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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, 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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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].

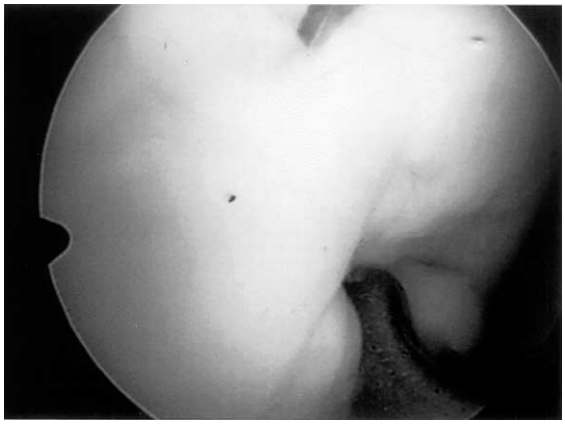

Fig. 1. Osteochondral lesion of the medial femoral condyle in a 35-year-old patient.

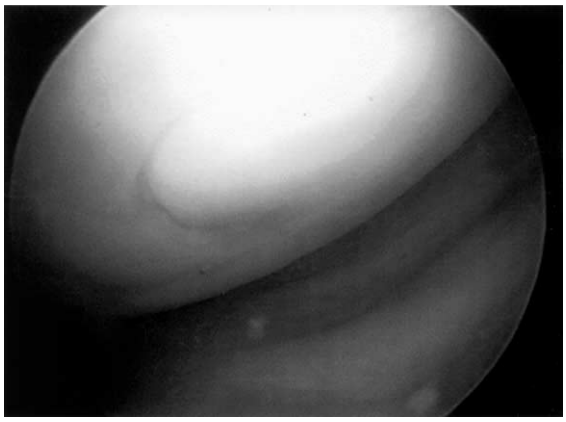

Fig. 2. Following treatment with autologous osteochondral transplantation covering of the defect with hyaline cartilage and satisfactory graft incorporation is seen during second look arthroscopy.

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 ($> 2 \times 2$ 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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