ORIGINAL ARTICLE

Comparative Study of Arthroscopic versus Open Mosaicplasty in Osteochondral lesions of the knee joint

Ibrahim A. Mostafa, Usama G. Abd Alla, Mohammed A. A. Mohammed *

Department of Orthopedic Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: ***It can be difficult to treat chondral and osteochondral abnormalities effectively. To generate hyaline or hyaline-like healing in the affected region, autologous osteochondral transplantation is one option. This study details the outcomes of autologous osteochondral mosaicplasty over a moderate amount of time in clinical practice.***

Aim and objectives: ***For the purpose of comparing and contrasting the radiological and functional outcomes of arthroscopic and open (mini arthrotomy) Mosaicplasty procedures for the treatment of osteochondral defects.***

Patients and methods: ***Forty patients with osteochondral lesions in the knee joint were enrolled in this prospective trial. Half of the patients were treated arthroscopically, while the other half had open (mini arthrotomy) mosaicplasty. The study ran from January 2022 to January 2024. We followed up with patients for at least 12 months after they were recruited from the outpatient clinic at Al-Azhar University Hospital.***

Results: ***From August 2022 to October 2024, forty cases were enrolled in this study. This study included 35 males and five women, with 27 right knee joints and 13 left knee joints. There were nine traumatic instances and 31 degenerative cases. Both the arthroscopic and open groups had mean operative ages of 24.65 and 25.65 years, respectively, with a range of 18–40 years. While both the Arthroscopic and open groups' Lysholm scores were significantly higher before and after surgery, the open group's score was higher after surgery than it had been before.***

Conclusion: ***When used appropriately, mosaicplasty is a powerful instrument for the management of osteochondral damage; moreover, the arthroscopic approach yields superior outcomes compared to open mosaicplasty.***

Keywords: Arthroscopy; Open (Mini arthrotomy) Mosaicplasty; Osteochondral lesion knee joint

1. Introduction

Between five and ten percent of knees that undergo knee arthroscopy are found to be cartilage repair surgery candidates, which can lead to impairment and early onset of osteoarthritis (OA).[1]

Joint dysfunction, discomfort, and effusion can result from full-thickness abnormalities in weight-bearing articular surfaces, which also have a limited healing capacity. A variety of bone marrow stimulation methods, including resurfacing procedures like abrasion arthroplasty, drilling, and the microfracture technique (MF), encourage fibrocartilage-type repair.[2] Due to the regenerating tissue's moderate biomechanical properties, it has limited utility. A more long-lasting hyaline cartilage surface can be achieved in the affected location by cell therapies, such as autologous chondrocyte implantation and osteochondral transfer procedures. For decades, patients have benefited from Mosaicplasty, a technique that involves transplanting autologous osteochondral blocks, which allows the transplanted hyaline cartilage to survive. A relatively new variation on osteochondral transplantation, mosaicplasty, involves the use of many tiny cylinders of osteochondral tissue rather than a single large block of bone and cartilage. A mosaic-like implantation approach can offer adequate contouring in the defective area, and availability can be regulated by harvesting linear grafts from the less-weight-bearing periphery of the trochlea donor site. Initially, autogenous osteochondral grafts were detailed for use in the femoral condyles' weight-bearing regions.[3]

Accepted 15 April 2025.
Available online 30 June 2025

* Corresponding author at: Orthopedic Surgery, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: mohamedabdelhakem.623@azhar.edu.eg (M. A. A. Mohammed).

https://doi.org/10.21608/aimj.2025.446608

Successful utilization of osteochondral autografts and survival of transplanted articular cartilage were initially reported in 1985 by Yamashita et al.[4]

This study set out to compare and contrast the radiographic and functional outcomes of arthroscopic and open (mini arthrotomy) Mosaicplasty procedures for the repair of osteochondral defects.

2. Patients and methods

This prospective study was carried out from January 2022 to January 2024. Out of forty patients who had osteochondral lesions in their knees, twenty-five underwent Arthroscopic treatment, and twenty-five underwent open (mini arthrotomy) mosaicplasty. We followed up with patients for at least 12 months after they were recruited from the outpatient clinic at Al-Azhar University Hospital. Two groups were formed from the random selection of participants.

Inclusion criteria:

Individuals ranging in age from 18 to 45 years old, with an ICRS grade of 3 or 4, small, pinpoint lesions on the femoral condyles that bear weight in a normally-aligned knee Following the ineffectiveness of conservative treatments, patients exhibiting clinical symptoms such as discomfort, swelling, locking, and giving way, with a body mass index (BMI) ranging from 18.5 to 30, and lastly, a combination of traumatic and degenerative origins, around 1-4 cm2.

Exclusion criteria:

Some of the conditions that can affect a patient's ability to undergo the procedure include: untreated limb malalignment or instability in the knee, bipolar lesions or diffuse knee osteoarthritis, inflammatory diseases, patients who refuse the procedure, large bone defects larger than 4cm2, patients older than 45 years old, and patients with trochlea or tibial plateau lesions.

Preoperative Evaluation:

To collect data about the age, occupation, and previous surgical interventions, as well as, to exclude the presence of any associated medical or surgical condition, special emphasis was laid on pain, catching, giving way, and swelling besides other symptoms: also, the ability to do different daily activities like standing, walking, sitting, getting into the car, kneeling, squatting finally symptoms were graded and put in the Lysholm scoring system.

Examination: All the patients were subjected to:

General examination and local examination, during walking for abnormal gait malalignment in standing for the scar of old operation wound skin pigmentation effusion wasting of quadriceps in the supine position for confirmation of wasting degree of effusion if present alignment and q angle and patellar instability tests and Willson test and other special tests of the knee to exclude other causes of knee pain. Evaluation of the mechanical axis of the limb was done in all of the cases to assess the femoral-tibial alignment.

Preoperative Radiological Evaluation:

Every single patient had a standard X-ray taken, with anteroposterior, lateral, notch, and skyline viewpoints. Tomography scans are performed by a computer. In every case, MRI was used to evaluate the location, size, depth, stability of the osteochondral fragments, bone marrow edema, osteonecrosis, meniscal lesion, synovitis, effusion, ligamentous disruption, and related lesions.

Operative Technique:

Arthrex® Co., LTD.'s osteochondral autograft transfer system (OATS) was one of the sets utilized, figure 1.

Figure 1. The OATS instruments (Arthrex)®

Diagnostic arthroscopy:

Initial diagnostic arthroscopic examination of the knee was done in all cases, for the following purposes: analysis of the defect's extent When the debridement process is complete, a small probe with a defined length is used to precisely quantify the defect.

Arthroscopic procedure:

After achieving stable, healthy cartilage all around the defect, the preparation of the defect was initiated by debridement and remeasurement. Subsequently, a tiny incision was made in the skin on the side of the patella, running laterally from the Lateral femoral condyle and above the level of the sulcus terminalis. A donor tube was inserted perpendicular to the cartilage, either through a scope inserted inside the knee or through an external one, until its length reached 17 mm. Before removing the core, the T handle was turned three or four times in both directions, 90 degrees clockwise and anticlockwise.

Using a recipient tube with the same diameter and a depth of up to 15 mm, while simultaneously rocking in two directions and rotating 90 degrees clockwise and anticlockwise, the recipient site of the defect is prepared. The donor tube had the cartilage guard put on it. The prepared tunnel was used to position the graft tube, which was then

hammered to secure it while keeping it upright. The grafts were then seen via the tube's opening. Thoroughly hammer the graft until the cartilage is flush with the condyle's surface.

Open (mini arthrotomy) Technique:

In order to investigate articular cartilage lesions for femoral condyle abnormalities, a short parapatellar mini-arthrotomy was performed following diagnostic arthroscopy. For distal viewing of the lesion with the knee bent, and for proximal viewing of the superior aspect of the trochlea (the area from which donor grafts can be obtained) with the knee extended, the incision should be sufficiently long. As an arthroscopic technique, the defect was prepared.

The 17 mm length was achieved by hammering the tube until it was delivered perpendicular to the cartilage. After that, the tube was gently spun while being withdrawn, just like previously stated. Inserting the graft tube into the ready-made tunnel allowed the surgeon to see the grafts as they were hammered into place, ensuring they were perpendicular. Be careful to hammer the graft until the cartilage meets the condyle surface, then repeat the process for the second plug.

Postoperative medications and rehabilitation:

The drain was removed if used, as it may be used and may not be used, and the patient was discharged after 24 hours. Venous antibiotics were given for 1 day. Intravenous analgesics were given, then were taken on demand to decrease pain, with a follow-up of the wound for any signs of infection, and then removal of the stitches.

Postoperative rehabilitation: We followed the rehabilitation program described by Hangody et al.,[5]

Phase I:

Non weight bearing for 4-6 weeks for the fear of sinking of the graft. But early range of motion was instructed to the patients. In open Technique due to the presence of wound and pain; patient was left for rest and ice backs, for 48 hours with isometric quadriceps strengthening.

Third day to 1-week flexion on the side of the bed by aid of the other leg from 0° extension to 90° flexion as pain permits: 5-10min 5-times a day with quadriceps strengthening next week pendulum exercise on chair or bed side and isometric quadriceps strengthening and straight leg raising in abduction /adduction manner all for 15-20 min for 5-times a day, also ambulation was permitted by the use of 2 elbow crutches. Cold compresses are regularly applied after every rehabilitation setting to decrease edema. Hot fomentation before starting the administered program.

Increasing the R.O.M. above 90° gradually while lying supine in bed by forced gradual flexion, better with the aid of another person, as this should be repeated 5 times a day. This should be continued from the third to the sixth week.

Phase II:

For 2 weeks after phase 1

Partial weight bearing using only one crutch was allowed. The sets for quadriceps strengthening and R.O.M. were decreased to 2- 3 times a day with ice backs after it. Climbing stairs was allowed minimally as possible. Walking was permitted for 5-10 min gradually.

A full range of motion was encountered, but squatting was not allowed.

Phase III:

For 8-16 weeks, full weight bearing and full R.O.M. were promoted.

Closed kinetic chain exercises- Running

Deep squats and full-contact sporting activity were discouraged for 6 months postoperatively.

Follow-up of the cases:

The peroid of follow-up minimum 12-months with a mean of 14-month. Follow-up visits were every 3 months after end of phase III of rehabilitation. The patients were examined for pain, swelling, and range of motion. Plain radiographs were also examined.

Statistical analysis:

SPSS v26, developed by IBM Inc. of Armonk, NY, USA, is a statistical tool for social science applications. It was used to process and analyze pre-coded data. The normality of the data distribution was assessed using the Shapiro-Wilks test and histograms. Standard deviation (SD) and mean (Mean) were used to display quantitative data. Qualitative data were shown using percentages and frequency counts. If the quantitative variables were regularly distributed, we used the mean and standard deviation to summarize the data. Qualitative variables are described using percentages and numbers. When comparing groups with regularly distributed quantitative data, an independent T-test is utilized, whereas the Chi-square test is utilized for qualitative variables.

A battery of tests was conducted: Self-contained samples. For data that follows a normal distribution, the t-test of significance was employed for comparing two means. Non-parametric data were compared using the chi-square test. P-value, or probability. A statistically significant result was defined as a P-value<0.05, a very significant result as a P-value<0.001, and an inconsequential result as a P-value>0.05.

3. Results

Table 1. Distribution of postoperative clinical symptoms among the studied groups.

	ARTHROSCOPIC GROUP N=20	OPEN GROUP N=20	P-VALUE
LOCKING			
NONE	20(100%)	20(100%)	1
POST CLICKING			
YES	10(50%)	12(60%)	0.525
NO	10(50%)	8(40%)	
PAIN(VAS) SCOR			
MILD	17(85%)	15(75%)	
MODERATE	0(0%)	2(10%)	0.345
NO	3(15%)	3(15%)	
SWELLING			
MILD WITH ACTIVITY	11(55%)	10(50%)	0.751
NO	9(45%)	10(50%)	
ROM			
NORMAL	15(75%)	10(50%)	0.102
LOSS OF DEGREE	5(25%)	10(50%)	
(LOSS OF DEGREE) MEAN±SD	18±10.9	19±8.75	0.75

P-value>0.05:Not significant, P-value<0.05 is statistically significant, p<0.001 is highly significant.

SD:standard deviation, ROM: Range of motion.

There was no statistically significant difference between the studied groups regarding postoperative clinical symptoms.

Table 2. Regarding postoperative clinical symptoms.

	ARTHROSCOPIC GROUP N=20	OPEN GROUP N=20	P-VALUE
GOOD COVER, GOOD INCORPORATION	16(80%)	17(85%)	0.68
GOOD COVER, ONE PLUG PROTRUDED 2MM	4(20%)	3(15%)	

P-value>0.05:Not significant, P-value<0.05 is statistically significant, p<0.001 is highly significant

Distribution of postoperative MRI among the studied groups.

There was no statistically significant difference between the studied groups regarding postoperative MRI

Table 3. Distribution of pre-and post-operative Lysholm Score among the studied groups.

LYSHLOM SCORE	ARTHROSCOPIC GROUP N=20	OPEN GROUP N=20	P-VALUE
PREOPERATIVE MEAN±SD	42.25±14.7	44.35±13.4	0.63
POSTOPERATIVE MEAN±SD	87.9±8.3	86.75±9.03	0.67
P-VALUE	<0.001	<0.001	

P-value>0.05:Not significant, P-value<0.05 is statistically significant, p<0.001 is highly significant, SD:standard deviation.

Forty participants were included in the study between August 2022 and October 2024. We had an 85.1% follow-up ratio. Also included were 35 men and 5 women, 27 knee joints on the right side and 13 on the left, 9 traumatic instances, and 31 degenerative cases. The average age of the subjects undergoing arthroscopic surgery was 24.65 years, whereas that of the open group was 25.65 years (ranging from 18 to 40 years old), and the average duration of follow-up was 12 months (ranging from 12 to 28 months).

Table 1 displays the details of the two age groups, including the recipient sites, donor sites, grafted plug diameter, and number of grafted plugs. Excluding the age of surgery, there were no discernible disparities between the two age groups. Traumatic and degenerative cartilage injuries were the primary disorders examined in this research.

Associated intraoperative findings among the studied groups there was medial femoral condyl(MFC) ulcers in all arthroscopic cases and 17-cases(85%) MFC ulcer and 3-cases(15%) Lateral femoral condyl ulcers in open group Combined operation in (4-cases), posterior horn medial meniscus tear 2-cases(10%) in arthroscopic and 1-case(5%) in open , 1-case degenerative posterior horn medial meniscus meniscectomy , and loose body in 18-cases, and 19-cases arthroscopica and open groups respectively synovitis in 7-cases 7(35%) in arthroscopic and 4-cases 4(20%)in open groups the doner site was LFC and beside the trochlealer groove pain postoperative according to VAS Score was mild in 17-cases and no pain in 3-cases in Arthroscopic group ,butmild in 15-cases moderate in 2-cases and no pian in 3-cases postoperative complications were pain over the doner site 1-case(5%) in Arthroscopic group, 2-cases in open groups, 2-cases(10%) with hemoarthrosis in open group, DVT 1 case(5%) in open group managed by vascular surgeons, one-case with stiff knee in open group managed by physiotherapy and medical treatment and 1-case with slight dislodgment of the doner site plug managed conservative and follow up no mechanical symptoms. Six months Postoperative MRI shows good coverage and good incorporation 16-cases(80%) in the arthroscopic group ,17-cases(85%) in open group protrusion of the graft were recorded in 4-cases Arthroscopic and 3-cases open . End results were fair in 1-case Arthroscopic, 6 cases in open group, good in 16-cases(80%)arthroscopic and 14-cases(70%) open. Excellent in 3-cases(15%) Arthroscopic.

Combined operation in(4-cases), posterior horn medial meniscus tear(2-cases) in arthroscopic peripheral tear managed by menisectomy and 1-case in open, 1-case degenerative posterior horn medial meniscus meniscectomy, and loose body in 18-cases, and

19-cases arthroscopic and open groups respectively synovitis in 7-cases in arthroscopic and 4-cases in open groups.

Finally, mosaicplasty when indicated is a good tool for osteochondral lesions and there wase significant increase in lysholm score in Arthroscopic than open group,

CASE PRESENTATION

History: 28-years old male with BMI(27) works as an electrician. He had a history of Twisting LT knee injury 9-months ago with a recurrent history of pain, effusion and catching. In last 2-months the pain got worse with infrequent attacks of locking and giving away he took medical treatment and advised to do further investigation.

Imaging: 1- Plain X-ray

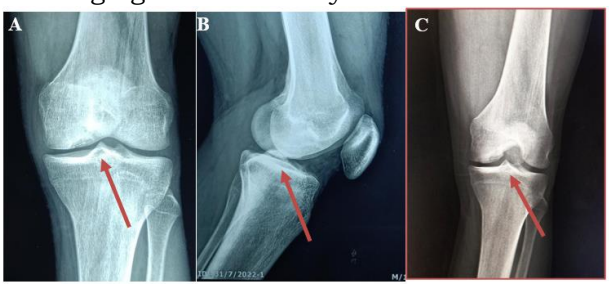
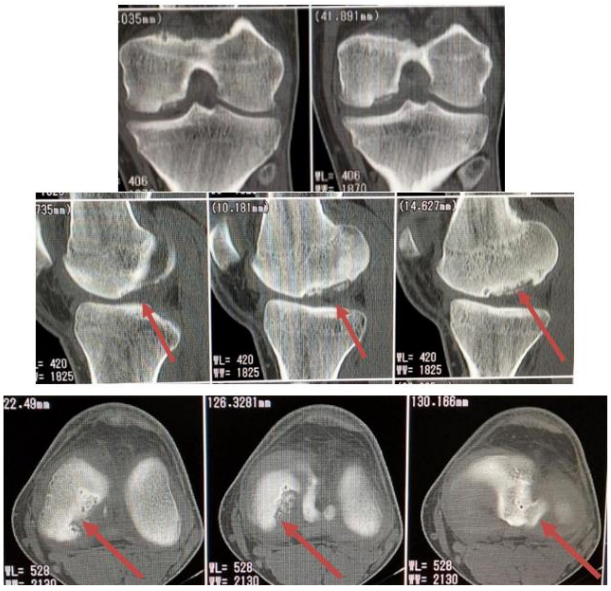
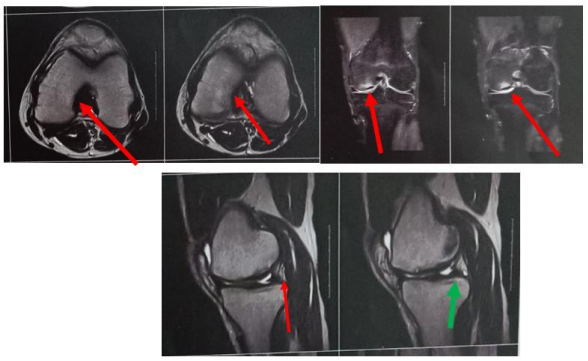


Figure 1. Preoperative X-rays (A) AP & (B) lateral views (c) notch views showing slight sclerosis, or flattening of the medial femoral condyle and loose bodies.



MRI.



MRI showed an osteochondral lesion(2.8cm) occupying the Centro-lateral part of the weight-bearing area in the medial femoral condyle.

Preoperative evaluation:

Preoperative score was as followed lysholm 69.

Arthroscopic mosaicplasty:

Diagnostic arthroscopy, debridement, Preparation of the lesion and re-sizing after debridement by measuring rod.

Figure 4. Diagnostic arthroscopy showing loose body and chondral ulcer.

Figure 5. Intraoperative: (A) preparation of the recipient site (defect size 2.8cm2). (B)(C) Insertion of 1st, 2nd,3rd plugs10 mm in diameter. (D)final arthroscopic view after impaction of the 3-pluges

Rehabilitation: it was illustrated and discussed in the methodology chapter.

Postoperative evaluation: postoperative lysholm was 96.

Figure 6. Postoperative x rays at 6-months follow up (A) AP, (B) lateral, (C) tunnel and(D) sky line views

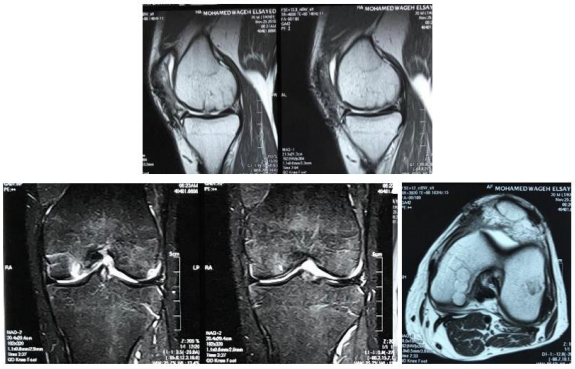


Figure 7. Postoperative MRI at 6-months follow up coronal, sagittal and axial views showing healing of donor site and healing recipient site and congruent articular surface and full incorporation of the graft at the recipient site.

Figure 8. Post-operative clinical photos at 6 months follow up of full ROM:
(A) full extension (B) squatting (C) full flexion.

4. Discussion

Articular cartilage is hypocellular and avascular, and thus has poor healing potential; damage to the knee can lead to chronic discomfort, joint effusion, and general dysfunction. There are a number of surgical treatments that have been proposed for the successful treatment of cartilage injury in the knee: Methods such as autologous chondrocyte transplantation, microfracture, osteochondral allograft transplantation, and osteochondral autograft transplantation .[6]

There was no statistically significant distinction within the analyzed groups for age, sex, BMI, side, and etiology when it came to the distribution of patient characteristics among the categories.

Our findings are supported by REVERTE-VINAIXA, Maria Mercedes, et al.[7], who found that autologous mosaicplasty has a satisfactory medium-term outcome for symptomatic femoral condyle osteochondral abnormalities. To assess the graft's long-term structural and functional stability, more extensive follow-up is required.

Our findings indicate that, when comparing the groups based on the distribution of preoperative clinical symptoms (p-value>0.05), no statistically significant distinction was found.

In agreement with our results Oztürk et al.,[8] all patients had activity-related knee pain before the operation, according to the researchers who intended to assess the medium-term clinical and radiological outcomes of patients having Mosaicplasty done to repair full-thickness cartilage defects in the knee. Recurring swelling affected 52.6% of patients, while 15.8% reported feeling locked up.

There was no statistically significant difference between the analyzed groups with a p-value>0.05 when it came to the distribution of intraoperative ulcer site, size, graft number, and donor site.

In contrast with our result, Tan et al.,[9] In their pursuit of establishing a gold standard for cartilage repair, the researchers set out to determine whether the arthroscopic or mini-open approach yielded better clinical outcomes. They found that while the open approach yielded higher scores on the Magnetic Resonance Observation of Cartilage, Repair Tissue, and Incidence of Reported Postoperative Complications of Revision Surgery and knee stiffness, the arthroscopic approach yielded higher scores on deep vein thrombosis.

In contrast with our results, Kizaki et al.,[6] intended to document the results of open and arthroscopic OATs in terms of clinical outcomes, postoperative complications, defect size, and defect placement. According to their findings, arthroscopic OATs had a defect size of 0.97±0.48cm2 and open OATs had a defect location of 2.96±0.76cm2, with a p-value<0.01. Open OATs were associated with better overall clinical results than arthroscopic OATs; however, open OATs could treat lesions around three times larger in dimension. In addition, arthroscopic OAT could only detect defects in the medial and lateral ligaments. Among the complications, hemarthrosis was the most common.

Based on the distribution of postoperative clinical symptoms among the groups that were studied, the results showed that locking, pain, swelling, and pain over the donor site were not significantly different between the groups (p-value>0.05). However, there was a significant decrease in range of motion (ROM) in the arthroscopic group compared to the open group (p-value<0.05).

In agreement with our results Oztürk et al.,[10] all

patients had activity-related knee pain before the operation, according to the researchers who wanted to assess the medium-term clinical and radiological outcomes of patients having mosaicplasty done to repair full-thickness cartilage lesions of the knee joint. Recurring swelling affected 52.6% of patients, while 15.8% reported feeling locked up.

There were no statistically significant differences between the analyzed groups regarding postoperative MRI distribution (p-value>0.05), according to our demonstration.

Also agreed with Chow et al.,[11] who sought to assess the mid-term outcomes of arthroscopic knee chondral and osteochondral lesion treatment with autogenous osteochondral transplantation (AOT) found that the average Lysholm score improved significantly (P=0.001) from 43.6 before surgery to 87.5 after.

In this study, researchers looked at the distribution of pre- and postoperative Lysholm ratings among the groups. They found no statistically significant difference between the groups. A statistically significant rise was noted in the postoperative Lysholm score compared to the preoperative Lysholm score in the open group, and in the arthroscopic group, this increase was also present.

This study found a statistically significant difference between the groups tested with respect to results (fair, good, exceptional) according to the distribution of end results (p-value=0.01).

Also, agreed with, Wang et al.,[12] who sought to analyze the outcomes of fifteen patients with sixteen knees who underwent osteochondral autograft to restore focal full-thickness articular cartilage defects of the knee and who were followed up for at least two years after the procedure. The researchers discovered a statistically significant difference (p-value 0.001) in pain and knee locking between the patients before and after the procedure.

Limitations and recommendations: The sample size was not large enough, and the short follow-up period was considered the main limitation of the current study. So, it is recommended by: using well-designed randomized controlled trials or large, comparative observational studies, inclusion a representative sample of patients with similar age, gender, and disease severity, large enough sample size to provide meaningful conclusions and to control for confounding factors, anda longer follow-up period .

4. Conclusion

Mosaicplasty when indicated is a good tool for osteochondral lesions, Ther is statistically significant between patients treated with the arthroscopic method and patients treated with open mosaicplasty in patient-reported outcomes, Lysholm score, so, the arthroscopic method had excellent results than open mosaicplasty.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

Funding

No Funds : Yes

Conflicts of interest

There are no conflicts of interest.

References

1. A Fernandes TL, SantAnna JP, Boff MS, et al. Age-related surgical management of chondral and osteochondral lesions. Journal of Cartilage & Joint Preservation.2024 Mar 12:100172.
2. Jenkins P, Shields DW, White TO. McRae's Elective Orthopaedics E-Book: McRae's Elective Orthopaedics E-Book. Elsevier Health Sciences; 2022.
3. Sherman SL, Thyssen E, Nuelle CW. Osteochondral autologous transplantation.Clinics in sports medicine.2017;36(3):489-500.
4. Yamashita F, Sakakida K, Suzu F, et al. The transplantation of an autogeneic osteochondral fragment for osteochondritis dissecans of the knee.Clinical Orthopaedics and Related Research (1976-2007).1985;201:43-50.
5. Hangody L, Dobos J, Baló E, et al. Clinical experiences with autologous osteochondral mosaicplasty in an athletic population:a 17-year prospective multicenter study. The American journal of sports medicine.2010;38(6):1125-33.
6. Kizaki K, El-Khechen HA, Yamashita F., et al. Arthroscopic versus open osteochondral autograft transplantation(mosaicplasty) for cartilage damage of the knee:a systematic review. The Journal of Knee Surgery.2021;34(01):094-107.
7. Reverte-Vinaixa MM, Joshi N, Díaz-Ferreiro EW, et al. Medium-term outcome of mosaicplasty for grade III-IV cartilage defects of the knee. Journal of orthopaedic surgery.2013; 21(1):4-9.
8. Oztürk A, Ozdemir MR, Ozkan Y. Osteochondral autografting(mosaicplasty) in grade IV cartilage defects in the knee joint:2-to 7-year results. International orthopaedics.2006; 30:200-4.
9. Tan CH, Huang XO, Tay ZQ, et al. Arthroscopic and open approaches for autologous matrix-induced chondrogenesis repair of the knee have similar results:a meta-analysis. Journal of ISAKOS.2023.
10. Oztürk A, Ozdemir MR, Ozkan Y. Osteochondral autografting (mosaicplasty) in grade IV cartilage defects in the knee joint:2-to 7-year results. Int Orthop.2006;30:200-4.
11. Chow JCY, Hantes ME, Houle JB, et al. Arthroscopic autogenous osteochondral transplantation for treating knee cartilage defects:a 2-to 5-year follow-up study. Arthrosc J Arthrosc Relat Surg.2004;20(7):681–90.
12. 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;122:169–72.