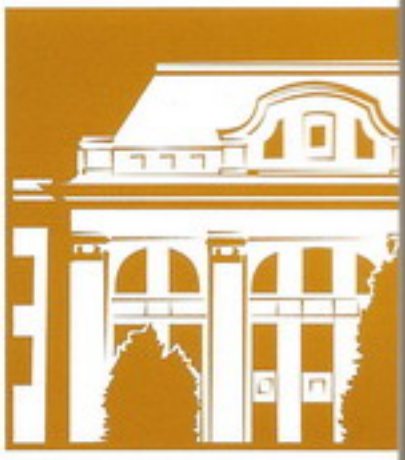
Volume 57 | Number 4 | 2011

ACTA MEDICA MARISIENSIS

OFFICIAL PUBLICATION OF THE
UNIVERSITY OF MEDICINE AND PHARMACY OF TÂRGU MUREŞ



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ISSN-L 2068-3324
ISSN 2068-3324

www.ammjournal.ro

Transchondral Drilling and Osteochondral Autografting (Mosaicplasty) in Knee Articular Cartilage Defects

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Background: The cartilage is a complex and specialized tissue. It is extremely difficult to repair or to replace it, once damaged. The management of cartilage defects remains controversial and over the last five decades various treatment options and surgical techniques have been tried to optimize the clinical outcome.

Objective: The aim of this study is to evaluate, but not to compare the results of two of the most used cartilage repair techniques: transchondral drilling and osteochondral autografting.

Material and methods: Between January 2009 and June 2010, we performed 55 transchondral drillings and 10 mosaicplasties on patients with articular cartilage defects of the knee. All patients were followed up at 6 months. Hughston clinical and radiological scales were used to evaluate the patients in the transchondral drilling group.

Results: The Hughston Clinic score was 2 in 2 cases (3.6%), 3 in 5 cases (9.9%) and 4 in 48 cases (86.5%), giving over 95% of good results. The Hughston radiological score was 2 in one case (2%), 3 in 4 cases (7.3%) and 4 in 50 cases (90.7%). In the mosaicplasty group,the average area of the osteochondral lesion covered with autologous osteochondral transplantation ranged from 0.8 to 6 cm^2 (average: 2.13 cm^2). The diameter of the grafts used ranged from 6 to 10 mm and 1 to 6 grafts were used in each case to achieve >90% covering of the lesion area.

Conclusions: Both techniques offer satisfactory functional outcome and do not compromise the patients' future options.

Keywords: transchondral drilling, osteochondral autografting, mosaicplasty, articular cartilage

Introduction

The cartilage is a complex and specialized tissue. It is extremely difficult to repair or to replace it, once damaged. The repair tissue found in the cartilage defects is fibrocartilage, which is mechanically and chemically inferior to hyaline cartilage [1]. The management of cartilage defects remains controversial and over the last five decades various treatment options and surgical techniques have been tried to optimize the clinical outcome.

In a review of 993 knee arthroscopies in patients with a mean age of 35 years, there was an 11% incidence of full-thickness lesions that could have benefited from surgical treatment [2]. In a larger and more generalized study, Curl et al. reviewed 31,516 knee arthroscopies of patients in all age groups and reported chondral lesions in 19,827 (63%) of patients; 5% of all cases were found in patients younger than 40 years of age who had grade IV lesions [3]. A review of 1,000 arthroscopies by Hjelle et al reported chondral or osteochondral lesions of any type in 610 patients (61%), out of which 190 patients had focal lesions (19% of all cases). Many of these lesions were clinically silent at the time of detection [4].

Keeping in mind that those procedures are relatively new, we presented the author's and the Orthopedic Clinic's experience in using these techniques. The aim of this study is to evaluate, but not compare, the results of two of the most used cartilage repair techniques: transchondral drilling and osteochondral autografting.

Material and methods

Between January 2009 and June 2010, we performed 55 transchondral drillings and 10 mosaicplasties on patients with articular cartilage defects of the knee. The study is a prospective longitudinal one, with 6 months patient follow-up. In the group with transchondral drilling, 39 patients (70.9 %) were male. In the group with mosaicplasty, 8 patients were male and 2 female. The medial condyle was affected in 58 cases (89.23%).

The mean age for the group with transchondral drilling was 42.55±9.32 years, the patients being between 19 and 49 years old. For the group with mosaicplasty, the mean age was 44.23±6.87 years, the patients being between 39 and 51 years old.

In all patients we performed a conventional radiography (anteroposterior and lateral views). In 8 patients, 6 from the transchondral drilling group (10.9%) and 2 patients from the mosaicplasty group we performed a CT scan. Magnetic resonance imaging was performed in 13 patients from the transchondral drilling group (23.6%) and 4 patients from the mosaicplasty group.

The performed procedure was chosen based on patient age, physical activity and lesion size.

Table I. Hughston clinical scale

Excellent	4	Normal sports activity No symptoms Normal physical examination
Good	3	Normal sports activity Knee pain with intense activities Normal physical examination
Average	2	Normal sports activity Knee pain and swelling with intense activities Normal physical examination
Bad	1	Knee pain and swelling with moderate activities Flexum less than 20°
Failure	0	Restriction of sports Knee pain and swelling with daily activities Flexum more than 20°

Table II. Hughston radiological scale

4	Normal
3	Defect or sclerosis
2	Flattening of the condyle
1	Irregular condyle with narrowing of the joint space less than 50%
0	Knee arthritis with narrowing of the joint more than 50%

The opportunity of surgical intervention was raised when the patient showed no improvement after the conservative treatment. All patients were followed-up at 6 months. Hughston clinical and radiological scales were used to evaluate the patients in the transchondral drilling group (Tables I and II).

Surgical technique

1 - 91%

Transchondral drilling. This technique was carried out with arthroscopy. After a conventional installation for knee arthroscopy, the diseased area is identified. This identification is made on the gross appearance of articular cartilage, gray or yellowish, with a frosted consistency, and abnormal to palpation due to its softening.

Multiple perforations (5–10) using a fine 1.2–1.5-mm diameter K-wire are made through the articular cartilage, opposite to the lesion of the subchondral bone and passing beyond the zone of sclerosis that circumscribes the lesion. After the drilling, one must observe bleeding from the healthy underlying bone through the puncture holes [5]. Postoperatively, non-weight-bearing for 1 month using two crutches with free mobilization of the knee has been proposed, with the discontinuation of sports activities. Follow-up involves clinical and radiographic monitoring. The resumption of sports activities was allowed 6 months after surgery.

Mosaicplasty. Autologous osteochondral transplantation was carried out with the OATS technique (Osteochondral Autograft Transplantation System, Arthrex, Naples, USA), which allows for press-fit graft implantation. We used the miniopen technique. Grafts were harvested from the lateral or medial edge of the trochlea. The depth of the donor osteochondral plug ranged from 12 to 15 mm and the recipient site was drilled to such a depth so as to compensate for any potential subchondral bone loss and at the same time allow for some bone impaction. Care was taken to achieve perpendicular graft insertion, deliver the graft flush with the joint surface and reproduce the joint curvature as close to anatomical as possible. A drain was inserted in the joint for 24 hours and patients were encouraged to start passive mobilization of their knee as soon as pain allowed. Touch-toe weight bearing was advocated for 4–6 weeks and patients gradually progressed to full weight bearing thereafter.

1 - 91%

For patients with a second look, condrocyte survival was evaluated by imunohistochemistry. We used CD31 and CD34 as markers, to assess the angiogenesis.

2 - 74%

Results

In the transchondral drilling group, we encountered no perioperative complications. The Hughston Clinic score was 2 in 2 cases (3.6%), 3 in 5 cases (9.9%) and 4 in 48 cases (86.5%), giving over 95% of good results. The Hughston radiological score was 2 in one case (2%), 3 in 4 cases (7.3%) and 4 in 50 cases (90.7%). We found a significant correlation between the clinical and radiological Hughston score ($p < 0.001$, $r = 0.96$). All the patients were able to resume their regular duties and life style.

In the mosaicplasty group,the average area of the osteochondral lesion covered with autologous osteochondral transplantation ranged from 0.8 to 6 cm^2 (average: 2.13 cm^2). The diameter of the grafts used ranged from 6 to 10 mm and 1 to 6 grafts were used in each case to achieve >90% covering of the lesion area. Two patients had a second look arthroscopy for ongoing swelling, pain or clicking 6 months following their initial procedure. Arthroscopic assessment was combined with arthrolysis in one case. The grafts were found to be stable, well incorporated and with satisfactory chondrocyte survival in all cases. In both patients, symptoms improved significantly. No donor-site related morbidity was recorded. One patient had a superficial wound infection that was successfully managed with oral antibiotics and one had a deep vein thrombosis and was successfully treated.

Discussions

3 - 99.5%

All patients in our series have maintained a conservative treatment by restriction of sports activities for an average of 6 months, and the use of surgical treatment was offered to one of the following criteria: instability or fragments sequestration, persistence of symptoms in a compliant patient, and the imminent closure of the physis. These indications were similar to those found in the literature [6]. For many authors, multiple transchondral drilling was the preferred treatment of juvenile osteochondritis condylar after failure of conservative treatment. Cepero et al. [6] showed excellent and good clinical and radiological results in 98% of patients operated on for arthroscopic drilling. Other study showed a normalization of radiological images in 87.5% of patients treated by drilling and all patients were clinically asymptomatic at 4 years of decline [7]. In our

series, all patients were operated by multiple arthroscopic transchondral drilling with good clinical and radiological results in over 95% of cases.

Osteochondral defects spontaneously heal with fibrocartilage and treatment options such as abrasion arthroplasty, also promote the formation of fibrocartilaginous tissue, whose load-bearing properties and histological characteristics are significantly inferior to those of normal hyaline cartilage [8–10]. In weight-bearing areas of the knee, this can cause impairment of smooth load transmission, leading to point loading and thus predisposing to development of osteoarthritis. Osteochondral transplantation and autologous chondrocyte implantation that can provide hyaline cartilage covering of the articular surface defect. Autologous chondrocyte implantation leads to covering of the defect with predominantly hyaline or hyaline-like cartilage [11], although this has been challenged by recent reports [12]. A number of authors have reported a high rate of symptom relief and functional improvement, as well as very satisfactory survival of the transplanted hyaline cartilage [13–22]. This method, though, has certain limitations, namely, increased donor site morbidity and a less favorable outcome when used for relatively large defects (>2×2 cm) [22, 23].

Conclusions

All patients from the group with transchondral drilling had good postoperative clinical and radiological outcomes, therefore confirming the validity and effectiveness of multiple transchondral drilling in the treatment of articular cartilage of the knee.

Patients from the mosaicplasty group also had a favorable evolution; both techniques offer satisfactory functional outcome and do not compromise the patients' future options.

Acknowledgement

This paper is partly supported by the Sectorial Operational Programme Human Resources Development (SOP HRD), financed from the European Social Fund and by the Romanian Government under the contract number POSDRU/6/1.5/S/17.

References

1. Kheir E, Shaw D – Management of articular cartilage defects. Orthopaedics and Trauma 2009, 23(4): 266–273
2. Aroen A, Loken S, Heir S, et al – Articular cartilage lesions in 993 consecutive knee arthroscopies. Am J Sports Med 2004, 32(1): 211–215
3. Curl WW, Krome J, Gordon ES, Rushing J, Smith BP, Poehling GG – Cartilage injuries: a review of 31,516 knee arthroscopies. Arthroscopy 1997; 13(4): 456–460
4. Hjelle K, Solheim E, Strand T, Muri R, Brittberg M. – Articular cartilage defects in 1,000 knee arthroscopies. Arthroscopy 2002, 18(7): 730–734.
5. Lefort G, Moyen B, Beaufils P, De Billy B, Breda R, Cadilhac C et al – L'osteochondrite disséquante des condyles fémoraux: analyse de 892 cas. Chir Orthop Traumatol 2006, 92(5):97–141
6. Cepero S, Ullot R, Sastre S – Osteochondritis of the femoral condyles in children and adolescents: our experience over the last 28 years. J Pediatr Orthop B 2005, 14:24–29
7. Aglietti P, Buzzi R, Bassi PB, Fioriti M – Arthroscopic drilling in juvenile osteochondritis dissecans of the medial femoral condyle. Arthroscopy 1994, 10:286–291
8. Bobic V, Noble J – Articular cartilageTo repair or not to repair? J Bone Joint Surg Br 2000, 82-B:165–6
9. Alleyne KR, Galloway MT – Management of osteochondral injuries of the knee. Clin Sports Med 2001, 20(2):343–64
10. Cain EL, Clancy WG – Treatment algorithm for osteochondral injuries of the knee. Clin Sports Med 2001, 20(2):321–42.
11. Bentley G, Biant LC, Carrington RWJ, Akmal M, Goldberg A, Williams AM, et al – A prospective randomised comparison of autologous chondrocyte implantation versus mosaicplasty for osteochondral defects in the knee. J Bone Joint Surg Br 2003, 85-B: 223–30
12. Horas U, Pelinkovic D, Herr G, Aigner T, Schnettler R – Autologous chondrocyte implantation and osteochondral cylinder transplantation in cartilage repair of the knee joint. A prospective comparative trial. J Bone Joint Surg Am 2003, 85-A: 185–92
13. Jacob RP, Franz T, Gautier E, Mainil-Varlet P – Autologous osteochondral grafting in the knee: indication, results and reflections. Clin Orthop 2002, 401: 170–84
14. Hangody L, Feczko P, Bartha L, Bodo G, Kish G – Mosaicplasty for the treatment of articular defects of the knee and ankle. Clin Orthop 2001, 391S: S328–36
15. 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(I): 25–32
16. Hangody L, Kish G, Karpati Z, Szerb I, Udvarhelyi I – Arthoscopic autogenous osteochondral mosaicplasty for the treatment of femoral condylar articular defects. A preliminary study. Knee Surg Sports Traumatol Arthrosc 1997, 5: 262–267
17. Hangody L, Kish G, Karpati Z, Udvarhelyi I, Szigeti I, Bely M – Mosaicplasty for the treatment of articular cartilage defects: application in clinical practice. Orthopedics 1998, 21(7): 751–756
18. Hangody L, Rathonyi GK, Duska Z, Vasarhelyi G, Fules P, Modis L – Autologous osteochondral mosaicplasty. Surgical technique. J Bone Joint Surg Am 2004, 86-A(I): 65–72
19. Marcacci M, Kon E, Zaffagnini S, Visani A – Use of autologous grafts for reconstruction of osteochondral defects of the knee. Orthopedics 1999, 22(6): 595–600
20. Morelli M, Nagomori J, Miniachi A. Management of chondral injuries of the knee by osteochondral autogenous transfer (mosaicplasty) – J Knee Surg 2002, 15(3): 185–90
21. Menche DS, Vangsness CT Jr, Pitman M, Gross AE, Peterson L – The treatment of isolated articular cartilage lesions in the young individual. Instr Course Lect 1998, 47: 505–15
22. Barber FA, Chow JCY – Arthroscopic osteochondral transplantation. Arthroscopy 2001, 17(8): 832–5
23. Agneskirchner JD, Brucker P, Burkart A, Imhoff AB – Large osteochondral defects of the femoral condyle: press-fit transplantation of the posterior femoral condyle (MEGA-OATS). Knee Surg Sports Traumatol Arthrosc 2002, 10(3): 160–8.
24. Laprell H, Petersen W – Autologous osteochondral transplantation using diamond bone-cutting system (DBCS): 6-12 years' follow-up of 35 patients with osteochondral defects at the knee joint. Arch Orthop Trauma Surg 2001, 121: 248–53.

J Child Orthop (2010) 4:39–44
DOI 10.1007/s11832-009-0225-2

ORIGINAL CLINICAL ARTICLE

Juvenile osteochondritis of femoral condyles: treatment with transchondral drilling. Analysis of 40 cases

Rammal Hayan · Gicquel Phillipe · Schneider Ludovic · Karger Claude · Clavert Jean-Michel

Received: 6 October 2009 / Accepted: 24 November 2009 / Published online: 18 December 2009

Abstract
Introduction Osteochondritis dissecans (OCD) of the femoral condyle is a rare lesion.
Materials and methods A retrospective study (level IV evidence) analyzing a series of 40 pediatric cases with juvenile femoral condyles osteochondritis treated by arthroscopic multiple transchondral drilling between February 1999 and June 2008 was undertaken. This lesion affected the medial condyle in 87.5% of cases. The average age at treatment was 13.4 years. Our study took into account the location of the lesion and its radiological evolutionary stage. The average follow up was 14.8 months. The postoperative evaluation was based on the clinical and radiological scores of Hughston.
Results Good clinical and radiological results in 97.5 and 95% of cases,respectively were obtained, with a significant correlation ($P < 0.001$) between clinical scores and radiological Hughston scores. The closed nature of the growth plate during surgery has a significant deleterious effect ($P < 0.001$) on the clinical and radiological score of Hughston.
Conclusion All patients presenting juvenile condylar osteochondritis with open growth plate during treatment had good clinical and radiological results, confirming the validity and effectiveness of multiple transchondral drilling in this type of lesion.

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Keywords Juvenile osteochondritis dissecans · Femoral condyles · Arthroscopic transchondral drilling

Introduction

Osteochondritis dissecans (OCD), a term introduced by König in 1887 [1], is a rare lesion that affects the articular cartilage and the epiphyseal bone and may result in lack of consolidation to the separation of osteochondral fragment [2–6].

Most cases of OCD (75%) are present at the knees and three-quarters of those occur in the medial femoral condyle [7].

The pathophysiology of this disease is still mysterious and several etiological hypotheses have been discussed [8–10]: repetitive microtrauma, ischemia, lack of ossification, genetic cause, etc.

Treatment is variable and depends on both the lesion itself (stable or unstable) and the patient (closure or non-closure of the growth plate) [2, 7, 8].

The objective of this study is to evaluate the results in the medium and long term of femoral condyles OCD in children and adolescents carried out by arthroscopic multiple transchondral drilling.

Materials and methods

Between February 1999 and June 2008, 39 patients with juvenile osteochondritis of femoral condyles (accounting for 40 cases) were treated by arthroscopic transchondral drilling. Among the patients, 28 (71.8%) were male. The medial condyle was affected in 87.5% of cases, with involvement of the right knee in 14 cases, the left knee in

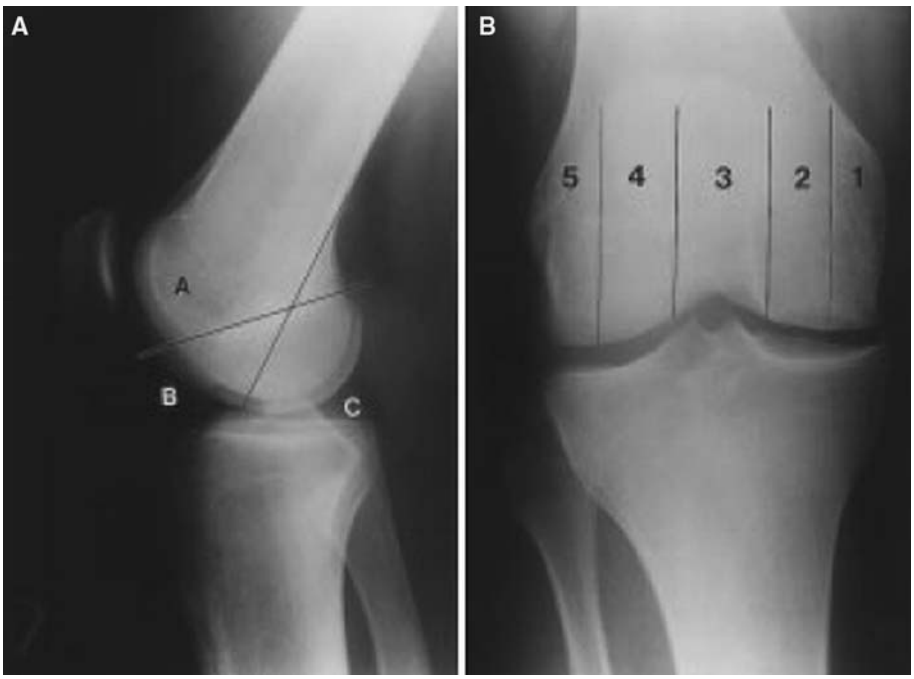

Fig. 1 **a** Harding classification to distinguish anterior, mean, and posterior lesions. **b** Cahill and Berg classification for medio-lateral localization of the lesions

22 cases, and two cases of bilateral OCD. One patient had a unilateral bicondylar OCD. Among the five cases of OCD of the lateral condyle, two cases (40%) were associated with discoid lateral meniscus.

The mean patient age at diagnosis of OCD was 12 years (range 8–16 years). The average age at the time of surgery was 13.4 years, with age limits of 9.75 and 16.5 years.

Clinically, all patients complained of knee pain at diagnosis and one patient had episodes of locking associated with a discoid lateral meniscus.

Initially, all patients received conservative treatment by restriction of sports activities for an average of 6 months (range 3–12 months) without immobilization or non-weight-bearing gait.

A conventional radiography was performed in all patients (anteroposterior [AP], lateral, and skyline views). A computed tomography (CT) scan was performed in 15 cases (37.5%) and magnetic resonance imaging (MRI) in 21 patients (52.5%).

Surgical indication was raised when symptoms persisted after conservative treatment was followed appropriately

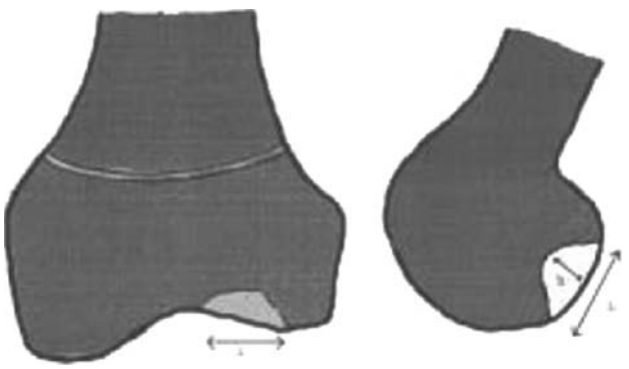

Fig. 2 Measures to calculate the lesion volume on anteroposterior (AP) and lateral views of the knee

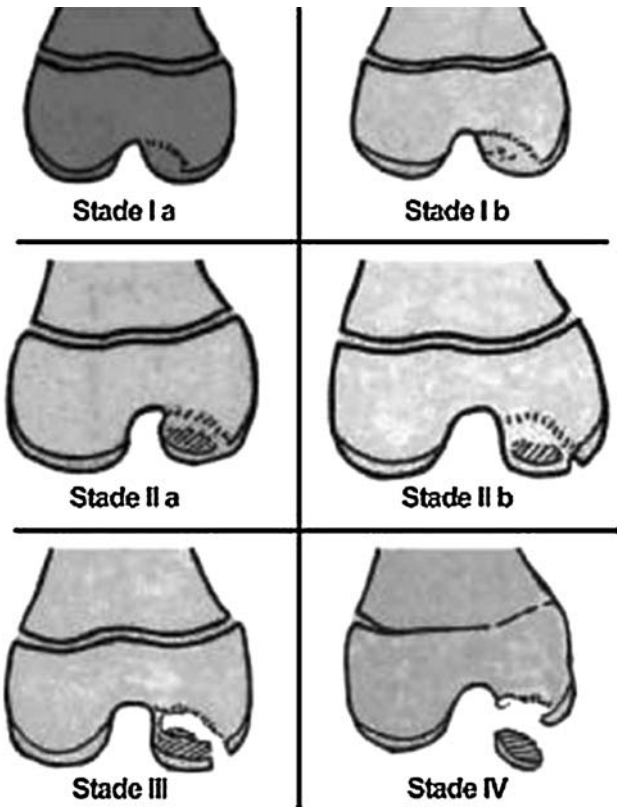

Fig. 3 Bedouelle's radiological classification

and/or when the control radiographs showed a worsening of the lesion of osteochondritis, especially when approaching the end of growth.

The location of OCD was defined according to the classifications of Harding [11] and Cahill and Berg [3, 12] on the lateral and AP views, respectively (Fig. 1).

The radiographic evaluation, as classified by Cahill and Berg, showed a predominance of type 2 lesions (87.5%) and, as classified by Harding, showed a predominance of type B lesions (85%) against 12.5% of type C. One case had a lesion extended to areas B and C of the femoral condyle.

The volume of OCD lesions was measured on AP and lateral views (Fig. 2).

The mean volume of the lesions was 1,835.4 mm^3 (204–6,750 mm^3).

Fig. 4 **a**, **b** A patient with Cahill type 2, Harding type B, and Bedouelle grade IIb osteochondritis dissecans (OCD). **c**, **d** The same patient 19 months after a transchondral drilling with a Hughston radiological score of 4

Table 1 Hughston clinical scale

Excellent	4	Normal sports activity No symptoms Normal physical examination
Good	3	Normal sports activity Knee pain with intense activities Normal physical examination
Average	2	Normal sports activity Knee pain and swelling with intense activities Normal physical examination
Bad	1	Knee pain and swelling with moderate activities Flexum less than 20°
Failure	0	Restriction of sports Knee pain and swelling with daily activities Flexum more than 20°

Table 2 Hughston radiological scale

4	Normal
3	Defect or sclerosis
2	Flattening of the condyle
1	Irregular condyle with narrowing of the joint space less than 50%
0	Knee arthritis with narrowing of the joint more than 50%

The evolutionary stages of condylar osteochondritis were defined according to Bedouelle's classification [13] (Fig. 3).

The radiographic evaluation according to the classification of Bedouelle, at the time of surgery, noted 10% stage Ia, 15% Ib, 40% IIa, 22.5% IIb, and 12.5% III; thus, 87.5% of cases were stages I and II. The distal femoral growth plate was open at the time of surgery in 95% of cases.

The postoperative average follow up was 14.8 months (range 8–46 months).

The clinical and radiological evaluation of patients (Fig. 4) was performed by the Hughston score [14] (Tables 1 and 2).

This is a retrospective descriptive study. The statistical analysis has appealed, for quantitative variables, to non-parametric tests of Spearman, to search for correlations, analysis of variance (ANOVA) by ranks of the Kruskal–Wallis test, and for comparison between groups. For qualitative variables, according to the effectiveness, Fisher's test or the Chi test were used. The significance level chosen was 0.05.

Surgical technique

Transchondral drilling was described by Smillie in 1957 [15] and was performed, at that time, by open surgery. Currently, this technique is almost exclusively carried out with arthroscopy. So, after a conventional installation for knee arthroscopy, the diseased area is identified. This identification is made on the gross appearance of articular cartilage, gray or yellowish, with a frosted consistency, and abnormal to palpation due to its softening. In case of doubt, an intraoperative fluoroscopic tracking can help. Multiple perforations (5–10) using a fine 1.2–1.5-mm diameter K-wire are made through the articular cartilage, opposite to the lesion of the subchondral bone and passing beyond the zone of sclerosis that circumscribes the lesion. After the drilling, one must observe bleeding from the healthy underlying bone through the puncture holes [16].

Postoperatively, non-weight-bearing for 1 month using two crutches with free mobilization of the knee has been proposed. Discontinuation of sport was the rule. Follow up involves clinical and radiographic monitoring. The resumption of sports activities was allowed 6 months after surgery.

Results

No complications were encountered during the perioperative period. The Hughston Clinic score was 0 in 2.5%, 3 in 25%, and 4 in 72.5%; thus, giving 97.5% of good results (score 3 or 4). The clinical score of 0 corresponds to a skeletally mature patient.

The Hughston radiographic score was 2 in 5%, 3 in 35%, and 4 in 60%; thus, giving 95% of good results (score 3 or 4) (Fig. 5). The radiological score of 2 was found in two skeletally mature patients. A significant correlation ($P < 0.001$) was found between the radiological and clinical scores of Hughston.

The closed nature of the growth plate at the time of surgery has a significant deleterious effect ($P < 0.001$) on the clinical and radiographic scores of Hughston.

On the contrary, we have not found any influence on the results of clinical and radiological Hughston scores of the lesion's volume, its radiological stage, or its location following the Cahill and Berg or Harding classification.

Discussion

The primary goal of the treatment of osteochondritis is to promote the consolidation of the subchondral bone, the preservation of cartilage, and to prevent osteoarthritis.

The 'immature' knee, whose physis is still open, has a high potential for cure [2], therefore, conservative treatment should always be the first-line choice in stable juvenile osteochondritis, knowing that about 50% of lesions develop in a positive way in a period of 10–18 months [3, 17].

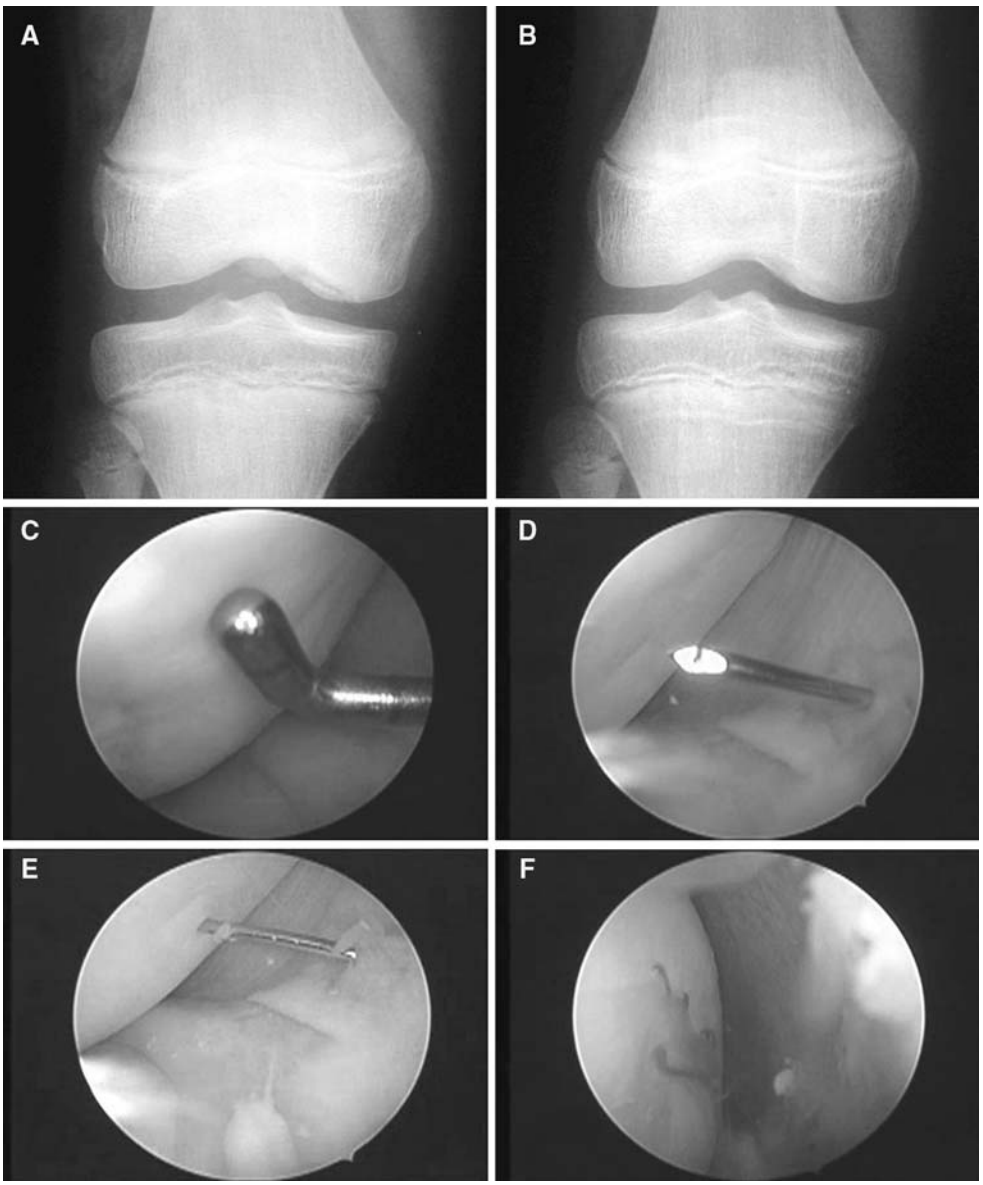

Fig. 5 **a** Grade II b Bedouelle OCD. **b** Radiograph 6 months later with a Hughston radiological score of 4. **c** Arthroscopic views for the same patient. Localization of the OCD region. **d**, **e** Transchondral drilling with a 1.2-mm K-wire. **f** Bleeding from the drilling holes

3

All patients in our series have maintained a conservative treatment by restriction of sports activities for an average of 6 months, and the use of surgical treatment was offered to one of the following criteria: instability or fragments sequestration, persistence of symptoms in a compliant patient, and the imminent closure of the physis. These indications were similar to those found in the literature [18–20].

For many authors, multiple transchondral drilling was the preferred treatment of juvenile osteochondritis condylar after failure of conservative treatment. Guhl [18] showed in their study that, among the 15 patients, aged 11–18 years, operated by multiple transchondral drilling, 13 had excellent and good results (86.7%). Cepero et al. [19] showed excellent and good clinical and radiological results in 98% of patients operated on for arthroscopic drilling. Aglietti et al. [20] showed a normalization of radiological images in 87.5% of patients treated by drilling and all patients were clinically asymptomatic at 4 years of decline. Bradley and Dandy [21] have performed this technique and noted a radiological and clinical cure in 91% of patients after 2 years of decline. Anderson et al. [2] noted good results in 90% of patients with condylar juvenile osteochondritis. Transarticular drilling was conducted by Ganley et al. [22] in 49 patients aged under 18 years. The drilling was effective in 83% of immature knees against 75% of adolescents with a closed growth plate. Kocher et al. [23] studied the functional and radiological results of this technique in 23 patients with 30 lesions of osteochondritis for a

3
mean of 3.9 years and found clinical and radiological healing in all patients. Louisia and Beaufils [24] have shown good clinical and radiological results in 70.6% of juvenile osteochondritis against 50% in adult osteochondritis.

In our series, all patients were operated by multiple arthroscopic transchondral drilling with good clinical and radiological results in 97.5 and 95% of cases, respectively. From a radiological point of view, the two patients who scored 2 on the Hughston scale were skeletally mature at the time of the surgery.

Conclusion

All patients with osteochondritis dissecans (OCD) of the femoral condyles with an open growth plate had good postoperative clinical and radiological outcomes, therefore, confirming the validity and effectiveness of multiple transchondral drilling in the treatment of juvenile OCD.

References

1. König F (1887) Ueber freie Körper in den Gelenken. Dtsch Z Chir 27:90–109
2. Anderson AF, Richards DB, Pagnani MJ, Hovis WD (1997) Antegrade drilling for osteochondritis dissecans of the knee. Arthroscopy 13(3):319–324
3. Cahill BR (1995) Osteochondritis dissecans of the knee: treatment of juvenile and adult forms. J Am Acad Orthop Surg 3:237–247
4. Clanton TO, DeLee JC (1982) Osteochondritis dissecans. History, pathophysiology and current treatment concepts. Clin Orthop Relat Res 167:50–64
5. Glancy GL (1999) Juvenile osteochondritis dissecans. Am J Knee Surg 12:120–124
6. Pappas AM (1981) Osteochondrosis dissecans. Clin Orthop Relat Res 158:59–69
7. Murray JRD, Chitnavis J, Dixon P, Hogan NA, Parker G, Parish EN et al (2007) Osteochondritis dissecans of the knee; long-term clinical outcome following arthroscopic debridement. Knee 14:94–98
8. Kocher MS, Tucker R, Ganley TJ, Flynn JM (2006) Management of osteochondritis dissecans of the knee: current concepts review. Am J Sports Med 34(7):1181–1191
9. Mubarak SJ, Carroll NC (1979) Familial osteochondritis dissecans of the knee. Clin Orthop Relat Res 140:131–136
10. Hefti F, Beguiristain J, Krauspe R, Möller-Madsen B, Riccio V, Tschauner C et al (1999) Osteochondritis dissecans: a multicenter study of the European Pediatric Orthopedic Society. J Pediatr Orthop B 8:231–245
11. Harding WG 3rd (1977) Diagnosis of ostechondritis dissecans of the femoral condyles: the value of the lateral X-ray view. Clin Orthop Relat Res 123:25–26
12. Cahill BR, Berg BC (1983) 99m-Technetium phosphate compound joint scintigraphy in the management of juvenile osteochondritis dissecans of the femoral condyles. Am J Sports Med 11:329–335
13. Bedouelle J (1988) L'ostéochondrite disséquante des condyles fémoraux chez l'enfant et l'adolescent. In: Cahiers d'enseignement de la SOFCOT. Expansion Scientifique Française, pp 61–93
14. Hughston JC, Hergenroeder PT, Courtenay BG (1984) Osteochondritis dissecans of the femoral condyles. J Bone Joint Surg Am 66:1340–1348
15. Smillie IS (1957) Treatment of osteochondritis dissecans. J Bone Joint Surg Br 39:248–260
16. Lefort G, Moyen B, Beaufils P, De Billy B, Breda R, Cadilhac C et al (2006) L'ostéochondrite disséquante des condyles fémoraux: analyse de 892 cas. Rev Chir Orthop Traumatol 92(S5):97–141
17. Cahill BR, Phillips MR, Navarro R (1989) The results of conservative management of juvenile osteochondritis dissecans using joint scintigraphy. A prospective study. Am J Sports Med 17:601–606
18. Guhl JF (1982) Arthroscopic treatment of osteochondritis dissecans. Clin Orthop Relat Res 167:65–74
19. Cepero S, Ullot R, Sastre S (2005) Osteochondritis of the femoral condyles in children and adolescents: our experience over the last 28 years. J Pediatr Orthop B 14:24–29
20. Aglietti P, Buzzi R, Bassi PB, Fioriti M (1994) Arthroscopic drilling in juvenile osteochondritis dissecans of the medial femoral condyle. Arthroscopy 10:286–291
21. Bradley J, Dandy DJ (1989) Results of drilling osteochondritis dissecans before skeletal maturity. J Bone Joint Surg Br 71:642–644
22. Ganley TJ, Amro RR, Gregg JR, Halpern KV (2002) Antegrade drilling for osteochondritis dissecans of the knee. Pediatric Orthopaedic Society of North America
23. Kocher MS, Micheli LJ, Yaniv M, Zurakowski D, Ames A, Adrignolo AA (2001) Functional and radiographic outcome of juvenile osteochondritis dissecans of the knee treated with transarticular arthroscopic drilling. Am J Sports Med 29:562–566
24. Louisia S, Beaufils P (1997) Perforations transcartilagineuses dans le traitement de l'ostéochondrite disséquante du condyle fémoral interne, vol 7. Sauramps Médical, Montpellier

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The Knee 13 (2006) 32–35

THE KNEE

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Autologous osteochondral transplantation for the treatment of chondral defects of the knee

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Received 1 December 2004; accepted 26 May 2005

Abstract

Full-thickness chondral defects of weight-bearing articular surfaces of the knee are a difficult condition to treat. Our aim is to evaluate the mid- and long-term functional outcome of the treatment of osteochondral defects of the knee with autologous osteochondral transplantation with the OATS technique. Thirty-six patients (37 procedures) were included in this study. Twenty-three patients were male and thirteen were female with a mean age of 31.9 years (range: 18–48 years). The cause of the defect was OCD in 10 cases, AVN in 2, lateral patellar maltracking in 7, while in the remaining 17 patients the defect was post-traumatic. The lesion was located on the femoral condyles in 26 cases and the patellofemoral joint in the remaining 11. The average area covered was 2.73 cm^2 (range: 0.8–12 cm^2) and patients were followed for an average of 36.9 months (range: 18–73 months).

The average score in their Tegner Activity Scale was 3.76 (range: 1–8), while their score in Activities of Daily Living Scale of the Knee Outcome Survey ranged from 18 to 98 with an average of 72.3. Thirty-two out of 37 patients (86.5%) reported improvement of their pre-operative symptoms. All but 5 patients returned to their previous occupation while 18 went back to sports. No correlation was found between patient age at operation, the size or site of the chondral lesion and the functional outcome.

We believe that autologous osteochondral grafting with the OATS technique is a safe and successful treatment option for focal osteochondral defects of the knee. It offers a very satisfactory functional outcome and does not compromise the patient's future options.

Keywords: Osteochondral transplantation; Chondral defect; Knee; Arthroscopy

1. Introduction

The management of full-thickness chondral defects of a weight-bearing articular surface remains a contentious issue. The repair capacity of articular cartilage is limited, especially in large defects occurring after skeletal maturity [1–5]. Spontaneous repair as well as resurfacing promoted by treatment options such as abrasion arthroplasty, microfractures and drilling occurs with the formation of reparative fibrocartilage, has poor biomechanical characteristics compared to hyaline cartilage [2,5].

Osteochondral autograft transplantation is a method, which provides autologous hyaline cartilage for resurfacing the chondral defect, thus reconstructing more accurately both the histological and biomechanical properties of the articular surface [6–11]. It has, though, technical limitations, mainly related to the size of the defect and to donor site morbidity [12].

Our aim was to evaluate the mid- and long-term functional outcome of the treatment of osteochondral defects of the knee joint with autologous osteochondral transplantation with the OATS technique.

2. Materials and methods

Between July 1998 and March 2003, 42 patients underwent 43 procedures for autologous osteochondral transplantation (one bilateral) with the OATS technique (Osteochondral Autograft Transplantation System, Arthrex, Naples, USA). Six patients were

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0968-0160/$ - see front matter © 2005 Published by Elsevier B.V.
doi:10.1016/j.knee.2005.05.006

not available on final follow-up, and therefore, 36 patients (37 procedures) were included in this study. Of those patients, 23 were male and 13 were female with a mean age of 31.9 years (range: 18–48 years). The cause of the chondral defect was osteochondritis dissecans (OCD) in 10 cases, avascular necrosis (AVN) in 2, lateral patellar maltracking in 7, while in the remaining 17 patients, the defect was post-traumatic following a road traffic accident, fall from a height or a sporting injury. The lesion was located on the medial femoral condyle in 18 cases, on the lateral femoral condyle in 8, on the trochlea in 7 and on the patella in the remaining 4.

The joint was initially assessed arthroscopically and the defect size, as well as the extent of subchondral bone loss was recorded (Fig. 1). Subsequently autologous osteochondral transplantation was carried out with the OATS technique (Osteochondral Autograft Transplantation System, Arthrex, Naples, USA), which allows for press-fit graft implantation (Fig. 2). Grafts were harvested from the lateral or medial edge of the trochlea and secondarily from the notch if more graft was required. The depth of the donor osteochondral plug ranged from 12 to 15 mm and the recipient site was drilled to such a depth so as to compensate for any potential subchondral bone loss and at the same time allow for some bone impaction. Care was taken to achieve perpendicular graft insertion, deliver the graft flush with the joint surface and reproduce the joint curvature as close to anatomical as possible. In 22 cases, graft harvesting and subsequent implantation was carried out following an arthrotomy, while in the remaining 15 cases, grafts were harvested through a mini-arthrotomy and implanted arthroscopically. In two patients where the lesion size was 12 cm^2 and 6.7 cm^2, respectively, a combination of autograft and allograft material was used due to the size of the defect.

A drain was inserted in the joint for 24 hours and patients were encouraged to start passive mobilisation of their knee as soon as pain allowed. Touch-toe weight bearing was advocated for 4–6 weeks and patients gradually progressed to full weight-bearing thereafter. Patients who underwent osteochondral transplantation to the articular surface of the trochlea or the patella had their knee immobilised in extension for 3–4 weeks in order to protect the graft. 1

Osteochondral transplantation was combined with ACL reconstruction in 4 cases, lateral meniscal repair in 1 and a lateral release or an Elmslie–Trillat procedure in all 7 cases with an element of lateral patellar maltracking. Functional evaluation was performed using questionnaires using the Tegner activity scale and the Activities of Daily Living Scale of the Knee Outcome Survey [13].

Fig. 1. Osteochondral lesion of the medial femoral condyle in a 35-year-old patient.

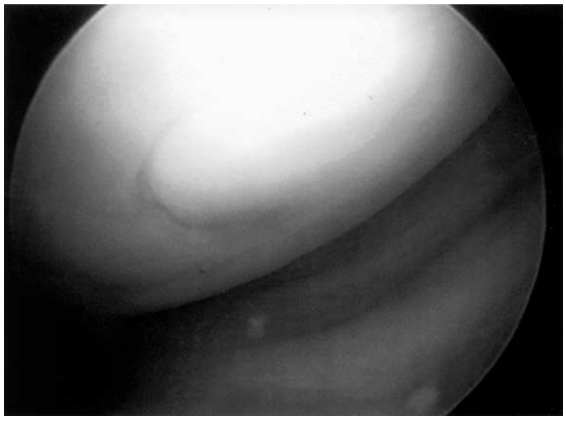

Fig. 2. Following treatment with autologous osteochondral transplantation covering of the defect with hyaline cartilage and satisfactory graft incorporation is seen during second look arthroscopy.

3. Results 2

The average area of the osteochondral lesion covered with autologous osteochondral transplantation ranged from 0.8 to 12 cm^2 (average: 2.73 cm^2). The diameter of the grafts used ranged from 6 to 10 mm and 1 to 8 grafts were used in each case to achieve > 90% covering of the lesion area. Patients were hospitalised for an average period of 3.06 days (range 1–6 days).

Patients were followed for a minimum of 18 months (average: 36.9 months, range: 18–73 months). The average score in their Tegner Activity Scale was 3.76 (range: 1–8), while their score in Activities of Daily Living Scale of the Knee Outcome Survey ranged from 18 to 98 with an average of 72.3. Thirty-two out of thirty-seven patients (86.5%) reported improvement of their pre-operative symptoms. All but 5 returned to their previous occupation and regular day-to-day activities and 18 went back to sports. No correlation was found between patient age at operation, the size or site of the chondral lesion and the functional outcome as depicted in the outcome measures used.

Nine patients had a second look arthroscopy for ongoing swelling, pain or clicking 7–13 months following their initial procedure. Arthroscopic assessment was combined with arthrolysis in one case, debridement and chondroplasty around the graft in four cases and partial medial meniscectomy in a further two cases. The grafts were found to be stable, well incorporated and with satisfactory chondrocyte survival in all but two cases, where they were loose and were therefore revised. In four out of those nine patients, symptoms improved significantly.

No donor-site related morbidity was recorded. One patient had a superficial wound infection that was successfully managed with oral antibiotics and one had a deep vein thrombosis and was warfarinised.

4. Discussion

Osteochondral defects spontaneously heal with fibrocartilage and treatment options such as abrasion arthroplasty, microfractures and drilling also promote the formation of fibrocartilaginous tissue, whose load-bearing properties and histological characteristics are significantly inferior to those of normal hyaline cartilage [2,14–16]. Furthermore, fibrocartilage has been shown to fibrillate and degrade with time, resulting in further deterioration of its loading characteristics [17]. In weight-bearing areas of the knee, this can cause impairment of smooth load transmission, leading to point loading and thus predisposing to development of osteoarthritis.

It is only osteochondral transplantation and autologous chondrocyte implantation that can provide hyaline cartilage covering of the articular surface defect. Autologous chondrocyte implantation leads to covering of the defect with predominantly hyaline or hyaline-like cartilage [18], although this has been challenged by recent reports [19]. Cost, as well as the need for two operative procedures, in order to initially harvest cartilage, culture it and subsequently implant it during a second procedure a few weeks later, remain concerns regarding this method. The functional outcome with autologous chondrocyte implantation is satisfactory, but it is a matter of debate if it is superior to autologous osteochondral transplantation [18,19].

Autologous osteochondral transplantation, on the other hand, is an appealing option, as it allows for coverage of the chondral lesion with adequate thickness, good quality hyaline cartilage and at the same time closely reproduces the anatomical condyle curvature [20–23]. Stabilisation of the grafts in the recipient area with a press-fit technique allows for satisfactory initial graft stability and obviates the need for any sort of internal fixation. A high rate of successful graft incorporation is subsequently achieved through direct bone healing in the surface between the graft and the recipient area. A number of authors have reported a high rate of symptom relief and functional improvement, as well as very satisfactory survival of the transplanted hyaline cartilage [6–11,24–27]. This method, though, has certain limitations, namely, increased donor site morbidity and a less favourable outcome when used for relatively sizeable defects (> 2 × 2 cm) [12,28].

Cadaveric studies have demonstrated that grafts harvested from the lateral or medial edge of the trochlea can better reproduce the anatomical curvature of the recipient sites on the femoral condyle [22,23]. Ahmad et al. also suggested that the distal medial trochlea is totally non-load bearing, unlike the intercondylar notch, lateral trochlea and proximal medial trochlea where non-load-bearing areas are fairly limited [20]. Therefore, the distal medial trochlea appears to be the area of choice for osteochondral graft harvesting, bearing in mind the above-mentioned biomechanical considerations. Grafts from other areas may have to be harvested, though, if a sizeable lesion has to be covered. Other factors that seem to influence the outcome are perpendicular graft insertion [9], delivering the graft flush with the joint surface and achieving adequate graft stability to avoid graft micromotion [29].

Our results are comparable with those reported in the literature regarding functional improvement and pain relief and suggest that this method is very effective in treating full-thickness chondral defects. Although no direct correlation between the size of the lesion and the functional outcome was found, one should bear in mind that increased lesion size raises concerns about graft availability and the ability to achieve stable graft fixation.

In conclusion, with this method, defects are resurfaced with osteochondral autografts, thus permitting joint surface covering with autologous hyaline cartilage as well as stable and safe graft incorporation. We believe that autologous osteochondral transplantation is a successful treatment option for focal osteochondral defects of the knee. It offers a very satisfactory functional outcome and does not compromise the patients' future options.

References

[1] Prasad D, Learmonth D. Natural progression of osteo-chondral defect in the femoral condyle. Knee 2002;9:7–10.

[2] Bobic V, Noble J. Articular cartilageTo repair or not to repair? J Bone Joint Surg Br 2000;82-B:165–6.

[3] Farnworth L. Osteochondral defects of the knee. Orthopedics 2000; 23(2):146–57.

[4] Jaberi FM. Osteochondritis disecans of the weight-bearing surface of the medial femoral condyle in adults. Knee 2002;9:201–7.

[5] Gross AE. Repair of cartilage defects in the knee. J Knee Surg 2002; 15(3):167–9.

[6] Jacob RP, Franz T, Gautier E, Mainil-Varlet P. Autologous osteochondral grafting in the knee: indication, results and reflections. Clin Orthop 2002;401:170–84.

[7] Hangody L, Feczko P, Bartha L, Bodo G, Kish G. Mosaicplasty for the treatment of articular defects of the knee and ankle. Clin Orthop 2001;391S:S328–36.

[8] 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. II):25–32.

[9] Hangody L, Kish G, Karpati Z, Szerb I, Udvarhelyi I. Arthoscopic autogenous osteochondral mosaicplasty for the treatment of femoral condylar articular defects. A preliminary study. Knee Surg Sports Traumatol Arthrosc 1997;5:262–7.

[10] Hangody L, Kish G, Karpati Z, Udvarhelyi I, Szigeti I, Bely M. Mosaicplasty for the treatment of articular cartilage defects: application in clinical practice. Orthopedics 1998;21(7):751–6.

[11] Hangody L, Rathonyi GK, Duska Z, Vasarhelyi G, Fules P, Modis L. Autologous osteochondral mosaicplasty. Surgical technique. J Bone Joint Surg Am 2004;86-A(Suppl. I):65–72.

[12] Agneskirchner JD, Brucker P, Burkart A, Imhoff AB. Large osteochondral defects of the femoral condyle: press-fit transplantation of the posterior femoral condyle (MEGA-OATS). Knee Surg Sports Traumatol Arthrosc 2002;10(3):160–8.

[13] Irrgang JJ, Snyder-Mackler L, Wainner RS, Fu FH, Harner CD. Development of a patient-reported measure of function of the knee. J Bone Joint Surg Am 1998;80-A:1132–45.

[14] Akizuki S, Yasukawa Y, Takizawa T. Does arthroscopic abrasion arthrosplasty promote cartilage regeneration in oateoarthritic knees with eburnation? A prospective study of high tibial osteotomy with abrasion arthrosplasty versus high tibial osteotomy alone. Arthroscopy 1997;13(1):9–17.
[15] Alleyne KR, Galloway MT. Management of osteochondral injuries of the knee. Clin Sports Med 2001;20(2):343–64.
[16] Cain EL, Clancy WG. Treatment algorithm for osteochondral injuries of the knee. Clin Sports Med 2001;20(2):321–42.
[17] Shahgaldi BF. Repair of large osteochondral defects: load-bearing and structural properties of osteochondral repair tissue. Knee 1998;5: 111–7.
[18] Bentley G, Biant LC, Carrington RWJ, Akmal M, Goldberg A, Williams AM, et al. A prospective randomised comparison of autologous chondrocyte implantation versus mosaicplasty for osteochondral defects in the knee. J Bone Joint Surg Br 2003;85-B:223–30.
[19] Horas U, Pelinkovic D, Herr G, Aigner T, Schnettler R. Autologous chondrocyte implantation and osteochondral cylinder transplantation in cartilage repair of the knee joint. A prospective comparative trial. J Bone Joint Surg Am 2003;85-A:185–92.
[20] Outerbridge HK, Outerbridge AR, Outerbridge RE. The use of a lateral patellar autologous graft for the repair of large osteochondral defects on the knee. J Bone Joint Surg Am 1995;77-A:65–72.
[21] Outerbridge HK, Outerbridge AR, Outerbridge RE, Smith DE. The use of lateral patellar autologous grafts for the repair of large osteochondral defects in the knee. Acta Orthop Belg 1999;65 (Suppl. 1):129–35.
[22] Ahmad CS, Cohen ZA, Levine WN, Ateshian GA, Mow VC. Biomechanical and topographic considerations for autologous osteochondral grafting in the knee. Am J Sports Med 2001;29(2):201–6.
[23] Bartz RL, Kamaric E, Noble PC, Lintner D, Bocell J. Topographic matching of selected donor and recipient sites for osteochondral autografting of the articular surface of the femoral condyles. Am J Sports Med 2001;29(2):207–12.
[24] Marcacci M, Kon E, Zaffagnini S, Visani A. Use of autologous grafts for reconstruction of osteochondral defects of the knee. Orthopedics 1999;22(6):595–600.
[25] Morelli M, Nagomori J, Miniachi A. Management of chondral injuries of the knee by osteochondral autogenous transfer (mosaicplasty). J Knee Surg 2002;15(3):185–90.
[26] Menche DS, Vangsness CT Jr, Pitman M, Gross AE, Peterson L. The treatment of isolated articular cartilage lesions in the young individual. Instr Course Lect 1998;47:505–15.
[27] Barber FA, Chow JCY. Arthroscopic osteochondral transplantation. Arthroscopy 2001;17(8):832–5.
[28] Laprell H, Petersen W. Autologous osteochondral transplantation using diamond bone-cutting system (DBCS): 612 years' follow-up of 35 patients with osteochondral defects at the knee joint. Arch Orthop Trauma Surg 2001;121:248–53.
[29] Pearse S, Hurtig MB, Clarnette R, Karla M, Cowan B, Miniaci A. An investigation of 2 techniques for optimizing joint surface congruency using multiple cylindrical osteochondral autografts. Arthroscopy 2001;17(1):50–5.