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ORIGINAL CLINICAL ARTICLE

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

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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.

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

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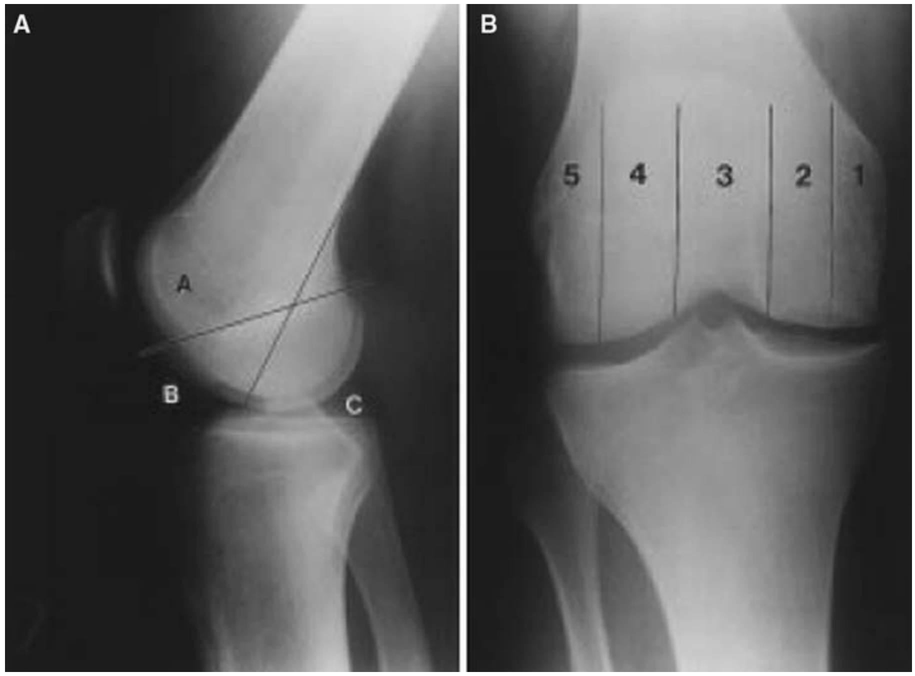

Fig. 1 **a** Harding classification to distinguish anterior, mean, and posterior lesions. **b** Cahill and Berg classification for medio-lateral localization of the lesions

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

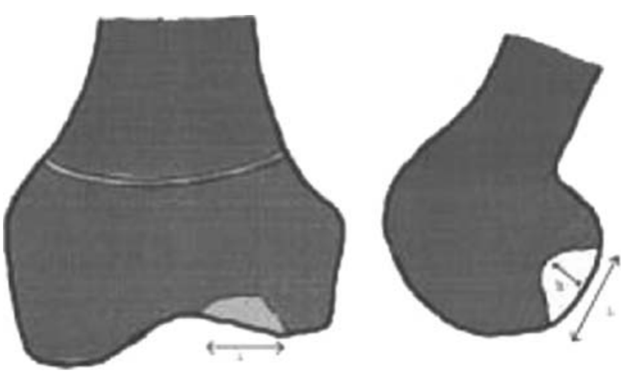

Fig. 2 Measures to calculate the lesion volume on anteroposterior (AP) and lateral views of the knee

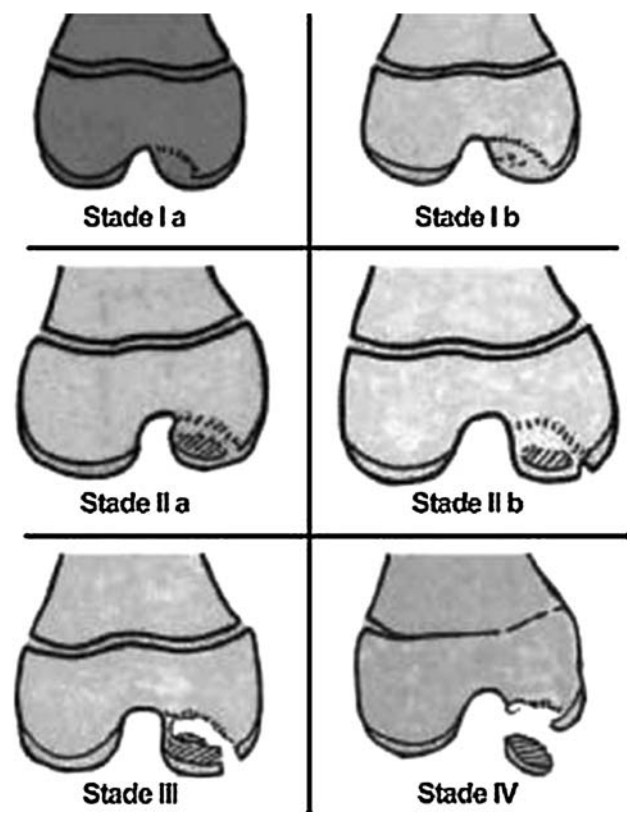

Fig. 3 Bedouelle's radiological classification

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 nonparametric 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].

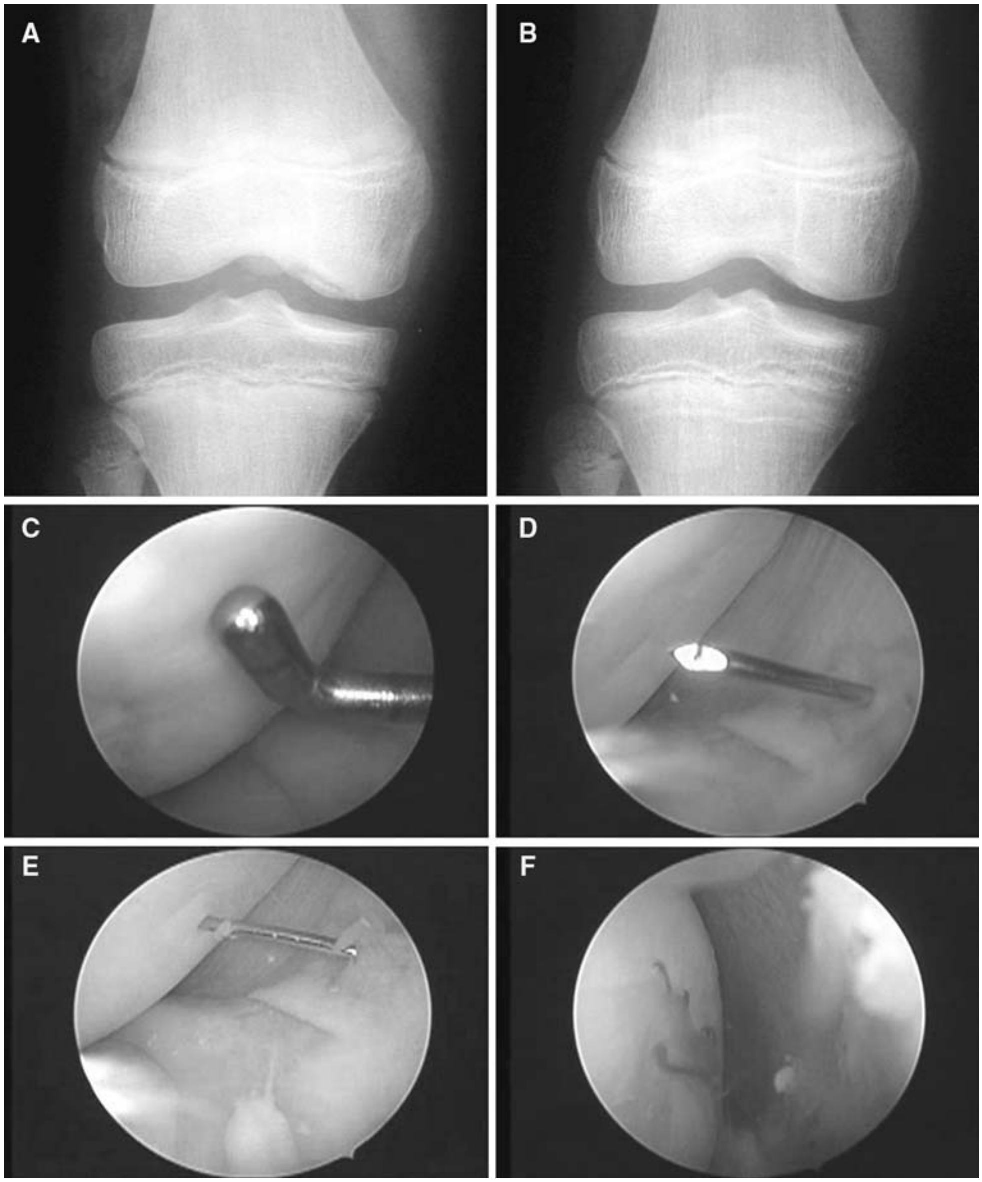

Fig. 5 **a** Grade II b Bedouelle OCD. **b** Radiograph 6 months later with a Hughston radiological score of 4. **c** Arthroscopic views for the same patient. Localization of the OCD region. **d**, **e** Transchondral drilling with a 1.2-mm K-wire. **f** Bleeding from the drilling holes

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 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.

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

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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, micro-fractures 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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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.

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.

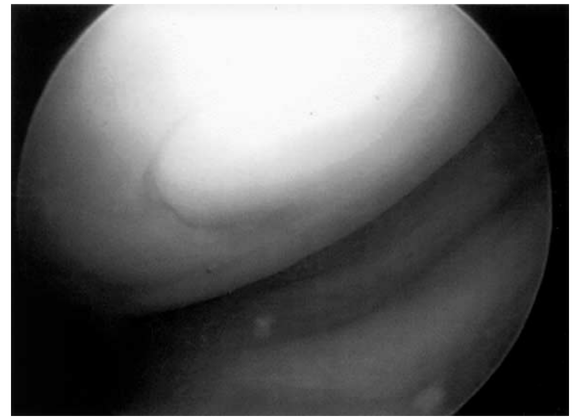

Fig. 2. Following treatment with autologous osteochondral transplantation covering of the defect with hyaline cartilage and satisfactory graft incorporation is seen during second look arthroscopy.

3. Results

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.

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Management of articular cartilage defects

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Abstract

This paper discusses the management of articular cartilage defects. Osteochondral defects (OCD) may be traumatic or degenerative in origin. Arthroscopic surgery is the gold standard diagnostic and therapeutic tool for the management of OCD. The management of OCD remains controversial and over the last five decades various treatment options and surgical techniques have been tried to maximise the clinical outcome. In this article we review the current practice of management of OCD. We also highlight the most recent approaches and research and look to the future of management of OCD.

Keywords articular cartilage; osteochondral defect

Introduction

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

Epidemiology

The true incidence of articular cartilage injury is still debated. Several studies have described a wide range of incidences. Noyes reviewed results of 85 knee arthroscopies of young patients (14 to 43 years old) following acute traumatic haemarthrosis. The study reported on acute chondral fractures associated with or without anterior cruciate ligament (ACL) disruption as 10% and 4% respectively.[2] 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 (International Cartilage Repair Society grade III or IV) that could have benefited from surgical treatment.[3] In a larger and more generalised 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.[4] 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.[5]

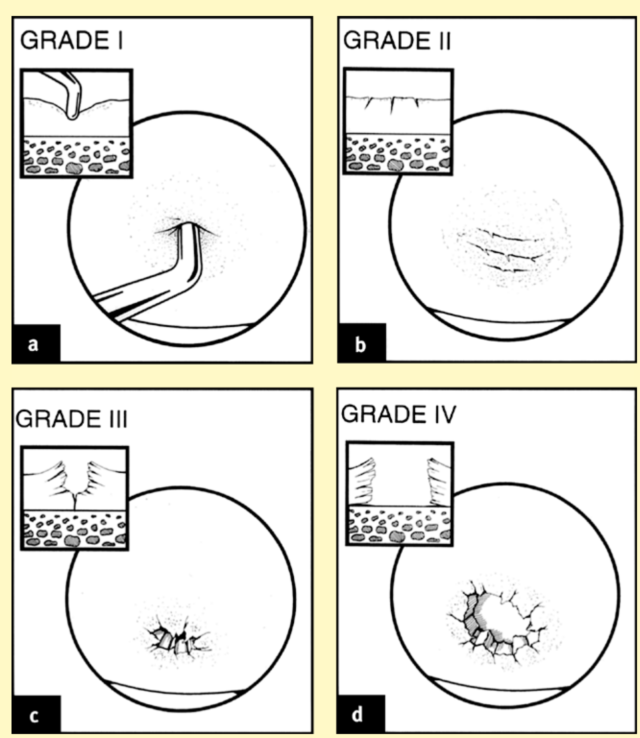
In conclusion OCD appears to be relatively commonly associated with knee problems which affect young active patients

Grades of OCD (Figure 2)

The most popular arthroscopic classification system of cartilage lesion was developed by Outerbridge[6] (Figure 1). Other less widely used grading systems have been developed[7,8] including the International Cartilage Repair Society (ICRS) index, which evaluates both the cartilage injury and degree of repair.[9]

Outerbridge classification: (Figure 1)

- grade 0: normal cartilage;
- grade I: cartilage with softening and swelling;
- grade II: a partial-thickness defect with fissures on the surface that do not reach subchondral bone or exceed 1.5 cm in diameter;
- grade III: fissuring to the level of subchondral bone in an area with a diameter more than 1.5 cm;
- grade IV, exposed subchondral bone.



Outerbridge grading system of cartilage damage.

Figure 1

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Synthetic scaffolds

Synthetic scaffolds are more durable and easier to handle and manipulate than natural materials, they also effectively integrate with the host tissues. Hitherto their biochemical properties remain inferior to native cartilage. Examples of some synthetic scaffolds used in articular cartilage tissue engineering are shown in Table 2.

Similar to natural scaffolds, synthetic scaffolds can be used in isolation although they are more commonly used in combination with other natural or synthetic materials.

Acellular scaffolds

Acellular grafts have been used in other fields of clinical practice. Since they have no cells they do not lead to cell necrosis as compared to autografts or allografts which have shown deterioration of mechanical strength following implantation.[78]

Acellular scaffolds have the advantage of being composed of natural ECM, giving them numerous advantages in terms of mechanical behaviour and biocompatibility.[79] Some examples of acellular scaffolds used in tissue engineering are shown in Table 3.

Acellular cartilage bone matrix could potentially provide a favourable substitute in the treatment of OCD or as a biological joint replacement.

The authors of this article are currently developing a technique to decellularise cartilage/bone matrix scaffold for use in cartilage tissue engineering. The primitive results showed that it is possible to decellularise a porcine cartilage-bone matrix that can be used as a biological scaffold for recellularisation with autologus chondrocytes with a view to use as an osteochondral implant.

Conclusion

The management of OCD remains controversial and over the last five decades, various treatment options and surgical techniques have been tried to optimise the clinical outcome.

Microfractures or marrow stimulation techniques remain the gold standard and are most commonly used. Currently this is the least technically demanding option with the longest follow up results and it is the least expensive. For these reasons it is the current "gold standard".[17]

Nevertheless the basic concept of this treatment is to replace hyaline cartilage with fibrocartilage, which has inferior mechanical properties compared to hyaline cartilage and microfracture is not suitable for large osteochondral defects.

Synthetic scaffolds for articular cartilage tissue engineering

Scaffold	References
Polylactic acid (PLA)	68,69
Polyglycolic acid (PGA)	70
PLA-PGA Copolymer,	71,72
Dacron	73,74
Teflon	75
Hydroxyapatite	76,77

Table 2

Acellular scaffolds for tissue engineering

Scaffold	References
Pericardial acellular matrix	80,81
Small intestinal submucosa (SIS) as a vascular graft	82,83
Acellular vascular matrix	84,85
Acellular meniscus	86
Acellular tendons	87,88

Table 3

OCD autograft does provide a native hyaline osteochondral constructs, although the major drawback of this surgical technique is donor site morbidity.[20] The large OCD remains an obstacle to using this technique.[24]

OCD allograft can provide greater coverage for large OCD.[29] However the risks of disease transmission, as well as immunological rejection,[36] are the main disadvantages.[35] The availability of cartilage donors can add difficulties for using this treatment option.[33]

Tissue engineering has developed rapidly over the last decade and there are a number of biomaterials being tried for cartilage substitution.[89] The properties of biomaterials are key to the success of tissue engineering.[45] High porosity is important to promote integration of cells into the scaffold which would allow them to generate their own ECM, biocompatibility and mechanical properties are crucial for a scaffold to mimic the host tissues.[45] Decellularised tissues and organs have been successfully used in both pre-clinical animal studies and in human clinical applications.[90] Decellularisation and generation of biological acellular scaffolds was achieved in cardiac valves,[91] vascular tissues,[79] pericardial matrix,[81] porcine meniscus[86] and different other tissues and organs.

An acellular osteochondral scaffold will potentially provide functioning hyaline cartilage and primary healing of these constructs will be clinical integration through bone-to-bone healing providing the best results. ◆

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