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Long term results of operative treatment of knee osteochondritis dissecans

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Langzeitergebnisse der operativen Behandlung der Osteochondritis dissecans am Kniegelenk

Zusammenfassung

Ziel der Studie Diese retrospektive Studie soll die Hypothese prüfen, ob die open reduction internal fixation (ORIF) einer instabilen Osteochondritis dissecans (OCD) Läsion akzeptable Langzeitergebnisse liefert.

Methodik Es wurden acht Patienten, bei denen eine ORIF wegen einer instabilen Knie-OCD-Läsion durchgeführt worden war, in die Studie aufgenommen. Die Langzeitergebnisse wurden mittels eines subjektiven Fragebogens sowie mittels eines Knie-Untersuchungsformblatts des internationalen Komitees zur Knie-Dokumentation (IKDC 2000) und mittels einer OCD spezifischen Hughston Bewertungsskala erhoben.

Ergebnisse Nach 3 Monaten waren alle Läsionen verheilt und arthroskopisch stabil. Bei einer im Durchschnitt 14,8 Jahre (12–21 Jahre) nach der Operation durchgeführten Kontrolle lagen die mittleren IKDC Scores bei 80,9. Bei der IKDC Untersuchung erreichten sechs Patienten die Gruppe A (= normal), zwei Patienten die Gruppe B (fast normal) beziehungsweise die Gruppe C (abnormal). Nach den Hughston Kriterien waren drei Patienten ausgezeichnet, drei gut, eins mittel und eins schlecht.

Schlussfolgerungen Wir empfehlen aggressive Versuche, den Gelenksknorpel bei OCD zu erhalten.

Schlüsselwörter: Ostechondritis dissecans, Knie, ORIF, Heilung, Funktionelles Ergebnis

Summary

Purpose This retrospective study was designed to evaluate the hypothesis that open reduction internal fixation (ORIF) of an unstable osteochondritis dissecans (OCD) lesion results in a high percentage of acceptable outcomes at long-term follow-up.

Methods Eight patients who had been treated with ORIF for unstable knee OCD lesions were identified. Long-term outcomes were assessed with a Subjective Knee Evaluation Form and Knee Examination Form of the International Knee Documentation Committee (IKDC 2000) and an OCD specific Hughston rating scale.

Results All lesions were healed and stable to arthroscopic probing at 3 months. At the average follow-up of 14.8 years (range 12–21 years), the mean IKDC subjective score was 80.9. In IKDC examination form, six patients reached group A (normal) and two patients reached groups B (near normal) and C (abnormal), respectively. According to Hughston criteria, three patients were rated excellent, three good, one fair, and one poor.

Conclusions We recommend aggressive attempts to preserve articular cartilage in OCD.

Keywords: Ostechondritis dissecans, Knee, ORIF, Healing, Functional outcome

Introduction

Osteochondritis dissecans (OCD) is a condition that most commonly affects juveniles and young adults. It is an acquired, potentially reversible idiopathic subchondral lesion with typical location on the lateral aspect of the medial femoral condyle.

The etiology is controversial. Many explanations have been proposed. The potential role of inflammation was postulated by König [1]. Other possible causes include ossification abnormality [2], ischemia [3], genetic pre-

Level of evidence Therapeutic Study Level IV (Case series)

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disposition [4], and repetitive trauma [5, 6]. Fairbanks [7] proposed that OCD is a consequence of "violent rotation inwards of the tibia, driving the tibial spine against the inner condyle". Repetitive trauma may thus lead to stress fracture within the underlying subchondral bone. If repetitive loading persists and exceeds the ability of the subchondral bone to heal, necrosis of the fragment may occur and lead to fragment dissection and separation.

Depending on distal femoral physeal maturity, ODC is divided into juvenile and adult form. The majority of cases of adult OCD are thought to be the result of a persistent juvenile OCD lesion, although de novo adult OCD lesions have been described [8]. Juvenile OCD has a more promising prognosis in comparison to the adult OCD. However, in case that either do not heal, there is a potential for sequelae, including premature degenerative joint disease [9].

The OCD lesions have been classified into four stages based on the arthroscopic appearance [10]. Stage I defects are stable to probing, stage II lesions show early signs of separation with intact cartilage, stage III lesions are partially detached, and stage IV lesions are characterized by craters and presence of loose bodies. These loose bodies consist of articular cartilage with or without attached subchondral bone.

Treatment of OCD lesions is still controversial. Nonoperative initial management (avoding sports, no weight bearing) is proposed for stable lesions in skeletally immature patients [8, 11]. Healing rates of nonoperative management fall between 50 and 94 % [11]. Higher healing rates are associated with skeletal immaturity, small lesion size, and lesion location on the medial femoral condyle [3, 6, 8]. Operative treatment is indicated for any detached or unstable lesions (determined by MRI or arthroscopy) in patients whose physeal closure is imminent or completed and nonoperative management has failed [8]. Operative management of unstable lesions that remain in the defect (stage II or III) requires operative fixation, often in conjunction with drilling and/or bone grafting [12]. There are several treatment options in case of a loose body (grade IV): excision, osteochondral autologous transplantation, and reattachment of the loose body back into the defect. Poor results have been reported in case of excision [5, 13]. Many authors support fixation of loose bodies in OCD despite the fact that long-term results of these procedures are not known. In the present study we present a case series of OCD patients treated with operative fragment fixation with long-term follow-up.

Patients and methods

Our study included eight patients who underwent operative treatment of OCD lesions between December 1988 and February 1997. Lesion size was calculated by measuring the maximal lesion dimensions on the AP and lateral radiographs (Fig. 1a, b) [14]. Since most OCD lesions have an oval shape, a formula for the area of an ellipse was used (lesion size = maximal AP dimension × maximal

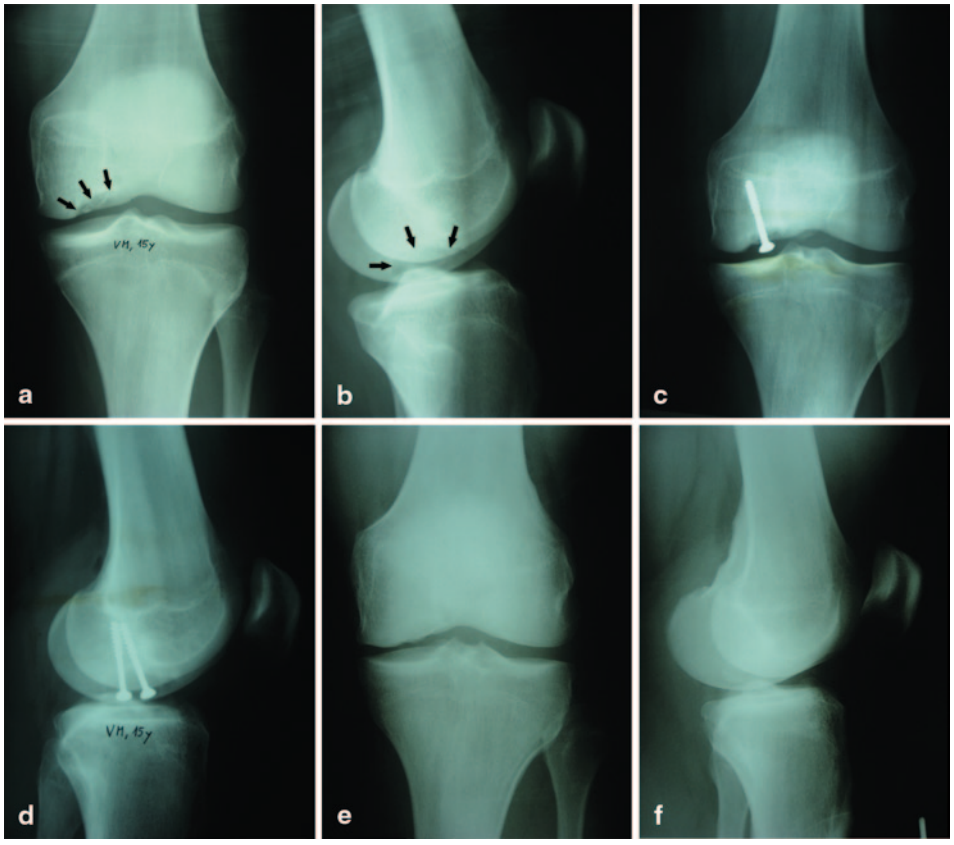

Fig. 1 Radiographs of a patient with grade IV OCD lesion presented at 15 years of age. **a** Anteroposterior view showing a crater of medial femoral condyle with a loose body. **b** A large defect can be seen on the lateral view. **c** and **d** The fragment was securely fixed in the crater with two lag screws. **e** and **f** Excellent bone restoration at 16-years follow-up

Table 1. Hughston rating criteria

Rating	Criteria
Excellent	No limitation to activity, no symptoms, examination and radiographs normal
Good	Mild aching with strenuous activity, examination normal, healed defect or sclerosis
Fair	Mild aching and swelling with strenuous activity, examination normal, flattened condyle
Poor	Pain with mild activity, tenderness, $<20°$ motion loss, <2.5 cm thigh atrophy, narrowed joint space
Failure	Pain and swelling with no activity, tenderness, $>20°$ motion loss, >2.5 cm thigh atrophy, absent joint space

lateral dimension $\times \pi/4$). Arthroscopic procedure was undertaken in order to confirm lesion size and determine stability. In every case the lesion was found on the medial femoral condyle and was unstable on probing. All lesions were stage III or IV according to arthroscopic classification. Open operative procedure followed and included limited medial arthrotomy, crater curetting to the bleeding bone and drilling of the sclerotic base with a Kirschner wire. Detached osteochondral part was appropriately positioned and internally fixed (ORIF) into the defect with one or two AO/ASIF small-fragment metallic lag screws. Postoperatively, continuous passive motion and quadriceps strengthening exercises were started on the day of surgery. Patients were put on crutches and no weight bearing was allowed. Radiographs were taken at 6 weeks and 3 months when signs of bone healing were usually present. At 3 months, arthroscopy was performed on an outpatient basis, repair and stability of the lesion was assessed, and screws were removed. Weight bearing as tolerated, active range of motion, and quad-strengthening exercises were encouraged for the first 2 weeks. Full weight bearing was allowed for the next 10 weeks and full sports activity thereafter.

The IKDC 2000 score (International Knee Documentation Committee) [15] was determined for each patient who underwent medical examination after written consent. Two parts of IKDC 2000 questionnaire were included and scores calculated. Firstly, the IKDC 2000 Subjective Knee Evaluation form was completed by the patient. Maximum score was defined as 100 points. Secondly, IKDC 2000 Knee Examination form was completed by a physician not involved in the treatment. According to the score in the examination form, patients were divided into four groups (A—normal, B—near normal, C—abnormal, D—very abnormal). An OCD specific Hughston form was also completed [6]. This form organizes patients into five groups (excellent, good, fair, poor, failure) according to the patients' subjective symptoms and objective signs (Table 1).

Standard statistical techniques were used to determine means and ranges. A nonparametric measure of correlation (Spearman's coefficient) was used to relate the lesion size to IKDC subjective score, IKDC objective score, Hughston score and patient's age at the time of operation. All data analysis was performed using the software package SPSS (version 15, SPSS Inc., USA). A probability of $p<0.05$ was regarded as significant.

Results

Average age at the time of surgery was 15.3 years (range 12–23 years). Six of the patients were males (75 %) and two females (25 %). Average lesion size was 4.3 cm^2, ranging from 2.54 cm^2 to 5.96 cm^2. Average follow-up was 14.8 years (range 12–21 years). Only one patient reached physeal closure at the time of the procedure and we were not able to find out if the lesion in this patient was de novo case or he had already developed it in his childhood. Figure 1 shows a series of preoperative, postoperative, and follow-up X-rays in a patient with a typical grade IV OCD lesion that was treated with two screws.

The results of treatment are summarized in the Table 2. At second look, the arthroscopy hardware was removed and healing assessed. All lesions were noted to be healed and stable to probing. None of the patients required subsequent surgery for a loose body. All eight patients completed IKDC subjective evaluation form

Table 2. Patient data and results at follow-up

Gender	Age at surgery (years)	Skeletal maturity	Lesion stage	Number of screws	Lesion size—AP (mm)	Lesion size—LP (mm)	Lesion size (mm2)	Findings at second look arthroscopy	Follow-up (years)	IKDC—subjective form (score)	IKDC—examination form (group)	Hughston score
Male	23	Mature	IV	2	23	33	596	Healed	17	57	C	Fair
Male	12	Immature	III	1	16	22	276	Healed	21	100	A	Excellent
Female	15	Immature	III	1	20	29	455	Healed	15	49	B	Poor
Male	16	Immature	IV	2	21	24	396	Healed	12	98	A	Excellent
Male	12	Immature	III	1	16	25	314	Healed	12	100	A	Excellent
Male	15	Immature	III	1	23	29	524	Healed	12	72	A	Good
Male	15	Immature	IV	2	26	30	612	Healed	16	97.7	A	Good
Female	14	Immature	III	1	18	18	254	Healed	13	73.6	A	Good

AP anteroposterior, *LP* lateral, *IKDC* International Knee Documentation Committee

and the mean score was 80.9 (range 49–100). In completed IKDC examination form, six patients reached group A. The remaining two patients reached groups B and C, respectively. According to Hughston criteria, three patients were rated excellent, three good, one fair, and one poor. In summary, six (75 %) of the patients gained a successful result (IKDC group A and good-to-excellent Hughston score).

There was no statistically significant correlation between the lesion size and the IKDC subjective score ($p=0.243$). Similarly, there was no correlation between the lesion size and objective measurements (IKDC objective score, $p=0.319$; Hughston score, $p=0.206$). Additionally, patients' age did not correlate with any of the outcome measurements (IKDC subjective score, $p=0.112$; IKDC objective score, $p=0.145$; Hughston score, $p=0.217$).

Discussion

There are several surgical approaches to treat patients with OCD: excision of the loose body (with or without drilling of the base of the crater), osteochondral autologous transplantation and operative fixation (ORIF) of the loose body in the defect.

Short-term results of some authors support excision of the loose body and optional drilling [6]. Ewing and Voto [16] treated 29 patients and reported satisfactory results in 72 % of patients at 1-year follow-up. Based on this early data, many surgeons applied this simple technique. However, the results were different in studies with long-term follow-up. For example, Anderson and Pagnani [13] included 19 patients with a 9-year follow-up. They reported successful healing in only 25 % of patients. Similarly, Wright et al. [17] noted only 35 % patients had successful results according to Hughston criteria. The study included 30 patients with 8.9-year follow up. Other authors have also reported poor results with long-term follow-up [5]. Poor long-term results could be explained with formation of fibrocartilage instead of a true hyaline cartilage in the place of the defect. Denoncourt et al. [18] demonstrated the presence of fibrocartilage in the defect. Thus the degenerative process is more likely to proceed at a faster rate.

Osteochondral autograft transplantation is another viable cartilage repair technique. Gudas et al. [19] conducted a prospective, randomized study comparing osteochondral autograft transplantation (mosaic type) to microfracturing of grade III and IV OCD lesions in 47 children under the age of 18 years. Even though significant short- and mid-term clinical improvements observed in both groups, the mid-term (mean 4.2 years) results were superior in the osteochondral autologous transplantation group. Authors also reported significantly worse clinical results in patients with lesion larger than 3 cm^2 if they were treated with microfracturing.

Autologous chondrocyte implantation is also a newer technique that could be used in the treatment of OCD, especially if the lesion is unsalvageable. Unfortunately, there are no studies that would report the results of this treatment in the skeletally immature patients.

However, many authors advocated treatment of OCD lesion performing ORIF of the loose body into the defect [20–22]. Those studies include at least one patient with grade IV defect. The reported results were generally good.

Johnson et al. [23] repaired the OCD lesion by arthroscopic compression screw fixation in 32 patients and at the second surgery—2 months after the initial surgery, when metallic screws had to be removed—94 % of the knees were determined to be initially healed. Later on, 6 % of them needed repeated surgery because these apparently successful repairs subsequently loosened. However, after a 2-year minimum follow-up, 88 % of repairs were still determined to be healed successfully [23]. All fragments in our series were successfully healed in the follow-up period. Similarly, Makino et al. [24] used compression screw fixation to treat 15 knees and after a 4.2 year mean follow-up, 13 knees showed a successful result. The mean age of the patients was 20 years (range from 12 to 35 years) and the case series included grade I, II, and III defects. Single screw was used in all cases except in three patients, where two screws were used for fragment fixation. We believe that two screws provide a rotationally more stable fixation so two screws were used in our patients with grade IV lesions. No technical problems appeared at the second surgery when the hardware was removed arthroscopically. To go one step further, Tabaddor et al. [25] used bioabsorbable fixation and 22 out of 24 patients had a successful result after a 3.3-year mean follow-up. The mean age was 14.4 years and the study included unstable lesions only. Using bioabsorbable fixation of the fragment certainly has an advantage over metallic fixation since the second surgery can be avoided. However, at the time when patients in our series were treated, no reliable bioabsorbable screws were available. To summarize, all these studies reporting outcomes after ORIF of OCD fragment are limited by their short-term follow-up (5 years or less). Apart from these, there was one case series with 12 patients and a 9-year follow-up [26]. It included grade IV defects only. The results were in favor of operative fixation. However, two patients (17 %) were lost at the long-term follow-up and the results were based on patient-reported outcomes only. No imaging was obtained to verify the position of the repaired loose body on the long term.

Although our study presents a small case series with only eight patients, the follow-up period is amongst the longest reported (14.8 years). Besides, a thorough evaluation—including patient report—the physician examination and radiograph image evaluation was performed in all patients with no dropout.

According to our data, short-term arthroscopic evaluation showed healed defect in all cases. Long-term evaluation using the IKDC 2000 and Hughston forms as validated clinical tools showed excellent results as well. The group A which corresponds to completely normal knee function was reached by 75 % of patients. Only

one patient's knee was regarded as abnormal (group C). Similarly, 75 % of patients were assessed as excellent or good according to the Hughston rating criteria. According to this assessment, our treatment could be regarded as successful.

However, this study is certainly not without limitations. The number of patients is small, there is no control group, and no comparison to a different treatment method. Additionally, clinical evaluation tools in this study were used for the postoperative setting only. Namely, IKDC form was not developed by the time our patients were treated for OCD lesion, and the Hughston rating criteria were designed as a follow-up evaluation tool. The fact that we have not used magnetic resonance imaging which would, admittedly, offer additional information to assess the healing of the fragment, could be regarded as another drawback of our study.

Finally, we could not demonstrate any correlation between the lesion size and the patients' age with either subjective or objective clinical outcomes. A larger randomized clinical trial would be needed to find out more about the eventual correlations, although, in our opinion, the conduction of such a trial might be unethical.

In conclusion, our data show that restoring joint congruency with OCD fragment preservation and stabilization yields good long-term functional and radiographic results.

Disclosure
No funds were received in support of this study.

Conflict of interest
The authors declare that there is no conflict of interest.

References

1. König F. Über freie Körper in den Gelenken. Dtsch Z Chir. 1887;27:90–109.
2. Milgram JW. Radiological and pathological manifestations of osteochondritis dissecans of the distal femur: a study of 50 cases. Radiology. 1978;126:305–11.
3. Green WT, Banks HH. Osteochondritis dissecans in children. J Bone Joint Surg Am. 1953;35:26–47.
4. Mubarak SJ, Carroll NC. Familial osteochondritis dissecans of the knee. Clin Orthop Relat Res. 1979;140:131–6.
5. Aichroth P. Osteochondritis dissecans of the knee. J Bone Joint Surg Br. 1971;53:440–7.
6. Hughston JC, Hergenroeder PT, Courtenay BG. Osteochondritis dissecans of the femoral condyles. J Bone Joint Surg Am. 1984;66:1340–8.
7. Fairbanks HAT. Osteochondritis dissecans. Br J Surg. 1933;21:67–82.
8. Cahill BR. Osteochondritis dissecans of the knee: treatment of juvenile and adult forms. J Am Acad Orthop Surg. 1995;3:237–47.
9. Twyman R, Kailish D, Aichroth P. Osteochondritis of the knee: a long-term study. J Bone Joint Surg Br. 1991;73:461–4.
10. Guhl JF. Arthroscopic treatment of osteochondritis dissecans. Clin Orthop Relat Res. 1982;167:65–74.
11. 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. 1989;17:601–6.
12. Crawford DC, Safran MR. Osteochondritis dissecans of the knee. J Am Acad Orthop Surg. 2006;14:90–100.
13. Anderson AF, Pagnani MJ. Osteochondritis dissecans of the femoral condyles: long-term results of excision of the fragment. Am J Sports Med. 1997;25:830–4.
14. Paletta GA, Bednarz PA, Stanitski CL, Sandman GA, Stanitski DF, Kottamasu S. The prognostic value of quantitative bone scan in knee osteochondritis dissecans: A preliminary experience. Am J Sports Med. 1998;26:7–14.
15. IKDC Committee. 2000 IKDC knee forms. University of Delaware Web [Internet]. 2003 [cited 2011 Dec 26]. Available from: http://www.udel.edu/PT/PT%20Clinical%20Services/journalclub/sojc/03_04/sep03/IKDC.pdf.
16. Ewing JW, Voto SJ. Arthroscopic surgical management of osteochondritis dissecans of the knee. Arthroscopy. 1988;4:37–40.
17. Wright RW, McLean M, Matava MJ, Shively RA. Osteochondritis dissecans of the knee. Long-term results of excision of the fragment. Clin Orthop Relat Res. 2004;424:239–43.
18. Denoncourt PM, Patel D, Dimakopoulos P. Treatment of osteochondritis dissecans of the knee by arthroscopic curettage, follow-up study. Orthop Rev. 1986;15:652–7.
19. Gudas R, Simonaityte R, Čekanauskas E, Tamosiunas R. A prospective, randomized clinical study of osteochondral autologous transplantation versus microfracture for the treatment of osteochondritis dissecans in the knee joint in children. J Pediatr Orthop. 2009;29:741–8.
20. Lipscomb PR Jr, Lipscomb PR Sr, 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;60:235–40.
21. Zuniga JJR, Sagastibelza JJ, Blasco JJL, Martinez Grande M. Arthroscopic use of Herbert screw in osteochondritis dissecans of the knee. Arthroscopy. 1993;9:668–70.
22. Kouzelis A, Plessas S, 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 Arthrosc. 2006;14:70–5.
23. Johnson LL, Uitvlugt G, Austin MD, Detrisac DA, Johnson C. Osteochondritis dissecans of the knee: arthroscopic compression screw fixation. Arthroscopy. 1990;6:179–89.
24. Makino A, Muscolo DL, Puigdevall M, Costa-Paz M, Ayerza M. Arthroscopic fixation of osteochondritis dissecans of the knee: clinical, magnetic resonance imaging, and arthroscopic follow-up. Am J Sports Med. 2005;33:1499–504.
25. Tabaddor RR, Banffy MB, Andersen JS, McFeely E, Ogunwole O, Micheli LJ, et al. Fixation of juvenile osteochondritis dissecans lesions of the knee using poly 96L/4D-lactide copolymer bioabsorbable implants. J Pediatr Orthop. 2010;30:14–20.
26. Magnussen RA, Carey JL, Spindler KP. Does operative fixation of an osteochondritis dissecans loose body result in healing and long-term maintenance of knee function? Am J Sports Med. 2009;37:754–9.