



Original article

MOSAICPLASTY TECHNIQUES IN THE TREATMENT OF OSTEOCHONDRAL INJURIES

Emil Simeonov

Department of orthopaedics and traumatology, Faculty of medicine, Medical University – Pleven, Bulgaria.

ABSTRACT

Introduction: Articular cartilage damage is quite a common problem within the general population, especially in the younger and more athletic populations. These defects, if left untreated, would lead to post-traumatic osteoarthritis. Taking into consideration the high frequency and socioeconomic burden of osteoarthritis, the treatment of osteochondral lesions presents a unique challenge for surgeons.

Materials/Methods: Several hypotheses were formulated to discover whether mosaicplasty could be used in order to successfully treat osteochondral lesions. Furthermore, open mini and arthroscopic surgery were tested to determine whether they could achieve the same result as mosaicplasty. A sample of 45 patients from the general population volunteered for the study, of whom 13 patients underwent open mosaicplasty, 17 mini-open and 15 patients arthroscopic mosaicplasty. Assessment of the knee articular cartilage reconstruction was done during each visit, utilising Lysholm and the VAS scale. A histological examination was also performed.

Results: A significant difference was observed between pre- and post-surgical Lysholm score, as well as between pre- and post-surgical VAS score. Additionally, histological analysis confirmed the success of osteochondral autograft transfer and integration into the recipient's knee.

Conclusion: The study demonstrated that several mosaicplasty techniques could be used in articular cartilage reconstruction. Moreover, the histological examination further confirmed the viability of the autograft.

Keywords: Autologous osteochondral graft, Cartilage, Full-thickness defect, Knee, Osteochondral transfer,

INTRODUCTION

Osteochondral lesions, while occurring regularly, present an unremitting challenge to surgeons. The reason for this is that the therapy should not only consider anatomical reconstruction but also the prevention of osteoarthritis as a long-term complication and provide adequate pain relief [1]. This is particularly true for younger patients, for whom hemi or total knee arthroplasty is rarely advised [2, 3, 4, 5, 6]. Using multiple cylinders, mosaicplasty allows the restoration of the contour of the affected surface thus restoring the integrity of the joint surface.

Treatment of osteochondral lesions through mosaicplasty is shown to be an appropriate, cost-efficient method, which could restore the articular cartilage to its original condition in patients for whom arthroplasty is otherwise contra-indicated [2, 7, 8, 9]. Furthermore, mosaicplasty could be performed as a single-stage procedure as an open, semi-open or arthroscopic surgery.

MATERIALS AND METHODS

Clinical research was conducted at the Clinic of Orthopaedics and Traumatology of University Hospital Pleven "Dr Georgy Stranski" from 2010 to 2018.

A sample of 45 patients (27 males and 18 females, mean age 37 ± 10 years) from the general population volunteered for the study, of whom 13 patients were selected to undergo open mosaicplasty, 17 mini-open and 15 patients to undergo arthroscopic mosaicplasty.

Initially, each study began with a pre-operative assessment at the first meeting at the hospital (Table 1). After surgery, patients received follow ups several more times.

The assessment of the successfulness of the knee articular cartilage reconstruction was done during each visit utilising the Lysholm scale [10, 11] and the Verbal Analogue Scale (VAS) scale [12].

Ethical approval for the study was granted by the Medical University - Pleven Research Department. Informed consent was obtained from all individual participants included in the study, and all participants were provided with correct and adequate information to take part in the study. Furthermore, patients were informed about the possible necessity of taking a graft from the contralateral knee.

Table 1. List of inclusion and exclusion criteria which have been used within the present study

Inclusion criteria	Exclusion criteria
Symptoms of knee dysfunction (Pain, recurrent oedema, mechanical symptoms)	Degenerative knee osteoarthritis (Advanced stage)
Isolated chondral and osteochondral lesions located in loading areas of femoral condyles	Systemic inflammatory disease (Rheumatoid arthritis)
Defect diameter of 1 – 5 cm ²	Collagenous or vascular diseases
Normal or correctable axial deviation of the knee	Obesity (BMI >35)
Normal or correctable ligamentous stability of the knee	Long-term immunosuppressive treatment (Corticosteroids)
Functional meniscal structure (>50% of intact meniscus)	Two-pole (kissing) lesions of the knee
Between 19 – 55 years of age	Osteochondral lesions over 8 cm ²
Adequate patient compliance	Depth of osteochondral lesion over 10mm
	Over 60 years of age
	Non-corrected axial deviation or knee instability
	All patients who missed their last appointment, as well as all patients who missed more than 2 follow-up appointments

Surgical Procedure

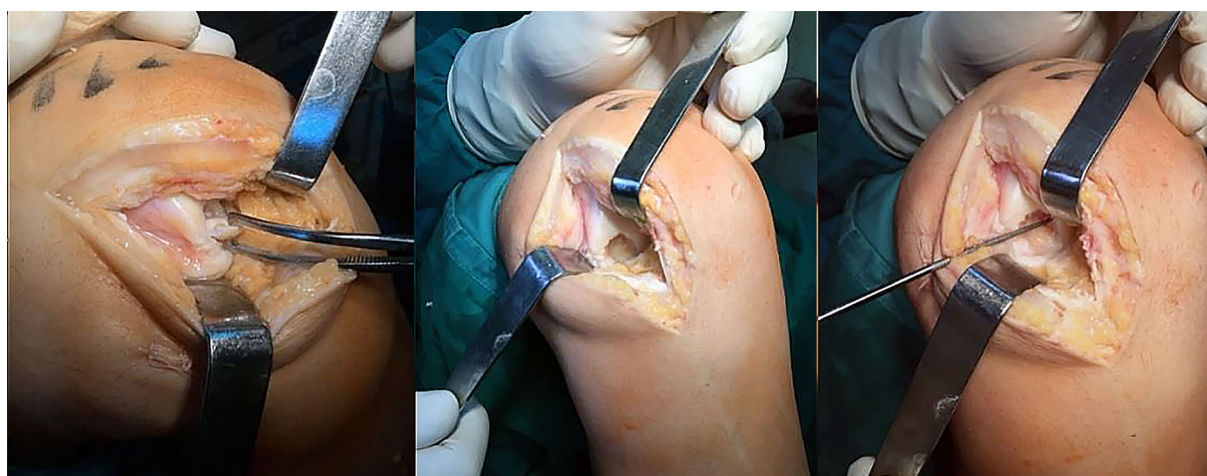
All surgeries were performed either under spinal or full anaesthesia, and all patients underwent prophylaxis for pulmonary embolism with low molecular weight heparin (Fraxiparine) 0.6 ml and broad-spectrum antibiotic. At the start of the operation, a diagnostic arthroscopy was performed. The default choice for all patients was to undergo the arthroscopic method of operation. Depending on the lesion size and localisation, the decision to continue with arthroscopic or to transform into mini-open or open surgery was made peri-operatively.

Anteromedial and anterolateral portals were used for arthroscopic operation, whereas medial parapatellar access

was used during open mosaicplasty. We propose using a spinal needle percutaneously to the joint to choose the initial right access to the joint and for the correct orientation of the instruments. Furthermore, it is recommended to make vertical incisions, which will simplify the procedure of acquiring grafts.

After access to the joint, the defects were localised and probed. The length and depth of the cartilage lesions were then measured. Debridement of all damaged, free or unstable cartilage was performed, followed by resection, in order to achieve stable and healthy cartilage edges. The floor of the defects was also prepared with burs until subchondral bone could have been seen.

Fig. 1. Open osteochondral autograft transfer (OAT) surgery through the medial para-patellar incision and debridement of the defect

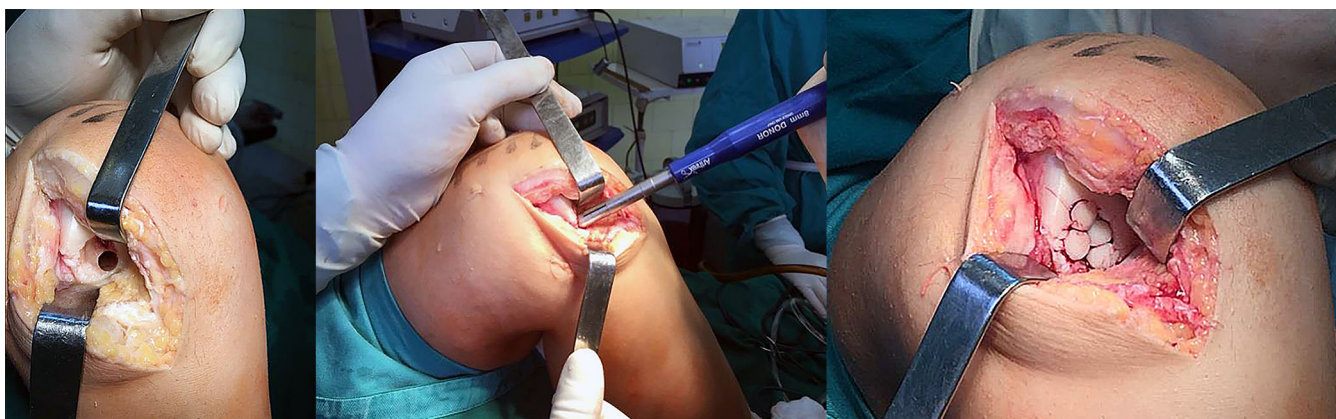


OAT mosaicplasty procedure was performed as described by Hangody L et al. in 2004. [13]

After assessment of the number of chondral cylinders required, the OAT--reconstruction (Arithrex, osteo-

chondral autograft transfer system) with a diameter of 4, 6 or 8 mm was used to acquire cylindrical osteochondral grafts from the periphery of medial patella-femoral groove. The aim was to take grafts of at least 6 mm.

Fig. 2. Preparation and implantation of the osteochondral grafts. The right side photo shows the reconstructed defect with 4 grafts of 8 mm each. Further down, Fig. 5 will present arthroscopic findings after 6 months of the same patient.



When restoring femoral defects, we preferred in our study to take grafts from the medial and lateral periphery patellar surface of the femur. From the studies concerning contact pressure on the retro-patellar surface, it is known that average contact pressure is higher on the lateral side of the femoral condyle than the medial. Thus, the peripheral area of the medial patellofemoral joint was the first choice donor site for grafts. Furthermore, the most distal part of the lateral femoral condyle, above the terminal sul-

cus, could be used as a donor area. Donor cylinders should be acquired at no less than 2 -3 mm from each other. Otherwise, tunnels may cross, and it will lead to a deficiency of subchondral bone in the graft.

A step-by-step procedure was used to fill in the defects with press-fit to recipient tunnels, which were prepared in advance at the site of chondral defect. Furthermore, a table of additional operational procedures that were performed during surgical operations is supplied (Table 2).

Fig. 3. Arthroscopic insertion of the autografts into the recipient tunnel



Table 2. List of additional operational procedures

Procedure	Number of patients who underwent such additional procedure
Plastics due luxation of patella	3
Meniscectomy	3
Free intra-articular fragments removal	2
ACL plastics	1
Plica resection	1

Rehabilitation

All groups of patients have followed the same rehabilitation protocol. Knee braces, which allow motion from 0 to 90 degrees, were installed on the day after the operation, and patients were instructed to begin rehabilitation within a determined degree of range of movement (0 – 90 degrees). The patients were encouraged to perform isometric quadriceps exercises. The main focus of early rehabilitation was to restore the range of movement and to decrease post-operational oedema. Patients were, however, not allowed to weight bear on the operated knee for the first 6 weeks and were instructed to use crutches when walking using the toe-touch technique. This was done to allow the integration of allografts into recipient tunnels. Subsequently, 6 weeks post-operation, patients were allowed to progressively bear weight on the operated knee on the con-

dition of satisfactory x-ray findings and lack of subjective complaints. After 6 months, patients were permitted to return to full activity, including sports activity.

RESULTS

Statistical analysis was performed with Statistical Package for the Social Sciences (SPSS Inc., Chicago, Illinois, USA) and Microsoft Excel [14].

According to the results from a study, the medial femoral condyle was affected in more than 80% of operated patients, with the remaining 20% being the lateral condyle ($p < 0.01$).

More than 1/3 of patients (18; 40%) correlated their disease with previous history of trauma. Osteochondritis dissecans was found in 18 (40%) of patients, and in the other 9 cases (20%), the cause was unknown. An absolute majority of chondral defects were located on the medial femoral condyle (89%), and in the rest cases, the lateral femoral condyle was affected.

From 45 patients, partial meniscectomy was performed in 17 patients, ACL reconstruction in 7 patients, lateral release procedure in 3 patients, free body removal in 2 patients and 1 patient plicae resection, respectively.

The average time of surgery was recorded to be around 60 ± 15 minutes.

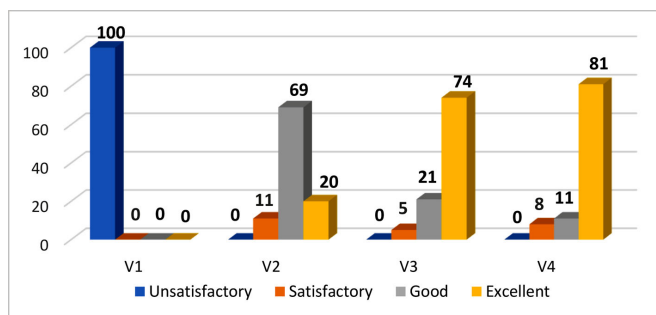
All patients were with lesion through the subchondral bone (ICRS – 4).

In 23 patients (53.4%), the area of defect was $< 2 \text{ cm}^2$.

The average history of complaints was 9.5 months.

Pre-operative Lysholm score was 43.6 (from 18 – 61). Post-operative Lysholm score increased to an average of 93.5 (from 74 – 100), which is statistically significant compared to an average pre-operative score of 43.6 ($p = 0.001$). In 40 patients (91.4%) received excellent or good outcomes, with restored joint function, and patient have returned to normal daily life activities. The average result was received with 5 patients (8.6%).

Table 3. Lysholm score results, which demonstrated a significant difference between V1 and V4 ($p = 0.0001$)



Furthermore, it was found that in patients who received 6 or more grafts, the average Lysholm score (V4) was 84.7 compared to patients who only received up to 3 grafts (V4 was 93.4; $p = 0.007$).

DISCUSSION

Surgical treatment of articular cartilage requires special caution due to the absence of a direct blood supply, lymphatics and nerves, relying solely on synovial fluid nourishment [3, 15, 16, 17, 18].

From the literature perspective, mosaicplasty provides very good results, ranging from 72% to 92%. According to Versier and Dubrana [19], factors that provide a better prognosis were reported as follows: lesions on medial condyle, osteochondritis desiccans, deep, small lesions and the shortest possible surgical time. The results of this study, therefore, also support the findings of Versier and Dubrana [19].

The Lysholm score has been reported to be used in numerous studies regarding cartilage surgery, including mosaicplasty. Furthermore, Briggs et al. 2006, have proved that the Lysholm score has an acceptable test-retest reliability, floor and ceiling effects, criterion validity, construct validity, and accurately records responsiveness to change [11]. Moreover, the Lysholm score is easy to understand and complete for patients, which is important for the general population. Hence, the Lysholm score was used in this study and confirmed that mosaic grafting could be used to restore the cartilaginous surface. Additionally, this study has found that all 3 surgical techniques provide a similar Lysholm score, meaning all 3 surgical techniques could be applied in the management of osteochondral lesions.

The results of this study confirms that mosaicplasty could be used for the treatment of osteochondral lesions of the knee [20]. Furthermore, our study has found that all 3 surgical techniques could be used to provide long-term pain and functional relief with the same result.

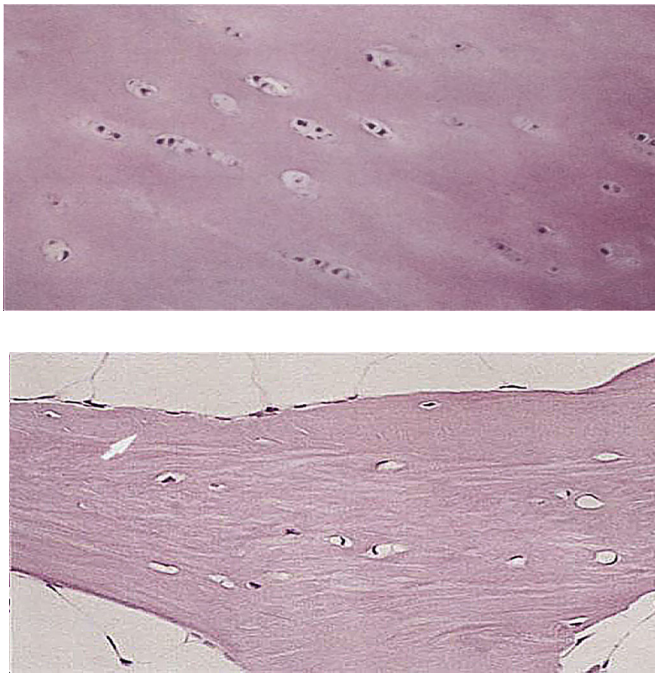
However, in the opinion of the author, arthroscopic procedures should be used initially or at least attempted. Although not measured in the present study, after the arthroscopy procedure, patients reported feeling less pain immediately after surgery. This was noted to be in contrast with patients who had undergone mini or open surgery instead.

Furthermore, a study has compared patients with an excellent outcome and those with a good or poor outcome. It was found that patients with a poor outcome had a significantly longer duration of pre-operative symptoms (~23 months compared with ~7.5 months in those with an excellent outcome). Additionally, the two subgroups also differed in age.

A comparative analysis of patients under 45 years of age and those over 45 years of age furthermore revealed a significant difference in the final Lysholm score (92.3 in the under - 45 years of age and 87.1 in the other subgroup).

Histological analysis of 7 patients also confirmed the successful osteochondral autograft transfer and their integration into the recipient knee (Fig. 4, Fig. 5). Nevertheless, fibrous cartilage was found in 2 patients, with both reporting the same Lysholm score, we can, therefore, assume that histological findings would be true and similar in the other patients with an equal score.

Fig. 4. Biopsy of autologous osteochondral graft. Histological findings present vital chondrocyte.

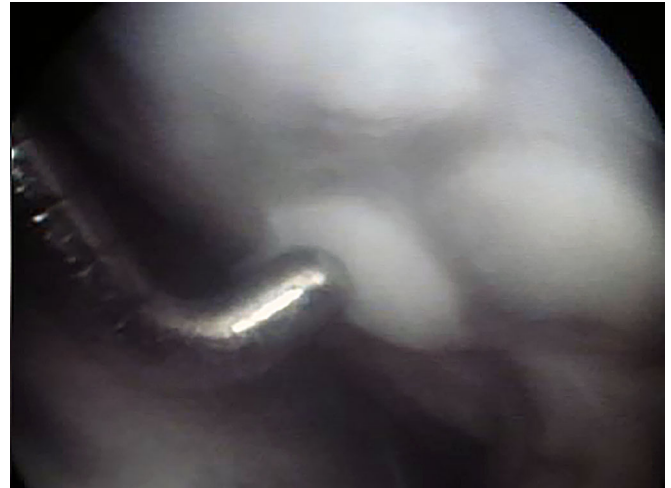


This study has also observed that patients who underwent arthroscopic surgery had a much quicker recovery than their counterparts, as shown by the data. Approximately 80% of patients who underwent an arthroscopic surgery had recovered in just under two weeks, whereas only 7.7% of patients demonstrated such quick recovery rates after open surgery and 58.8% after mini-open surgery.

As such, we may conclude that mosaicplasty demonstrates certain benefits, such as being a low cost and efficient procedure, which could be used to reconstruct normal hyaline cartilage (Fig. 5). This was proven by histology (Fig. 4) and may be performed as a single surgical procedure [21].

The disadvantage of the mosaicplasty technique is the issue of the donor site morbidity [22]. In the systemic review of Andarde et al., it was found that osteochondral mosaicplasty harvesting often leads to arthritic changes at the donor sites [23]. However, within the same report, it was stated that no correlation was found between the number of and the size of the plugs and the donor site morbidity. None-

Fig. 5. Arthroscopic finding of successful integration of the osteochondral grafts



theless, Andarde et al. also report that further studies should specifically report donor site morbidity due to a lack of information on donor site morbidity [23].

Thus, we may conclude that our study provides support for the use of mosaicplasty as a reconstructive technique, which could be used to provide good functional results and symptomatic relief. Surgeons should also be wary of possible complications from using the mosaicplasty technique.

CONCLUSION

Treatment of osteochondral lesions up to this day still presents a challenge [16, 23, 24]. Once damaged, they will have little ability to regenerate and will stay damaged [16, 22].

The present study has shown by virtue of histological examination, Lysholm score and VAS score that mosaicplasty could be successfully used to transplant the autografts and integrate them into traumatised cartilage and provide acceptable clinical results [21]. Surgeons should be wary of possible donor site morbidity from the use of the mosaicplasty technique.

Abbreviations

VAS - Verbal Analogue Scale

OAT - Osteochondral Autograft Transfer

REFERENCES:

1. Litwic A, Edwards MH, Dennison EM, Cooper C. Epidemiology and burden of osteoarthritis. *Br Med Bull.* 2013;105(1):185–99. [[PubMed](#)]
2. Gudas R, Kalesinskas RJ, Kimtys V, Stankevicius E, Toliushis V, Bernotavicius G, et al. A prospective randomized clinical study of mosaic osteochondral autologous transplantation versus microfracture for the treatment of osteochondral defects in the knee joint in young athletes. *Arthroscopy.* 2005 Sep;21(9):1066–75. [[PubMed](#)]
3. Katz JN, Earp BE, Gomoll AH. Surgical management of osteoarthritis. *Arthritis Care Res (Hoboken).* 2010 Sep;62(9):1220–8. [[PubMed](#)]
4. Kish G, Módis L, Hangody L. Osteochondral mosaicplasty for the treatment of focal chondral and osteochondral lesions of the knee and talus in the athlete. *Clin Sports Med.* 1999 Jan;18(1):45–66. [[PubMed](#)]
5. León SA, Mei XY, Safir OA, Gross AE, Kuzyk PR. Long-term results of fresh osteochondral allografts and realignment osteotomy for cartilage repair in the knee. *Bone Joint J.* 2019 Jan;101-B(1_Suppl_A):46–52. [[PubMed](#)]
6. Smith GD, Knutsen G, Richardson JB. A clinical review of

cartilage repair techniques. *J Bone Joint Surg Br.* 2005 Apr;87(4):445–9. [PubMed]

7. Kowalczyk M, Musahl V, Fu FH. Cochrane in CORR®: Surgical Interventions (Microfracture, Drilling, Mosaicplasty, and Allograft Transplantation) for Treating Isolated Cartilage Defects of the Knee in Adults. *Clin Orthop Relat Res.* 2018 Jan;476(1):16-18. [PubMed]

8. Haklar U, Tüzüner T, Kocaođlu B, Güven O. [Mosaicplasty technique in the treatment of osteochondral lesions of the knee]. [in Turkish] *Acta Orthop Traumatol Turc.* 2008 Nov-Dec;42(5):344-9. [PubMed]

9. Karmali S, Guerreiro R, Costa DSD, Fonseca J, Gonçalves R. Mosaicplasty Technique in the Treatment of Isolated Knee Femoral Condyle Osteochondral Lesions - a Retrospective Study. *Rev Bras Ortop (Sao Paulo).* 2019 May;54(3):316-321. [PubMed]

10. E Albuquerque RP, Giordano V, Calixto A, Malzac F, Aguiar C, Do Amaral NP, et al. Analysis on the Modified Lysholm Functional Protocol Among Patients with Normal Knees. *Rev Bras Ortop.* 2015 Nov 16;46(6):668-74. [PubMed]

11. Briggs KK, Kocher MS, Rodkey WG, Steadman JR. Reliability, validity, and responsiveness of the Lysholm knee score and Tegner activity scale for patients with meniscal injury of the knee. *J Bone Joint Surg Am.* 2006 Apr;88(4):698-705 [PubMed]

12. Briggs M, Closs JS. A descriptive study of the use of visual analogue

scales and verbal rating scales for the assessment of post-operative pain in orthopedic patients. *J Pain Symptom Manage.* 1999 Dec;18(6):438-46. [PubMed]

13. Hangody L, Ráthonyi GK, Duska Z, Vásárhelyi G, Füles P, Módis L. Autologous osteochondral mosaicplasty. Surgical technique. *J Bone Joint Surg Am.* 2004 Mar;86-A Suppl 1:65-72. [PubMed]

14. Solheim E, Hegna J, Inderhaug E. Clinical outcome after mosaicplasty of knee articular cartilage defects of patellofemoral joint versus tibiofemoral joint. *J Orthop.* 2019 Oct 31;18:36-40. [PubMed]

15. Armiento AR, Alini M, Stoddart MJ. Articular fibrocartilage - Why does hyaline cartilage fail to repair? *Adv Drug Deliv Rev.* 2019 Jun;146:289-305. [PubMed]

16. McCoy B, Miniaci A. Osteochondral autograft transplantation/mosaicplasty. *J Knee Surg.* 2012 May;25(2):99-108. [PubMed]

17. Richter DL, Schenck RC Jr, Wascher DC, Treme G. Knee Articular Cartilage Repair and Restoration Techniques: A Review of the Literature. *Sports Health.* 2016 Mar-Apr; 8(2):153-60. [PubMed]

18. Ulstein S, Årøen A, Røtterud JH, Løken S, Engebretsen L, Heir S. Microfracture technique versus osteochondral autologous transplantation mosaicplasty in patients with articular chondral lesions of the knee: a prospective randomized trial with long-term follow-up. *Knee Surg Sports Traumatol Arthrosc.* 2014 Jun;22(6):

1207-15. [PubMed]

19. Versier G, Dubrana F, French Arthroscopy Society. Treatment of knee cartilage defect in 2010. *Orthop Traumatol Surg Res.* 2011 Dec;97(8 Suppl):S140-53. [PubMed]

20. Bentley G, Biant LC, Vijayan S, Macmull S, Skinner JA, Carrington RW. Minimum ten-year results of a prospective randomised study of autologous chondrocyte implantation versus mosaicplasty for symptomatic articular cartilage lesions of the knee. *J Bone Joint Surg Br.* 2012 Apr;94(4):504-9. [PubMed]

21. Bartha L, Vajda A, Duska Z, Rahmeh H, Hangody L. Autologous osteochondral mosaicplasty grafting. *J Orthop Sports Phys Ther.* 2006 Oct; 36(10):739-50. [PubMed]

22. Nakagawa Y, Mukai S, Setoguchi Y, Goto T, Furukawa T, Nakamura T. Clinical Outcomes of Donor Sites After Osteochondral Graft Harvest From Healthy Knees. *Orthop J Sports Med.* 2017 Oct 13;5(10):2325967117732525. [PubMed]

23. Andrade R, Vasta S, Pereira R, Pereira H, Papalia R, Karahan M, et al. Knee donor-site morbidity after mosaicplasty - a systematic review. *J Exp Orthop.* 2016 Dec;3(1):31. [PubMed]

24. Solheim E, Hegna J, Inderhaug E. Long-Term Survival after Microfracture and Mosaicplasty for Knee Articular Cartilage Repair: A Comparative Study Between Two Treatments Cohorts. *Cartilage.* 2020 Jan;11(1):71-76. [PubMed]

Please cite this article as: Simeonov E. Mosaicplasty techniques in the treatment of osteochondral injuries. *J of IMAB.* 2023 Oct-Dec;29(4):5230-5235. [Crossref - <https://doi.org/10.5272/jimab.2023294.5230>]

Received: 18/09/2023; Published online: 22/11/2023



Address for correspondence:

Emil Simeonov

Clinic of Orthopaedics & Traumatology, UMBAL “Dr. Georgi Stranski” - Pleven, Bulgaria

89, Ruse Blvd., Pleven 5803, Bulgaria

E-mail: emil.simeonov.pl@gmail.com,