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Treatment of focal articular cartilage lesions of the knee with autogenous osteochondral grafts

A 2- to 4-year follow-up study

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Abstract A retrospective study of 15 patients with 16 knees who underwent osteochondral autografts for focal full thickness articular cartilage defects of the knee with 2- to 4-year follow-up showed 80% good or excellent clinical results. There was no correlation of the clinical results with the underlying diagnoses, including osteonecrosis, osteochondritis dessicans and traumatic cartilage defect, or a size of the lesion smaller than 600 mm^2. However, cartilage lesions larger than 600 mm^2 were associated with increasing fibrous tissue formation and fissuring between the grafts and the host tissues and poor results. The improvement in symptoms appeared time-dependent, ranging from 6 to 16 weeks, suggesting that postoperative protection of the graft is warranted. There was no radiographic progression of degenerative changes of the knee on the medium-term follow-up. Therefore, an autogenous osteochondral graft is considered a good method in the treatment of knees with moderately sized articular cartilage defects.

Keywords Cartilage lesion · Osteochondral graft · Knee

Introduction

A full-thickness articular cartilage defect of the knee frequently results in fibrous tissue formation and degenerative changes, and a defect larger than 9 mm^2 often leads to degenerative arthritis of the knee [2]. Many surgical techniques including microfracture, periosteal and perichondral grafts, chondrocyte transplantation, chondrogenesis-stimulating factors, gene therapy, osteochondral grafts, etc. have been studied in an attempt to restore the damaged articular cartilage [1, 4, 5, 7, 8, 9]. However, there is no consensus of opinion on the best method to repair full-thickness articular cartilage defects of the knee

Autogenous osteochondral graft has gained in clinical popularity because of its technical feasibility and cost effectiveness. However, only a few series have been reported in the literature, many of them case reports [1, 3, 4, 8]. The purpose of this study was to review the results of 15 patients with 16 knees undergoing osteochondral autograft to repair focal full-thickness articular cartilage defects of the knee with a minimum of 2 years' follow-up.

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Patients and methods

Fifteen patients with 16 knees undergoing autogenous osteochondral graft for focal articular cartilage defects of the knee between January 1997 to June 1998 were included in this study. There were 8 men and 7 women with an average age of 38 (range 20–65) years old. The average age was 46 years for patients with osteonecrosis, 26 years for patients with osteochondritis dessicans, and 35 years for patients with traumatic defects. Eight times the right knee was affected and the left knee in the other 8 cases. One patient had bilateral knee involvement, and 1 patient had repeated surgery on the same knee. Therefore, this series included 17 procedures in 16 knees in 15 patients. The average duration of symptoms was 13.6 (range 4–40) months, and the average follow-up time was 32 (range 24–47) months.

The diagnoses included 7 knees with osteonecrosis, 5 with osteochondritis dessicans, and 4 with traumatic cartilage defect. The locations of the lesion included the lateral femoral condyle in 10 knees, medial femoral condyle in 5 knees, and both the medial and lateral femoral condyles in 1 knee. The average size of the lesion was 434 (range 128–900) mm^2 for the lateral femoral condyle and 207 (range 120–375) mm^2 for the medial femoral condyle. The types of injury included 3 motor vehicle accidents, 2 falling accidents, 3 sports-related injuries (2 basketball and 1 badminton), 1 work-related, 1 steroid-induced (systemic lupus erythematosis), and 6 unknown. The prior surgeries included 5 knees with abrasion chondroplasties and removal of loose fragments, 4 meniscectomies, 1 meniscal repair, and 1 anterior cruciate ligament reconstruction.

Ten procedures were performed arthroscopically and 7 through arthrotomy. The Arthrex osteochondral transfer instruments (Arthrex, Naples, Fla.) were utilized in all cases. The damaged and detached articular cartilage was debrided to the bleeding subchondral bone first. The number and length of osteochondral plugs were determined according to the size and depth of the lesion. The predetermined bone plugs were removed from the lesion (recipient site). Then 1.0 mm oversized osteochondral plugs of the same length

were harvested from the articular cartilage either around the intercondylar notch or the sulcus terminalis of the lateral femoral trochlea, and were transplanted into the recipient site. The osteochondral plug was secured at the recipient site by the press-fit technique. The surfaces of the osteochondral cores were made flush with the surrounding articular cartilage. Special attention was paid to avoid fracture or breakage of the osteochondral plugs during the course of transplantation. The number of osteochondral plugs used ranged from 1 to 5. An attempt was made to place the osteochondral plugs within 1.0 mm proximity to each other when more than two plugs were used. The bone plugs from the recipient site were implanted into the defects of the donor site. The wounds were closed in a routine manner.

Prophylactic antibiotic (keflin 1.0 g) was given before and every 8 h after surgery for 24 h. Postoperatively, patients received continuous passive motion (CPM) exercises, but remain non-weight-bearing for 12 weeks. Quadriceps and hamstring strengthening exercises were encouraged.

The evaluations were based on functional assessments, which included pain, giving way, locking, recurrent effusion, knee scores, functional scores, and Lysholm scores. Radiographs of the knee were examined for joint congruence, joint space narrowing, and degenerative changes. The preoperative and postoperative values were compared statistically using Wilcoxon Singed Rank test with statistical significance set at $p<0.05$. Eight patients with 9 knees were evaluated through a second look arthroscopy.

Results

All patients were operated on because of knee pain ranging from mild to severe preoperatively. Postoperatively, 12 of 16 knees (75%) had no pain and 4 knees (25%) showed mild pain ($p=0.001$). The duration to pain relief of the knee ranged from 6 to 16 weeks after surgery. A history of the knee giving way was present in 12 of 16 knees (75%) preoperatively and in only 2 knees (12.5%) postoperatively ($p=0.002$). Knee locking was noticed in 15 of 16 knees (93.7%) preoperatively and in only 3 knees (18.8%) postoperatively ($p=0.001$). Recurrent knee effusion was seen in 13 of 16 knees (81.2%) preoperatively and in only 1 knee (6.3%) postoperatively ($p=0.002$). The average range of knee motion was 122.8°±8.8° preoperatively vs 134.4°±7.9° postoperatively ($p=0.005$). The average Lysholm scores were 67.9±12.4° preoperatively vs 90.4°±10.1° postoperatively ($p=0.001$). The average knee score was 94±12 and the average functional score 88±15 at follow-up. The results of functional assessments of the knee are summarized in Table 1. The overall results were excellent in 7 (43.75%), good in 6 (37.50%), fair in 2 (12.50%), and poor in 1 (6.25%).

The preoperative radiographs of the knee showed mild degenerative changes in 7 knees with involvement of the medial compartment in 4, lateral compartment in 2, and patellofemoral joint in 1. Postoperatively, the incidence of degenerative changes of the knees by radiographic examination was noticed in 8 knees with 5 in the medial compartment, 2 in the lateral compartment, and 1 at the patellofemoral joint. Seven of 8 knees showed no progression of degenerative changes, while 1 showed a slight increase in the severity of degenerative changes.

The postoperative values of functional assessments among the three categories of diagnosis (osteonecrosis, osteochodritis dessicans, and traumatic cartilage defect) were compared statistically using Kruskal-Wallis test with statistical significance set at $p<0.05$. The results showed that there was no statistically significant difference in the functional assessments including pain, swelling, giving way, and locking of the knee and the Lysholm scores among these three categories ($p>0.05$). Three knees including 2 with osteonecrosis and 1 with osteochondritis dessicans with lesions larger than 600 mm^2 showed fair and poor results.

Eight patients with 9 knees had their lesions evaluated through a second-look arthroscopy at 24–32 months postoperatively. Six of the 9 knees with a lesion smaller than

Table 1 Pre- and postoperative functional assessments of the knee after osteochondral graft (*ROM* range of motion)

	Preoperative	Postoperative	*p* value*
No. of cases	16	16	
Knee pain			0.001
None	0	12 (75%)	
Mild	5 (31.3%)	4 (25%)	
Moderate	10 (62.5%)		
Severe	1 (6.3%)		
Giving way			0.002
None	4 (25%)	14 (87.5%)	
Mild	7 (43.8%)	2 (12.5%)	
Moderate	5 (31.3%)		
Locking			0.001
None	1 (6.3%)	13 (81.3%)	
Mild	10 (62.5%)	3 (18.8%)	
Moderate	5 (31.35)		
Effusion			0.002
None	3 (18.8%)	15 (93.8%)	
Mild	7 (43.8%)	1 (6.3%)	
Moderate	5 (31.3%)		
Severe	1 (6.3%)		
ROM			0.005
Mean±SD	122.8°±8.8°	134.4±7.9	
Range	105°, 135°	115°, 145°	
Lysholm score			0.001
Mean±SD	67.9±12.4	90.4±10.1	
Range	48, 86	67, 100	

*Wilcoxon Signed Rank test

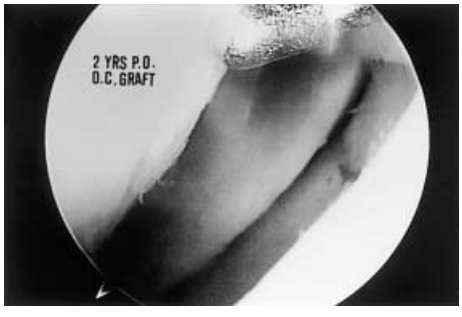

Fig. 1 Arthroscopic appearance of an osteochondral graft of the lateral femoral condyle for a medium-sized defect due to osteochondritis dessicans done 2 years postoperatively showed viable articular cartilage with complete incorporation with the adjacent cartilage. There was minimal fibrous tissue formation and fissuring between the graft and the adjacent cartilage. This knee was completely asymptomatic

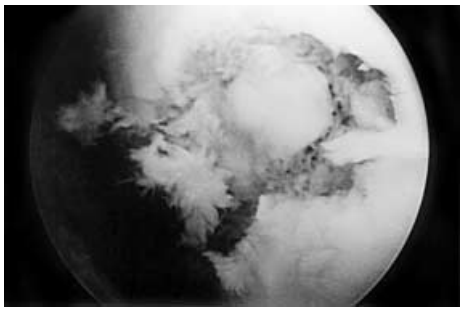

Fig. 2 Arthroscopic appearance of an osteochondral graft of the medial femoral condyle for a large defect due to osteonecrosis taken 6 months postoperatively showed extensive fibrous tissue formation and fissuring between the graft and the surrounding cartilage. This knee has recurrent symptoms and poor result

600 mm^2 were asymptomatic, while 2 knees with lesions of 750 mm^2 and 1 knee with a lesion of 900 mm^2 showed recurrent pain, giving way, and effusion of the knee. The arthroscopic findings of those six asymptomatic knees showed complete bonding of the graft to the adjacent cartilage. The grafts were viable and had a smooth articular surface and good consistency (Fig. 1). Three of the knees showed mild fissuring and scanty fibrous tissues between the grafts and the host tissues. Two knees with lesions of 750 mm^2 and 1 knee with a steroid-induced osteonecrosis of 900 mm^2 showed moderate to severe fibrous tissue formation and fissuring between the grafts and the surrounding tissues (Fig. 2). It appears that the amount of fibrous tissue formation and fissuring between the grafts and the host tissues is correlated with the size of the lesions. We speculate that extension of the lesion was due to the original disease or inadequate debridement of the damaged lesions, which resulted in further deterioration of the tissues between the grafts and the host tissues. Additional grafts were performed in these 3 cases. It appears that an articular cartilage lesion larger than 600 mm^2 is associated with a poor prognosis.

Discussion

This study showed good or excellent results for 80% of the knees after an osteochondral autograft for a focal articular cartilage lesion of the knee. Marcacci et al. reported that 12 of 13 knees with an articular cartilage defect greater than 1.5 cm^2 which were treated by osteochondral graft showed satisfactory results, and the patients were able to resume their pre-injury level of activities. There was 1 case with a poor result [7]. Solheim reported satisfactory results for 33 patients undergoing osteochondral grafts for knees with an average cartilage lesion of 2.8 cm^2 and recommended such an operation for knees with a moderately sized osteochondral lesion (1–5 cm^2) [9]. Hangody et al. reported 91% good or excellent results in 57 of 227 patients undergoing an osteochondral graft of the knee with more than 3 years' follow-up [4]. The results of our study were comparable with other reported series [1, 4, 9].

The average duration to pain relief of the knee ranged from 6 to 16 weeks after surgery. The improvement of symptoms appeared to be time-dependent. Lane et al. reported that the osteochondral graft remained viable, functionally and structurally intact for 12 months in a rabbit model. The subchondral bone underwent replacement in less than 6 weeks [6]. Dew and Martin showed that osteochondral grafts incorporated radiographically in 12 weeks in an experiment involving the talus of dogs [3]. Wang et al. studied osteochondral grafts in pigs and found that the subchondral bone healed and remodeled in 4 weeks, which provided better stability and nutrients for the graft; the cartilage healed to the adjacent cartilage by direct bonding in 12 weeks or longer [10]. Our results were supported by the studies by Lane et al. and Wang et al. that knee pain improved when the graft became stable, with remolded subchondral bone healing in 4–6 weeks after the osteochondral graft and eventual cartilage healing in approximately 12 weeks or longer. The grafts remained viable and were structurally intact up to 32 months based on a second-look arthroscopic examination.

This study showed that there was no statistical correlation of the results after an osteochondral autograft with the underlying diagnoses, including osteochondritis dessicans, osteonecrosis, and traumatic defect of the articular cartilage as long as the size of the lesion was smaller than 600 mm^2. There was no statistical correlation of the results with the size of the lesion smaller than 600 mm^2 as long as there was a sufficient number of osteochondral plugs implanted in close proximity and there was good graft stability. However, larger lesions were associated with increasing fibrous tissue formation and fissuring between the grafts and the surrounding tissues according to a second-look arthroscopic evaluation despite a good clinical outcome. An articular cartilage lesion of the knee larger than 600 mm^2 is at risk for a poor result even after an osteochondral autograft. The findings of this study were in agreement with those of Solheim [9] that osteochondral mosaicplasty may be considered in cartilage lesions of moderate size (1–5 cm^2) on the femoral condyle.

The postoperative incidence of degenerative changes of the knee was similar to the preoperative status. All knees except 1 with radiographic evidence of degenerative changes preoperatively showed no progression of degenerative changes of the knee postoperatively. It appeared that osteochondral autografts did prevent or delay the development of degenerative changes of the knee in the medium-term follow-up.

In conclusion, the osteochondral autograft achieved a high rate of good or excellent clinical results in knees with focal full-thickness articular cartilage defects. There was no correlation of the clinical results with the underlying diagnoses including osteochondritis dessicans, osteonecrosis, and traumatic defect of the articular cartilage. There was no direct correlation of the clinical results with the sizes of the lesions smaller than 600 mm^2, but lesions larger than 600 mm^2 tended to result in increasing fibrous tissue formation and fissuring between the grafts and the surrounding tissues and poor results. The improvement of

knee pain was time-dependent, ranging from 6 to 16 weeks, and postoperative protection of the graft was warranted. It appears that an osteochondral graft has the potential to prevent or delay the development of degenerative changes of the knee in the medium-term follow-up. Therefore, an autogenous osteochondral graft is considered a good method of treatment in knees with a moderately sized full-thickness articular cartilage defect.

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