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Medium-term outcomes of mosaicplasty versus arthroscopic microfracture with or without platelet-rich plasma in the treatment of osteochondral lesions of the talus

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Abstract
Purpose This study aimed to compare medium-term functional effects of three different treatment modalities in patients with osteochondral lesions of the talus (OLT).
Methods Fifty-four patients undergoing arthroscopic surgery for osteochondral lesion of the talus were included in this study. Patients were assigned to one of the three treatment groups: microfracture surgery ($n = 19$), microfracture surgery plus platelet-rich plasma (PRP) ($n = 22$), and mosaicplasty ($n = 13$). Function was assessed using the American Orthopedic Foot and Ankle Society (AOFAS) scoring system and VAS scores for pain, before and after surgery. In addition, the Foot and Ankle Ability Measure (FAAM) tests for pain and 15-min walking were done at follow-up visits.
Results The median duration of follow-up was 42 months (range 12–84 months). All groups showed significant improvements in AOFAS and VAS pain scores at the last follow-up visit, when compared to baseline. The groups did not differ with regard to change in baseline AOFAS score; however, improvement in VAS pain scores was significantly better in the mosaicplasty group when compared to the microfracture group (change from baseline, -5.8 ± 1.0 vs. -3.2 ± 2.9, $p = 0.018$).
Conclusions All the three treatment modalities resulted in good medium-term functional results. However, mosaicplasty procedure seems to be a promising option and it might be preferred particularly in patients where pain control is important.
Level of evidence II.

Keywords Osteochondral lesions of the talus (OLT) · Mosaicplasty · Arthroscopic microfracture · Platelet-rich plasma (PRP)

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Introduction

Ankle is the second most frequent site following knee that requires cartilage repair, which is a challenging process [7]. The osteochondral lesions of the talus (OLT) typically occur at the posteromedial and anterolateral dome of the talus, and OLT have been reported to occur in up to 6.5 % of the individuals who endured an ankle sprain [14].

Early detection and treatment of the lesions of the joint cartilage carry a significant importance in terms of the preservation of joint functions, relief of pain, and prevention of early osteoarthritis [1]. Currently the first choice in the surgical treatment of OLT is arthroscopic excision in conjunction with debridement (curettage) and bone marrow stimulation (microfracture) [24], based on the results of studies that reported quick recovery, high success rate, and low morbidity associated with this procedure. For the purpose of increasing the quality of the cartilage repair tissue, platelet-rich plasma (PRP), which is also used in other fields of medicine for its therapeutic role, may also be utilized [16, 23]. Addition of PRP to arthroscopic microfracture surgery has been shown to exhibit a favourable effect on clinical outcomes in the medium term [8]. However, whether this

effect in the medium term translates into long-term benefits is currently unknown. On the other hand, mosaicplasty is associated with high endurance of the cartilage due to the quality of the hyaline cartilage obtained and is particularly recommended for younger patients with high physical expectations.

In this study, for the first time in the literature, arthroscopic microfracture surgery and mosaicplasty were compared among patients with OLT of similar severity, in terms of functional clinical outcomes. In addition, the effects of arthroscopic microfracture surgery, either with or without addition of PRP, were examined.

Materials and methods

Fifty-four patients all undergoing arthroscopic surgery with a diagnosis of osteochondral lesion of the talus between June 2007 and December 2011 were included in this study. Thirty-two patients were male and 22 were female, with a mean age of 40.1 ± 14.7 years (range 11–69 years).

The patients were assigned to one of the three following groups: microfracture surgery ($n = 19$), microfracture surgery plus PRP ($n = 22$), and mosaicplasty ($n = 13$). Patients who would undergo microfracture surgery were assigned to PRP treatment if they were given a patient ID with an odd number at the time of admission. All microfracture surgery patients underwent arthroscopy; but in the mosaicplasty group, open mosaicplasty was done through medial malleolus osteotomy following the identification of the lesion with arthroscopy. Lesions were classified according to the radiological classification of Hepple. Mosaicplasty was performed in patients with high physical demand and a stage ≥3 lesion greater than 15 mm in size, in case they accept to undergo mosaicplasty operation after being informed about the procedure. The median duration of follow-up was 42 months (range 12–84 months), and patients were monitored with annual follow-up visits after the first postoperative year.

Surgical technique

Microfracture and PRP

In patients undergoing arthroscopic microfracture surgery, the osteochondral fragment was lifted and excised using the arthroscopy clamp following arthroscopic identification of the lesion through standard anterior portals. Then the granulation tissue as well as soft and necrotic tissues was removed with curettage, and the underlying viable and hard subchondral bone was exposed. Curettage up to the level of healthy cartilage tissue was performed, and the resultant debris was removed. Then, 4-mm-deep microfractures perpendicular to the subchondral bone were created in the lesion bed with 4-mm intervals, using 20°, 40°, and 90° microfracture awls. Awls were conical in shape with 1 mm diameter at the tip and 1.5 mm at the base. About 3–4 holes were made per cm^2. Fat particles were observed to come out of these holes. The procedure was terminated, the tourniquet was released, and bleeding was observed in the holes. No drainage tubes were placed in the ankles.

PRP was administered to 22 patients in the microfracture surgery group immediately after the removal of hemovac drain (6–24 h after the operation, mostly on the second postoperative day). PRP was harvested using a FDA-approved SmartPReP®2 system (Harvest Autologous Hemobiologics, Norwell, MA). Sixty millilitres of autologous venous blood was drawn from the patient and processed. A 5.4-fold (±1.2) platelet increase on average was achieved with a resultant mean platelet count of 1.335.500 ± 276.500 platelets/μL. Since all samples had a pH below 7.35, 10 % $NaHCO_3$ was added to adjust the pH between 7.35 and 7.55. On average 4 ml of (range 3–6) PRP was obtained and administered through the site of arthroscopic portal entry, using a blunt and long-tip injector.

Mosaicplasty

In 13 patients undergoing mosaicplasty, using the Osteochondral Autograft Transfer System (OATS®, Acufex, Smith &Nephew, Andover, MA, USA) graft harvester, osteochondral grafts appropriate in size and number for the contours of the talus defect were harvested from the ipsilateral knee joint. A total of two or three grafts were used at the lesion. Graft tunnels appropriate for the height of osteochondral grafts were prepared using the apparatus in the OATS® set. The depth and alignment of the tunnels were checked using the alignment rods. Osteochondral grafts were placed using the osteochondral graft harvester, and their contours were aligned with the talus surface using the tamp. Anatomic reduction in the medial malleolus was performed using the two K wires that were previously placed. The final fixing was done using an appropriately sized cannulated 4.5-mm compression screw (Acutrack) through the K guide wires. Following radiographic controls, absorption drainage tubes were placed and a short-leg cast was applied after the closure of the surgical planes.

Postoperative protocol

The objectives of rehabilitation after ankle arthroscopy included control of pain and inflammation, recovery of normal range of motion in the joint, increased strength, improving neuromuscular control, achievement of proprioceptive control, and return to normal physical activity and

sports. A splint that fixated the ankle at 90° was applied. Patients were mobilized on postoperative day 1 with crutches. No loading was allowed on the ankle for three weeks. In the second 3-week period, partial loading was allowed, with full loading after week 6. On the other hand, in the mosaicplasty group, partial loading was allowed if radiographic examination shows union at the osteotomy line on day 45, and full loading was allowed after 8 weeks.

Functional assessments

Patient functions were assessed using the American Orthopedic Foot and Ankle Society (AOFAS) scoring system and VAS scores for pain, before and after surgery. In addition, the Foot and Ankle Ability Measure (FAAM) tests for pain and 15 min walking were done at follow-up visits. For the assessment of functional status at medium-term after surgery, test results at the last follow-up visit were used.

This study was approved by Erciyes University Ethics Committee for Clinical Studies (approval No: 2012/739).

Statistical analysis

Statistical Package for Social Science (SPSS) version 21 was used for the statistical analysis of data. Shapiro–Wilks test and graphical methods were used to test normality. Within-group differences of the parameters between baseline versus study end measurements were tested using student t test for paired samples (for normally distributed data) or Wilcoxon signed rank test (for data without normal distribution). For inter-group differences, ANOVA or Kruskal–Wallis test was used depending of the normality of the distribution. For pairwise comparisons, adjusted p values were used. Pearson Chi-square test was used for the comparison of categorical variables. A p value smaller than 0.05 was considered an indication of statistical significance.

Results

Characteristics of the three groups are shown in Table 1. Groups did not differ with regard to age and sex distribution, history of trauma, location of the lesion, Hepple grade, or duration of symptoms. However, duration of follow-up was significantly shorter in the mosaicplasty group when compared to the microfracture group (30.1 ± 13.1 vs. 47.3 ± 16.9 months, $p = 0.014$). Comparison of the groups with regard to pain and functional assessment scores is shown in Table 2.

The groups did not differ with regard to AOFAS scores at baseline and AOFAS scores at the last follow-up visit. All the three groups had significant improvements when compared to baseline ($p < 0.001$ for all groups); however, groups did not differ with regard to change in baseline score at the last follow-up visit.

At baseline, mosaicplasty group had significantly higher VAS score when compared to the microfracture group (7.8 ± 0.7 vs. 6.8 ± 0.9, $p = 0.01$). However, groups did not differ at the last follow-up visit. All the three groups had significant reduction in VAS scores when compared to baseline ($p < 0.001$ for all groups). Reduction in the mosaicplasty group was significantly higher when compared to the microfracture group (-5.8 ± 1.0 vs. -3.2 ± 2.9, $p = 0.018$).

At the last follow-up, groups did not differ with regard to FAAM scores for pain and FAAM scores for 15-min walking.

Five subjects required re-operation due to worsening pain in the microfracture surgery group. No other re-operations were required, or complications were noted.

Discussion

The most important finding of the present study was the slight superiority of mosaicplasty over microfracture

Table 1 Characteristics of the three groups

Characteristic	Microfracture ($n = 19$)	Microfracture plus PRP ($n = 22$)	Mosaicplasty ($n = 13$)	p for overall difference
Age	37.4 ± 16.0	43.9 ± 12.7	37.6 ± 15.7	n.s.
Male gender	10 (52.6 %)	11 (50.0 %)	11 (84.6 %)	n.s.
History of trauma	15 (78.9 %)	17 (77.3 %)	11 (84.6 %)	n.s.
Location (right side)	11 (57.9 %)	12 (54.5 %)	7 (53.8 %)	n.s.
Hepple grade				
Grade II–III	14 (73.7 %)	16 (72.7 %)	5 (38.5 %)	n.s.
Grade IV–V	5 (26.3 %)	6 (27.3 %)	8 (61.5 %)	
Symptom duration, months	2.7 ± 1.8	3.3 ± 2.7	2.9 ± 3.3	n.s.
Duration of follow-up, months	47.3 ± 16.9	40.4 ± 10.4	30.1 ± 13.1	0.014

Unless otherwise stated, data presented as mean ± standard deviation

n.s non-significant

Table 2 Comparison of the groups with regard to pain and functional assessment scores

Assessments	Microfracture ($n = 19$)	Microfracture plus PRP ($n = 22$)	Mosaicplasty ($n = 13$)	P for overall difference
AOFAS—baseline	46.8 ± 11.2	44.1 ± 10.7	43.8 ± 14.2	n.s.
AOFAS—last follow-up	73.1 ± 17.2	75.4 ± 15.6	77.3 ± 10.8	n.s.
Change in AOFAS scores	26.3 ± 23.0	31.3 ± 16.6	33.5 ± 13.4	n.s.
VAS—baseline	6.8 ± 0.9	7.2 ± 1.0	7.8 ± 0.7	0.014
VAS—last follow-up	3.6 ± 2.5	2.9 ± 2.4	2.1 ± 0.8	n.s.
Change in VAS scores	−3.2 ± 2.9	−4.3 ± 2.7	−5.8 ± 1.0	0.023
FAAM pain—last follow-up	4.1 ± 0.7	3.6 ± 1.0	3.8 ± 0.7	n.s.
FAAM 15-min walking—last follow-up	3.9 ± 0.9	3.9 ± 0.9	3.5 ± 1.1	n.s.

Data presented as mean ± standard deviation

n.s non-significant

technique—either with or without the addition of PRP—in terms of pain control, in the treatment of osteochondral lesions of the talus.

Under ideal conditions, treatment of cartilage lesions should be able to attain histologic, functional, and biomechanical healing of the native hyaline cartilage and should provide integration with the intact cartilage tissue. Based on the results of previous studies and experience, several algorithms have been developed for the treatment of cartilage lesions, giving consideration to the effect of a number of factors on clinical results such as the age of the patient and the lesion size [22].

In the studies by Robinson et al. and by Schumann et al. [15, 18] comparing cartilage repair techniques (autologous chondrocyte transplantation or osteochondral autografting) with bone marrow stimulation techniques (microfracture or arthroscopic drilling), similarly favourable results have been reported for both strategies. These authors have suggested that bone marrow stimulation techniques should be the first choice of treatment for osteochondral lesions of the talus, although they are associated with biomechanically weaker fibrocartilage formation. On the other hand, for persistent lesions not responding to stimulation techniques, autologous chondrocyte implantation or osteochondral autografting was recommended.

Steadman et al. [19] reported an 80 % clinical success after an 11.3-year follow-up of 72 patients undergoing microfracture surgery, with significantly better results in those under 45 years of age. Knutsen et al. treated 40 patients with microfracture surgery and 40 patients with autologous chondrocyte implantation and compared the results after 1 year of the same rehabilitation programme. Although patients in the microfracture group clinically performed better, histological assessments showed the presence of a repair tissue that was more akin to native hyaline cartilage in patients in the autologous chondrocyte implantation group [10]. Similarly, Steadman observed a hybrid repair process following microfracture surgery, i.e. both fibrocartilaginous repair tissue mostly consisting of type I collagen fibres and hyaline cartilage tissue containing type II collagen fibres were found [19]. However, the predominant healing tissue was of fibrocartilaginous character. Over the years, this tissue undergoes degeneration due to physical loads, leading to a search for methods that would facilitate the formation of a more stable, hyaline-like cartilage tissue at the injury site.

In the present study, clinical outcomes obtained with bone marrow stimulation (microfracture surgery) and osteochondral autografting (mosaicplasty) were compared. Mosaicplasty group showed better improvement of pain. Better results with mosaicplasty than with microfracture surgery may be expected due to the quality of the hyaline cartilage formed with the former strategy. In this study, five subjects required re-operation due to worsening pain in the microfracture surgery group, further supporting the advantage for mosaicplasty in terms of reduced need for re-surgery.

Combination of microfracture surgery and other repair procedures with PRP is a relatively new therapeutic modality that aims to stimulate the repair of the damaged cartilage through the growth factors secreted by the alpha-granules of platelets that play a role in the regulation of the joint cartilage. Due to its positive effects on the wound healing process, it is commonly used in the treatment of tendon, cartilage, or muscular injury [5, 6]. In a study by Mei-Dan et al. [13] assessing the effects of PRP and hyaluronate on talar osteochondritis dissecans (OCD) lesions, although both injections were found to improve pain scores and resulted in functional improvement for at least 6 months, PRP had significantly superior results than hyaluronate. Lee et al. [12] assigned 49 patients (age: 40–50 years) with early degenerative cartilage defects into two groups: control subjects only received microfracture surgery, while the treatment group had both microfracture surgery and PRP.

After 2 years of follow-up, despite clinical improvement in both groups, better results were obtained when the treatment was combined with PRP.

Again Guney et al. [8] examined the effects of PRP in 35 patients with OLT who were treated with either microfracture surgery alone or microfracture surgery plus PRP. These authors reported successful outcomes after an average follow-up of 16 months and proposed that combination of PRP with microfracture surgery was associated with better medium-term results than microfracture alone. Since a benefit in terms of repair tissue improvement is expected in the short-term, PRP was administered early after the operation in this study, but not before the removal of drains to prevent its drainage outside. However, this study examining medium-term effects of different treatment methods in OLT patients did not find any significant functional advantage of microfracture surgery plus PRP.

After the original report by Hangody et al. [9] suggesting better outcomes with mosaicplasty as compared to microfracture surgery, drilling, or abrasion arthroplasty, this therapeutic modality has gained widespread popularity. The mosaicplasty method developed by Hangody et al. involves harvesting cylinder-shaped osteochondral grafts from the lateral part of the lateral condyle of the femur, and then the adjoined graft blocks are seated in the lesion area. This allows concurrent implantation of the spongy bone required for the repair of the subchondral depression together with the hyaline cartilage. Short- and medium-term studies implementing this therapeutic strategy reported success rates varying between 80 and 94 % [3, 4, 9, 20]. A good-to-excellent outcome was found in 92 % of the patients with talar osteochondral lesions in the study by Valderranbo, while a note of caution was raised with regard to donor area morbidities and their potential association with the future development of patellofemoral osteoarthritis [20]. In this study, two of the patients had persistent knee pain, although these patients had no signs of patellofemoral osteoarthritis. The open mosaicplasty preferred in our patients involved the use of malleolar osteotomy and provided good surgical exposure with improved surgical manipulation. This technique minimizes the risk of fracture in the osteochondral blocks placed at different angles. On the other hand, in arthroscopic mosaicplasty procedures involving a transmalleolar approach, certain challenges in the identification of the localization of the tunnels in the medial malleolus and in the placement of grafts may be experienced [21]. Although mosaicplasty is associated with higher surgical morbidity than microfracture surgery and drilling, it offers the extra advantage of coverage of the lesion area with hyaline cartilage [17, 20].

Complications related to the osteotomy of the medial malleolus and donor site represent potential morbidities [2]. In the study by Lamb, 94 % of the patients had no symptoms after medial malleolar osteotomy, and radiological union occurred after an average duration of 6 weeks following surgery [11]. In this study, none of the patients in the mosaicplasty group experienced symptoms or bleeding complication related to the osteotomy site.

Main limitations of this study include small sample size, lack of histopathological evaluation, and the wide age range of the patients. A large sample size could not be reached owing to the low number of admissions. This may give rise to type II statistical error; therefore, negative results should be evaluated cautiously and firm conclusions should be avoided. Another limitation is that quality and integrity of repair tissue was not evaluated using radiological methods, which would give additional idea on the efficacy of treatment modalities.

This study for the first time compared the clinical results of arthroscopic microfracture technique and mosaicplasty (osteochondral plug transfer) in the treatment of TOL. Medium-term results seem to be in favour of mosaicplasty when compared to microfracture technique, probably since the repair cartilage obtained with the former technique is weaker and of lower quality when compared to the transferred cartilage in the mosaicplasty technique. In an attempt to improve the quality of repair cartilage and assure strength in the long term, PRP application has recently gained interest. This study also examined the effect of such application on mid-term clinical results; however, no benefit could be demonstrated despite previous findings on its short-term benefits, suggesting reduced effect over time. Nevertheless, PRP application may still be recommended, given its potential short-term benefits.

Conclusion

Despite good medium-term functional results with all the three treatment modalities, mosaicplasty shows more promise than microfracture technique in patients with OLT, particularly when pain is considered. However, this finding warrants testing in larger controlled studies.

Compliance with ethical standards

Conflict of interest None declared.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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

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