Arthroscopic Micro-Fracture in Treating Chondral Lesions in Knee Joint in Baghdad

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ABSTRACT

Background: Isolated chondral and osteochondral defects of the knee are difficult clinical challenge. Micro fracture is a kind of cartilage repair procedure that makes a fibrin clot containing mesenchymal stem cells in the chondral lesion.
Objectives: To evaluate the short-term outcome of micro-fractured lesions in group of patients in terms of pain symptoms and activity.
Methods: Micro-fracture was performed for twenty-three patients who were diagnosed arthroscopically to have chondral lesions. Post-operative knee injury and osteoarthritis outcome score was evaluated and compared to their pre-operative score to know the significance of the procedure for improving pain, functional activity, and symptoms (morning stiffness, evening stiffness, swelling, catching and grinding).
Results: This study showed that 82.6% of our patients have knee osteoarthritis and injury outcome score above 60 while 17.4% have scores below 60 after 6-8 months post-operative and that micro-fracture produces a significant improvement in functional activities (t=12.322, P-value=0.001), pain intensity (t=11.945, P-value=0.001), and symptoms (t=10.810, P-value=0.001).
Conclusion: Micro-fracture is a minimally invasive cost effective surgery with short operative time and faster recovery that give benefit to patients in short term follow up.
Keywords: **Micro-fracture**, **Chondral lesions**, **Knee arthroscopy**, **Knee trauma**.

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Articular cartilage is a highly specialized tissue acting as a shock absorber, enabling synovial joints to articulate with low frictional forces[1].

Chondral injuries occur commonly within the knee. In two studies reviewing over 30,000 arthroscopic procedures revealed that approximately 60% of patients were found to have high grade chondral defects with lesion depths involving 50% or more of the cartilage surface[2,3].

Symptomatic lesions may cause pain, locking, catching, swelling, and functional impairment. Quality of life may be affected to the same extent as in patients scheduled for knee replacement[4,5].

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After the onset of the injury, the cartilage undergoes a series of biochemical and biomechanical changes, which include loss of the typical structure and macromolecular organization, reduction of proteoglycan, and an increase in permeability and stiffness that causes vulnerability to future mechanical damage[6].

About 200 years ago, a Scottish doctor, William Hunter, documented that chondral lesions had been considered difficult to treat and heal from the time of Hippocrates[7].

The ultimate aim of treatment is restoration of normal knee function by regenerating hyaline cartilage in the defect and complete integration of the regenerated cartilage with the surrounding cartilage and underlying bone[5].

Conservative treatment can be useful for symptom relief only and not for

restoring structural integrity of the articular cartilage[7].

It is well established that these defects have a limited ability to independently heal because of the intrinsic properties of articular cartilage, specifically a relative avascularity and hypocellular composition, which over time may lead to osteoarthritis. Therefore, surgical management has become the mainstay for symptomatic defects that interfere with knee function[5,8].

In comparison to patients with osteoarthritis, individuals with isolated chondral surface damage are often younger, significantly more active, and usually less willing to accept limitations in activities that require higher impact. So, isolated chondral and osteochondral defects of the knee are considered to be a difficult clinical challenge particularly in younger patients for whom alternatives such as partial or total knee arthroplasty are rarely advised[2,4,9].

Pridie recognized the potential of mesenchymal stem cell (MSCs) stimulation for the aim of cartilage repair in the 1950s[10].

The purpose of surgical treatment is to improve symptoms and prevent degenerative changes by achieving structural and biomechanical restoration of the articular cartilage[7].

Cartilage procedures can largely be classified into three categories:

(1) Palliation (debridement or chondroplasty),
(2) repair (micro-fracture or drilling),
(3) restoration (autologous chondrocyte implantation[8].

The micro-fracture technique often is considered the golden standard therapy for the treatment of cartilage defects. It is a marrow stimulation technique with minimally invasive nature, technical ease, limited surgical morbidity, and relatively low cost[6].

Tiny fractures are made 3-5 mm apart from each other to cause bleeding in the subchondral bone and fibrin clots in the perforations release mesenchymal stem cells that would differentiate into chondrocytes. Multi-potential mesenchymal stem cells can differentiate into fibrocartilage cells and chondrocytes and induce fibrocartilage or hyaline-like cartilage formation[2,6]. Fibrocartilage contains more collagen and less proteoglycans compared to hyaline cartilage. It is composed of more type I collagen than type II collagen. Type I collagen has lower compressive strength, elasticity, and wear resistance compared to type II collagen. Biopsies after micro-fractures showed that approximately 10% had hyaline cartilage, with the majority having predominantly fibrocartilage[4,7]. Although the biochemical and biomechanical properties of the resultant repair tissue have been shown to be inferior to that of normal articular cartilage, there were excellent short-term improvements in knee function in a high percentage of treated patients[2,11].

However, the main objective of our study was to evaluate the short-term effectiveness of arthroscopic micro-fracture in the treatment of chondral defects and to make it a base line for the future mid and long term follow up.

Methods

Our study was conducted on 23 patients with chondral lesion in the knee joint at Alnuman Teaching Hospital during the period from March 2015 to June 2017.

Inclusion criteria include: patients above 18 years, who were complaining of knee pain not responding to one month of conservative treatment and physiotherapy, body mass index below 29 with normal limb alignment, no history of previous open or arthroscopic knee surgery, and no x-ray features of osteoarthritic changes involving the knee. The procedure and the rehabilitation program were discussed with the patient, preoperatively. We followed the technical Pearls for micro-fracture surgery in the knee that was suggested by Joshua et al, after grading the chondral lesion according to the International Cartilage Research Society (ICRS)

grading, (Figure 1). Removal of all injured articular cartilage, clean, stable borders of the articular cartilage defect, vertical walls of the defect. Removal of the calcified cartilage layer at the base of the articular defect, (Figure 2). We measured the size of the lesión using the short arm of the hook, (Figure 3) which measured 0.5 cm then we created micro-fracture holas, (Figure 4) by moving inward from peripheral to central, holes were 3-5 mm apart created by K. wire hammered to the subchondral bone 3-4 mm depth, remove all bony debris after hole creation and finally ensure tourniquet is deflated to observe marrow elements entering joint.

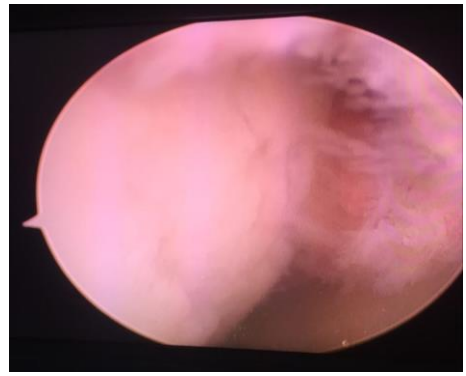

Figure 1: Chondral lesion ICRS3. (Adapted from this study)

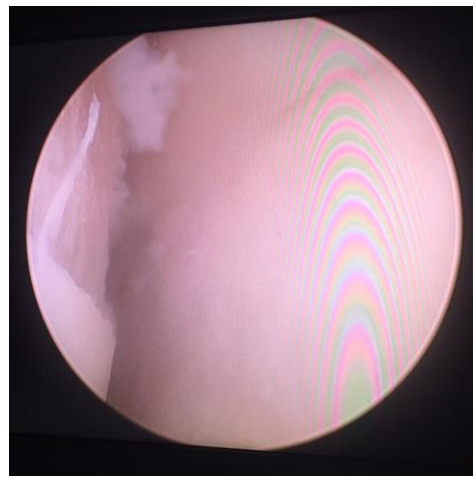

Figure 2: Removal of calcified cartilage and creation of stable perpendicular edge. (Adapted from this study).

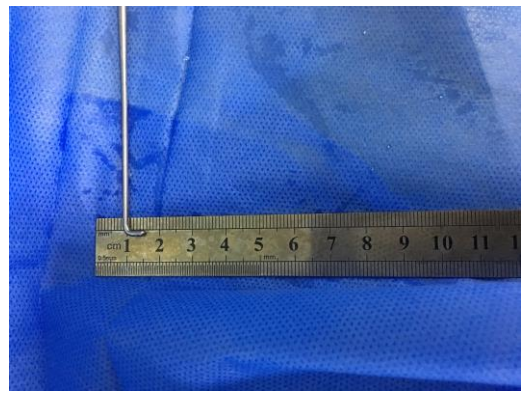

Figure 3: Measuring the size of the defect by the short arm of the hook.

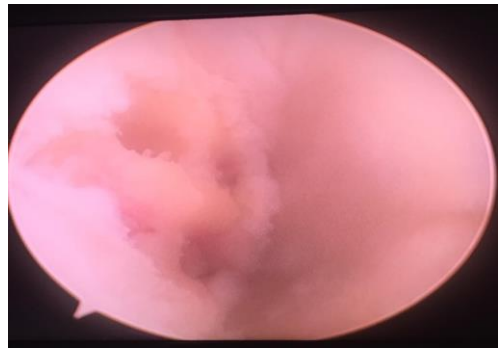

Figure 4: Creation of micro-fracture holes (Adapted from this study).

Post-operative analgesia was given according to patient requirement, drop-lock knee brace was used to keep the knee in extension, quadriceps muscle exercises and hamstring stretching were begun in the first post-operative day.

Rehabilitation was designed based upon four biological stages of cartilage healing: Proliferation, transition, transformation and maturation[12].

Patients were assessed pre- and post-operatively depending on the Knee Injury and Osteoarthritis Outcome Score (KOOS)[13]. It is a questionnaire designed to assess short and long-term patient-relevant outcomes following knee injury.

The simplified KOOS's three patient-relevant dimensions were scored separately: Pain (five items); symptoms (five items); daily activities (five items); and all items had five possible answer options scored from 0 (No problems) to 4 (Extreme problems) and each of the five scores was calculated as the sum of the items included.

Scores were transformed to a 0-100 scale, with zero representing extreme knee problems and 100 representing no knee problems as common in orthopedic scales and generic measures, 100 – (100 $\times \frac{mean}{4}$).

Results

During the period of this study, micro-fracture was performed to 31 patients who were diagnosed arthroscopically to have knee chondral lesions at Al-Nu'man Teaching Hospital, 23 (74.2 %) patients were enrolled in this study while the other eight patients (25.8%) were excluded from the study because not fit for inclusion criteria.

The age of the patients ranged from 18 years to 55 years with average mean and standard deviation of 39.2± 13 years. The average mean value of pre- and post-operative of KOOS was higher among patients with age ≤ 40 years (32.0 and 85.2) than those with age > 40 years old (29.5 and 68.4), respectively, (Figure 5).

The females constituted a higher proportion (73.9%) of the sample study; there were 17 female patients and six males, the male to female ratio was (0.26:1). The mean post-operative KOOS value was higher among male patients (79.4) than that in females (77.3), (Figure 5).

Chondral lesion was caused by trauma in 12 patients (52.2%), while 11 patients (47.8%) had knee cartilage lesions without trauma. The average mean post-operative KOOS value was higher among patients with history of trauma (81) than that in patients without history of trauma (71.6), (Figure 5).

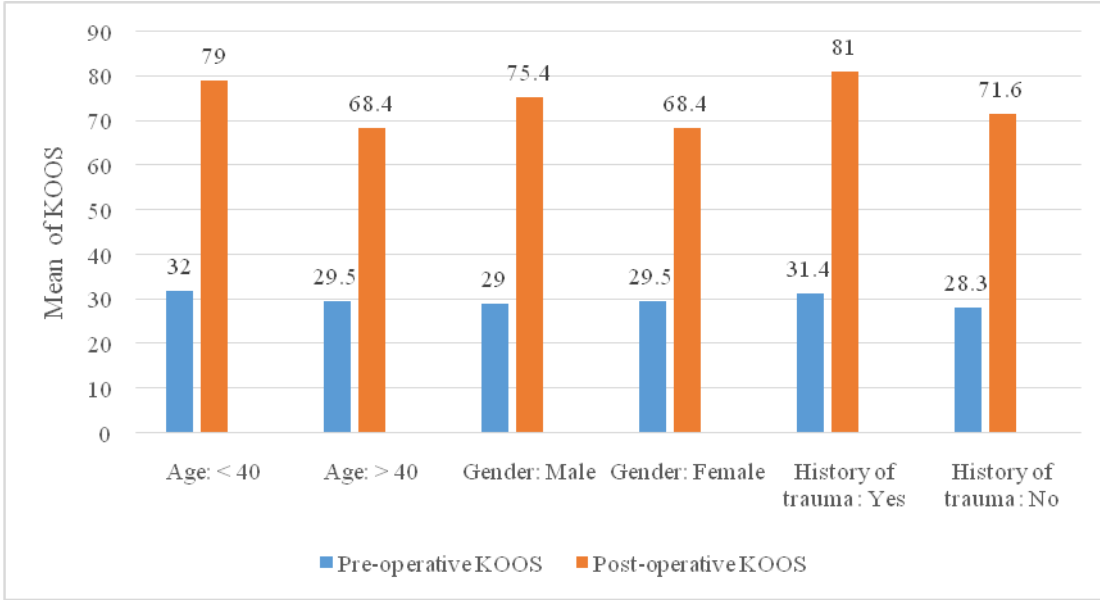

Figure 5: Distribution of pre- and post-operative KOOS mean among the study subjects according to their age, gender and etiology of knee cartilage lesions.

The majority of the patients 15(65.2%) had knee cartilage lesions in the medial femoral condyle, 6(26.1%) lesions in both medial and lateral femoral condyles, while only two patients (8.7%) had their lesion in the lateral femoral condyle. The results showed that the average mean value of post-operative KOOS was higher in patients with lateral femoral condyle chondral lesions (90.5) than in patients with medial chondral lesion (85), and in patients who had both (medial and lateral) chondral lesions (55.0), (Figure 6).

Lesion size was measured by the short arm of the hook. The lesion size of the study subjects ranged from three cm^2 to eight cm^2 with an average of 4.3± 1.9 cm^2. There were 12 patients (52.1%) with chondral lesion size of three cm^2, five patients (21.8%) had lesion size of four cm^2, and six patients had lesion size more than four cm^2 {four patients (17.4%) with two lesion sites had lesion size of 8 cm^2 (5 + 3 cm^2) and two patients (8.7%) with two lesion sites had lesion size of 6 cm^2 (4+2 cm^2). The mean values of post-operative KOOS and pre-operative KOOS were higher among patients who had knee cartilage lesion size of 3 cm^2 (88.7 and 33.0) than that reported among patients with knee cartilage lesion of size 4 cm^2 (79.3 and 32.2) and in patients of lesion size more than 4 cm^2 (55 and 30.0), respectively, (Figure 6).

The chondral lesion was graded according to the International Cartilage Research Society (ICRS) grade, there were 11 patients (47.8%) grade 3, nine patients (39.1%) in the grade 4. Three patients (13.1%) have osteochondritis dissicance (OCD), (Figure 6). The results showed that the average mean value of post operative KOOS was higher than the mean value of pre-operative KOOS in all grades. The mean values of post-operative KOOS and pre-operative KOOS were higher among patients with OCD (90.5 and 36.1) than that reported among patients with knee cartilage lesion of grade 3 (85.7 and 32.0) and in patients of grade 4 (64 and 27.0), respectively, (Figure 6).

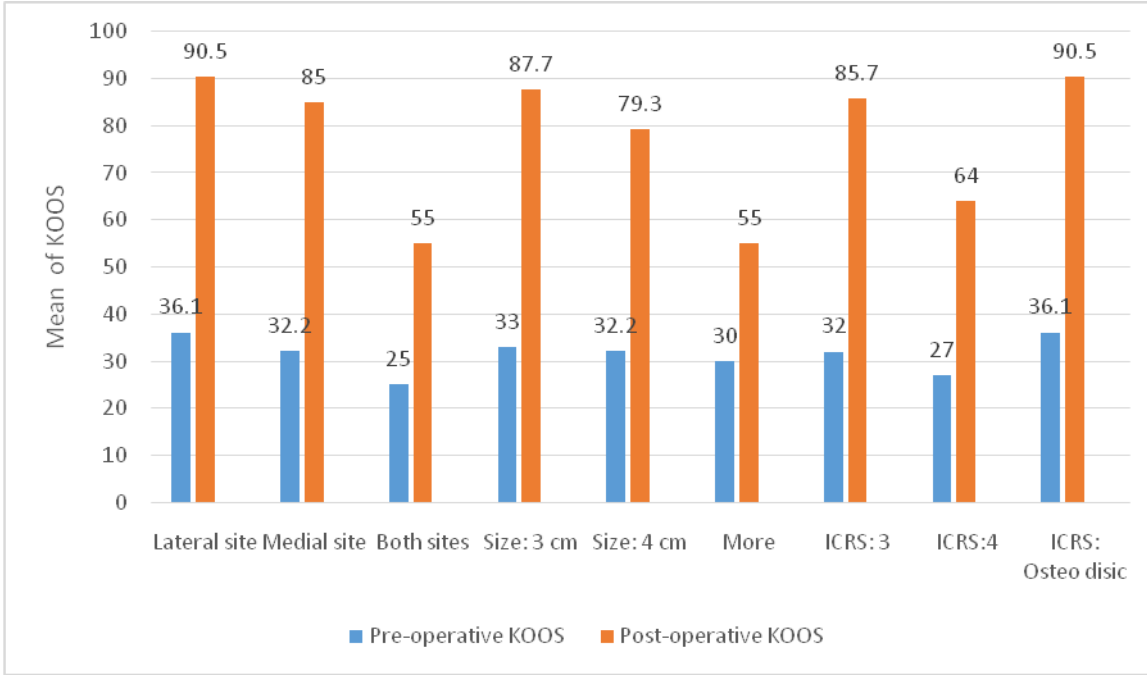

Figure 6: Distribution of pre- and post-operative KOOS mean among the study subjects according to the site, size and grade of knee cartilage lesions (ICRS).

Surgical results and outcomes for pain intensity, chondral lesion related symptoms and functional activity were analyzed in the study subjects and evaluated through a follow up period ranging from six to eight months. The results showed that the average mean of KOOS value were higher in post-KOOS than in pre-operative KOOS among the study subjects. These differences were found to be statistically of highly significance for pain intensity, symptoms, and functional activity of the knee joint. These finding revealed that there is an excellent improvement of pain intensity (t=11.945, p-value=0.001, 95% CI of 38.984-55.364), symptoms (t=10.810, p-value=0.001, with 95% CI of 34.610-51.042) and functional activity (t=12.322, p-value=0.001, with 95% CI of 42.489-59.685) within 6-8 months after arthroscopic micro-fracture of chondral lesion of knee joint compared to that before surgery, (Tables 1, 2 and 3).

Table 1: Pre- and post- operation KOOS pain intensity assessment among study subjects.

KOOS OPERATOIN	Pain intensity				
	No.	Mean ± SD	Std. Error	Mean differences	95% CI of the Difference
Post- KOOS	23	81.52 ± 17.085	3.562	47.174 ± 18.939	38.984- 55.364
Pre- KOOS	23	34.35± 9.805	2.045		

t: 11.945, df: 22, P-value: 0.001

Table 2: Pre- and post- operative KOOS symptoms assessment among study subjects.

KOOS OPERATOPN	Symptoms assessment				
	No.	Mean ± SD	Std. Error	Mean differences	95% CI of the Difference
Post- KOOS	23	80.87± 14.589	3.042	42.826± 18.999	34.610 – 51.042
Pre- KOOS	23	38.04± 14.904	3.108		

t: 10.810, df: 22, P-value: 0.001

Table 3:Pre- and post-operative KOOS functional activity assessment among study subjects

KOOS OPERATOPN	Functional activity assessment				
	No.	Mean ± SD	Std. Error	Mean differences	95% CI of the Difference
Post- KOOS	23	71.30± 18.229	3.801	51.087± 19.884	42.489 – 59.685
Pre- KOOS	23	20.22± 14.100	2.940		

t: 12.322, df: 22, P-value: 0.001

——————————Discussion

Chondral defects in the knee are common in both athletes and non-athletes. These defects may cause significant pain and disability in addition, chondral lesions my initiate a catabolic intra articular environment that result in progression of the lesions. Surgical treatment of these defects has demonstrated success with several different cartilage techniques, including marrow stimulation (micro-fracture or subchondral drilling), osteochondral autograft and allograft, and cell-based therapies such as autologous chondrocyte implantation[14,15].

In a survey done by Nurzat et al[16] on 147 of experienced musculoskeletal surgeons, to analyze the preferences for treatment of focal knee cartilage defects, micro-fracture was found to be the most common cartilage repair procedure (60-80%) followed by mosaicplasty in 20-40%[16].

Knutsen et al[17] studied eighty patients who had a single chronic symptomatic cartilage defect on the femoral condyle in a stable knee without general osteoarthritis. Forty patients were treated with autologous chondrocyte implantation, and forty were treated with micro-fracture. After two and five years follow up interval, they found that both groups had significant clinical improvement compared with the preoperative status and there were nine failures (23%) in both groups compared with two failures of the autologous chondrocyte implantation and one failure of the micro-fracture treatment at two years. Bae et al[18] reported that patients with full-thickness chondral defects in the osteoarthritic knee could obtain functional improvement and an increase in the joint space after micro-fracture. They reported that the joint space was widened by 1.06 mm on standing anteroposterior radiographs and by 1.37 mm on standing lateral radiographs.

Jea Jeong et al[19] reported that the success rate with micro-fracture was 79.4% in terms of the Lysholm score. In 2003, Steadman[20] published a paper on outcomes of micro-fracture in professional football players. Twenty-five National Football League (NFL) players who were treated with micro-fracture were reviewed. Nineteen players returned to professional foot- ball at an average of 10 months following micro-fracture. Average Lysholm scores significantly improved from 52 to 90.9.

In a study done by Masoud et al[21] on professional footballers to detect the significance of short term improvement

showed that all of the patients who had undergone micro-fracture can return to their sport within 18 months they concluded that micro-fracture produces a durable repair tissue but for how long?

The clinical evaluation in the present study was performed using the KOOS since it focus the attention on the patient pain clinical symptoms and the degree of joint function. We compared the average scores at time zero preoperative and at time t1 which is 6-8 months post-operative.

In the present study, we found that 82.6% of our patients have KOOS above 60 while 17.4% have scores below 60 after 6-8 months post-operative

We found that micro-fracture could give benefit to all groups of patients enrolled in the study in short-term follow up.

We found that the groups of patients below 40 years of age, with chondral lesions below three cm^2, and with history of trauma have more significant improvement in KOOS in pain, symptoms and daily activities.

Isolated chondral lesions of the lateral femoral condyle in the present study were all caused by trauma in young age patients and their average KOOS had improved from 36.1 to 90.5.

We found that micro-fracture produced a significant improvement in functional activities in patients with t value of 12.322 followed by pain t: 11.945 then symptoms t: 10.810.

Average KOOS improved from an average of 30.87± 9.794 pre operatively to an average of 77.90± 15.988 post-operatively.

There is a growing evidence to study the long-term effectiveness of the micro-fracture in chondral lesion but there is much less studies to demonstrate the short-term effectiveness of micro-fracture.

The strengths of the present study were the inclusion criteria of the studied group, while the drawback was that we had depended only on KOOS and we didn't performed MRI or second look arthroscopy for diagnosing the development of the fibrocartilage post micro-fracture

We agree with Matthias et al[3], Dustin et al[4], and Alexander et al[8], that in order to get good results there must be a strict inclusion criteria which include:

1. Limb alignment.
2. Pre-existing concomitant injury or arthritis within the knee.
3. Patient expectations and rehabilitation potential.
4. Instability and ligament damage.
5. Previous total or subtotal meniscectomy.
6. Age of the patient.
7. Body mass index.

In conclusion, micro-fracture is a minimally invasive cost effective surgery with short operative time and faster recovery that give benefit to patients in short term follow up.

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