Eklem Hastalıkları ve Cerrahisi
Joint Diseases and Related Surgery

Original Article / *Özgün Makale*

Eklem Hastalik Cerrahisi
2019;30(2):97-105
doi: 10.5606/ehc.2019.64401

Comparison of arthroscopic microfracture and cell-free scaffold implantation techniques in the treatment of talar osteochondral lesions

Talar osteokondral lezyonların tedavisinde artroskopik mikrokırık ve hücresiz çatı implantasyonu tekniklerinin karşılaştırılması

Toygun Kağan Eren, MD[1], Muhammet Baybars Ataoğlu, MD[1], Ali Eren, MD[1], Dilan Ece Geylan, MD[2], Ali Yusuf Öner, MD[2], Ulunay Kanatlı, MD[1]

[1]Department of Orthopedics and Traumatology, Gazi University Faculty of Medicine, Ankara, Turkey
[2]Department of Radiology, Gazi University Faculty of Medicine, Ankara, Turkey

ABSTRACT

Objectives: This study aims to compare two single-step arthroscopic techniques, microfracture and cell-free scaffold implantation, in the treatment of talar osteochondral lesions (OCLs) clinically and radiologically.

Patients and methods: This retrospective study included 62 patients (35 males, 27 females; mean age 41±13 years; range, 15 to 65 years) diagnosed with talar OCLs between March 2007 and January 2015. Patients who were followed-up with a minimum of 24 months with lesions larger than 1 cm^2 were included. Pre- and postoperative clinical evaluations were performed according to the American Orthopedic Foot and Ankle Society (AOFAS) ankle-hindfoot scale and radiological evaluations according to the magnetic resonance observation of cartilage repair tissue (MOCART) scale.

Results: Patients were divided into microfracture (n=22) and scaffold (n=40) groups. The mean follow-up duration was 36.1±14.9 months. The mean preoperative AOFAS score increased from 60.6±13.9 to 82.1±11.8 in the microfracture group (p<0.001) and from 53.8±13.6 to 89.4±9.9 in the scaffold group (p<0.001). The scaffold group had superior results than the microfracture group clinically (p=0.011). Clinical results were superior in younger patients (<45 years) (p=0.018), male patients (p=0.020), and traumatic lesions (p=0.014). There was no significant difference between the two techniques according to the total MOCART scores (p=0.199). However, the scaffold technique was more successful in terms of lesion border and effusion subgoups of MOCART scale.

Conclusion: Both single-step arthroscopic techniques are effective and safe in the treatment of talar OCLs. The scaffold technique showed superior clinical results than the microfracture technique in short-term follow-up. Age, trauma history and gender significantly affected the treatment outcomes. The scaffold technique can be considered as a safe and good alternative particularly in the treatment of large lesions.

Keywords: Cartilage, magnetic resonance observation of cartilage repair tissue, microfracture, osteochondral lesion, scaffold, talus.

ÖZ

Amaç: Bu çalışmada talar osteokondral lezyon (OKL)'ların tedavisinde tek aşamalı iki artroskopik teknik olan mikrokırık ve hücresiz çatı implantasyonu klinik ve radyolojik olarak karşılaştırıldı.

Hastalar ve yöntemler: Bu retrospektif çalışmaya Mart 2007 ve Ocak 2015 tarihleri arasında talar OKL tanısı konulmuş olan 62 hasta (35 erkek, 27 kadın; ort. yaş 41±13 yıl; dağılım, 15-65 yıl) dahil edildi. Minimum 24 ay takip edilen ve lezyonları 1 cm^2'den büyük olan hastalar çalışmaya dahil edildi. Ameliyat öncesi ve sonrası klinik değerlendirmeler Amerikan Ortopedik Ayak ve Ayak Bileği Cemiyeti (AOFAS) ayak bileği-arka ayak ölçeği ve radyolojik değerlendirmeler kıkırdak tamir dokusunun manyetik rezonans gözlemi (MOCART) ölçeğine göre yapıldı.

Bulgular: Hastalar mikrokırık (n=22) ve hücresiz çatı (n=40) gruplarına ayrıldı. Ortalama takip süresi 36.1±14.9 ay idi. Ameliyat öncesi ortalama AOFAS skoru mikrokırık grubunda 60.6±13.9'dan 82.1±11.8'e (p<0.001) ve hücresiz çatı grubunda 53.8±13.6'dan 89.4±9.9'a (p<0.001) yükseldi. Hücresiz çatı grubu sonuçlarının klinik olarak mikrokırık grubundan daha iyi olduğu görüldü (p=0.011). Klinik sonuçların daha genç (<45 yıl) (p=0.018), erkek (p=0.020) hastalarda ve travmatik lezyonlarda (p=0.014) daha iyi olduğu görüldü. Toplam MOCART skorlarına göre iki teknik arasında anlamlı farklılık yoktu (p=0.199). Fakat hücresiz çatı tekniği; MOCART skorlamasının lezyon kenarı ve efüzyon alt grupları açısından daha başarılı oldu.

Sonuç: Her iki tek aşamalı artroskopik teknik de talar OKL'lerin tedavisinde etkili ve güvenlidir. Hücresiz çatı tekniği kısa dönem takipte mikrokırık tekniğinden daha iyi klinik sonuçlar göstermiştir. Yaş, travma öyküsü ve cinsiyet tedavi sonuçlarını anlamlı şekilde etkilemiştir. Hücresiz çatı tekniği özellikle büyük lezyonların tedavisinde güvenli ve iyi bir alternatif olarak kabul edilebilir.

Anahtar sözcükler: Kıkırdak, kıkırdak tamir dokusunun manyetik rezonans gözlemi, mikrokırık, osteokondral lezyon, hücresiz çatı, talus.

Received: December 27, 2018 *Accepted:* March 12, 2019 *Published online:* May 30, 2019

Correspondence: Toygun Kağan Eren, MD. Ankara Eğitim ve Araştırma Hastanesi Ortopedi ve Travmatoloji Kliniği, 06230 Altındağ, Ankara, Turkey.
Tel: +90 533 - 438 88 53 e-mail: toyguneren@gmail.com

Citation:
Eren TK, Ataoğlu MB, Eren A, Ece Geylan D, Öner AY, Kanatlı U. Comparison of arthroscopic microfracture and cell-free scaffold implantation techniques in the treatment of talar osteochondral lesions. Eklem Hastalik Cerrahisi 2019;30(2):97-105.

The talar osteochondral lesions (OCLs) involve both cartilage and subchondral bone.[1] Etiology consists both ischemic and traumatic events. Usually, traumatic OCLs occur after ankle injury and mostly at anterolateral side of talar joint surface while ischemic lesions are mostly at posteromedial side.[2] Osteochondral lesion incidence can be as high as 73% after ankle fracture and 50% after ankle injury.[3] Because of the high incidence, treatment strategies become more important and differ according to the characteristic of lesion. The most important aspects are size, depth, location and involvement of subchondral bone.[4] The importance of loss in subchondral bone mass has been demonstrated radiologically and histopathologically in the pathogenesis of osteoarthritis.[5]

Arthroscopic microfracture technique is one of the most widely used and easily accessible methods. The method is based on blood marrow stimulation and gathering mesenchymal stem cells (MSCs) to provide healing.[6,7] Despite the short-term good results of the microfracture technique, some lower outcomes with larger lesions (particularly >1.5 cm^2) or longer follow-up durations led to questioning its efficacy in the cartilage treatment.[6,7] Also, autologous chondrocyte implantation (ACI) technique has become popular in the treatment of OCL. Despite the promising results, two-step surgery is needed in this technique. Furthermore, the high cost and time needed for cell culture process are other concerns.[8] Recently, the ACI has failed to show superiority against microfracture and its effectiveness has been questioned.[9] Osteochondral autograft transfer (OAT) is another method which provides hyaline cartilage repair tissue. However, this technique has several disadvantages including donor site morbidity and the need of malleolar osteotomy to access to articular surface which could lead to non-union, delayed union of osteotomy site and restricted ankle dorsiflexion.[10]

Single-step surgical options that does not require osteotomy are developed in the treatment of talar OCL. Particulated juvenile cartilage allograft transplantation and cartilage autograft implantation system are cell-based procedures with promising results.[11] However, the high cost of technology and limited data regarding clinical outcomes are the drawbacks of single-step cell-based procedures.[12]

Autologous matrix-induced chondrogenesis (AMIC) method consists arthroscopic bone marrow stimulation and implantation of a scaffold to provide superior distribution and attachment of MSCs in a single-step surgery, and the technique showed promising results in the treatment of talar and other joint OCLs.[13-15] Our previous study demonstrated that scaffold implantation technique has presented good results with lesions larger than 1.5 cm^2.[15] However, the study investigated only scaffold group and did not include lesions smaller than 1.5 cm^2. Despite promising results, the literature is limited regarding the comparison of cell-free scaffold technique with microfracture in the treatment of talar OCL. Therefore, in this study, we aimed to compare two single-step arthroscopic techniques, microfracture and cell-free scaffold implantation, in the treatment of talar OCLs clinically and radiologically.

PATIENTS AND METHODS

This study was conducted at Gazi University Faculty of Medicine. Clinical and radiological outcomes of arthroscopically treated 71 patients who were diagnosed with talar OCL between March 2007 and January 2015 were evaluated retrospectively. Patients who were followed-up with a minimum of 24 months with lesions larger than 1 cm^2 were included. Exclusion criteria were accompanying ankle fracture (n=1), kissing lesions (n=3), degenerative arthritis (n=1) and patients lost to follow-up (n=4). Thus, 62 patients with talar OCLs (35 males, 27 females; mean age 41±13 years; range, 15 to 65 years) were divided into two groups according to the applied procedure (microfracture group, n=22; scaffold group, n=40). Autologous iliac bone grafting was applied to lesions which had depth more than 10 mm (n=12) and anterior talofibular ligament reconstruction was applied to patients with lateral ankle instability (n=11). The study protocol was approved by the Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital Ethics Committee. A written informed consent was obtained from each patient. The study was conducted in accordance with the principles of the Declaration of Helsinki.

All patients in both groups were treated arthroscopically by the same surgeon. According to health insurance policies of patients, either microfracture or cell-free scaffold method was performed. The position of each patient was chosen according to the location of the lesion; supine position for anterior lesions and prone for posterior ones. Owing to the position selection, traction was not required to access to the lesion. Microfracture was applied to all lesions and bone defects which had depth more than 10 mm, were filled with autologous iliac bone graft. In the scaffold group, lesions were additionally covered with a bio-absorbable polyglycolic acid-hyaluronan scaffold (Chondrotissue® BioTissue AG, Zurich, Switzerland), as previously described (Figures 1, 2).[15]

Figure 1. Arthroscopic images of right ankle. **(a, b)** Microfracture application after debridement of lesion. **(c)** Osteochondral lesion which is filled with autologous iliac bone graft.

No fixation method was used for scaffold stabilization. Following the surgery, ankle joint was held in neutral position for two weeks in a short-leg brace. After the immobilization period, partial weight bearing was allowed according to pain toleration of the patient. Return to sports was not allowed at least for four weeks after surgery and was decided on according to patient's toleration.

Talar dome articular surface was divided into nine equal zones as Elias et al.[16] suggested. The factors which could affect the treatment outcomes of cartilage repair were also evaluated. Patients were divided into groups according to age (≤45 and >45 years), lesion size (≤1.5 cm^2 and >1.5 cm^2), body mass index (BMI) as normal weight (18.5-24.9) overweight (25-29.9), obese (>30), and follow-up period (≤48 months and >48 months). The effects of these factors on the treatment outcomes were evaluated. The effects of other factors such as trauma history, smoking habits and gender on the treatment outcome were also analyzed. Pre- and postoperative clinical evaluations were performed according to the American Orthopedic Foot and Ankle Society (AOFAS) ankle-hindfoot scale by two blinded orthopedic surgeons, in consensus. Postoperative AOFAS ankle-hindfoot scores were categorized as excellent (90-100 points), good (80-89 points), fair (70-79 points) or poor (less than 70 points). Radiological evaluations were performed according to the magnetic resonance observation of cartilage repair tissue (MOCART) scale by two blinded radiologists using RadiAnt DICOM Viewer (Version 3.2.3, Medixant Company, Poznan, Poland) software, in consensus (Figure 3).

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Estimated sample size was calculated as 11 for each treatment group with a 95% confidence interval and 80% power. The pre- and postoperative comparisons of the groups and subgroups were performed using the Kruskal-Wallis, Mann-Whitney U and chi-square tests ($p<0.05$).

RESULTS

Of the 62 patients, 56.6% were male and 43.4% were female. The mean follow-up duration was 36.1±14.9 months. The patient and lesion characteristics were similar in the scaffold and microfracture groups regarding the distribution of age, BMI, preoperative AOFAS score and size of the lesion ($p>0.05$). The follow-up duration was longer in the microfracture group with a median of 44 months (range, 24 to 87 months) than the scaffold group with a median of 27 months (range, 24 to 65 months) ($p=0.0014$). The demographic characteristics of the patients are shown in Table I.

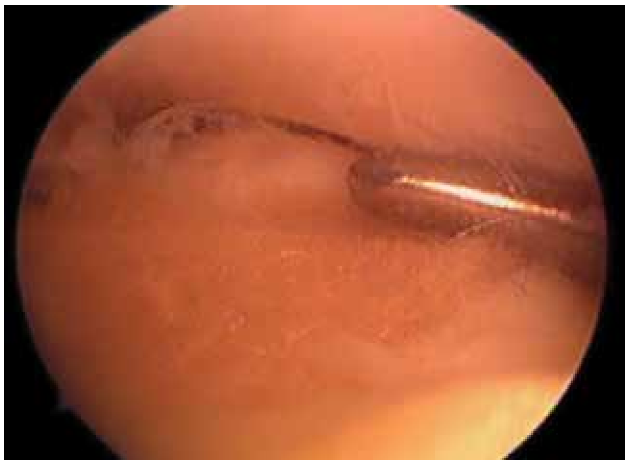

Figure 2. Arthroscopic image of right ankle. Application of cell-free scaffold on lesion site.

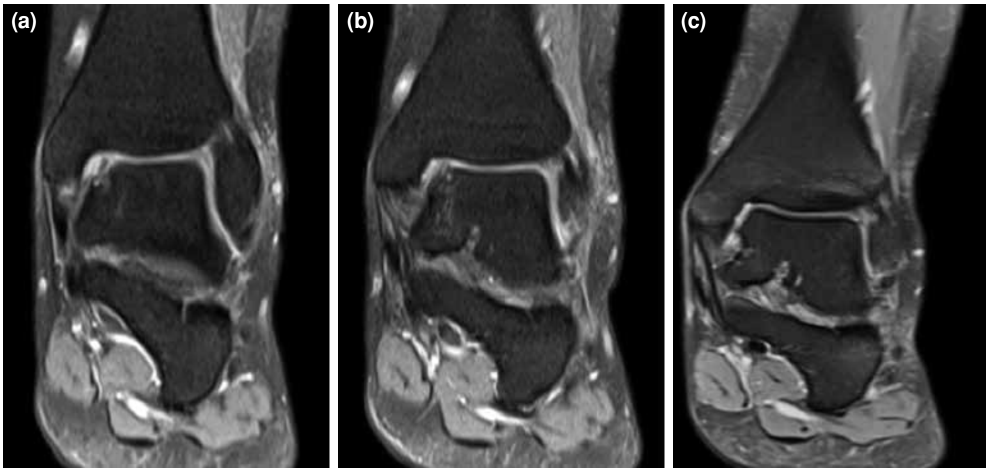

Figure 3. Magnetic resonance images of left ankle treated with cell-free scaffold technique. **(a)** Preoperative: Osteochondral lesion on medial talar dome. **(b)** Postoperative second year hypertrophic repair tissue. **(c)** Postoperative sixth year good healing of lesion.

Fifty-six lesions (90%) were located on medial dome and two (%3) were located centrally and only four (6%) on lateral dome. Twenty lesions (32.3%) were located at posteromedial zone and equally 20 lesions (32.3%) were located at medial central zone which were the most frequent locations. Only three lesions were located at anterolateral zone. Trauma history was present in 55.2% (31/56) of the medial lesions and 100% (4/4) of the lateral lesions.

A significant clinical improvement was observed in both treatment groups (p<0.0001). Median AOFAS ankle-hindfoot score increased from 69 (range, 34 to 72) to 85.5 (range, 52 to 100) in the microfracture group and from 52 (range, 15 to 79) to 90 (range, 67 to 100) in the scaffold group.

Postoperative AOFAS scores of the scaffold group were significantly higher than the microfracture group with a median of 90 (range, 67 to 100) and 85.5

TABLE I
Demographic characteristics of patients

	Microfracture group (n=22)			Cell-free scaffold group (n=40)			
	n	Median	Range	n	Median	Range	*p*
Age (year)		47	15 to 65		39	15 to 58	0.105
Body mass index (kg/m²)		27.7	19.7 to 34.8		27.04	21.5 to 37.2	0.889
Lesion size (cm²)		1.65	1 to 4		1.97	1 to 3.7	0.251
Follow-up period (month)		44	24 to 87		27	24 to 65	0.001
Gender							
Female	12			15			
Male	10			25			
Lesion location							
Medial	21			35			
Central	0			2			
Lateral	1			3			
Bone graft							
Grafted	0			12			
Non-grafted	22			28			
Anterior talofibular ligament reconstruction							
Yes	2			9			
No	20			31			

TABLE II

Clinical and radiological comparison of two groups of surgical techniques

	Microfracture group (n=22)		Cell-free scaffold group (n=40)		
	Median	Range	Median	Range	*p*
Preoperative AOFAS score	69	34 to 72	52	15 to 79	0.106
Postoperative AOFAS score	85.5	52 to 100	90	67 to 100	0.011
AOFAS change	+16	-18 to +60	+31.5	0 to +85	0.008
MOCART score	55	20 to 80	65	40 to 95	0.199

AOFAS: American Orthopedic Foot and Ankle Society; MOCART: Magnetic resonance observation of cartilage repair tissue.

(range, 52 to 100), respectively (p=0.011). Excellent to good results were 68.2% for the microfracture group and 82.5% for the scaffold group. AOFAS score improvement of the scaffold group was also higher than the microfracture group. Median of score change was 31.5 (range, 0 to 40) in the scaffold group and 16 (range, -18 to 60) in the microfracture group and the difference was statistically significant (p=0.008) (Table II).

TABLE III

Radiological evaluation according to treatment groups by using magnetic resonance observation of cartilage repair tissue score

		Microfracture group		Cell-free scaffold group	
	Score	n	%	n	%
1. Degree of defect repair and filling of the defect					
Complete	20	6	30	7	17.5
Hypertrophy	15	7	35	23	57.5
Incomplete, >50% of the adjacent cartilage	10	2	10	4	10
Incomplete, <50% of the adjacent cartilage	5	4	20	6	15
Subchondral bone exposed	0	1	5	0	0
2. Integration to border zone					
Complete	10	1	5	24	60
Demarcating border visible	5	10	50	16	40
Defect visible <50% of the length	0	7	35	0	0
Defect visible >50% of the length		2	10	0	0
3. Surface of the repair tissue					
Surface intact	10	5	25	17	42.5
Surface damaged <50% of tissue depth	5	13	65	7	17.5
Surface damaged >50% of tissue depth	0	2	10	16	40
4. Structure of the repair tissue					
Homogeneous	5	3	15	12	30
Inhomogeneous or cleft formation	0	17	85	28	70
5. Signal intensity of the repair tissue					
Isointense	30	10	50	21	52.5
Moderately hyperintense	15	8	40	19	47.5
Markedly hyperintense	0	2	10	0	0
6. Subchondral lamina					
Intact	5	1	5	11	27.5
Not intact	0	19	95	29	72.5
7. Subchondral bone					
Intact	5	2	10	4	10
Not intact	0	18	90	36	90
8. Adhesions					
No	5	19	95	39	97.5
Yes	0	1	5	1	2.5
9. Effusion					
No	5	14	70	37	92.5
Yes	0	6	30	3	7.5

The median total MOCART score of the microfracture group was lower than the scaffold group but there was no significant difference between them (p=0.199). Particularly, surface integration and effusion subgroups of MOCART presented higher scores in the scaffold group compared with the microfracture group. Subchondral bone was not intact in both groups with a rate of 90%. The rate of patients in the scaffold group which had effusion was 7.5% and the rate was 30% for microfracture group (Table III). Lesions were classified according to size of 1.5 cm^2. In smaller lesions (≤1.5 cm^2), there was no significant difference between the groups in terms of postoperative AOFAS scores (p=0.156). However, in larger lesions (>1.5 cm^2), the scaffold group presented superior outcomes and higher AOFAS improvement (p=0.022).

Postoperative AOFAS scores of the patients who were younger than 45 years, male or had history of ankle trauma were significantly higher ($p<0.05$) (Table IV). Accompanying pathologies such as lateral instability or subchondral cyst did not demonstrate significant effects on the outcomes. Median of postoperative AOFAS scores were 87.5 (range, 52 to 100) for non-grafted and 90 (range, 69 to 100) for grafted patients (p=0.479) and, similarly, 87 (range, 52 to 100) for patients without instability and 89 (range, 69 to 100) for patients who were treated with ligament reconstruction (p=0.565).

Excellent to good outcome ratios regarding the postoperative AOFAS score were 93.3% (14 of 15) for normal BMI group, 80.8% (21 of 26) for overweight group, and 66.7% for obese (14 of 21) group ($p>0.05$). Also, smoking habits of the patients or follow-up period had no significant effect on the treatment outcome (Table IV).

No complication such as septic arthritis, soft tissue infection or hypersensitivity reaction occurred.

TABLE IV

Effect of different factors according to postoperative American Orthopedic Foot and Ankle Society and magnetic resonance observation of cartilage repair tissue scores, independent from treatment method

		Postoperative AOFAS score		MOCART score	
Factor	n	Median	*p*	Median	*p*
Age (year)			0.018		0.315
<45	36	90		65	
>45	26	85		67	
Gender			0.020		0.929
Male	35	90		65	
Female	27	86		65	
Body mass index (kg/m^2)			0.446		0.134
Normal	15	94		70	
Overweight	26	87		60	
Obese	21	89		65	
Smoking			0.409		0.149
Yes	17	90		65	
No	45	87		65	
Trauma history			0.014		0.940
Yes	26	90		65	
No	36	86		65	
Lesion size (cm^2)			0.639		0.615
<1.5	19	89		67	
>1.5	43	87		65	
Bone graft			0.754		0.888
Yes	12	90		65	
No	50	87		62	
Follow-up period (month)			0.889		0.446
<48	49	88		65	
>48	13	86		62	

AOFAS: American Orthopedic Foot and Ankle Society; MOCART: Magnetic resonance observation of cartilage repair tissue.

Prolonged ankle swelling was documented in five patients. However, the symptoms were alleviated at the last visit.

DISCUSSION

Arthroscopic microfracture treatment has been clinically successful in the knee and hip joints.[17,18] Fontana and de Girolamo[18] compared the microfracture and AMIC techniques in the treatment of acetabular lesions and found that both methods were effective in a five-year follow-up. Autologous matrix-induced chondrogenesis technique was superior clinically and the complication rate was lower compared with the microfracture technique. According to other studies, the AMIC technique was also successful in the treatment of talar OCL.[14,19] In the present study, the microfracture technique resulted in satisfying clinical scores. However, the scaffold group outcomes were superior than the microfracture group clinically according to AOFAS ankle-hindfoot scale.

The present MOCART results of the scaffold group were slightly superior while not statistically significant probably due to the number of patients. It should be noted that integration with border was superior in the scaffold group, similar to previous studies.[13,20] This is consistent with the idea that homogenous distribution of MSC is acquired with scaffold implantation.[21] Defect filling was 35% hypertrophic in the microfracture group while 57% hypertrophic in the scaffold group. No use of any fixation method for scaffold placement and as a result not leveled scaffold implantation with normal cartilage tissue may cause hypertrophic repair. Kubosch et al.[22] did not use any fixation method other than fibrin glue and reported 61% hypertrophic filling, similar to the present study.

The rate of patients in the scaffold group with effusion was 7.5%, which was lower than the microfracture group. The present findings were comparable with previous studies that reported rates of 4% in the treatment of talar OCL with the AMIC technique.[13,20]

In a previous systematic review, it was reported that 58% of OCLs were located medially and 42% laterally.[23] Moreover, lateral talar dome lesions were associated with trauma with a rate of 93% and for medial lesions, the rate was 61%.[23] In the present study, although the majority of lesions were on the medial side, trauma association was 55% for medial and 100% for lateral lesions. Elias et al.[16] also found the medially located OCL rate as 62.9% and the most common location was medial-central zone with a rate of 53%. In the present study, the most common locations were also medial-central and posteromedial zones.

The effectiveness of the microfracture technique has been questioned in the treatment of larger cartilage lesions. In the knee joint, microfracture is indicated in the treatment of smaller lesions than 4 cm^2.[24] Chuckpaiwong et al.[7] demonstrated that outcomes were dramatically worse for talar OCLs which were larger than 1.5 cm^2. The present results are in line with these previous studies. Both treatment methods presented good clinical outcomes in smaller lesions than 1.5 cm^2, while in larger lesions, the scaffold group was significantly superior. Chondrocyte implantation techniques are widely used in the treatment of larger lesions and cell-free scaffold technique may be a good alternative for these lesions. Mancini and Fontana[25] reported comparable results with AMIC and matrix-induced autologous chondrocyte implantation (MACI) in the treatment of acetabular lesions and they suggested that AMIC should to be considered as an alternative to MACI method due to less morbidity while providing similar benefit.

Arthroscopic cell-free implantation appears to be a good alternative for indications where microfracture is not sufficient and other cartilage repair procedures are needed. Cell-free scaffold implantation technique has multiple advantages over other repair methods such as ACI and OAT. When compared to ACI, scaffold implantation technique is a single-step surgery, requires no need of cell-culture and has lower cost. Also, the scaffold implantation technique has advantages over OAT with no need of osteotomy and consequently no donor site morbidity with fewer complications.

In the present study, the clinical scores of younger patients (<45 years) were higher. Gille et al.[17] reported superior outcomes in the treatment of knee joint with AMIC in younger patients, with no significance. Although reports support superior outcomes in younger patients with talar OCL,[6,22] Becher and Thermann[19] could not find any difference between younger and older patients. Kubosch et al.[22] reported superior pain scores in younger patients without significance. Age may have some negative effect on cartilage repair; however, the clinical significance is controversial because of the lower expectancy of older patients. Filardo et al.[26] suggested that age should not be a contraindication in the treatment of OCL.

Increased BMI led to worse outcomes without significance. High BMI has been shown to reduce success of blood marrow stimulation.[27] However, some authors suggest that cartilage repair should be applied in obese patients.[28] In the present study, obese patients had lower but acceptable scores. Higher BMI may have negative effect on the results while not being clinically important to be accepted as a contraindication.

Smoking habits of the patients or duration of follow-up period had no effect on the present clinical or radiological results. Although some reports suggested that smoking had negative effect on healing,[29] others indicated no influence of smoking on the treatment outcome in mosaicplasty microfracture technique.[30] Of note, none of these studies focused on talar OCL or scaffold implantation method.

Based on the present findings, the clinical outcomes of male patients were significantly superior than those of females. Radiologically, there was no significant difference. Although it seems to be a surprising result, Vanlauwe et al.[31] reported more failure in female patients in the outcome of knee joint treatment. Gille et al.[32] showed that the clinical scores of male patients were significantly higher than that of female patients. On the other hand, Siclari et al.[33] reported that gender had no influence on the clinical results of the AMIC treatment. Although there is not much data regarding the effect of gender on the treatment outcome in the literature, cartilage repair was associated with inferior results in female patients in previous studies.[31,32]

The longer duration of follow-up period can affect the success of clinical outcomes. Giannini and Vannini[34] reported that AOFAS scores decreased as the duration of follow-up increased in the treatment of talar OCL. On the other hand, Usuelli et al.[14] reported that postoperative AOFAS scores increased gradually at 6, 12 and 24 months. Also, Steadman et al.[35] suggested that two- to three-year follow-up periods are required to observe maximum improvement. The effect of follow-up period on the clinical scores and exact timing of failure are unclear. In the present study, there was significant difference between the groups regarding the follow-up period. The effect of follow-up period could be more observable in long term follow-up.

This study has some limitations, first of which was the retrospective design. Secondly, despite the similar characteristics of the treatment groups, the follow-up duration was longer in the microfracture group and this could affect the outcome of the treatment. Moreover, the sample size was not large enough to investigate the factors (age, gender, trauma etc.), which may affect treatment results, with subgroup analysis according to treatment method. Furthermore, long-term results are important to investigate the consistency of healing or the occurrence of degenerative arthritis. Lastly, the characteristics and resemblance to hyaline cartilage of repair tissue are questionable because no histological evaluation or delayed gadolinium-enhanced magnetic resonance imaging was performed. However, the MOCART scoring is an objective and effective tool for the assessment and quantitative analysis of repair tissue.

In conclusion, both single-step arthroscopic techniques, the microfracture and cell-free scaffold implantation, were effective and safe in the talar OCL treatment. The scaffold technique presented superior clinical results than the microfracture technique in short-term follow-up. Age, trauma history and gender significantly affected the treatment outcome. The scaffold technique can be considered as a safe and good alternative in the treatment of large lesions where microfracture is not sufficient and other cartilage repair procedures are needed.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding

The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Badekas T, Takvorian M, Souras N. Treatment principles for osteochondral lesions in foot and ankle. Int Orthop 2013;37:1697-706.
2. Navid DO, Myerson MS. Approach alternatives for treatment of osteochondral lesions of the talus. Foot Ankle Clin 2002;7:635-49.
3. Leontaritis N, Hinojosa L, Panchbhavi VK. Arthroscopically detected intra-articular lesions associated with acute ankle fractures. J Bone Joint Surg [Am] 2009;91:333-9.
4. Camp CL, Stuart MJ, Krych AJ. Current concepts of articular cartilage restoration techniques in the knee. Sports Health 2014;6:265-73.
5. Tokgöz MA, Atik OŞ, Esendağlı G, Öğüt B, Bozkurt HH. Is it possible that the pathogenesis of osteoarthritis could start with subchondral trabecular bone loss like osteoporosis? Eklem Hastalik Cerrahisi 2018;29:152-8.
6. Gudas R, Kalesinskas RJ, Kimtys V, Stankevicius E, Toliusis 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;21:1066-75.

7. Chuckpaiwong B, Berkson EM, Theodore GH. Microfracture for osteochondral lesions of the ankle: outcome analysis and outcome predictors of 105 cases. Arthroscopy 2008;24:106-12.
8. Derrett S, Stokes EA, James M, Bartlett W, Bentley G. Cost and health status analysis after autologous chondrocyte implantation and mosaicplasty: a retrospective comparison. Int J Technol Assess Health Care 2005;21:359-67.
9. Van Assche D, Staes F, Van Caspel D, Vanlauwe J, Bellemans J, Saris DB, et al. Autologous chondrocyte implantation versus microfracture for knee cartilage injury: a prospective randomized trial, with 2-year follow-up. Knee Surg Sports Traumatol Arthrosc 2010;18:486-95.
10. Valderrabano V, Leumann A, Rasch H, Egelhof T, Hintermann B, Pagenstert G. Knee-to-ankle mosaicplasty for the treatment of osteochondral lesions of the ankle joint. Am J Sports Med 2009;37:105S-11S.
11. Farr J, Cole BJ, Sherman S, Karas V. Particulated articular cartilage: CAIS and DeNovo NT. J Knee Surg 2012;25:23-9.
12. Saltzman BM, Lin J, Lee S. Particulated Juvenile Articular Cartilage Allograft Transplantation for Osteochondral Talar Lesions. Cartilage 2017;8:61-72.
13. Valderrabano V, Miska M, Leumann A, Wiewiorski M. Reconstruction of osteochondral lesions of the talus with autologous spongiosa grafts and autologous matrix-induced chondrogenesis. Am J Sports Med 2013;41:519-27.
14. Usuelli FG, D'Ambrosi R, Maccario C, Boga M, de Girolamo L. All-arthroscopic AMIC® (AT-AMIC®) technique with autologous bone graft for talar osteochondral defects: clinical and radiological results. Knee Surg Sports Traumatol Arthrosc 2018;26:875-81.
15. Kanatlı U, Eren A, Eren TK, Vural A, Geylan DE, Öner AY. Single-step arthroscopic repair with cell-free polymer-based scaffold in osteochondral lesions of the talus: Clinical and radiological results. Arthroscopy 2017;33:1718-26.
16. Elias I, Zoga AC, Morrison WB, Besser MP, Schweitzer ME, Raikin SM. Osteochondral lesions of the talus: localization and morphologic data from 424 patients using a novel anatomical grid scheme. Foot Ankle Int 2007;28:154-61.
17. Gille J, Behrens P, Volpi P, de Girolamo L, Reiss E, Zoch W, et al. Outcome of Autologous Matrix Induced Chondrogenesis (AMIC) in cartilage knee surgery: data of the AMIC Registry. Arch Orthop Trauma Surg 2013;133:87-93.
18. Fontana A, de Girolamo L. Sustained five-year benefit of autologous matrix-induced chondrogenesis for femoral acetabular impingement-induced chondral lesions compared with microfracture treatment. Bone Joint J 2015;97:628-35.
19. Becher C, Thermann H. Results of microfracture in the treatment of articular cartilage defects of the talus. Foot Ankle Int 2005;26:583-9.
20. Wiewiorski M, Miska M, Kretzschmar M, Studler U, Bieri O, Valderrabano V. Delayed gadolinium-enhanced MRI of cartilage of the ankle joint: results after autologous matrix-induced chondrogenesis (AMIC)-aided reconstruction of osteochondral lesions of the talus. Clin Radio 2013;68:1031-8.
21. Meng Q, Man Z, Dai L, Huang H, Zhang X, Hu X, et al. A composite scaffold of MSC affinity peptide-modified demineralized bone matrix particles and chitosan hydrogel for cartilage regeneration. Sci Rep 2015;5:17802.
22. Kubosch EJ, Erdle B, Izadpanah K, Kubosch D, Uhl M, Südkamp NP, et al. Clinical outcome and T2 assessment following autologous matrix-induced chondrogenesis in osteochondral lesions of the talus. Int Orthop 2016;40:65-71.
23. Verhagen RA, Struijs PA, Bossuyt PM, van Dijk CN. Systematic review of treatment strategies for osteochondral defects of the talar dome. Foot Ankle Clin 2003;8:233-42.
24. Mella C, Nuñez A, Villalón I. Treatment of acetabular chondral lesions with microfracture technique. SICOT J. 2017;3:45.
25. Mancini D, Fontana A. Five-year results of arthroscopic techniques for the treatment of acetabular chondral lesions in femoroacetabular impingement. Int Orthop 2014;38:2057-64.
26. Filardo G, Andriolo L, Sessa A, Vannini F, Ferruzzi A, Marcacci M, et al. Age is not a contraindication for cartilage surgery: a critical analysis of standardized outcomes at long-term follow-up. Am J Sports Med 2017;45:1822-8.
27. Mithoefer K, McAdams T, Williams RJ, Kreuz PC, Mandelbaum BR. Clinical efficacy of the microfracture technique for articular cartilage repair in the knee: an evidence-based systematic analysis. Am J Sports Med 2009;37:2053-63.
28. Zaslav K, Cole B, Brewster R, DeBerardino T, Farr J, Fowler P, et al. A prospective study of autologous chondrocyte implantation in patients with failed prior treatment for articular cartilage defect of the knee: results of the Study of the Treatment of Articular Repair (STAR) clinical trial. Am J Sports Med 2009;37:42-55.
29. Jaiswal PK, Macmull S, Bentley G, Carrington RW, Skinner JA, Briggs TW. Does smoking influence outcome after autologous chondrocyte implantation?: A case-controlled study. J Bone Joint Surg [Br] 2009;91:1575-8.
30. Ollat D, Lebel B, Thaunat M, Jones D, Mainard L, Dubrana F, et al. Mosaic osteochondral transplantations in the knee joint, midterm results of the SFA multicenter study. Orthop Traumatol Surg Res 2011;97:160-6.
31. Vanlauwe J, Saris DB, Victor J, Almqvist KF, Bellemans J, Luyten FP. Five-year outcome of characterized chondrocyte implantation versus microfracture for symptomatic cartilage defects of the knee: early treatment matters. Am J Sports Med 2011;39:2566-74.
32. Gille J, Schuseil E, Wimmer J, Gellissen J, Schulz AP, Behrens P. Mid-term results of Autologous Matrix-Induced Chondrogenesis for treatment of focal cartilage defects in the knee. Knee Surg Sports Traumatol Arthrosc 2010;18:1456-64.
33. Siclari A, Mascaro G, Kaps C, Boux E. A 5-year follow-up after cartilage repair in the knee using a platelet-rich plasma-immersed polymer-based implant. Open Orthop J 2014;8:346-54.
34. Giannini S, Vannini F. Operative treatment of osteochondral lesions of the talar dome: current concepts review. Foot Ankle Int 2004;25:168-75.
35. Steadman JR, Briggs KK, Rodrigo JJ, Kocher MS, Gill TJ, Rodkey WG. Outcomes of microfracture for traumatic chondral defects of the knee: average 11-year follow-up. Arthroscopy 2003;19:477-84.