RESEARCH ARTICLE

# Autogenous Osteochondral Grafting for Treatment of Knee Osteochondritis Dissecans: A Case Series Study

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## Abstract

**Background:** Although some surgical techniques have been described for the operative treatment of unstable Osteochondritis dissecans (OCD) of the knee, outcomes are variable and are not satisfying totally. The aim of the present study is to evaluate the outcomes of autogenous osteochondral grafting for OCD of the knee.

**Methods:** In a case series study, from June 2014 to July 2015, 16 patients with stage II-IV OCD (International Cartilage Repair Society (ICRS)) of the femoral condyle were investigated. Surgical intervention considered in cases of stage III (4 cases) and IV (2 cases) and in stage II (10 cases) ones that were nonresponsive to conservative treatment. At the initial and final visits, the IKDC, Lysholm score and Tegner activity scale were evaluated.

**Results:** The mean preoperative IKDC score (53.4) increased significantly following surgery (84.3) (*P<0.001*). Based on the IKDC grading system, before the operation, the knee status was graded as nearly normal, abnormal, and severely abnormal in 4, 10, and 2 patients, respectively. At final post-surgical follow up, 15 normal and 1 abnormal knee were documented (*P<0.001*). The mean Lysholm score increased from 44.3 per operatively to 86.3 (*P<0.001*).Tegner activity score improved from 2.8±1 pre operatively to 5.6±2 (*P<0.001*).

**Conclusion:** Surgical treatment of unstable OCD using autogenous osteochondral graft shows successful outcomes. In addition to reliable fixation, it can enhance healing and convert an uncontained lesion to contained one appropriate for autogenous osteochondral grafting with healthy cartilage.

**Level of evidence:** IV

**Keywords:** Autogenous osteochondral grafting, Healing enhancement, OCD, Osteochondritis dissecans

## Introduction

Osteochondritis dissecans (OCD), a rare and localized pathological condition, is characterized with aseptic necrosis of a subchondral bone segment with partial or complete fragmentation along with its adjacent articular cartilage (1, 2). Despite substantial researches, the etiology remains idiopathic. However, ossification disorders, frequent loading and repetitive microtraumas, and ischemia are the suggested causes (3-5). OCD may present in various joints, however, the medial and lateral femoral condyles are most commonly involved (6).

As with etiology, the treatment of OCD is controversial. Previous studies have shown that the treatment outcomes for OCD are dependent on the patient's age,

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skeletal maturity, location, size, and the intensity of pathology (7, 8). The prognosis is better with smaller lesions, in younger patients without epiphyseal fusion, and lesions located in the medial femoral condyle (2, 5). Nonsurgical managements including limitation of movement, immobilization, and nonweight bearing ambulations are advised for initial stages of the disease with stable lesions (7, 9, 10). Conservative managements has shown 50-94% success (11). Based on the premise that the pathology is essentially a fracture nonunion that requires neovascularization, drilling, which enhances vascular channels in the devitalized segment, has been advocated for stable OCDs not responding to conservative treatment. A success rate of 80-90% has been seen with the procedure (2, 12-14). For unstable (Mobile lesions while probing during arthroscopy) and symptomatic OCDs, various surgical options are available, however, with limited success results and often requiring a second surgical procedure (7, 15). In general, unstable lesions mandate surgical debridement of fibrotic tissue, enhancing vascular supply, and finally, fixation in association with drilling and maybe osteochondral autogenous transplantation (OAT) (11, 16-20). Previous studies have documented radiographic healing of 80% to 100% with satisfactory clinical outcomes in many patients (5). In recent years, open and arthroscopic OAT of unstable OCDs have shown largely acceptable results (2, 7, 8, 21, 22). The method has been employed for OCD treatment of capitulum with favorable outcomes (10). However, more studies will be needed to verify limited results by this method. The current study evaluated the outcomes of OAT for OCD of the knee.

## Materials and Methods

A total of 21 patients with stage II-IV OCD of the medial and lateral femoral condyle were investigated from June 2013 to July 2014. After obtaining the ethical approval, informed consent was taken from all eligible candidates. The presence of OCD in femoral condyles was diagnosed and evaluated by MRI and CT arthrography and confirmed by arthroscopy in all patients. The lesions were classified based on the Clanton and DeLee Classification preoperatively (3).

Patients with concomitant knee injuries, stage I OCDs, gross malalignment, instability, systemic diseases and past history of knee surgery were excluded. The remaining 16 patients were enrolled in the study. Surgical intervention was considered in cases of stage III (4 cases) and IV (2 cases) and in stage II (10 cases) patients who were nonresponsive to conservative treatment.

Following clinical examination, anteroposterior, lateral, tunnel, and patellar view radiographies and magnetic resonance imaging (MRI) were conducted. Demographic and preliminary data including age, gender, body mass index, the duration of symptoms, and the size of the lesion were recorded. Furthermore, the International Knee Documentation Committee (IKDC) subjective questionnaire, Lysholm score, and Tegner activity scale were completed for patients.

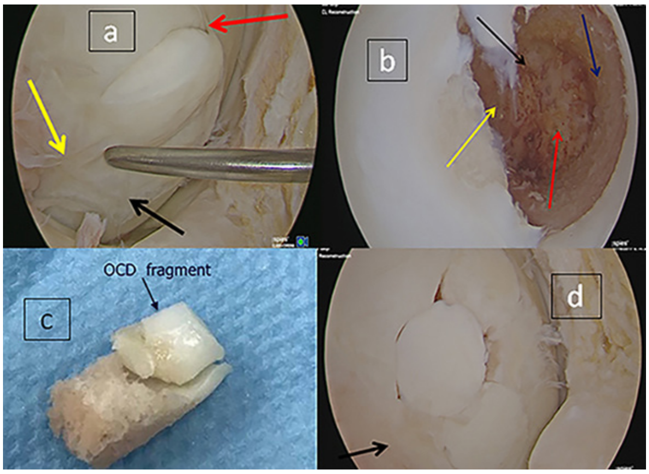


**Figure-1.**
**a. Arthroscopic view of non-contained OCD before displacement (type-3)**
**b. Arthroscopic view of recipient area before plug insertion**
**c. Photography of a plug removed from recipient (OCD) area**
**d. Arthroscopic final view after OCD fixation using osteochondral auto graft transplantation technique**

### *Surgical technique*

Determination of the maximum depth of the lesion was essential for harvesting the proper length of the osteochondral plugs. To obtain the stability of the lesion and prevent fracture of the plugs, it was necessary that the plug length measured at least twice the depth of the lesion at the central zone (7). As in the current study, 6-8 mm-based plugs were harvested from the lateral zone of the trochlea of the affected knee. In order to cover at least 50% of the lesion surface, one or sometimes more plugs were needed (8). Initially, all patients were examined arthroscopically using two standard portals, (anterolateral and anteromedial portals). The topographic mapping of the lesions was performed prior to surgery. To prevent levering and step-off of the lesion at the periphery, one plug was initially inserted in the center of the lesion and other plugs were introduced at the periphery subsequently. In order to maintain the perpendicularity to the lesion to prevent incongruity, the portals for graft insertion were created in vertical direction to the lesion if needed [Figure 1]. Arthrotomy was mandatory in two cases with stage IV lesions to find the large loose bodies and for refreshing, drilling, and bone grafting the crater to promote revascularization and to prevent subsidence of reinserted segment [Figure 2]. In a patient with one fragmented lesion (two large and one small segment), the large fragments were addressed through arthroscopic OAT and the small one which was positioned in the lateral ridge of medial femoral condyle (Uncontained lesion) was fixed with one screw (4 mm stainless steel cancellous screw), arthroscopically [Figure 3].

The plugs were implanted from central to the periphery and posterior to anterior, preserving the normal curvature

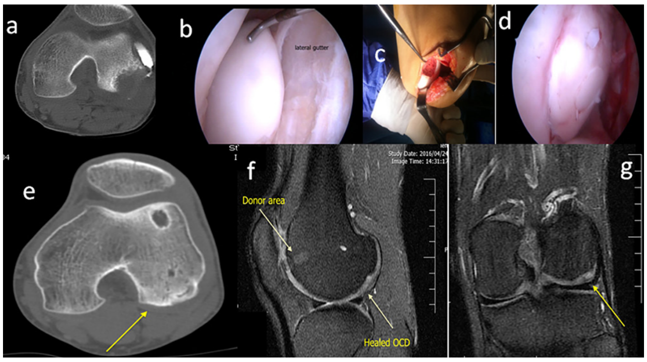


**Figure-2.**
**a. Pre operative CT- scan of a large non contained OCD (type 4) - Axial cut**
**b. Arthroscopic view of displaced OCD, entrapped in lateral Gutter**
**c. Preparation the crater to bleeding bone, drilling and bone grafting to enhance healing via lateral arthrotomy**
**d. Arthroscopic view after OCD fixation using osteochondral auto graft transplantation technique**
**e. Post op CT-scan after 6 months (Axial view)**
**f. Post operative MRI after one year (Sagital view)**
**g. Post operative MRI after one year (Coronal view)**

of the femoral condyle and to prevent unacceptable leverage and incongruity. Intraoperatively, the site of the fibrosis and fragmentation of the lesion was inspected from the recipient tunnel to ensure the appropriate length and location of the plug [Figure 1-b, 3-d]. The donor sites weren't filled after graft harvesting. In order to prevent hematoma, the joint was drained for 24 hours. After the surgery, the operated knee was immobilized; isometric exercises and ankle motion were started immediately. Joint motions were initiated on the third post-operative day. Partial weight bearing with crutches was permitted after six weeks post-operatively. Full weight bearing was reached after 3 months and sports activity was permitted after 12 months.

Follow up visits were conducted at 1, 3, 6, 12, 24, and 36 months post- operatively. Routine physical and radiographic examinations were performed to evaluate the status of the grafts and knee function. CT scan and MRI were performed six months after the surgery to assess the union of the plugs and cartilage condition. At the initial and final visits, the subjective IKDC, Lysholm score, and Tegner activity scale were completed. Pre- and post-operative data were compared using SPSS statistical software. To compare the pre- and post-operative subjective IKDC and Lysholm scores, the paired t-test were utilized. Tegner activity scales prior to and after surgery were compared using non-parametric Wilcoxon test. Furthermore, the functional status of the knee based on IKDC was compared by Mc-Nemar test. $P<0.05$ was considered significant.

## Results

Table 1 illustrates the demographic and preliminary data of the patients. The topographic mapping of

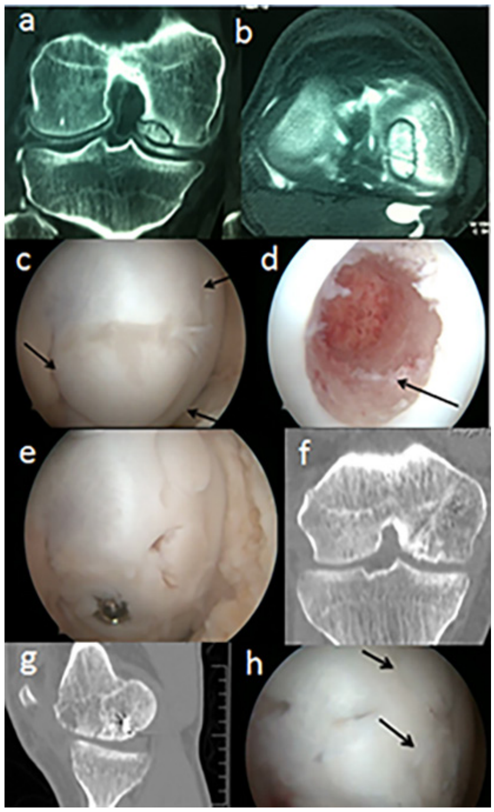


**Figure-3.**
**a. Pre-operative CT- arthrogram of a fragmented OCD (type 3); Coronal view**
**b. Pre-operative CT- arthrogram of a fragmented OCD (type 3); axial view**
**c. Arthroscopic view of lesion with 3 fragments**
**d. Arthroscopic view of the lesion after harvesting plug showing necrotic bone in the depth of crater recipient area**
**e. Arthroscopic view after OCD fixation using 2 plugs and one screw**
**f. Post-operative CT scan after 3 months (coronal view)**
**g. Post-operative CT scan after 3 months (Sagittal view)**
**h. Post- operative arthroscopic view after 3 months for screw removal (second look)**

**Table 1. Patients' demographic characteristics**

| | |
|---|---|
| **Age: mean+/-SD (Range)** | 23.7+/_6.2 (19-32) |
| **Gender(M/F)** | 16(12/4) |
| **BMI (Kg/M2)** | 21.3 (20-24) |
| **Duration of symptoms(Range)** | 14 (7-21 months) |
| **afflicted knee(RT/LT)** | 9/7 |
| **Femoral involvement(MC/LC)** | 12/4 |
| **Mean size of lesions(Range)** | 1-4 $cm^2$ |
| **Mean number of fragments** | 1.3 (1-3) |
| **Mean number of plugs** | 1.2 (1-4) |

Table 2. preoperative and postoperative outcomes

| | Pre-operative | Post-operative | *P-value* |
|---|---|---|---|
| **IKDC (Subjective)** | 53.4 ± 12.2 (38-67) | 84.3 ± 7.8 (71-93) | *P < 0.001* |
| **Lysholm** | 44.3 ± 9.4 (31-52) | 86.3 ± 10.7 (72-97) | *P < 0.001* |
| **Tegner** | 2.8 ± 1 | 5.6 ± 2 | *P < 0.001* |

the lesions was determined during the diagnostic arthroscopiy according to ICRS. CT scan at sixth month displayed bony union in all patients [Figure 2-E, 3-F]. The mean preoperative IKDC score increased significantly following the surgery (*P<0.001*). Based on the IKDC grading system, before the operation, the knee status was graded as nearly normal, abnormal, and severely abnormal in 4, 10, and 2 patients, respectively. At the final follow up (36 months after surgery), 15 normal and 1 abnormal knee were documented (*P<0.001*) [Table 2]. Post-operative diagnostic arthroscopy in 1 case showed congruity and fixed fragment, indicating successful results [Figure 3-h]. At the final visit, all patients (except one) were asymptomatic and returned to their previous activity levels.

## Discussion

Timely diagnosis and appropriate management of OCD are essential for prevention of early degenerative arthritis. The surgical intervention of unstable OCD should attempt to accomplish stable and reliable fixation; enhance revascularization of the subchondral fragment; employ structural graft with the articular cartilage for augmenting the healing; and preserve hyaline articular cartilage (7).

Pitch screw, partially threaded cannulated screw, bioabsorbable screw, pin or rod, and bone stick or bone peg have already been used for fixation of the OCD fragments (23-26). Kocher et al revealed proper healing with internal fixation by different devices in 22 patients (84.6%) and failure in 4 cases (23). Autologous bone stick fixation of OCD by Navarro et al. documented one failed case (9.1%) (26). Metal fixation devices warranted removal of the implant. In a study by Webb and colleagues, 50% of patients were advocated a second surgery for removal of the device; moreover, with fixation by metal devices, an articular defect could develop. Although drilling of the subchondral bone revascularizes the OCD region, metal implants, unlike autogenous osteochondral grafts, do not promote healing (7, 27). Previous studies observed complications in the fixation of OCD segment by bone pegs and absorbable devices. Recently, Camathias et al. observed failures in 23% of 30 knees with OCD fixed with biodegradable screws, due to breakage of screws (28). High failure rates were discouraging and indicated that fixation by this method could have the unfavorable sequel. Additionally, complications such as loosening of the bone peg, fracture at the donor site tibial bone, and nonunion of OCD have been reported (29-31). These complications were more significant in sportsmen.

Limited studies have presented the fixation of the OCD fragment using autogenous osteochondral graft. Miniaci et al. have tried justifying the above mentioned procedure based on their studies and similar previous studies. They stated that due to the complex shapes of OCD pieces, this method could offer multiple grafts to achieve rigid fixation. Additionally, significant fibrotic tissues and sclerotic bone were cleared from the sites of pathology and substantial portions of OCD segments were replaced by the normal osteochondral graft. Eventually, in this method, the bone graft between the pathological fragment and healthy bone augmented the healing and the articular hyaline cartilage enabled congruent joint surface (7). All 20 patients treated for stage II, III, and IV OCD had normal IKDC questionnaires. Furthermore, pain decreased significantly from 8.3 points before surgery to 0.8 postoperatively. Serial MRIs demonstrated that bone healing and continuous chondral healing was attained within 6 and 9 months, respectively, in all knees. No complication was observed in their study (7).

Another interesting advantage of the presented technique was to convert uncontained OCDs to contained ones which are eligible for mosaicplasty [Figures 2; 3]. Also, the interspaces between the plugs was covered by hyaline cartilage instead of the less effective fibrocartilage.

In 2004, Kobayashi et al. observed that the treatment outcomes of two OCD patients using cylindrical osteochondral grafts were very satisfactory (8). This method has also been employed for the treatment of stage IV OCD. Sasaki and co-authors reported very acceptable results in 12 cases of juvenile stage II and IV OCD with arthroscopic OAT. The score of IKDC and Lysholm questionnaires with 26 months follow-up had significantly improved 6 months after the surgery. All patients were able to return to the pre-ailment activity level and no complications were reported (2). In another study with 12 OCD cases in 2007, Miura et al. reported a significant improvement in functional outcomes with arthroscopic cylindrical autogenous osteochondral plugs. In addition, they stated that MRI findings in all patients showed no interface between the graft and subchondral bone after 3 months and no complication was seen (32).

Several surgical procedures have been developed for OCDs not amenable to conservative management, indicating that no single procedure has been universally accepted. None the less OCD stage II, III, and IV subjected to arthroscopic or open autogenous osteochondral grafting in this study showed significantly improved functional outcomes. All patients except one were able to return to their previous level of activity after 12 months. CT scan showed bone healing in all patients 6 months following the surgery. No complications occurred in either donor site. Complete healing and good cartilage status were observed in one second-look arthroscopic study [Figure 3-h].

Since the major part of the lesion was replaced in this technique with healthy and fresh osteochondral autograft with preservation of maximal surface congruity and hyaline cartilage along with converting uncontained OCDs to contained lesions that are suitable for OAT without any need to second procedure for device removal, the promising outcomes seem reasonable.

As with all other studies, our research project had its own limitations as well. The most important shortcoming was that the study was descriptive and the results were not compared with other methods. Moreover, due to the shortage of the cases we couldn't describe and discuss the results separately for each age group or each ICRS classification. Moreover, the study employed diagnostic imaging that cannot definitively assess the healing and congruity of articular cartilage; although healing and congruity were confirmed in one post-operative arthroscopy. However, the desirable functional and clinical outcomes can represent the acceptable status of the articular cartilage.

***List of abbreviations***

OCD: osteochondritis dissecans
OAT: osteochondral autogenous transplantation
IKDC: International Knee Documentation Committee
ICRS: International Cartilage Repair Society

***Authors' contributions:*** Developing the original idea and the protocol: Sohrab Keyhani, Mohammadreza Abbasian

Definition of intellectual content: Sohrab Keyhani

Study supervision: René Verdonk

Contribution to the development of the protocol: Mehran Soleymanha

Preparation and drafting of the manuscript: Mohammadreza Abbasian

All authors read and approved the final manuscript.

***Informed consent:*** Informed consent was obtained from all individual participants included in the study.

***Conflicts of interest:*** the authors declare that they have no conflict of interest.

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***Ethical approval:*** This study was approved by the Akhtar hospital research Ethic Committee in Tehran; Iran (No: 9868).

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