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ORIGINAL ARTICLE

Arthroscopic Osteo-chondral Auto-Graft Transplantation for Focal Cartilage Defect of the Medial Condyle of the Femur

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Abstract

Purpose: To evaluate the efficacy and outcomes (functional and radiological) of arthroscopic Osteo-chondral Auto-graft Transplantation (OAT) for focal cartilage defects of medial condyle of the femur.

Method: Twenty patients, Seventeen males (85%) and three females (15%), with a mean age of (24.95±6.6) and mean body mass index (BMI) (24.6±2.46) and a full-thickness chondral lesion of the articulating weight bearing surface of the medial femoral condyle, were treated by (OAT) from non-weight bearing region of the lateral femoral condyle. Our patients were evaluated using Lysholm score pre-and postoperatively. Post-operative and pre-operative plain radiographs of the affected knee and knee MRI were done for all patients (n=20).

Results: Following a median follow-up period of 32±14 months (ranging from 13 to 46 months), there was a highly statistically significant increase in post-operative Lysholm Score (84.2±10.9) compared with pre-operative Lysholm Score (45.2±14.6) with P value (<0.001). Follow-up MRI of the affected knee at six months showed adequate graft incorporation in all cases, with adequate coverage of the defect in 17 cases (85%) and inadequate coverage in 3 cases (15%). Chondral defect size demonstrates a substantial positive correlation with the statistically significant results (P value 0.047), suggesting a robust relationship.

Conclusion: The (OAT) although technically demanding, in this work, it was demonstrated that Osteo-chondral Auto-graft transplantation is an effective method for treating focal cartilage defects on the weight-bearing surface medial condyle of the femur, even in cases with significant defects (up to 4 cm^2).

Keywords: Medial femoral condyle; Osteo-chondral Auto-graft Transplantation; Osteo-chondral Defects

1. Introduction

Significant knee dysfunction, chronic pain, and recurrent knee effusion can result from a focal cartilage defect of the weight-bearing surface of the medial condyle of the Femur. This condition may also hasten the onset of osteoarthritis (OA) and induce disability.[1-3]

The goals of treating symptomatic medial femoral condyle chondral abnormalities are to lessen discomfort, enhance joint congruence, and stop further cartilage deterioration.[4]

A number of factors need to be considered in order to make the right decision. The most crucial factors include the patient's physical and emotional well-being, limb malalignment, and the extent and location of the problem.[5]

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There are different treatments modalities whether non-operative[5], or palliative measures appropriate for individuals with low demand, like debridement and lavage, reparative such as marrow-stimulating techniques that enhance a fibrocartilage healing response in the area of the defect (drilling, abrasion arthroplasty, or micro-fracture)[4,6,7], or reconstructive methods that use intact articular cartilage to replace the damaged one; these methods include osteochondral auto-grafting [8,9], autologous chondrocyte implantation [10,11], or osteo-chondral allo-grafting.[12]

The process known as "Osteo-chondral Autograft Transfer" involves moving subchondral bone and healthy cartilage from an area with little load bearing to the lesion.[9] Open procedure, mini-arthrotomy, or arthroscopic procedures could be used for this. There is ample documentation of the complications, which include donor-site morbidity and the finite quantity of plugs that may be extracted.[13,14]

This study's objectives were to assess the effectiveness of OAT in correcting localized cartilage defects, particularly those that are located on the medial condyle of the femur, as well as any potential side effects.

2. Patients and methods

Twenty patients with mean ages of 24.95±6.6 and BMIs of 24.6±2.46, of whom seventeen (85%) were male and three (15%) were female, participated in this prospective study. Every patient gave their informed permission (Table 1).

Table 1: Demographic characteristics of studied patients.

		STUDIED PATIENTS (N=20)
GENDER	Male	17 (85 %)
	Female	3 (15 %)
AGE	Mean±SD	24.95±6.6
	Range	17-38
BMI	Mean±SD	24.6±2.46
	Range	20-30

Antero-posterior and lateral plain radiographs of the afflicted knee were obtained (fig. 1). In every instance, a knee MRI was performed to evaluate the location, extent, and size of the chondral defect as well as any related pathology and the existence of loose osteo-chondral fragments (fig. 2).

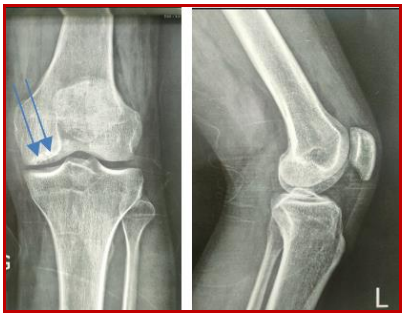

Figure (1): Plain X-ray of the knee that reveals an osteochondral problem

Figure (2): The MRI images indicate an osteochondral defect on the medial condyle of the femur

We included patients with full thickness focal chondral or osteochondral lesion located on weight bearing articulating surface of the medial femoral condyle, with a defect between 1.5 and 4 cm^2.

Patients with radiographic advanced osteoarthritis, major mal-alignment, concomitant ligament reconstruction, concomitant meniscal repair, skeletally immature, or systemic inflammatory disorders, were excluded.

2-1Surgical Technique

All patients in our study underwent arthroscopic surgery under regional (spinal) anesthesia.

Diagnostic Arthroscopy: Arthroscopic examination of the knee joint was conducted, utilizing two portals (anterolateral and anteromedial), to evaluate the size and position of the cartilage defect on the medial femoral condyle (MFC). Additionally, any loose osteo-chondral fragments were removed, and any related pathology was assessed. (Fig 3,4).

Figure (3): Two arthroscopic portals

Figure (4): Loose osteo-chondral fragment

Cartilage Defect Preparation and Measurement: Any unstable or damaged cartilage surrounding the defect was debrided using arthroscopic shavers and curettes to create a stable base for graft placement. The size and depth of the defect were measured using arthroscopic probes to detect the size and number of harvested plugs.

Donor Site Preparation: With the antero-medial portal serving as the viewing portal and the anterolateral portal serving as the working portal, graft harvesting got underway. A non-weight-bearing region in the lateral condyle, away from the patellofemoral articulation, was shown to be the donor location for the osteochondral auto-graft when the knee was in a 15-degree flexion position or fully extended. The Arthrex Osteochondral Autograft Transfer System (OATS; Arthrex, Naples, FL) donor harvesting blue set (of the chosen size) was introduced to designate and prepare the area for graft harvesting (Fig. 5) which applied perpendicular to the articular cartilage through the anterolateral portal. Hammering over the harvesting blue set till it reaches the desired length about 15-17 mm. The harvesting set was spun 90° clockwise and counterclockwise three to four times before extracting the core (Fig. 6).

Figure (5): Arthrex Osteochondral Autograft Transfer System (OATS; Arthrex, Naples, FL).

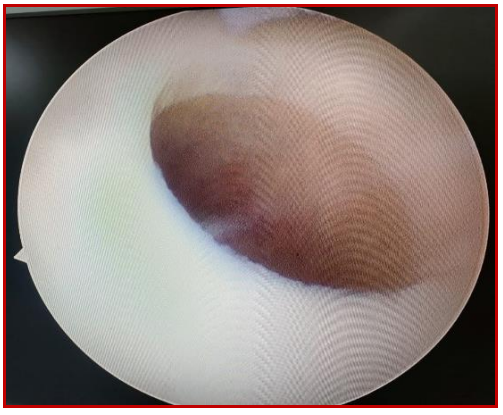

Figure (6): Donor site at lateral femoral condyle.

Graft Insertion: Again, Anterolateral portals were used for observing, and antero-medial portals were used for working with the knee sufficiently bent to provide complete access to the defect, a recipient white set (of the selected size) was introduced perpendicular to the defect. Hammering over the recipient white set till it reaches the desired length about 12-14 mm. After three or four 90° clockwise and counterclockwise rotations of the recipient white set, the core was removed (Fig. 7).

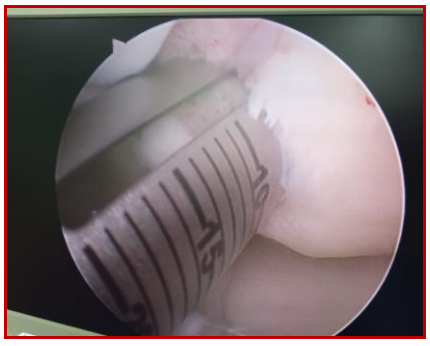

Figure (7): Recipient site preparation of the medial femoral condyle.

The harvested osteo-chondral auto-graft transferred to the defect site using transparent tube. The graft was impacted gently into the defect to ensure stability and proper alignment with the surrounding cartilage (Fig 8). The recipient plug was inserted in the donor socket (Fig. 9).

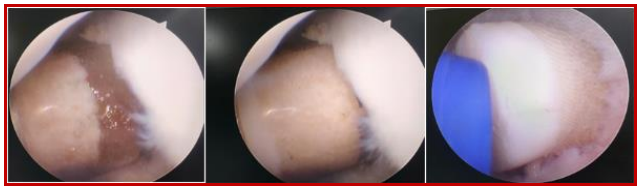

Figure (8): Auto-Graft insertion in the defect

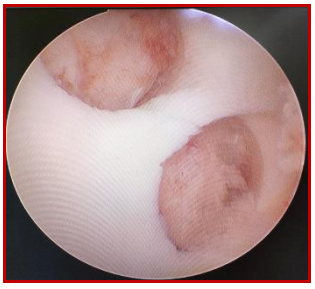

Figure (9): Donor Socket.

Depending on the magnitude of the defect and the quantity of harvested plugs, the process was repeated two or three times (Fig. 10).

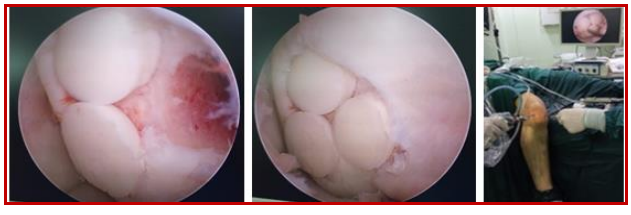

Figure (10): Three Auto-Graft plugs (10 mm) filling the defect.

Closure and Dressing: The knee was moved to its maximum range of motion after the osteochondral auto-plugs were firmly in place to ensure the plugs' stability. Sutures were used to seal the arthroscopy portals; suction drains were not used.

2-2Postoperative Care:

The knee was fitted in a hinged knee brace, and after two weeks, The motion range was gradually upgraded until it reached full flexion after eight weeks. The goal was to quickly restore proprioceptive neuromuscular control. Six weeks following surgery, dynamic strength activities were included. Four weeks following surgery, partial weight bearing was permitted, and at eight weeks, full weight bearing was permitted. After six months, patients were typically permitted to resume their regular activities.

2-3Evaluation

Regular follow-up was scheduled to assess the progress of the patient's recovery and degree of knee function restoration. The clinical outcome was analyzed at 12 months after operation using lyshlom score.[15] At six months following surgery, all patients had plain radiographs and MRIs to assess graft congruency and corporation (Fig. 11). We didn't routinely do a 2nd lock except for female patient with knee stiffness that didn't respond to physiotherapy.

The statistical program of social science software, version 21 (SPSS), was used to input pre-coded data onto the computer for statistical analysis. For quantitative variables, data are described using mean ± SD, and for qualitative factors, number and percent. Statistical significance was defined as a P value of less than 0.05.

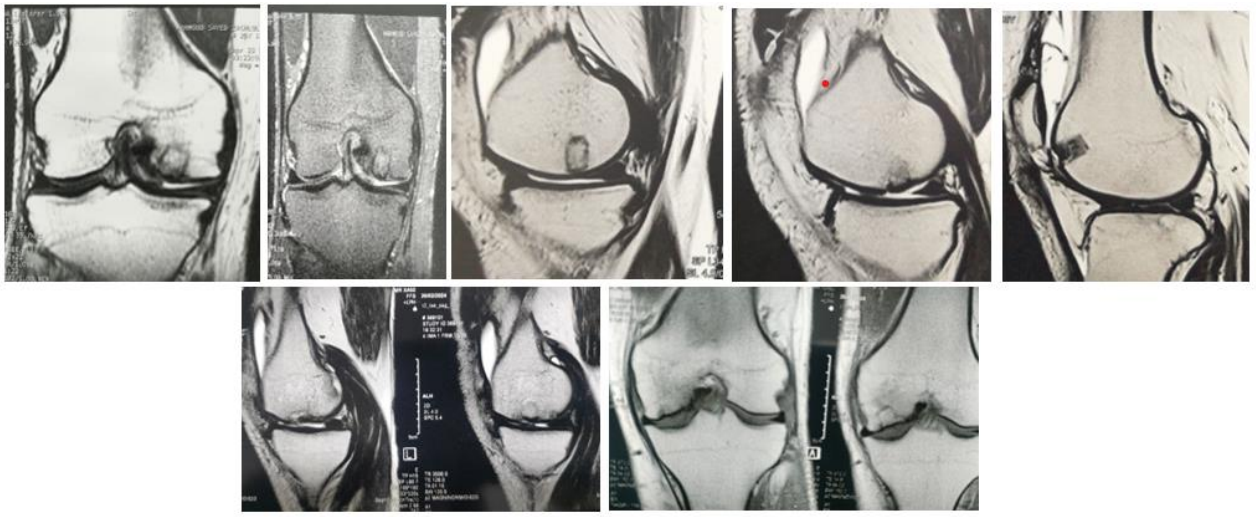

Figure (11): Post-operative follow up MRI of 2 cases

3. Results

The average follows up range from 13 months to 46 months (mean 32±14 months). The average Lysholm score twelve months after operation were improved significantly (P value <0.001), from 45.2±14.64 preoperatively to 84.2±10.9 postoperatively. The end results were categorized as excellent in five cases (25%), good in eleven cases (55%), and fair in four cases (20%). These outcomes indicate predominantly positive results following the intervention, with the majority achieving good or excellent outcomes. Table 2. All patients returned to activity of daily living at an average of 5.4±2.6 months.

Table 2: Lysholm Score

LYSHOLM SCORE STUDIED PATIENTS (N=20)			
PRE-OPERATIVE	Mean ± SD		45.2±14.64
	Range		21-71
POST-OPERATIVE	Mean ± SD		84.2±10.9
	Range		60-100
P VALUE			<0.001
		N (20)	%
END RESULTS	Excellent	5	25
	Good	11	55
	Fair	4	20

Intermittent locking was present in 55 % of patients preoperatively and totally improved at last follow up post-operatively. The mean preoperative flexion motion deficit was 35.0±29.1 degrees that was significantly improved to 9.5±15.71 postoperatively (p value≤0.001) Table 3.

Table 3: Pre- and post-operative clinical

		STUDIED PATIENTS (N=20)	
		N	%
PRE (LOCKING)	Intermittent	11	55
	No-locking	9	45
PRE-OPERATIVE FLEXION MOTION DEFICIT	Mean ±SD	35.0±29.1	
	Range	0-70	
POST-OPERATIVE FLEXION MOTION DEFICIT	Mean ±SD	9.5±15.71	
	Range	0-60	
P VALUE		≤0.001	

Intraoperative arthroscopic assessments showed, reactive synovitis in six cases (30%), loose bodies extraction in twelve cases (60%), PHMM degenerative fraying with arthroscopic shaving in two cases (10%), and PHMM complex tears with arthroscopic partial menisectomy in one case (5%). The mean chondral defect size was 2.25±0.52 cm^2 with range from 1.5-4 cm2. The number of graft plugs varied, with the most common being two plugs of 10 mm grafts (45%) Table 4.

Table 4: Intra-operative Arthroscopic Findings.

		STUDIED PATIENTS (N=20)	
		N	%
INTRA-OPERATIVE FINDING	Reactive Synovitis	6	30
	Loose body	12	60
	Degenerative PHMM	2	10
	Complex tear PHMM	1	5
SIZE OF THE DEFECT (CM^2)	Mean ±SD	2.25±0.52	
	Range	1.5-4	
NUMBER OF GRAFT PLUGS	Two plugs (8mm)	8	40%
	Two plugs (10mm)	9	45%
	Three plugs (8mm)	2	10%
	Three plugs (10mm)	1	5%

Follow up MRI at six months showed good graft incorporation in all cases with adequate coverage of the defect in 17 cases (85%), and inadequate coverage in 3 cases (15%).

The correlation analysis reveals that age and Body Mass Index (BMI) exhibit weak positive correlations with end results, although these associations lack statistical significance (P value 0.086 and 0.073, respectively). In contrast, chondral defect size and gender (with male results better than females) demonstrates a substantial positive correlation that is statistically significant (P value 0.047 and 0.046 respectively), suggesting a robust relationship. Notably, as the defect size decreases, end results tend to be better.

In our study, complications included one female case (5%), which required manipulation and arthroscopic arthrolysis due to knee stiffness; two cases (10%) had haemoarthrosis; two cases (10%) had superficial wound infections; one case (5%), which had DVT; and three cases (15%) had donor site pain and patellofemoral crepitus.

4. Discussion

Because articular cartilage is avascular, it cannot fully regenerate. In active people, an untreated chondral defect may enlarge and cause degenerative arthritis. The type of the procedure depends on the extent and magnitude of the defect.[5,16]

An arthroscopic or mini-arthrotomy surgery can be used to treat the localized chondral defect of the medial femoral condyle using the (OAT) technique.

The mean chondral defect size in our study was 2.25±0.52 cm^2 with range from 1.5-4 cm2. The arthroscopic OAT was used in all cases of our study with no need for open technique. On the other hand, Kizaki et al.[17] in his systematic review reported that open OAT allowed treatment of large lesions. The defect size in Quarch et al.[18] and Clavé et al.[19] with open techniques were 4.6 cm2 and 4.07 cm2 respectively while in Gudas et al.[20] and Kosiur et al.[21] with arthroscopic techniques were 2.8 cm2 and 0.8 cm2 respectively.

The outcomes of our study were evaluated using the Lysholm score method. Twelve months following surgery, the average Lysholm score improved dramatically (P value<0.001), going from 45.2±14.64 preoperatively to 84.2±10.9 postoperatively.

The findings of our research were similar to those of Oztürk et al.[8]; Lysholm's score increased from 45.8 to 86.5 points in their study.

Also Chow et al.[22] conducted a study including 33 patients, and the Lysholm score was improved from 43.6 to 87.5 points.

Solheim et al.[23] presented a similar outcome. Thirty-three of their patients were as old as fifty. The diameter of the articular cartilage defects ranged from 1 to 5 cm. The Lysholm score was used to assess the clinical result; at the one-year follow-up, the mean preoperative score was 48 and had improved to 82 after surgery.

Our outcomes were better than those of Ulstein et al.[4] that included 15 patients with lesion sizes ranging from 2-4 cm2 diameters and a mean age of (32.7±7.8) years. Complete medial parapatellar arthrotomy was employed. At a 2-year follow-up, the study's mean Lysholm score increased from 49.2 points before surgery to 69.7 points afterward. This could be related to significant wound issues that could postpone recovery, yet in our investigation, we exclusively employed arthroscopic procedures.

On the other hand, our results were inferior to results of Ma et al.[3]; Eighteen patients with post-traumatic localized osteochondral lesions of the knee were treated using mosaicoplasty. Twelve of them were men and six were women, ages 16 to 51, with an average age of 29. The average Lysholm score before surgery was 47.5, and the average Lysholm score after surgery was 92.4. It might be because the lesions were brought on by posttraumatic rather than pathologic reasons because the defect was so tiny-between one and two and a half centimeters in diameter.

The correlation analysis reveals that age and (BMI) exhibit weak positive correlations with end results, although these associations lack statistical significance (P value 0.086 and 0.073, respectively). In contrast, chondral defect size and gender (with male results better than females) demonstrates a substantial positive correlation that is statistically significant (P value 0.047 and 0.046 respectively), suggesting a robust relationship. Notably, as the defect size decreases, end results tend to be better.

On the other hand, Chow et al.[22] Barber and Chow [24]; discovered no correlation between the functional outcome and the patient's age at surgery. Solheim et al.[23] discovered that there was a substantial association between the patient's age at the time of surgery and the final Lysholm score, but not between the patient's gender or the size of the grafted area.

Since we didn't employ a closed suction drain in our study, knee haemoarthrosis was one of the side effects of the arthroscopic OAT operation in two of the cases; nevertheless, this haemoarthrosis was alleviated by early application of ice packs and anti-oedematous and prophylactic antibiotics. In the study of Ma et al.[3], a closed suction drain was used with no postoperative effusion nor haemoarthrosis.

We had a lady that had a three graft plugs each of them 8 mm to manage a chondral defect (3 cm) and was lost during early follow up. She was presented to us after 3 months by knee stiffness. Although she was managed by manipulation under anesthesia with arthroscopic arthrolysis but the final result was fair with inadequate coverage of the defect in MRI.

Other complications in our study were deep vein thrombosis that was occurred in one patient with fair final outcome. In the study of Solheim et al.[23]; One patient developed deep vein thrombosis, another patient had septic arthritis, two patients had haemoarthrosis following surgery, and three patients had superficial wound problems.

We did a second look only for one symptomatic knee stiffness case was managed by manipulation under anesthesia with arthroscopic arthrolysis. Solheim et al.[23] did a second look for 23 cases out of 33 case due to insufficient improvement of symptoms. Also, Muller et al.[25] did a second look for 3 symptomatic cases out of 15 knees one of them with purulent discharge and 2 cases due to donor site morbidity by exophyte and last due to remaining cartilage defect.

On the other hand, Chow et al.22 did a second look for 8 cases out of 30 without symptoms. Also, Marcacci et al.26 did a second look for 5 patients with good coverage of the defect.

5. *Conclusion*

Arthroscopic Osteo-chondral Auto-graft Transplantation (OAT), despite its technical complexity, has been shown to be an effective surgery for treating localized cartilage defects in the medial femoral condyle, even in cases of extensive defects (up to 4 cm2). This procedure consistently yields highly favorable outcomes, with a majority of patients experiencing good to excellent results. In our series, the treatment was characterized by being less invasive, more cosmetic, and a one-step process with low morbidity.

Disclosure

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Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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