

# Arthroscopic microfracture alone or combined application of acellular scaffold: Which one is more effective in the treatment of osteochondral lesions of the talus?

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## Ethics Committee Approval

The study was approved by the Ethics Committee of Acibadem University (Date 17.09.2020 /No. 2020-20/07)

All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

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## Conflict of Interest

No conflict of interest was declared by the authors.

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## Abstract

**Background/Aim:** The optimal treatment method of the talar osteochondral lesions (TOLs) is still controversial. Although the success of arthroscopic microfracture treatment (AMFx) in smaller lesions is known, different treatment methods are tried in larger-sized TOLs. This study aimed to compare the clinical and radiological outcomes of the single-step AMFx repair procedure and the combined application of AMFx and cell-free scaffold (CFS) in the treatment of TOLs.

**Methods:** This retrospective cohort study included patients presenting with a TOL larger than 1.5 cm<sup>2</sup> and smaller than 3 cm<sup>2</sup> between March 2015 and June 2018 who received arthroscopic treatment and attended follow-up for at least 24 months. Eighteen patients (group 1) were treated with the AMFx method, and 16 patients (group 2) with AMFx + CFS. American Orthopedic Foot and Ankle Society (AOFAS), Visual Analog Scale (VAS), and Tegner Activity Scores were used for clinical evaluation, and MOCART (magnetic resonance observation of cartilage repair tissue) score was used to assess cartilage repair tissue.

**Results:** The mean patient age was 33.47 (8.67) years and the mean follow-up time was 32.24 (9.33) months. There was no significant difference between the two groups in terms of age ( $P=0.984$ ), body mass index ( $P=0.450$ ), defect size ( $P=0.081$ ) and follow-up time ( $P=0.484$ ). The median AOFAS score increased from preoperative assessment until follow-up assessment at 12 months in groups 1 ( $P<0.001$ ) and group 2 ( $P<0.001$ ). There was no significant difference between the two groups in terms of clinical scores, or the components of the MOCART score.

**Conclusion:** Comparisons revealed that outcomes at the end of 24-month follow-up were similar between two groups. Therefore, TOLs appear to benefit similarly from the AMFx and AMFx + CFS techniques.

**Keywords:** Talus, Osteochondral Lesion, Microfracture, Scaffold

## Introduction

Although the etiology of the talar osteochondral lesions (TOLs) is still uncertain, these lesions are well-defined to be cartilage injuries involving both the chondral and subchondral layers that are thought to occur secondary to ankle trauma [1] or ischemic causes [2]. The clinical findings of TOLs may vary from asymptomatic disease to the presence of severe pain and significantly worsened quality of daily life [3]. While TOL secondary to trauma generally manifests in the anterolateral area, ischemic lesions are usually located posteromedially [4]. Planning of treatment approach has become more important due to the increasing incidence of TOLs [5]. The main factors affecting treatment are the size, depth, and localization of the TOL and the degree of subchondral bone involvement [5]. Several treatment options are available, including conservative treatment, arthroscopic debridement and microfracture, mosaicplasty, allograft applications, and autologous chondrocyte implantation [6,7]; however, it has been shown that inappropriate treatment may lead to cartilage degeneration and osteoarthritis in the long-term [8].

The arthroscopic microfracture (AMFx) technique is an easily performed single-step procedure that is the most frequently employed cartilage repair method. Today, arthroscopic techniques are usually based on the stimulation of bone marrow and the gathering of mesenchymal stem cells (MSCs) in order to ensure healing [9-11]. Despite being reported to have inadequate effectiveness in long-term follow-up due to the high failure rate and formation of biomechanically poor fibrocartilage in lesions larger than 1.5 cm<sup>2</sup>, the AMFx procedure remains popular, especially for the treatment of smaller lesions [9,10,12].

Cell-free scaffolds (CFS) are cost-effective and can be applied as a single-step arthroscopic procedure. The application of CFS in combination with AMFx provides a basis for the maturation of mesenchymal stem cells from the subchondral bone [13,14]. In addition, these biomaterials also ensure the mechanical stability of mesenchymal stem cells by providing 3-dimensional support [15]. Current evidence shows that, compared to 2-dimensional support, a 3-dimensional support environment preserves chondrocyte structure, enables relatively better chondrocyte transformation, and procures a tissue structure that mimics native tissue characteristics, thereby enhancing repair [15-17].

In this study, it was aimed to comparatively present the short-term clinical and radiological outcomes of the stand-alone AMFx procedure and the combined AMFx + CFS application, which are utilized in the single-step treatment of TOLs.

## Materials and methods

The study was approved by the Ethics Committee of Acibadem University (Date 17.09.2020 /No. 2020-20/07), and written informed consent –for the procedures and also the use of data as part of a scientific study– was obtained from all patients. This study was performed in line with the principles of the Declaration of Helsinki. In this retrospective cohort study, patients who were screened for talus focal osteochondral lesions between March 2015 and June 2018 were evaluated. Inclusion

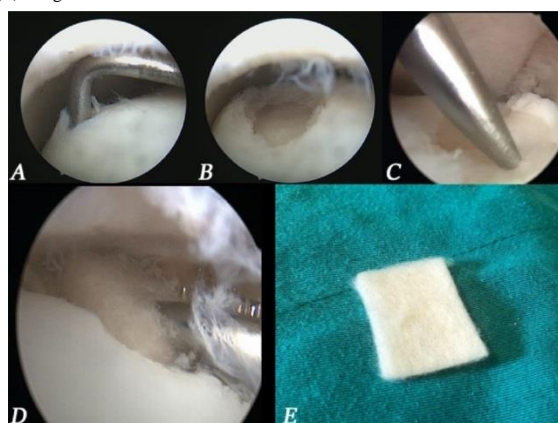
criteria were as follows: Being aged between 20 and 50 years, having received surgical treatment for Outerbridge grade 3–4 lesions larger than 1.5 cm<sup>2</sup> and smaller than 3 cm<sup>2</sup> affecting the talar dome, having a body mass index (BMI) of <30 kg/m<sup>2</sup>, and attending follow-up visits for at least 24 months. Patients who were lost to follow-up, those who had a history of ankle surgery, patients who needed revision surgery, and those who had ankle instability or a kissing lesion were excluded from the study. The sample size was reached by including thirty-four patients who met the inclusion/exclusion criteria, out of a total of one-hundred-eighteen patients who were operated for TOLs between the dates mentioned above.

Thirty-four patients who fulfilled the inclusion/exclusion criteria were included in the study. All patients were operated on by one of two surgeons (A and B). Eighteen patients (10 females, 8 males) who were operated by surgeon A using the AMFx procedure (stand-alone) comprised Group 1, and 16 patients (10 males, 6 females) who were operated by Surgeon B using the combined procedure (AMFx + CFS) (SupraFelt™, BMT Calsis, Ankara, Turkey) comprised Group 2.

The data of the two groups were reviewed, and age, body mass index (BMI), follow-up time, and TOL size were recorded. The American Orthopedic Foot and Ankle Society (AOFAS) Ankle-Hindfoot Scale, Visual Analog Scale (VAS), and Tegner Activity Scale were determined preoperatively. They were consistently used to evaluate clinical results during the postoperative period. Magnetic resonance observation of cartilage repair tissue (MOCART) score was used to evaluate cartilage quality from magnetic resonance (MR) images [18]. The groups were compared in terms of demographics and the size of cartilage defects, in addition to scores obtained from the AOFAS, VAS, Tegner Activity Scale, and MOCART analysis.

In both groups, debridement was performed on cartilage defects, and subchondral bone was reached via standard ankle arthroscopy. A probe was used to measure the depth and size of the lesions in millimeters. In Group 1, AMFx was performed using a 30-degree awl on the TOL site, and the procedure was terminated following joint debridement. In Group 2, AMFx was also performed via the use of a 30-degree awl on the TOL site, followed by arthroscopic application of CFS (SupraFelt™) in order to fill the defect completely. A fixation method was not used for scaffold stabilization, and the procedure was terminated (Figure 1).

Figure 1: Arthroscopic images of ankle arthroscopy (A) Osteochondral lesion (OCL) of the medial talar dome of talus (B) After debridement of the OCL to stable margins (C) Microfracture (AMFx) application (D) Application of the cell-free scaffold (CFS) after AMFx (E) Image of CFS



**Statistical analysis**

All analyses were performed with SPSS v21 (SPSS Inc., Chicago, IL, USA). The Shapiro-Wilk test was used to check normality. Data were expressed with mean (standard deviation-SD) or median (minimum-maximum) values for continuous variables according to the normality of distribution and frequency (percentage) values for categorical variables. Normally distributed variables were analyzed with the independent samples t-test, and non-normally distributed variables, with the Mann-Whitney U test. Categorical variable distributions were assessed with the Pearson Chi-square test or the Fisher's exact test. Repeated measurements were evaluated with Friedman's analysis of variance by ranks depending on the normality of distribution. Pairwise comparisons were performed with the Bonferroni correction method. Comparisons of the changes in these variables between the groups were performed by analyzing the differences between measurements via the Mann-Whitney U test. *P*-values of <0.05 were considered to demonstrate statistical significance.

**Results**

Among 34 patients included in the study, 55.5% of the patients in Group 1 (stand-alone AMFx) and 37.5% of the patients in Group 2 (combined procedure) were female. The mean ages were 28.8 (6.2) and 30.4 (7.6) years in Group 1 and Group 2, respectively. The mean BMI values were 24.2 (4.3) and 25.3 (3.6) kg/m<sup>2</sup> in Groups 1 and 2, respectively. In terms of defect size, the mean value was 1.9 (0.3) cm<sup>2</sup> in Group 1 and 2.1 (0.4) cm<sup>2</sup> in Group 2. Follow-up durations were 42.2 (9.2) months and 40.1 (11.6) months, in groups 1 and 2, respectively. There was no significant difference between the two groups in terms of demographic features and lesion size (*P*>0.05 for all, Table 1).

Table 1: Summary of the patient characteristics and scale scores with regard to the surgical method

	Surgical method		<i>P</i> -value
	Microfracture(n=18)	Microfracture + Scaffold (n=16)	
Age	33.50 (8.26)	33.44 ( 9.39)	0.984
Gender			
Female	10 (55.56%)	6 (37.50%)	0.479
Male	8 (44.44%)	10 (62.50%)	
Body mass index	26.13 ( 3.31)	25.28 ( 3.16)	0.450
Follow-up time	29 (24 - 52)	27.5 (12 - 49)	0.484
Size of the lesion	2.1 (1.6 - 4)	2.5 (1.8 - 3.2)	0.081
AOFAS Ankle-Hindfoot Scale score			
Baseline	60 (50 - 66) <sup>a</sup>	56 (52 - 66) <sup>a</sup>	0.198
1st assessment	89 (84 - 96) <sup>b</sup>	92 (86 - 96) <sup>b</sup>	
2nd assessment	92 (88 - 96) <sup>b</sup>	94 (92 - 96) <sup>b</sup>	
<i>P</i> (within variables)	<0.001	<0.001	
Visual Analog Scale score			
Baseline	6.5 (5 - 7) <sup>a</sup>	7 (6 - 7) <sup>a</sup>	0.281
1st assessment	2 (1 - 2) <sup>b</sup>	1 (1 - 2) <sup>b</sup>	
2nd assessment	1 (1 - 2) <sup>b</sup>	1 (1 - 2) <sup>b</sup>	
<i>P</i> (within variables)	<0.001	<0.001	
Tegner Activity Scale score			
Baseline	3 (1 - 7) <sup>a</sup>	3 (1 - 4) <sup>a</sup>	0.403
1st assessment	4 (2 - 7) <sup>ab</sup>	4 (2 - 7) <sup>b</sup>	
2nd assessment	4 (3 - 7) <sup>b</sup>	4 (2 - 7) <sup>b</sup>	
<i>P</i> (within variables)	<0.001	<0.001	
Complication	2 (11.11%)	1 (6.25%)	1.000

Data are given as mean (SD) or median (minimum - maximum) for continuous variables according to normality of distribution and as frequency (percentage) for categorical variables  
Same letters denote the lack of statistically significant difference between repeated measurements

When compared to preoperative findings, both groups exhibited a significant change in AOFAS, VAS, and Tegner Activity scores at the 12<sup>th</sup> month (the first postoperative evaluation included in the study) (*P*<0.001 for all, Table 1). However, the comparison of the amount of change in scores showed no statistically significant differences in the AOFAS, VAS, and Tegner Activity scores (*P*>0.05 for all, Table 1)

(Figure 2, Figure 3). Furthermore, in terms of AOFAS, VAS, and Tegner scores reported at baseline (preoperative) and postoperative 12<sup>th</sup> and 24<sup>th</sup> months, there were no significant differences between the two groups (*P*=0.198, *P*=0.281, *P*=0.403, respectively; Table 1).

Figure 2: AOFAS Ankle-Hindfoot Scale scores with regard to groups

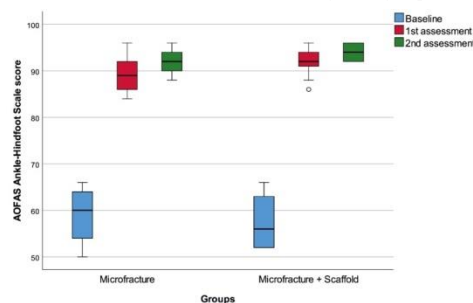
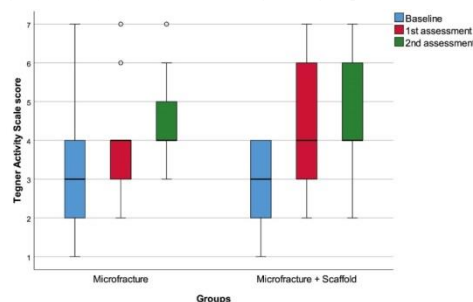


Figure 3: Tegner Activity Scale scores with regard to groups



There was again no significant difference in MOCART scores between the two groups (*P*>0.05, Table 2). Nevertheless, we observed that Group 2 had higher scores in the surface integration and effusion subgroups of the MOCART analysis compared to Group 1. Subchondral bone was intact in >60% of subjects in both groups. Effusion was identified in 22.22% and 18.75% of the patients in Group 1 and Group 2, respectively (Table 2).

Table 2: Summary of the MOCART scoring system with regards to the surgical method

	Surgical method		<i>P</i> -value
	Microfracture (n=18)	Microfracture + Scaffold (n=16)	
Degree of defect repair and filling of the defect			
Complete	8 (44.44%)	9 (56.25%)	0.305
Hypertrophy	0 (0.00%)	2 (12.50%)	
Incomplete			
> 50% of the adjacent cartilage	6 (33.33%)	3 (18.75%)	
< 50% of the adjacent cartilage	4 (22.22%)	2 (12.5%)	
Subchondral bone exposed	0 (0.00%)	0 (0.00%)	
Integration to border zone			
Complete	4 (22.22%)	6 (37.50%)	0.685
Incomplete			
Demarcating border visible (split like)	6 (33.33%)	5 (31.25%)	
Defect visible			
< 50% of the length of the repair tissue	5 (27.78%)	4 (25.00%)	
> 50% of the length of the repair tissue	3 (16.67%)	1 (6.25%)	
Surface of the repair tissue			
Surface intact	4 (22.22%)	6 (37.50%)	0.475
Surface damaged			
< 50% of repair tissue depth	11 (61.11%)	9 (56.25%)	
> 50% of repair tissue depth or total degeneration	3 (16.67%)	1 (6.25%)	
Structure of the repair tissue			
Homogenous	6 (33.33%)	6 (37.50%)	1.000
Inhomogeneous or cleft formation	12 (66.67%)	10 (62.50%)	
Signal intensity of the repair tissue			
T2-FSE			
Isointense	4 (22.22%)	5 (31.25%)	0.821
Moderately hyperintense	11 (61.11%)	9 (56.25%)	
Markedly hyperintense	3 (16.67%)	2 (12.50%)	
Subchondral Lamina			
Intact	6 (33.33%)	7 (43.75%)	0.787
Non-intact	12 (66.67%)	9 (56.25%)	
Subchondral bone			
Intact	11 (61.11%)	11 (68.75%)	0.849
Non-intact			
Edema	5 (27.78%)	4 (25.00%)	
Cyst formation or degeneration	2 (11.11%)	1 (6.25%)	
Adhesions			
No	18 (100.00%)	16 (100.00%)	N/A
Yes	0 (0.00%)	0 (0.00%)	
Effusion			
No	14 (77.78%)	13 (81.25%)	1.000
Yes	4 (22.22%)	3 (18.75%)	

There were no major complications in the patients. In Group 1, transient Sudeck's atrophy and paresthesia were observed, and both resolved within 6 months. In Group 2, one patient developed a superficial infection which was successfully treated with oral antibiotic therapy.

## Discussion

The most important finding of this study was that both the stand-alone AMFx and the combined AMFx + CFS procedures provided decreased pain levels and yielded considerably good clinical outcomes within the follow-up period among patients treated for TOL. Additionally, although results were similar in the majority of evaluations, we noted that hyaline-like chondral tissue was better organized, and MOCART scores were relatively higher with the AMFx + CFS technique.

Treatment for cartilage problems is still controversial, and the options vary depending on lesion size. While AMFx provides good clinical outcomes with the advantage of bone marrow stimulation in the treatment of small osteochondral lesions, it cannot achieve the desired success in large lesions since structural support to mesenchymal stem cells is insufficient when lesion size and depth are greater [7,19,20]. According to the literature, AMFx is the first-line treatment for TOLs, particularly those measuring around 1.5 cm<sup>2</sup> [9,21]. In a study by Choi et al., 32 patients with TOLs larger than 1.5 cm<sup>2</sup> were treated with the AMFx method, and it was reported that a successful outcome could only be achieved in 1 patient [21]. Therefore, a size of 1.5 cm<sup>2</sup> has been described as a critical threshold for AMFx treatment of TOLs [21,22]. Treatment options for TOLs larger than 1.5 cm<sup>2</sup> include methods that promote the formation of fibrous cartilage with cell-containing or cell-free scaffolds in addition to restoration techniques such as mosaicplasty and autologous chondrocyte implantation. At the same time, allograft use is suggested in much larger lesions [23]. However, it would be more effective to consider such restoration techniques in revision surgeries rather than in the first-line treatment of TOLs, since these techniques are more expensive and complex (compared to stand-alone AMFx) and may result in morbidity. From this standpoint, we comparatively evaluated the effectiveness of AMFx and AMFx + CFS treatments in lesions larger than 1.5 cm<sup>2</sup> (up to a maximum of 3 cm<sup>2</sup>) and found that both treatment methods provided a significant improvement in terms of clinical scores during short-term follow-up.

The interest in CFS treatment has been increasing due to several advantages, including low cost, wide availability, and the fact that there is no need for cell culture or a donor site [24-27]. Recent animal studies suggest that CFS is also effective in cartilage regeneration. It can provide a well-structured subchondral trabecular bone and enables the generation of repair tissue rich in proteoglycans and type II collagen, which are important histological characteristics of the hyaline cartilage [28,29]. In addition to the ease of using CFS as a single-step arthroscopic procedure without the need for arthrotomy for the treatment of TOL, CFS application was also shown to induce chondrogenesis due to its hyaluronic acid (HA)-based scaffold structure [30]. In a study by Kanatli et al., cell-free polyglycolic acid (PGA) - HA scaffolds were reported to provide successful clinical outcomes in the treatment of TOLs sized 2.5 cm<sup>2</sup> and

greater [31]. In the present study, we also obtained successful clinical outcomes after cell-free PGA-HA scaffold application in the treatment of TOLs measuring 1.5 cm<sup>2</sup> - 3 cm<sup>2</sup>, which is consistent with the literature. Considered together, these results indicate that PGA-HA-based CFSs are effective and successful in the treatment of TOLs sized up to 3 cm<sup>2</sup>.

The AMFx + CFS group had marginally better MOCART results; however, statistical significance was not present in any of the comparisons –possibly due to the low number of patients. Nonetheless, we believe it should be emphasized that the AMFx + CFS group had better border integration in the current study, similar to the results obtained by Valderrabano et al. and Wiewiorski et al. [32,33]. Two studies in the literature showed that PGA-HA-based CFS use led to a high rate of hypertrophic healing in TOLs [31,34]; whereas, in contrast to the literature, “none of the patients in the current study suffered from this complication”. This was attributed to the fact that the CFSs used in this study had a different scaffold-matrix structure as compared to their counterparts employed in other studies.

This study had some limitations. First of all, it had a retrospective design and follow-up was short, which might have prevented the identification of procedure-based differences that could develop with time. Second, although the procedures were carried out in a similar fashion by both surgeons, the fact that the groups had undergone treatment by different surgeons may be a cause of bias. Third, various important factors (age, gender, trauma characteristics etc.) that could have had an impact on treatment results could not be investigated separately with subgroup analyses, since sample size was not large enough. Finally, the lack of histological evaluation could put the current outcome analysis in question; however, we used the MOCART scoring system, which is accepted as an objective method that enables the quantitative analysis of repair tissue.

## Conclusion

Significant improvements in clinical scores were observed in the short-term follow-up of patients who underwent stand-alone AMFx and combined AMFx + CFS application for the treatment of TOLs measuring up to 3 cm<sup>2</sup>. The outcomes were similar in both groups when compared at postoperative 12 and 24 months, and the changes in scores were also similar with the two methods. Therefore, with respect to short-term follow-up, both the single-step AMFx and the combined AMFx + CFS techniques are effective in the treatment of TOLs.

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