Arthroscopic osteochondral autologous grafts for the management of small osteochondral defects of the knee

Mohamed G. Montaser

Department of Orthopedic, Faculty of Medicine, Benha University, Benha, Egypt

Correspondence to Mohamed G. Montaser, MD, Department of Orthopedic, Faculty of Medicine, Benha University, 13111 Benha, Egypt
Tel: +020133228666;
e-mail: mohamed.youssef@fmed.bu.edu

Received 4 January 2012
Accepted 20 January 2012

The Egyptian Orthopedic Association 2013, 48:254–262

Background
Articular cartilage is susceptible to mechanical trauma. Injury can occur through a single traumatic event or repetitive overloading with forces exceeding the biomechanical carrying capacity of articular cartilage. The treatment of a focal full-thickness articular defect in the knee has continued to present a challenge, with no traditional treatment method providing consistent acceptable long-term clinical results.

Objective
The aim of this study is to evaluate the short-term functional outcome of the treatment of osteochondral defects of the knee with autologous osteochondral transplantation using the osteochondral autograft transfer system technique.

Patients and methods
This prospective study includes 19 adult patients, 16 men (84.2%), and three women (15.8%) with focal articular cartilage full-thickness defects of the knee less than 2 cm in diameter. The mean age of the patients was 29.6 years (range 22–35 years). All of them were treated by arthroscopic assisted osteochondral autograft transplantation in the period between May 2006 and June 2009. The mean follow-up period was 24.2 months (range 12–36 months). For a standard comparison between the preoperative and postoperative state of the knee, the Hospital for Special Surgery knee service rating system (HSS) was used, which assigns a maximum 100 points to a normal knee.

Results
About 84.2% (16 patients) of the patients were very satisfied with their results. All of these patients had satisfactory HSS results. Statistically, there was a highly significant correlation between patient assessment and postoperative results.

Conclusion
Osteochondral autograft has a good rate of success and reliability of subchondral bone healing, with a high survival rate of the articular cartilage graft and consequently improvement in joint function and pain relief.

Keywords:
arthroscopic, autologous, grafts, knee, osteochondral

Egypt Orthop J 48:254–262

1110-1148

Introduction

Articular cartilage is a highly specialized tissue that allows for unique functions within synovial joints. Disruption of the cartilage framework results in alteration of its biomechanical properties [1].

Articular cartilage is susceptible to mechanical trauma. Injury can occur through a single traumatic event or repetitive overloading with forces exceeding the biomechanical carrying capacity of articular cartilage. A single high-impact force may cause chondrocyte death, matrix damage, shearing of cartilage fragments, and subchondral bone injury. Abrasion injuries from chronic meniscal tears or loose bodies can also damage articular cartilage. Repetitive overloading with forces exceeding the biomechanical carrying capacity of articular cartilage from obesity or malalignment generally results in irreparable damage [2]. These alterations, in turn, can lead to the patient's perception of pain, loss of motion, strength, or instability [2].

The treatment of a focal full-thickness articular defect in the knee has continued to present a challenge, with no traditional treatment method providing consistent acceptable long-term clinical results. Analgesics and anti-inflammatory medications, chondroprotective agents, activity modification, and physical therapy may provide partial symptomatic relief, but they do not restore damaged articular cartilage to its normal state [3].

Full-thickness chondral defects of weight-bearing articular surfaces of the knee are a difficult condition to treat. Our aim is to evaluate the short-term functional outcome of the treatment of osteochondral defects of the knee with autologous osteochondral transplantation using the osteochondral autograft transfer system technique.

Patients and methods

This prospective study includes 19 adult patients, 16 men (84.2%), and three women (15.8%), mean age 29.6 years (range 22–35 years), with focal articular cartilage full-thickness defects of the knee less than 2 cm in diameter. All of them were treated by arthroscopic osteochondral autograft transplantation in the period between May 2006 and June 2009. All cases were treated by the same surgeon at the orthopedic department of Benha university hospital and Al Helal hospital, Cairo. The right side was affected in 13 (68%) patients and the left side was affected in six (32%) patients.

Preoperatively, patients had complaints of joint line pain, swelling especially after activities, catching, functional limitations, and giving way with activities.

The mean preoperative duration of symptoms was 17.4 months (ranged 9–36 months). The mean follow-up period was 24.2 months (range 12–36 months). Associated knee pathology was found in 12 patients (63.2%) and seven patients had an isolated chondral defect (36.8%). Associated knee pathology was synovitis and effusion (11 patients); medial plica (two patients); and/or loose body (three patients).

All patients with severe knee pathologies such as severe knee arthritis, severe malalignment, complete medial collateral ligament tears, lateral collateral or anterior cruciate ligament, or posterior cruciate ligament ruptures were excluded from the study. Patients with defect diameter of more than 2 cm were excluded from this study.

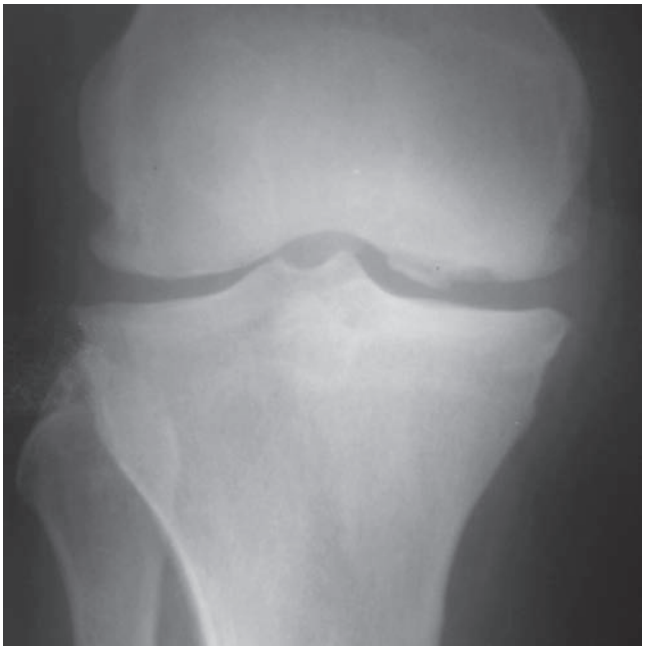
Methods

All patients were subjected to a thorough clinical examination preoperatively and postoperatively. This included analysis of complaints in relation to pain, swelling, giving way, locking, stiffness, walking ability, and functional limitation of activities such as running, squatting, and ascending or descending stairs. Physical examination included assessment of points of tenderness, swelling, range of motion, deformity, quadriceps strength, tests for menisci, stability testing, and patellar mobility.

All patients had been subjected to plain standing radiography in the anteroposterior view, a lateral view with the knee flexed 35°, a 45° patellar sunrise view, and an intercondylar notch view. Three patients were diagnosed with osteochondral defect on radiography they showed a loose fragment and a defect in bone in the medial femoral condyle (Fig. 1). One-third of the patients showed evidence of joint line narrowing, caused by decreased thickness of articular cartilage of that portion of the knee. Plain radiographs will be normal in most cases of localized, nonseparated articular cartilage lesions of the knee.

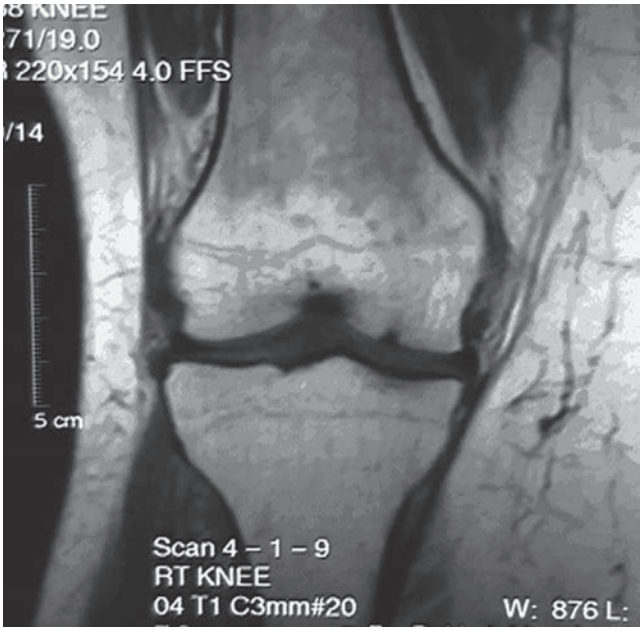
All patients in this study were subjected to preoperative MRI (Fig. 2) and all of them were subjected to postoperative MRI in the follow-up period (Figs 3 and 4).

Figure 1



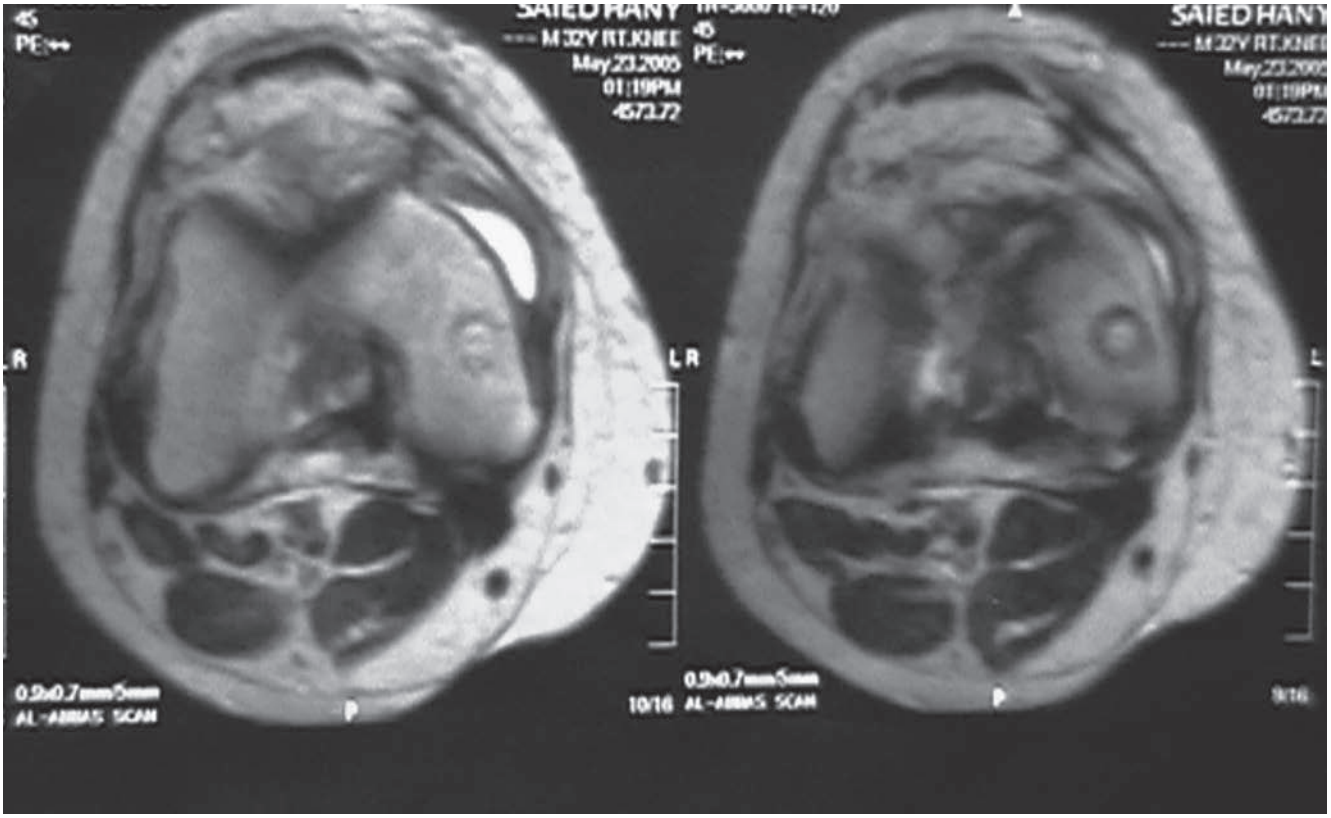
Preoperative radiograph showing osteochondral lesions of the medial femoral condyle.

Figure 2



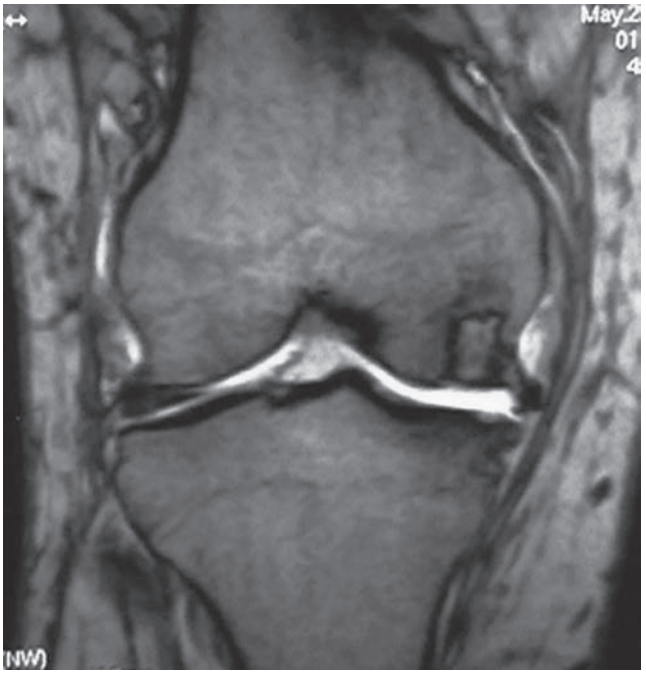
Preoperative MRI scan shows a cartilage defect in the medial femoral condyle as a depression field by knee fluid.

Figure 3



Follow-up MRI scan after 5 months of cartilage repair with excellent results.

Figure 4



Follow-up MRI scan after 3 months of cartilage repair.

Preoperative MRI plays an important role in detecting the lesion if plain films are normal. A crescentic or an ovoid focus of subchondral signal abnormality is evident. A high signal intensity line on T2W images between the fragment and the underlying bone is the most common sign of unstable lesions. Surface irregularities, focal defects filled with joint fluid, and knee effusion may be seen in separated osteochondral fragments. MRI sizing (using electronic calipers) and location of the defect were recorded. The diameter of the defect is an exclusion criterion for large defects more than 2 cm in diameter. Also, those with associated meniscal injury and or cruciate ligament injury were excluded from the study. Routine preoperative laboratory investigations were performed for all patients.

Inclusion criteria were patients younger than 50 years of age with symptomatic knee pain, limited function, and with focal lesions less than 2 cm in diameter on the weight-bearing surface of the femoral condyle with intact cartilage surrounding the defect area (Table 1).

Exclusion criteria were patients with a history of previous knee infection; generalized osteoarthritis; morbid obesity; severe malalignment; kissing cartilage lesions; and patients unwilling to comply with postoperative weight-bearing restrictions and a postoperative program.

For standard comparison between the preoperative and the postoperative state of the knee, several scoring systems

Table 1 Characteristics of the patients of the study

Cases	Age (years)	Sex (M/F)	Side (RT/LT)	Duration of symptoms	Preoperative score	Size of defect (cm)	Follow-up (months)	Postoperative score	Associated knee injuries and associated pathology
1	22	M	RT	12	85	1	24	95	Synovitis, EF
2	26	M	RT	24	82	0.8	36	90	MP, synovitis, EF
3	35	M	LT	26	69	1.2	24	84	Synovitis, EF
4	35	M	RT	14	79	1.2	24	95	–
5	33	F	RT	10	69	0.6	36	84	Synovitis, EF
6	29	M	LT	16	82	0.8	24	96	–
7	22	M	RT	30	68	1.2	12	59	Synovitis, EF
8	29	M	RT	9	84	1	18	96	–
9	24	M	LT	24	69	1.8	18	69	Synovitis, EF, LB
10	34	M	LT	12	78	1.4	24	96	LB, synovitis, EF
11	32	F	RT	18	84	0.8	24	98	–
12	29	M	RT	12	70	1	36	92	Synovitis, EF
13	31	M	RT	36	69	1.2	24	84	Synovitis, EF
14	29	M	LT	23	82	1	26	98	MP
15	30	M	RT	12	69	1.4	16	84	–
16	26	M	RT	10	58	0.6	30	84	Synovitis, EF
17	35	M	LT	20	84	1.2	36	69	LB, synovitis, EF
18	32	F	RT	12	64	1	18	84	–
19	30	M	RT	10	82	0.8	36	98	–

EF, effusion; F, female; LB, loose body; LT, left; M, male; MP, medial plica; RT, right.

were used. In our study, the Hospital for Special Surgery knee service rating system (HSS) was used, which assigns a maximum 100 points to a normal knee and is more simple and precise than other systems such as international knee documentation committee, which are more suitable for evaluation of knee ligament injuries [4,5] (Table 2).

Table 2 HSS rating system included the following

(1) Pain (30 points)	
No pain	30
Mild pain (not interfering with activity or sleep and/or relieved by aspirin)	20
Moderate pain (either reducing activity or disturbing sleep and relived partially by aspirin)	10
Sever pain (occurs after walking any distance and/or not relived by aspirin)	0
(2) Function (22 points)	
(A) Walking ability (12 points)	
Outdoor, 30 min or more or 500 m or more	12
Outdoors, 15 to <30 min or 300 to <500 m	8
Outdoors, 10 to <15 min or 100 to <300 m	4
Indoors only, <10 min or <100 m	2
(B) Climbing stairs (5 points)	
Able without support	5
Unable without support	2
(C) Transfer activity (5 points)	
Able without support	5
Unable without support	2
(3) Range of motion (18 points)	
More than 100°	18
81–100°	15
61–80°	8
Less than 61°	0
(4) Stability (10 points)	
Stable 0–5°	10
Mild instability 6–10°	8
Moderate instability 11–15°	5
Sever instability, more than 15°	0
(5) Flexion deformity (10 points)	
No flexion deformity	10
Less than 5°	8
5–10°	5
More than 10°	0
(6) Muscle strength (10 points)	
Cannot break quadriceps power	10
Can break quadriceps power	8
Moves through arc of motion	4
Cannot move through arc of motion	0

HSS scoring system was graded as follows: excellent, ≥85 points postoperative score; good, 70–84 points postoperative score; fair, 60–69 points postoperative score; poor, > 60 points postoperative score.
HSS, Hospital for Special Surgery knee service rating system.

Operative technique

General or regional anesthesia with tourniquet control is recommended; the patient is positioned supine with the knee capable of 120° flexion. Standard arthroscopic instrumentation and osteochondral autograft transfer complete system instrumentation are required; we used the Arthrex Osteochondral Autograft Transfer System (Arthrex, Inc., Naples, Florida, USA) in all cases. The fluid pump system was used in 12 patients.

Anteromedial or anterolateral portal 'incision,' which allows the best perpendicular approach to the surface of the lesion, is selected guided by a spinal needle (Fig. 5), which is usually more central than the standard portals because of the inward curve of the condyles. The surrounding fat pad is taken down using a motorized shaver.

Most of the femoral condylar defects can be managed arthroscopically, as for most of these lesions, central anterior medial and central anterior lateral portals will allow correct perpendicular access (Fig. 5).

The potential donor sites are directly adjacent to the superolateral margin of the intercondylar notch (notchplasty and roofplasty area in anterior cruciate ligament reconstruction).

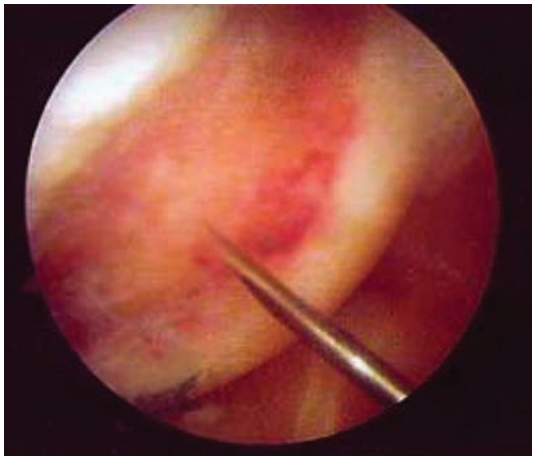
Alternative donor sites lie in an area along the outer edge of the lateral femoral condyle, above the sulcus terminalis. If a single core transfer has been selected to repair the defect, the recipient tube harvester is positioned to cover the entire defect and is driven into

the subchondral bone to a depth of ~13 mm. During socket creation, attention to maintaining the harvester at a 90° angle to the articular cartilage in both the sagittal and coronal planes is very important to achieve a successful transfer. A calibrated alignment stick of an appropriate diameter may be used to measure the recipient socket depth and to correctly align the angle of the recipient socket. The alignment stick may be used as an impactor to 'fine tune' recipient socket length.

In small defects 1 cm or less in size, only a single core is used (Fig. 6); if more than a single core is used, all subsequent grafts are harvested and inserted in a similar pattern. Each core transfer should be completed before processing the next one, leaving a 1–2 mm space to prevent fracture of the tunnel wall. Donor sockets are routinely left open after harvesting or cancellous bone removed from the recipient area may be inserted into donor sites and should be impacted firmly.

Postoperatively, suction drain for 24 h, crepe bandage, or a hinged brace for support, ice fomentation, and non-weight-bearing for a period of between 4 and 8 weeks, depending on the size and position of the cartilage defect, should be performed. Throughout this period, gradual return to weight bearing, knee mobilization without placing the grafts at risk, range of motion exercise until full hyperextension equal to the opposite side, and isometric exercises of all muscle groups, especially the vastus medialis muscle, are important.

Figure 5

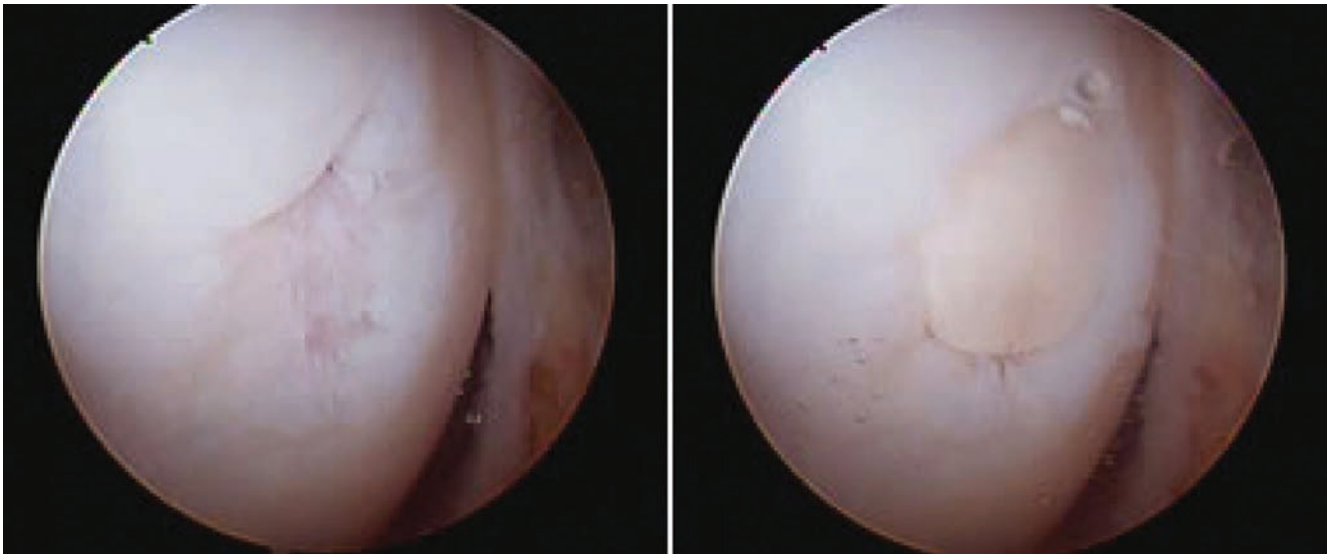


Identification of the best perpendicular portal site by a spinal needle.

Results

The patients were evaluated after osteochondral autograft transfer periodically every week for 4 weeks, every 2 weeks for 8 weeks, and every 3 weeks thereafter until the end of the follow-up period. During each visit, clinical evaluation and standing radiography were performed; postoperative MRI was performed after 12 weeks. The postoperative clinical assessment scoring was performed using the same preoperative scoring system (HSS). The excellent and good results were considered as satisfactory, whereas fair and poor results were considered as unsatisfactory results. The mean follow-up period was 24.2 months (range 12–36 months). A second-look arthroscopy was not routinely performed but was done in three unsatisfactory cases with recurrent attacks of pain and effusion. The HSS was

Figure 6



Operative arthroscopic pictures of the cartilage defect before and after OAT repair by one core harvested from the intercondylar notch. OAT, osteochondral autograft transfer.

used preoperatively as well as postoperatively for clinical evaluation of the knee states. The mean preoperative clinical score was 75.1 points (58–85 points). The results were collected and a sum of 100 points was obtained and graded. Excellent results were recorded in 10 patients (52.6%), good in six (31.6%), fair in two (10.5%), and poor in one patient (5.2%). There was a significant relation between the preoperative clinical score and postoperative results, that is, the higher the preoperative clinical scores, the better the postoperative results.

The best results were observed with patients who were followed for a period up to 24 months (14 patients, 72.7%). About 92.8% of these patients showed satisfactory results. Those followed for less than 24 months (five patients, 27.2%) had up to 60% (three patients) unsatisfactory results. Statistically, there was a highly significant effect of follow-p duration on the postoperative results.

About 84.2% (16 patients) of the patients were enthusiastic or satisfied with their results. All of these patients had satisfactory HSS results. Statistically, there was a highly significant correlation between patient assessment and postoperative results (Table 3). Although age was not an exclusion criterion in patient selection, all our patients were younger than 35 years old probably because of exclusion of patients with arthritic changes. Sex had no significant effect on the final postoperative result; of eight women, seven had satisfactory results (87.5%) and of 11 men, nine had satisfactory results (81.9%).

Statistically, there was an insignificant difference between the operated right and the left side. Nine patients presented with symptoms' duration equal to or less than 1 year; all of them showed satisfactory results. Eleven patients presented with symptoms' duration ranging from more than 12 months to 3 years; eight (72.7%) of these patients showed satisfactory results and three (27.3%) patients showed unsatisfactory results. The difference between both groups was found to be statistically significant.

Eleven patients (57.8%) had a chondral defect up to 1 cm; all of them showed satisfactory results. Eight patients (42.2%) had a chondral defect up to 1.8 cm; five of them showed satisfactory results (26.3% of all cases and 62.5% of those with a defect 1–2 cm). Three of this last group of patients with a 1–2 cm chondral defect showed unsatisfactory results (15.7% of all cases and 37.5% of those with a defect 1–2 cm).

Table 3 Relation between patient assessment and postoperative results

	Postoperative results				
Patient assessment	Excellent	Good	Fair	Poor	Total
Enthusiastic	7	1	0	0	8
Satisfied	3	5	0	0	8
Noncommitted	0	0	2	0	2
Disappointed	0	0	0	1	1
Total [*n* (%)]	10 (52.6)	6 (31.6)	2 (10.5)	1 (5.2)	19 (100)

Statistically, it was proved that the size of a chondral defect had a highly significant effect on the postoperative results. In terms of flexion range in our series, postoperatively, 14 patients (73.7%) had no lack of flexion compared with the healthy side whereas five patients (26.3%) had lack of up to 10° of flexion. Compared with preoperative data, there was a highly significant improvement in the flexion range ($P < 0.01$). Meanwhile, there was no significant effect of the degree of preoperative maximum limitation of flexion on the final end results. Thirteen patients (68%) had an articular cartilage defect on the medial femoral condyle and five patients had lesions in the lateral femoral condyle (32%). The difference between lesions in the medial and the lateral femoral condyle was found to be statistically insignificant.

Articular cartilage congruence could be achieved in 14 cases (73.7%); 13 of these patients (92.9%) showed satisfactory results. Five patients (26.3%) failed to achieve accurate cartilage congruence; two of these patients (10.5% of all patients) showed unsatisfactory results. The relation between articular cartilage congruence and end results was found to be statistically highly significant. In terms of graft harvesting and application, a good match between donor and recipient site was achieved, except in one case (5.2%), in which mismatch between the donor and the recipient site prevented good fitting. Thus, another core had to be taken from the superolateral area of the lateral condyle femur that matched in size; all grafts were well accepted.

Associated knee pathology was found in 12 patients (63.2%) and seven patients had an isolated chondral defect (36.8%). Associated knee pathology was synovitis and effusion (11 patients); medial plica (two patients); and or loose body (three patients). Different arthroscopic procedures were performed for patients: shaving of partial synovial debris, partial synovectomy, medial plica resection, and loose body extraction.

In terms of complications, five patients (26.3%) developed postoperative moderate hemarthrosis after removal of the intra-articular drain 24 h after the operation. Aspiration, cold therapy, and continuous postoperative medication were administered that led to an improvement in the condition of the knee. All cases with postoperative hemarthrosis showed complete recovery.

One patient (5.2%) developed moderate effusion and fever by the fifth day that did not improve by aspiration

or parentral broad-spectrum antibiotic medication. Arthroscopic lavage and partial synovectomy were performed on the 10th day. Culture and sensitivity test showed a streptococcal infection.

Donor site morbidity was present in three patients (15.8%) in the form of local lateral knee pain. These patients show marked improvement with NSAIDS, physiotherapy, and strengthening of muscles around the knee for 3 months.

All grafts were well accepted except for a large-sized graft in one patient (5.3%), which had not engaged properly and in which the surface geometry did not exactly match the surface of the articular lesion.

Discussion

Localized articular cartilaginous lesions such as traumatic chondral injury and osteochondritis dissecans present a challenging clinical problem.

Many surgical techniques, including subchondral drilling, abrasion arthroplasty, osteochondral grafts periosteal or perichondral grafts, and chondrocytes transplantation with collagen gel, have been developed and reported [6].

Because of its lack of both blood supply and undifferentiated mesenchymal stem cells, articular cartilage is known to have limited capacity to repair or regenerate itself; further, defects with articular surfaces often lead to symptomatic degenerative joint disease if left untreated [7].

Many investigators have searched for an ideal material to fill the articular cartilage defects and thereby recreate or restore the normal hyaline cartilage surface topography. Procedures to restore hyaline cartilage such as osteochondral autografting or allograft transfer or autologous chondrocyte implantation have been attempted with variable success [8].

In 1993, Mastusue *et al.* [9] published the first case report and the technique of arthroscopic osteochondral autograft transplantation in an anterior cruciate ligament-deficient knee.

In 1995, Outerbridge *et al.* [10] treated osteochondral defects of the femoral condyle with patellar osteochondral grafts in 10 patients and found that the function of the knee improved and symptoms were alleviated in all patients at an average of 6 and 1.5 years after transplantation. Hyaline cartilage survived up to 9 years.

In 1996 and 1997, Hangody and colleagues published several animal and clinical studies on multiple osteochondral autograft transplantation (Mosaicplasty technique). The animal trials and extensive clinical experience (over 370 procedures) indicated long-term survival of the hyaline articular cartilage. The longest follow-up is 6 years. The histological analysis of transplanted cartilage shows that the specimens were composed of 70–80% hyaline cartilage. The biopsy at 4.5 years showed normal-appearing chondrocytes, normal orientation of chondrocytes and matrix elements, and matrix integration between the hyaline and the fibrocartilage [11].

In terms of preoperative data, preoperative pain was the main complaint of all patients in relation to the other clinical parameters in the preoperative evaluation. This is in agreement with the results of Nicohlas *et al.* [1] that pain, as a complaint, is a very important parameter in the assessment of the degree of joint affection preoperatively and postoperatively. In the present series, the worst results were obtained with those who had severe pain preoperatively and this was highly statistically significant ($P < 0.05$). Ma *et al.* [12] found poor results with severe pain preoperatively.

In the present study, all patients with satisfactory results (75%) had no or mild pain postoperatively. This is in agreement with the findings of Wang [13], who reported that of his patients who achieved satisfactory results, none complained of pain.

Analysis of our results of functional abilities includes walking distance, use of walking aid, and climbing stairs according to the HSS scoring system. On comparing preoperative and postoperative functional abilities, there was no significant change in the walking distance but there was a significant improvement in the ability to climb stairs. Preoperatively, 13 patients (6 8.4%) could climb stairs with support; eight of these patients (61.5%) showed improvement in climbing stairs unsupported postoperatively. This proved that there was no significant effect of preoperative functional abilities on the postoperative results.

Kartaglia *et al.* [14] found no correlation between preoperative functional abilities and the final end results. Wang [13] and Jakop *et al.* [15] reported that 54% of their patients had no limitation in activities, with 21% of patients showing occasional limitation of activities, and it was these patients who had multiple or large-size defects. They also reported that 67% of the patients considered that the arthroscopic procedure had improved their activities.

In terms of the flexion range in the present series, it was comparable with the postoperative results of Mohamed [8], who reported that four patients (28.5%) had lack of flexion up to 15°; three of these patients (75%) achieved a flexion range of more than 100° postoperatively.

In the present study, the highest incidence of satisfactory results was obtained in small chondral defects. These results are in agreement with those of Wang [13], Ma *et al.* [12], Mohamed [8], and Duchow *et al.* [16]. They concluded that patients with small chondral defects have more satisfactory results than those with large cartilage defects.

The difference between lesions in the medial and lateral femoral condyle was found to be statistically insignificant. This was in agreement with the results of Pearce *et al.* [17], Hangody and Peter [18], and Mohamed [8].

For articular congruence in the present series, more unsatisfactory results were obtained with those of incongruence articular cartilage and this was statistically highly significant ($P \leq 0.01$). Wang [13] reported that 84.4% of patients achieved articular congruence; 97% of these achieved satisfactory results. Also, Mitsunobu *et al.* [19], Hangody and Peter [18], and Mohamed [8] reported the highest incidence of satisfactory results with articular cartilage congruence fit as one of two major factors to decreasing joint morbidity after osteochondral grafting.

In the present study, the operative time ranged from 1 to 2 h, with a mean of 1.6 h. Ma *et al.* [12] reported that the mean duration of surgery was 1.7 h, also with no significant relation to the final outcome.

In the present study, the follow-up period had a highly significant effect on the postoperative results and more satisfactory results were obtained up to 36 months. Hangody and Peter [18] attributed their satisfactory results (85%) to several factors, one of which is the relatively long follow-up period.

In our study, one patient (5.2%) developed moderate effusion and fever by the fifth day that did not improve by aspiration or parentral broad-spectrum antibiotic medication. Arthroscopic lavage and partial synovectomy were performed on the 10th day. Culture and sensitivity test showed a streptococcal infection. Wang [13] reported that two patients (2.5%) developed an infection. Neither had a positive culture, but clinically, they had septic arthritis and were treated successfully with arthroscopic lavage and antibiotics. After 2 years, one patient was assessed to have a normal knee and the other was assessed to have a poor knee.

Donor site morbidity was present in three patients (15.8%) in the form of local lateral knee pain. They show marked improvement with NSAIDS, physiotherapy, and strengthening of muscles around the knee for 3 months. This was similar to the results of Hangody *et al.* [20]. They confirmed that the transplanted osteochondral plugs usually heal with preserved vital cartilage. However, there was a persistent cleft between transplanted and recipient cartilage and the subchondral bone in the plugs showed increased stiffening. The donor defects healed with the formation of fibrocartilage. This fact has been considered to be of less concern as the grafts are harvested from areas known to be less-weight bearing. However, some studies suggest that the typical donor areas at the intercondylar notch and the periphery of the femoral condyles above the sulcus terminalis may sustain a significant contact pressure and degrading repair tissue could possibly progress to osteoarthritis.

Mohamed [8] reported that that there was donor site morbidity in three patients (21.4%) that improved after lateral retinacular release.

About 73.7% (14 patients) of the patients were enthusiastic or satisfied with their results. All of these patients had satisfactory HSS results. Statistically, there was a highly significant correlation between patient assessment and postoperative results.

These results are very similar to those obtained by Hangody *et al.* [20], Alan *et al.* [21], Ma *et al.* [12], and Mohamed [8], who reported that around 75% of their patients were satisfied with their results.

We conclude that mosaicplasty leads to an improvement in symptoms and function in knees with articular cartilage defects at the short-term follow-up. The majority of the patients (84.2%) experienced an improvement in symptoms and function compared with the preoperative situation and 84.2% reported that they would undergo the procedure again if necessary.

However, a deterioration in the results was observed from 12 months postoperatively to 5–9 years postoperatively.

Further research is necessary to investigate the implications and causes of the findings.

Conclusion

An osteochondral autograft has a good rate of success, reliability of subchondral bone healing with a high survival rate of the articular cartilage graft, and consequently improvement in joint function and decrease pain. Preoperative clinical score and the size of the chondral graft have a very highly significant effect on the final end results, with the best results observed in patients with a score of more than 69 points.

In an osteochondral autograft, preoperative planning using characteristic data of the donor and recipient sites with respect to articular cartilage thickness, concavity, and contact pressure seems to be very helpful. Primary stability of the grafts has been shown to play a role in the healing of these grafts. Incongruity of the articular surface at the repair site can occur either because of technical problems or later as a result of degeneration of osteochondral plugs.

Accurate alignment of the graft with the surrounding articular cartilage was found to be highly statistically significant. MRI has been shown to be an effective method to diagnose chondral injury, to aid in the selection of therapeutic intervention, and to assess the short-term outcome of repaired articular cartilage. Osteochondral autograft transplants have been associated with a good rate of success, but further long-term follow-up and biomechanical evaluation are essential.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

References

1 Nicohlas A, Sgaglione MD, Scott D. Update on advanced surgical techniques in the treatment of traumatic focal articular cartilage lesions in the knee. Arthroscopy 2002; 18:9–32.

2 Chu MD. Articular cartilage regeneration. Case report. Orthop Technol Rev 2002; 4:20–24.

3 Robert F, Brian K, Hollis M. Articular cartilage injuries of the knee: evaluation and treatment options. Phys Sportsmed 2001; 29:10–20.

4 Karataglis D, Green MA, Learmonth DJ. Autologous osteochondral transplantation for the treatment of chondral defects of the knee. Knee 2006; 13:32–35.

5 Gudas R, Stankevicius E, Monastyreckiene E, Pranys D, Romas JK, *et al*. Osteochondral autologous transplantation versus microfracture for the treatment of articular cartilage defects in the knee joint in athletes. Knee Surg Sports Traumatol Arthrosc 2006; 2:1066–1075.

6 Alleyne KR, Galloway MT. Management of osteochondral injuries of the knee. Clin Sports Med 2003; 20:343–364.

7 Buckwalter JA, Rosenberg LC, Huniziker EB. Articular cartilage: composition, structure response to injury, and methods of facilitating repair. In: Ewing JW, editor. *Articular cartilage and knee joint function: basic science and arthroscopy*. New York, NY: Raven Press; 1990. pp. 19–56.

8 Mohamed HN. Ostreochondral autograft transplantation in treatment of focal articular cartilage defects of the knee. Pan Arab J Orthop Trauma 2005; 9:183–189.

9 Mastusue Y, Yamamuro T, Hama M. Arthroscopic multiple osteocjondral transplantation to the chondral defect in the knee associated with anterior cruciate ligament disruption. Arthroscopy 1993; 9:318–320.

10 Outerbridge HK, Outerbridge AR, Outerbridge RE. The use of the lateral patellar autologous graft for the repair of a large osteochondral defect in the knee. J Bone Joint Surg 1995; 77A:312–322.

11 Hangody L, Feczko P, Barth L. Autogenous osteochondral graft technique for replacing knee cartilage defects. Orthop Int 1997; 5:175–181.

12 Ma HL, Hung SC, Wang ST. Osteochondral autografts transfer for post-traumatic osteochondral defect of the knee — 2 to 5 years follow-up. Injury 2004; 35:1286–1292.

13 Wang CJ. Treatment of focal articular cartilage lesions of the knee with autogenous osteochondral grafts. A 2- to 4-year follow-up study. Arch Orthop Trauma Surg 2002; 122:169–172.

14 Kartaglia D, Green MA, Learmonth DJ. Autologous osteochondral transplantation for the treatment of chondral defects of the knee. Knee 2006; 13:32–35.

15 Jakop RP, Franz T, Gautier E. Autologous osteochondral graft in the knee: indication, results, and reflections. Clin Orthop 2002; 401:170–184.

16 Duchow J, Hess T, Kohn D. Primary stability of press-fit-implanted osteochondral grafts. Influence of the graft size, repeated insertion, and harvesting technique. Am J Sports Med 2000; 28:24–28.

17 Pearce SC, Hurtig MB, Clarnette R, Kalra M, Cowan B, Miniaci A, *et al*. An investigation of 2 techniques for optimizing joint surface congruity using multiple cylindrical osteochondral autografts. Arthroscopy 2001; 17:50–55.

18 Hangody LA, Peter FU. Autologous osteochondral transfer graft for the treatment of full-thickness defects of weight-bearing joints. J Bone Joint Surg Am 2003; 85:25–32.

19 Mitsunobu TE, Hiroyuki FU, Shinchi YO. Analysis of the thickness and curvature of articular cartilage of the femoral condyle. Arthroscopy 2003; 19:969–973.

20 Hangody L, Kish G, Karpati Z. Mosaicplasty for the treatment of articular cartilage defects: application in clinical practice. Orthopedics 1998; 21:751–756.

21 Alan BA, James CY, Chow M. Arthroscopic osteochondral transplantation: histological and clinical results. Arthroscopy 2001; 17:832–835.