of meniscal tear on radiographic and symptomatic knee osteoarthritis: a sixteen-year followup of meniscectomy with matched controls. Arthritis Rheum. Aug; 2003 48(8):2178–2187. [PubMed: 12905471]
19. Ewing JW, Voto SJ. Arthroscopic surgical management of osteochondritis dissecans of the knee. Arthroscopy. 1998; 4(1):37–40. [PubMed: 3355637]
20. Flynn JM, Mininder SK, Ganley TJ. Osteochondritis dissecans of the knee. J Ped Orthop. 2004; 24(4):434–443.
21. Gepstein R, Conforty B, Weiss RE, Hallel T. Surgery for early stage osteochondritis dissecans of the knee in young adults: a preliminary report. Orthopedics. 1986; 9(8):1087–1089. [PubMed: 3748909]
22. Gillespie HS, Day B. Bone peg fixation in the treatment of osteochondritis dissecans of the knee joint. Clin Orthop Relat Res. 1979; 143:125–129. [PubMed: 509813]
23. Green JP. Osteochondritis dissecans of the knee. J Bone Joint Surg Br. 1966; 48-B(1):82–91. [PubMed: 5909068]
24. Green WT, Banks HH. Osteochondritis dissecans in children. J Bone Joint Surg Am. 1953; 35A: 26–47. [PubMed: 13022705]
25. Guhl JF. Arthroscopic treatment of osteochondritis dissecans. Clin Orthop Relat Res. 1982; 167:65–74. [PubMed: 7047040]
26. Hangody L, Fules P. Autologous osteochondral mosaicplasty for the treatment of full-thickness defects of weight-bearing joints: ten years of experimental and clinical experience. J Bone Joint Surg Am. 2003; 85-A(Suppl 2):25–32. [PubMed: 12721342]
27. Hefti F, Krauspe R, Moller-Madsen B, et al. Osteochondritis dissecans: A multicenter study of the European Orthopedic Society. J Ped Orthop. 1999; 8(4):231–245.
28. Hughston JC, Hergenroeder PT, Courtenay BG. Osteochondritis dissecans of the femoral condyles. J Bone Joint Surg Am. 1984; 66-A(9):1340–1348. [PubMed: 6501330]
29. Jaberi FM. Osteochondritis dissecans of the weight-bearing surface of the medial femoral condyle in adults. Knee. 2002; 9:201–207. [PubMed: 12126678]
30. Jakob RP, Miniaci AM. A compression pinning system for osteochondritis dissecans of the knee. Acta Orthop Scand. 1989; 60(3):319–321. [PubMed: 2750507]
31. Johnson EW, McLeod TL. Osteochondral fragments of the distal end of the femur fixed with bone pegs. J Bone Joint Surg Am. 1977; 59-A(5):677–679. [PubMed: 873963]

32. Johnson LL, Uitvlugt G, Austin MD, Detrisac DA, Johnson C. Osteochondritis dissecans of the knee: arthoscopic compression screw fixation. Arthroscopy. 1990; 6(3):179–189. [PubMed: 2206180]

33. Karataglis D, Green MA, Learmonth DJ. Autologous osteochondral transplantation for the treatment of chondral defects of the knee. Knee. Jan; 2006 13(1):32–35. [PubMed: 16125942]

34. Kennedy JC, Grainger RW, McGraw RW. Osteochondral fractures of the femoral condyles. J Bone Joint Surg Br. 1966; 48-B(3):436–440. [PubMed: 5913135]

35. Kim J, Lonner JH, Nelson CL, Lotke PA. Response bias: effect on outcomes evaluation by mail surveys after total knee arthroplasty. J Bone Joint Surg Am. Jan; 2004 86-A(1):15–21. [PubMed: 14711940]

36. Kivisto R, Pasanen L, Leppilahti J, Jalovaara P. Arthroscopic repair of osteochondritis dissecans of the femoral condyles with metal staple fixation: a report of 28 cases. Knee Surg Sports Traumatol Arthrosc. Sep; 2002 10(5):305–309. [PubMed: 12355306]

37. Kouzelis A, Spyros P, Papadopoulos AX, Gliatis I, Lambiris E. Herbert screw fixation and reverse guided drillings, for treatment of types III and IV osteochondritis dissecans. Knee Surg Sports Traumatol Athrosc. 2006; 14:70–75.

38. LaPrade RF, Bursch LS, Olson EJ, Havlas V, Carlson CS. Histologic and immunohistochemical characteristics of failed articular cartilage resurfacing procedures for osteochondritis of the knee: a case series. Am J Sports Med. Feb; 2008 36(2):360–368. [PubMed: 18006675]

39. Linden B. Osteochrondritis dissecans of the femoral condyles. J Bone Joint Surg Am. 1977; 59-A(6):769–776. [PubMed: 908702]

40. Lindholm S, Pylkkanen P. Internal fixation of the fragment of osteochondritis dissecans in the knee by means of bone pins. Acta Chir Scand. 1974; 140:626–629. [PubMed: 4456955]

41. Lindholm S, Pylkkanen P, Osterman K. Fixation of osteochondral fragments in the knee joint. Clin Orthop Relat Res. 1977; 126:256–260. [PubMed: 340092]

42. Lipscomb PR, Lipscomb PR, Bryan RS. Osteochondritis dissecans of the knee with loose fragments: treatment by replacement and fixation with readily removed pins. J Bone Joint Surg Am. 1978; 60-A(2):235–240. [PubMed: 641090]

43. Mackie IG, Pemberton DJ, Maheson M. Arthroscopic use of the Herbert screw in osteochondritis dissecans. J Bone Joint Surg Br. 1990; 72-B(4):1076. [PubMed: 2246293]

44. Makino A, Muscolo DL, Puigdevall M, Costas-Paz M, Ayerza M. Arthroscopic fixation of osteochondritis dissecans of the knee. Am J Sports Med. 2005; 33(10):1499–1504. [PubMed: 16009988]

45. Marx RG, Stump TJ, Jones EC, Wickiewicz TL, Warren RF. Development and evaluation of an activity rating scale for disorders of the knee. Am J Sports Med. Mar-Apr;2001 29(2):213–218. [PubMed: 11292048]

46. Matsusue Y, Nakamura T, Suzuki S, Iwasaki R. Biodegradable pin fixation of osteochondral fragments of the knee. Clin Orthop Relat Res. 1996; 322(1):166–173. [PubMed: 8542693]

47. Nakagawa T, Kurosawa H, Ikeda H, Kozawa M, Kawakami A. Internal fixation for osteochondritis dissecans of the knee. Knee Surg Sports Traumatol Athrosc. 2005; 13:317–322.

48. Navarro R, Cohen M, Filho MC, da Silva RT. The arthroscopic treatment of osteochondritis dissecans of the knee with autologous bone sticks. Arthroscopy. 2002; 18(8):840–844. [PubMed: 12368780]

49. Outerbridge RE. Osteochondritis dissecans of the posterior femoral condyle. Clin Orthop Relat Res. 1983; 175:121–129. [PubMed: 6839577]

50. Paradowski PT, Bergman S, Sunden-Lundius A, Lohmander S, Roos EW. Knee complaints vary with age and gender in the adult population. Population-based reference data for the Knee injury and Osteoarthritis Outcome Score (KOOS). BMC Musculoskelet Disord. 2006; 7(38)

51. Peterson L, Brittberg M, Kiviranta I, Akerlund EL, Lindahl A. Autologous chondrocyte transplantation. Biomechanics and long-term durability. Am J Sports Med. Jan-Feb;2002 30(1):2–12. [PubMed: 11798989]

52. Peterson L, Minas T, Brittberg M, Nilsson A, Sjogren-Jansson E, Lindahl A. Two- to 9-year outcome after autologous chondrocyte transplantation of the knee. Clin Orthop Relat Res. May. 2000 374:212–234. [PubMed: 10818982]

53. Roos EM, Lohmander LS. The Knee injury and Osteoarthritis Outcome Score (KOOS): from joint injury to osteoarthritis. Health Qual Life Outcomes. 2003; 1:64. [PubMed: 14613558]
54. Scott DJ, Stevenson CA. Osteochondritis dissecans of the knee in adults. Clin Orthop Relat Res. 1971; 76:82–86. [PubMed: 5578145]
55. Smillie IS. Treatment of Osteochondritis Dissecans. J Bone Joint Surg Br. 1957; 39-B(2):248–260. [PubMed: 13438964]
56. Thomson NL. Osteochondritis dissecans and osteochondral fragments managed by Herbert compression screw fixation. Clin Orthop Relat Res. 1987; 224:71–78. [PubMed: 3665256]
57. Tuompo P, Arvela V, Partio EK, Rokkanen P. Osteochondritis of the knee fixed with biodegradable self-reinforced polyglycolide and polylactide rods in 24 patients. Int Orthop. 1997; 21:355–360. [PubMed: 9498141]
58. Twyman RS, Desai K, Aicroth PM. Osteochondritis dissecans of the knee. J Bone Joint Surg Br. 1991; 73-B(3):461–464. [PubMed: 1670450]
59. Victoroff BN, Marcus RE, Deutsch A. Arthoscopic bone peg fixation in the treatment of osteochondritis dissecans in the knee. Arthroscopy. 1996; 12(4):506–509. [PubMed: 8864013]
60. Wall E, Von Stein D. Juvenile osteochondritis dissecans. Orthop Clin North Am. 2003; 34:341–353. [PubMed: 12974484]
61. Zarzycki W. Evaluation of treatment results for osteochondritis dissecans of the knee joint. Chir Narzadow Ruchu Ortop Pol. 2001; 66(1):61–66. [PubMed: 11481987]
62. Zuniga JJR, Sagastibelza JJ, Blasco JJL, Grande MM. Arthroscopic use of Herbert screw in osteochondritis dissecans of the knee. Arthroscopy. 1993; 9(6):668–670. [PubMed: 8305103]

NIH-PA Author Manuscript
NIH-PA Author Manuscript

Table 1

Patient Demographics

Patient	Age[a] (Years)	Sex	Skeletal Maturity[b]	Duration of Symptoms (Months)	Lesion Location	Lesion Size (cm^2)	Loose Body Type
1	21	Male	Mature	12	Lateral Femoral Condyle	2.0	Osteochondral[c]
2	14	Female	Immature	3	Medial Femoral Condyle	5.0	Osteochondral
3	13	Female	Immature	3	Medial Femoral Condyle	6.0	Osteochondral
4	21	Male	Mature	0.5	Lateral Femoral Condyle	2.3	Osteochondral
5	27	Female	Mature	6	Medial Femoral Condyle	2.2	Osteochondral
6	15	Male	Immature	4	Lateral Femoral Condyle	8.0	Osteochondral
7	15	Female	Mature	2	Lateral Trochlea	2.2	Osteochondral
8	12	Female	Immature	2	Medial Patellar Facet	2.2	Osteochondral
9	20	Male	Mature	2	Lateral Trochlea	1.5	Chondral[d]
10	13	Female	Immature	0.5	Lateral Trochlea	2.0	Osteochondral
11	25	Male	Mature	2	Medial Femoral Condyle	3.8	Chondral
12	13	Male	Immature	0.5	Lateral Trochlea	3.0	Chondral
13	18	Male	Mature	1	Medial Femoral Condyle	1.5	Chondral
14	34	Male	Mature	4	Medial Femoral Condyle	2.2	Osteochondral
15	22	Male	Mature	1	Medial Patellar Facet	2.2	Osteochondral
16	23	Male	Mature	18	Medial Femoral Condyle	6.0	Osteochondral
17	17	Female	Mature	15	Medial Femoral Condyle	2.8	Chondral
Mean	19.2	59 % Male	65 % Mature	4.5		3.3	71 % Osteochondral

[a]Age at the time of operative fixation of the loose body

[b]Maturity defined as closure of the distal femoral physis

[c]Loose body consisting of full thickness articular cartilage and a significant amount of bone

[d]Loose body consisting of full thickness articular cartilage without attached bone

Table 2

Arthroscopic Second Look and Long-Term Follow-up Knee injury and Osteoarthritis Outcome Score Subscales[a]

Patient	Ages[b] at surgery (Years)	Findings at Second Look Arthroscopy	Time to Long-Term Follow-up (Years)	Marx Activity Score[c]	Pain	Other Symptoms	Function in Daily Living	Function in Sport and Recreation	Knee Related Quality of Life
1	21	Healed	15.8	1	100	89	100	90	75
2	14	Healed	14.0	12	86	93	93	65	75
3	13	Healed	None	---	---	---	---	---	---
4	21	Healed	10.7	8	89	75	94	75	81
5	27	Healed	10.2	4	94	86	99	75	50
6	15	Partially Healed	9.6	8	78	68	100	65	31
7	15	Healed	9.5	1	100	86	100	100	88
8	12	Healed	9.1	0	72	75	76	40	50
9	20	Healed	7.8	16	94	86	94	70	81
10	13	Healed	5.4	5	67	61	72	45	63
11	25	Healed	None	---	---	---	---	---	---
12	13	Healed	4.5	16	94	79	97	60	56
13	18	Healed	4.4	11	78	75	76	55	56
14	34	Healed	3.9	6	94	96	100	100	31
15	22	Healed	None	---	---	---	---	---	---
16	23	Healed	3.8	1	97	89	97	85	75
17	17	Healed	None[d]	---	---	---	---	---	---
Mean	19.2	94 % Healed	8.4[e]	6.8	88.0	81.3	92.1	71.1[f]	62.5[f]
Controls[g]					92	87	94	85	84

[a]Range 0 – 100. Higher scores indicate less pain and other symptoms and better function

[b]Age at the time of operative fixation of the loose body

[c]Range 0 – 16. Higher scores indicated higher levels of activity

[d]This patient is only 1.8 years post-op at the time of publication

[e]Mean time to follow-up for those available for follow-up at greater than 2 years post-operative

[f]Statistically significant ($p < 0.05$) when compared with age-matched controls

[g]Age-matched Controls: Paradowski PT, Bergman S, Sunden-Lundius A, Lohmander S, Roos EW. Knee complaints vary with age and gender in the adult population. Population-based reference data for the Knee injury and Osteoarthritis Outcome Score (KOOS). *BMC Musculoskelet Disord*. 2006;7(38).

NIH-PA Author Manuscript
NIH-PA Author Manuscript

Table 3

Published series of ORIF of Grade IV OCD's

Year	Journal	First Author	Total Number of Lesions Reported	Patients in which loose bodies were replaced	Mean Patient Age (years)	Mean Lesion Size	Mean time to follow-up (years)	Percent Follow- up[a]	Treatment Method	Outcome	Comments
1957	JBJS-B[b]	Smillie	32	10	18.2	NR[c]	NR	NR	ORIF with metal nails	7/10 reported resolution of pain	
1966	JBJS-B	Green	32	5	26.6	NR	5.4	NR	ORIF with metal nails	5/5 good or excellent results	Radiographic evidence of arthritis noted in 4/5
1977	CORR[d]	Lindholm	20	3	NR	NR	NR	NR	ORIF with bone pegs from tibia	NR	15/20 overall good results but results for loose bodies not separately reported
1977	JBJS-A[e]	Johnson	2	1	17.0	12.0 cm^2	1.1	100 %	ORIF with bone pegs	1/1 Excellent result	Radiograph showed incorporation of the loose fragment
1978	JBJS-A	Lipscomb	7	7	25.7	NR	8.7	NR	ORIF with metal nails	6/7 with good or excellent results	
1979	CORR	Gillespie	18	2	17.5[f]	3.8[f] cm^2	3.2[f]	100 %	ORIF with bone pegs	both healed – good results	
1982	CORR	Guhl	51	1	17.0[f]	"Large"	NR	73 %	ORIF with k-wire	1/1 good result	
1983	CORR	Outerbridge	14	5	23.0	NR	2.5	NR	ORIF - 1 with metal screw, 4 with bone pegs	metal – 1 excellent bone pegs – 3/4 good, 1/4 fair	
1987	CORR	Thompson	23	3	NR	NR	NR	78 %	Arthroscopic Herbert screws	3/3 to union	
1990	AJSM[g]	Anderson	17	7	18.0	5.8 cm^2	NR	100 %	ORIF with k-wire fixation	4/7 good results	
1990	Arthroscopy	Johnson	32	4	19.0[f]	5.3[f] cm^2	3.5[f]	91 %	Arthroscopic screw fixation	3/4 to union	
1993	Arthroscopy	Zuniga	11	1	24.0[f]	4.6[f] cm^2	1.3[f]	100 %	Arthroscopic Herbert screws	NR	9/11 overall good and excellent results but result for the loose body not reported separately
1996	CORR	Matsusue	5	3	13.0	NR	5.2	NR	Arthroscopic l-lactide pins	3/3 good results	

Year	Journal	First Author	Total Number of Lesions Reported	Patients in which loose bodies were replaced	Mean Patient Age (years)	Mean Lesion Size	Mean time to follow-up (years)	Percent Follow- up[a]	Treatment Method	Outcome	Comments
1997	International Orthopedics	Tuompo	24	2	18.0	7.4 cm^2	1.6	100 %	ORIF via mini-arthrotomy - metal screws	2/2 good results	
1998	CORR	Dervin	9	1	19.1	5.0 cm^2	2.1	100 %	Arthroscopic with polylactic acid rods	Did not unite, poor outcome	
2002	KSSTA[h]	Kivisto	28	4	20.0	5.0[f] cm^2	NR	100 %	Arthroscopic with staples	2/4 fully healed 1/4 partially healed	
2005	KSSTA	Cetik	2	2	20	"Large"	0.4	100 %	ORIF with Herbert screws	2/2 healed	
2005	KSSTA	Nakagawa	8	5	16.4	3.1 cm^2	5[f]	80 %	Arthroscopic with poly-lactive acid rods	4/5 good-excellent results	1 required subsequent loose body removal
2006	KSSTA	Kouzelis	10	3	18.3	4.2[f] cm^2	2.1	100 %	ORIF (mini) with Herbert screws	Radiographic evidence of union in all 3	

[a]In all studies, percent follow-up reflects all patients in the study – not just those with Type IV defects

[b]Journal of Bone and Joint Surgery – British Edition

[c]Not Reported

[d]Clinical Orthopaedics and Related Research

[e]Journal of Bone and Joint Surgery – American Edition

[f]Includes all patients in the study – not just those with Type IV defects

[g]American Journal of Sports Medicine

[h]Knee Surgery, Sports, Traumatology, and Arthroscopy