Foot and Ankle Surgery 30 (2024) 219–225

Contents lists available at ScienceDirect

Foot and Ankle Surgery

journal homepage: www.journals.elsevier.com/foot-and-ankle-surgery

Arthroscopic microfracture and associated techniques in the treatment of osteochondral lesions of the talus: A systematic review and metanalysis

Susanna Basciani [a,b], Umile Giuseppe Longo [a,b,*], Giuseppe Francesco Papalia [a,b], Rocco Papalia [a,b], Andrea Marinozzi [a,b]

[a] Research Unit of Orthopaedic and Trauma Surgery, Department of Medicine and Surgery, Università Campus Bio-Medico di Roma, Via Alvaro del Portillo, 21, 00128 Roma, Italy
[b] Fondazione Policlinico Universitario Campus Bio-Medico, Via Alvaro del Portillo, 200, 00128 Rome, Italy

A R T I C L E I N F O

Article history:
Received 20 August 2023
Received in revised form 16 October 2023
Accepted 28 December 2023

Keywords:
Ankle
Osteochondral lesion
Talus
Ankle arthroscopy
PRP
Hyaluronic Acid
Bone Marrow cells

A B S T R A C T

Background: Osteochondral lesions of the talus are common in patients suffering even minor trauma; timely diagnosis and treatment can prevent the development of early osteoarthritis. The objectives of this systematic review and meta-analysis were to evaluate the effects of additional procedures on arthroscopic ankle microperforations for osteochondral lesions.
Methods: A systematic literature search was conducted using PubMed-Medline, Cochrane Central, and Google Scholar to select clinical studies analyzing the efficacy of platelet-rich plasma (PRP), hyaluronic acid (HA), and bone marrow concentrate (BMC) procedures. Ten articles following PRISMA guidelines with a total of 464 patients were included in this review. Quality assessment using MINORS was performed, and all studies demonstrated high quality.
Results: The results of the systematic review showed benefits in all patients undergoing infiltrative therapy with PRP, hyaluronic acid, and BMC. The best results in terms of AOFAS score and VAS scale were found in patients undergoing PRP injection. The meta-analysis showed improvements in pain relief and return to daily activities in patients undergoing arthroscopic microperforations and PRP, although not reporting statistically significant results ($p = 0.42$).
Conclusion: All treatment strategies reported better scores compared to the control groups. Among the various treatments analyzed, the addition of PRP appears to be the most valuable probably for the larger population receiving this treatment, showing excellent outcomes in pain reduction, clinical outcomes, and return to daily activities.
Level of Evidence: II

Contents

* Correspondence to: Fondazione Policlinico Universitario Campus Bio-Medico, Via Alvaro del Portillo, 21, 00128 Roma, Italy
E-mail address: g.longo@policlinicocampus.it (U.G. Longo).

https://doi.org/10.1016/j.fas.2023.12.005

1. Introduction

Osteochondral lesions of the talus (OLTs) is an acquired lesion, the most common aetiology is repetitive microtrauma associated with vascular impairment [16]. The diagnosis of OLTs is uncommon and the incidence is poorly understood [23]. Among the various etiological factors, we recognize acute or chronic trauma, repeated microtrauma, genetic predisposition, degenerative arthrosis, osteonecrosis secondary to systemic metabolic diseases, vascularization abnormalities, and alcohol abuse [1,2,7,10,20,21,24,26,30,43]. The hereditary genetic component has been studied, in fact, there is a high incidence in monozygotic twins, and it is bilateral in 10% of cases [44,46]. Depending on the localization and size of the lesion, the main etiological factors, the symptomatology, and the treatment change; lateral talar dome lesions are more often associated with a history of trauma, central and anterior localization, small size, lower incidence of spontaneous healing, and are more often symptomatic [2,35]. Otherwise, medial talar dome lesions are not often related to traumatic events, they are more posterior, larger, and deeper.

Nonoperative treatment with immobilization and non-weight bearing is enough for acute injuries, definable as occurring in less than a month without dislocation of fragments [14,28]. Surgical treatment is indicated for chronic lesions, and for a displaced fragment [8]. Among the various surgical techniques arthroscopy with the removal of the loose fragment, debridement, and marrow stimulation is the first line of treatment for lesions smaller than 1 cm [36]. Retrograde drilling and/or bone grafting is indicated when the lesion is > 1 cm with intact cartilage cap [5,19,45]. For lesions > 1 cm, dislocated, lesions of the talus shoulder, or failure of previous surgeries, osteochondral grafting (osteochondral autograft transplantation, autologous chondrocyte implantation, bulk allograft) is indicated.

This systematic review aimed to report how the additional procedures to arthroscopic microfracture surgery affect the improvement of the symptoms and quality of life [40].

2. Methods

This systematic review was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines and using the PRISMA checklist (Fig. 1) [27].

2. Inclusion criteria

The inclusion criteria were English-language studies examining the effectiveness of additional procedures in surgical management by arthroscopic microperforations in the treatment of osteochondral lesions.

All studies considering different procedures or non-arthroscopic microperforations were excluded.

We excluded case series, case reports, systematic reviews and meta-analysis.

4. Information sources, search strategy

A systematic literature search was conducted using the following online databases: PubMed-Medline, Cochrane Central, and Google Scholar. We used the following search strings: ("osteochondral"[All fields] OR "osteochondritis"[MeSH terms] OR "osteochondritis"[All fields] OR "osteochondritis"[All fields]) AND ("lesion"[All fields] OR "lesion s"[All fields] OR "lesions"[All fields] OR "lesions"[All fields]) AND ("talus"[MeSH terms] OR "talus"[All fields]). The literature search was conducted on 31 January 2023.

A manual search of the bibliography of each published study was performed, in order to find relevant articles that could potentially have been missed. After duplicates were removed, two reviewers independently read the abstracts of studies appropriate for inclusion. Finally, the full articles were checked by two investigators to choose the studies to include in the review and meta-analysis.

5. Data collection, analysis, and outcomes

Two authors of the review performed the data extraction independently. The following data were extracted from the included studies: authors, year of publication, type of study, level of evidence, number of participants and their age and sex in study and control groups, follow-up, and interventions. Outcomes were analyzed according to pain levels and recovery of normal daily activities using specific scales.

6. Study risk of bias assessment

The methodological index for nonrandomized studies (MINORS) was performed by two reviewers to assess the methodological quality of the studies [38].

7. Statistical analysis

It has been performed a meta-analysis adopting the software Review Manager (RevMan) version 5.4. Pain and clinical talus scores were compared between the different treatments as continuous outcomes. The data are indicated with the mean difference (MD) with 95% confidence intervals (CI). For forest plot with high heterogeneity ($I^2 > 60\%$) a random-effect model was applied. The statistical significance of the results was established at $p < 0.05$.

8. Results

8.1. Search Results

The search identified 1699 articles, of whom 1260 were screened. The full text of 63 articles was analyzed of which 53 were excluded

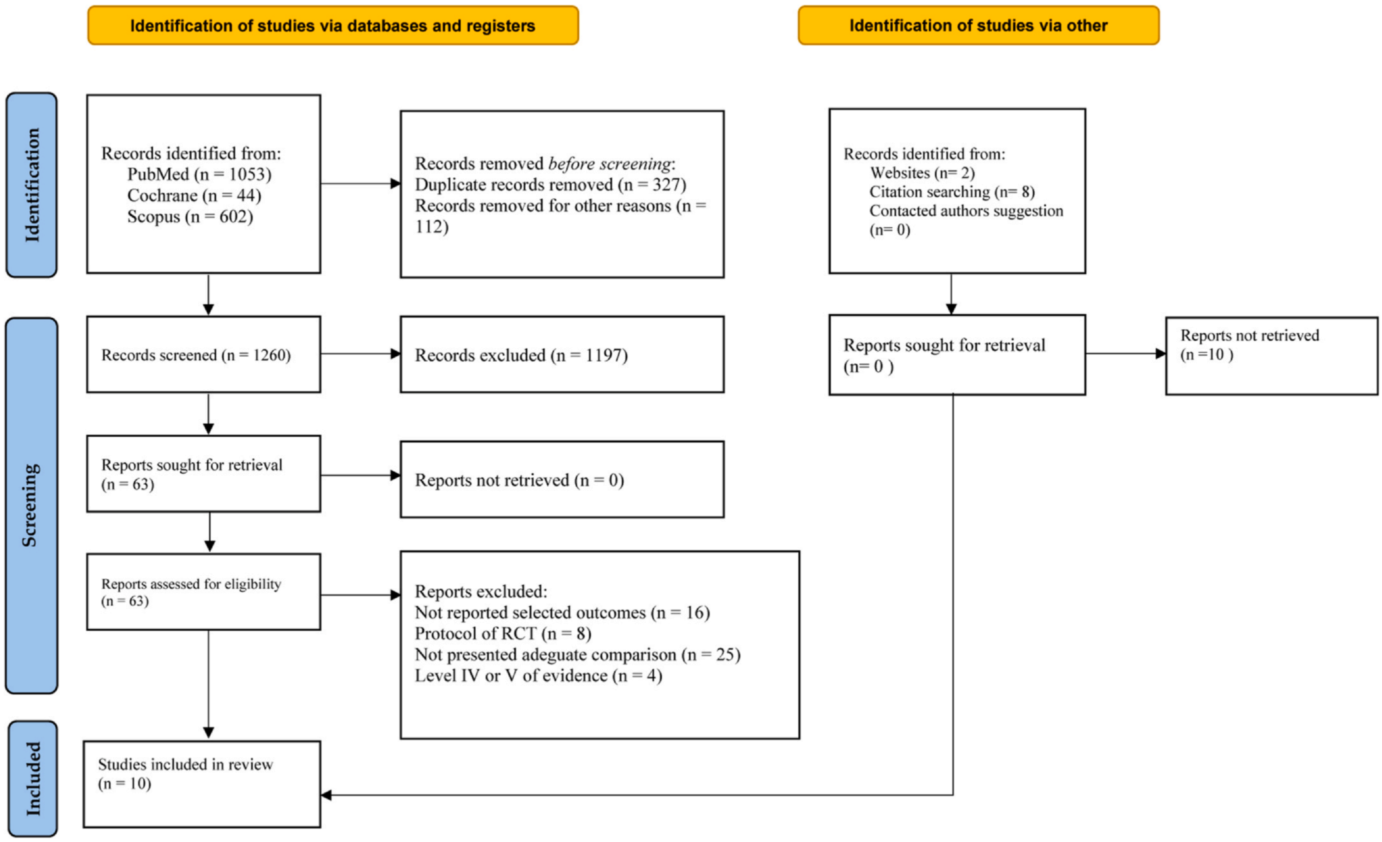


Fig. 1. Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) flow diagram.

for the following reasons: 8 were RCT protocols, 16 did not have reported postoperative outcomes, 25 did not have comparisons between the two groups being analyzed, and 4 were level IV or V evidence. Finally, 10 articles were included according to the PRISMA selection process (Fig. 1).

8.2. Included and excluded studies

Among the 10 studies, 5 were RCTs (LOE I), 2 were PS (LOE II), and 3 were CCS (LOE III). All studies shared arthroscopic microperforations as the basic procedure. In addition, some studies also used PRP injections, others studies had hyaluronic acid injections [3,12,15,18,37]. The remaining studies additionally used atelocollagen, autologous osteochondral transplantation, autologous cartilage transplantation or matrix-associated chondrocytes, or bone marrow aspirate with concentrate and fibrin glue [6,13,17,25,29].

8.3. Demographic data

The total number of participants in all included studies was 464, of whom 188 underwent arthroscopic microperforation surgery (AM) and the others underwent microperforation combined with additional therapies. Only one patient underwent bilateral surgical treatment. The mean age of the patients was 35.5 years. In the different groups, there were 195 total women corresponding to 42% of the total. The minimum and the maximum follow-up were 9 and 89.6 months, with a mean of 31.12 months. Except for two studies, the size of treated osteochondral lesions was always less than 2 cm [17,25]. The demographic characteristics of the patients are shown in Table 1. The characteristics related to the type of surgery are shown in Table 2.

8.4. Quality assessment (MINORS)

The MINORS score ranged from 20 to 22 with a mean value of 21, identifying the high quality of the studies considered. The scores for the 12 items for each study are described in Table 3.

8.5. Clinical results

In our study, all patients benefited from surgical treatment with or without additional associated procedures (Table 4).

The mean preoperative AOFAS values were 45.29. The postoperative value was 76.1 for patients undergoing microperforation only, 84.5 for patients with PRP addition, 62.6 for patients with HA addition, and finally 84.64 for patients with BCMs.

Analyzing the VAS scale, the preoperative values were 7.45, 3.34 for patients undergoing microperforations only, 2.6 for patients with PRP addition 2.6, 3.3 for patients with HA addition. Only one study mentioned the postoperative value of the scale at 3.38 after using BMCs.

8.6. Effect of intervention

8.6.1. VAS

In the postoperative period, there was no significant difference in pain relief when comparing AM and AM + HA (MD −0.57, 95% CI −3.61 to 2.47, p = 0.71) (Fig. 2).

8.6.2. AOFAS

Improvement of AOFAS presented no significant difference between comparing AM and AM + HA (MD 2.54, 95% CI −10.86 to 15.95, p = 0.71) (Fig. 3).

Table 1
Demographic characteristics of the patients at baseline. RCT: Randomized controlled trial; CCS: Case control study; PS: prospective study; *bilateral.

	Year	Type of study	LOE	Sample size	Age	Follow-up (months)
Dogar et al[12]	2021	RCT	I	62 (31 W 31 M)	37.2 ± 13.31	26.19
Doral et al[15]	2012	RCT	I	57 (28 W 29 M)	40.5 ± 13.00	24
Guney et al[3]	2013	PS	II	35 (19 W 15 M)	42.8 ± 14.7 38.5 ± 12.7	16.2
Görmeli et al[18]	2015	RCT	I	40 (19 W 21 M)	38.6 ± 9.1 39.7 ± 8.7 40.3 ± 9.4	15.3
Lee et al[25]	2020	RCT	I	60 (32 W 28 M)	35.03 ± 15.69 39.10 ± 14.86	24
Shang et al[37]	2015	PS	II	35 (12 W 23 M)	36.6 ± 10.7 34.7 ± 8.7	9
Gobbi et al[17]	2006	RCT	I	34 (12 W 20 M) *	32 (19-45) 24 (17-28) 27.8 (21-53)	53
Domayer et al[13]	2012	CCS	III	20 (11 W 7 M) *	30.2 ± 6.1	89.6
Apprich et al[6]	2012	CCS	III	20 (10 W 10 M)	31 ± 6.5 32.4 ± 9.2	18
Murphy et al[29]	2018	CCS	III	101 (21 W 80 M)	39.7 ± 10.78 34.6 ± 11.81	36

8.6.3. VAS

Postoperatively, there was no significant pain reduction between AM and AM + PRP (MD 0.46, 95% CI −0.89 to 1.81, p = 0.50) (Fig. 4).

8.6.4. AOFAS

When comparing AM and AM + PRP, there was a better improvement of AOFAS in AM + PRP group, although without statistical significance (MD −6.79, 95% CI −23.16 to 9.59, p = 0.42) (Fig. 5).

9. Discussion

The purpose of this study was to evaluate the effectiveness of the treatments for osteochondral lesions of the talus, analyzing the addition of other procedures to arthroscopic microperforations in order to establish a better strategy of treatment, that could influence the clinical outcomes.

This pathology generally affects young and athletic subjects and recognizes benefits in conservative treatment in 45% of cases [41]. In a review by Van Bergen, the treatment of choice for lesions lower than 15 mm consists of arthroscopic debridement and bone marrow stimulation [39]. Differently from talus fractures, which have a bone fragment thickness greater than 3 mm with a displacement of the fragment that requires early surgery, osteochondral lesions - especially if lower than 20 mm - can initially be treated conservatively for later surgery [31]. Positive predisposing factors of the effectiveness of microperforations are a good preoperative range of motion and the absence of preparative osteoarthritis, so it is recommended to perform surgery before the appearance of signs of arthrosis [4].

According to a review by Dilley, hyaluronic acid, in addition to arthroscopic microperforations, provides good results in function and pain improvement at short-term follow-up [11].

The use of PRP and BMC has also been studied extensively for osteochondral injuries of the knee, reporting good results [9,34]. Hyaluronic acid has been used also in the knee for the same pathology reporting less efficacy than PRP [32]. These results are similar to those of our study. For bone marrow stimulation, the best results were found for talus lesions smaller than 107.4 mm^2 in area and/or 10.2 mm in diameter, other unfavorable prognostic factors are related to the advanced age of patients, the presence of deep lesions, and the medial location of lesions [33,42,47].

As demonstrated in the meta-analysis, Jazzo et al. showed that the use of PRP was more effective than hyaluronic acid, saline, and microperforation surgery alone in both the short-term (4 weeks) and long-term (25 months) [22].

The results of the meta-analysis showed that only arthroscopy was almost overlapping compared to arthroscopy with HA addition. In contrast, the addition of PRP ensured greater improvement, although not statistically significant, however, given the few studies considered there is no strong evidence. A limitation of this study relates to the nonhomogeneity of the groups because patients undergoing AM + PRP appear to be numerically higher.

There are no meta-analyses in the literature analyzing this topic. However, this study has some limitations related to the heterogeneity of the additional procedures as the processing and administration methods of PRP, HA, and BMCs. In fact, for each study considered, the timing between infiltrations, and the type of hyaluronic acid used were different. The future perspective is to expand

Table 2
Type of surgery, size of lesions, and scores used. AOFAS: The American Orthopedic Foot and Ankle Score, VAS: Visual Analogue Scale, FAAM: Foot and Ankle Ability Measure, HSS: Hospital for Special Surgery score, SANE: Single Assessment Numeric Evaluation, FAOS: Foot and Ankle Outcome Score.

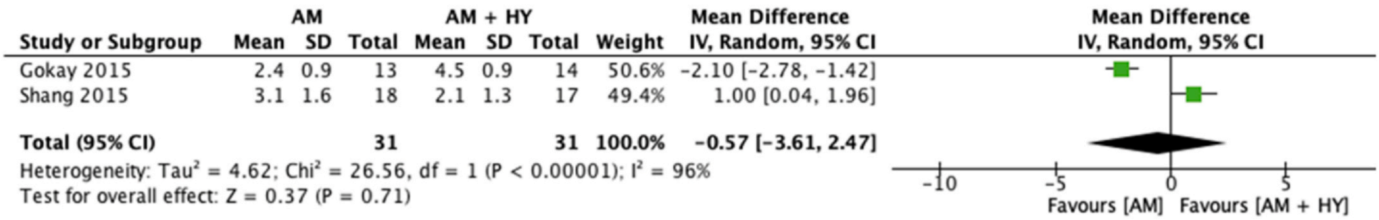
	Groups	Size (median)	Score
Dogar et al[12]	Arthroscopic microfracture (n = 22) Arthroscopic microfracture + PRP (n = 19) Arthroscopic microfracture + BST-Cargel	< 15 mm	AOFAS, VAS, FAAM
Doral et al[15]	Arthroscopic microfracture + HY (n = 41) Arthroscopic microfracture (n = 16)	< 20 mm	AOFAS, FREIBURG SCORING SYSTEMS
Guney et al[3]	Arthroscopic microfracture (n = 16) Arthroscopic microfracture + PRP (n = 19)	< 20 mm	AOFAS, VAS, FAAM
Görmeli et al[18]	Arthroscopic microfracture (n = 13) Arthroscopic + PRP (n = 13) Arthroscopic microfracture + HY (n = 14)	< 15 mm	VAS, AOFAS
Lee et al[25]	Arthroscopic microfracture + Atelocollagen (n = 23) Arthroscopic microfracture (n = 22)		VAS, HSS, AOFAS, MOCART from MRI
Shang et al[37]	Arthroscopic microfracture (n = 18) Arthroscopic microfacture + HY (n = 17)	< 20 mm	AOFAS, VAS, MRI
Gobbi et al[17]	Arthroscopic chondroplasty (n = 11) Osteochondral autologous transplantation (OAT) (n = 12) Arthroscopic microfracture (n = 8 +1 bilateral)		AOFAS-AHS, SANE, MRI
Domayer SE et al[13]	Arthroscopic microfracture (n = 10) Matrix-associated autologous cartilage transplantation (n = 10)	1.16 ± 0.49 1.39 ± 0.33 cm2	AOFAS, MRI, ROI analysis
Apprich et al[6]	Arthroscopic microfracture (n = 10) Matrix-associated autologous chondrocyte transplantation (n = 10)	1.21 ± 0.6 cm2 1.05 ± 0.6 cm2	AOFAS, Mocart
Murphy et al[29]	Arthroscopic microfracture (n = 52) Arthroscopic microfracture + bone marrow aspirate concentrate and fibrin glue (n = 49)	less than 1.5 cm2	VAS, FAOS, revision rate

Table 3
Minors: Methodological index for non-randomized studies.

Study	Stated aim	Inclusion of patients	Collection of data	Endpoints appropriate to the aim	Unbiased assessment of the study endpoint	Follow-up	Loss to follow up less than 5%	Prospective calculation of the study size	Control group	Contemporary groups	Baseline equivalence of groups	Statistical analyses	Total
Dogar et al[12]	2	2	2	2	0	2	0	2	2	2	2	1	21
Doral et al[15]	2	2	2	2	0	2	0	2	2	2	2	1	21
Guney et al[3]	2	2	2	2	1	1	0	2	2	2	2	1	21
Görmeli et al[18]	2	2	2	2	1	1	0	2	2	2	2	1	21
Lee et al[25]	2	2	2	2	1	2	1	2	2	2	2	1	20
Shang et al[37]	2	2	2	2	1	1	0	2	2	2	2	0	20
Gobbi et al[17]	2	2	2	2	1	2	0	2	2	2	2	1	22
Domayer et al[13]	2	2	2	2	0	2	0	2	2	2	2	1	21
Apprich et al[6]	2	2	2	2	1	2	0	2	2	2	2	1	22
Murphy et al[29]	2	2	2	2	0	2	0	2	2	2	2	1	21

Table 4
Outcome scores before and after treatment. AOFAS: The American Orthopedic Foot and Ankle Score, VAS: Visual Analogue Scale, FAAM: Foot and Ankle Ability Measure.

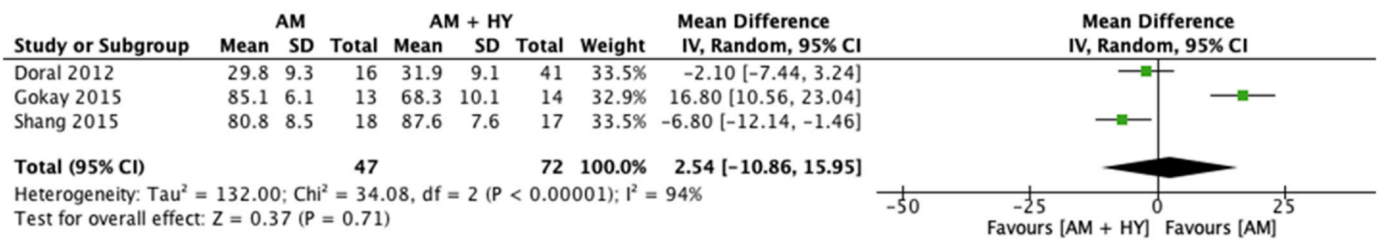
		AOFAS PREOPERATIVE	AOFAS POSTOPERATIVE	VAS PREOPERATIVE	VAS POSTOPERATIVE	FAAM SCORE PREOPERATIVE (MEDIAN RANGE)			FAAM SCORE POST OPERATIVE (MEDIAN RANGE)		
		(MEAN ± SD)	(MEAN ± SD)	(MEAN ± SD)	(MEAN ± SD)	OVERALL PAIN	15-MIN WALKING	RUNNING	OVERALL PAIN	15-MIN WALKING	RUNNING
Dogar et al.[12]	AM	47.59 ± 9.41	77.22 ± 13.10	7.36 ± 0.72	3.13 ± 1.28	1.0 (0-2.0)	1.0 (0-2.0)	1.0 (0-2.0)	1.0 (2.0-4.0)	3.0 (2.0-4.0)	4.0 (3.0-4.0)
	AM + PRP	42.52 ± 10.31	89.21 ± 3.96	8.0 ± 0.74	2.47 ± 0.61	1.0 (0-2.0)	1.0 (0-2.0)	1.0 (0-2.0)	3.0 (2.0-4.0)	3.0 (2.0-4.0)	4.0 (3.0-4.0)
	AM + BST	38.95 ± 6.18	87.76 ± 5.78	8.28 ± 0.64	1.95 ± 0.86	2.0 (0-2.0)	2.0 (0-2.0)	1.0 (0-2.0)	3.0 (2.0-4.0)	3.0 (2.0-4.0)	3.0 (2.0-4.0)
Doral. et al.[15]	AM + HY	18.8 ± 9.1	31.9 ± 9.1								
	AM	24.1 ± 7.3	29.8 ± 9.3								
Guney et al.[3]	AM	46.8 ± 9.87	71.0 ± 10.2	7.3 ± 0.7	3.8 ± 1.2	4.0 (3.0-5.0)	3.5 (3.0-5.0)	5.0 (4.0-5.0)	2.5 (1.0-4.0)	2.0 (1.0-4.0)	3.0 (2.0-5.0)
	AM + PRP	42.5 ± 10.3	89.2 ± 3.9	8.0 ± 0.7	2.2 ± 0.8	3.0 (2.0-5.0)	4.0 (2.0-5.0)	5.0 (3.0-5.0)	1.0 (1.0-2.0)	1.0 (1.0-2.0)	3.0 (1.0-4.0)
Görmeli et al.[18].	AM	43.6 ± 7.6	85.1 ± 6.1	8.0 ± 0.7	2.4 ± 0.9						
	AM + PRP	44.9 ± 9.2	75.1 ± 9.5	7.8 ± 0.9	3.3 ± 1.0						
	AM + HY	42.7 ± 7.1	68.3 ± 10.1	7.7 ± 0.7	4.5 ± 0.9						
Lee et al.[25]	AM + Collagen	72.23 ± 11.85	91.93 ± 8.62								
	AM	69.30 ± 17.95	86.91 ± 10.68								
Shang et al.[37]	AM	65.2 ± 4.7	80.8 ± 8.5	6.2 ± 0.8	3.1 ± 1.6						
	AM + HY	66.7 ± 4.1	87.6 ± 7.6	6.1 ± 0.7	2.1 ± 1.3						
Gobbi et al.[17]	Chondroplasty	36.8	82.7								
	OAT	31.1	85.4								
	AM	33.8	83.8								
Domayer et al.[13]	AM		91.3 ± 6.2								
	AM + MAC		85.3 ± 9.8								
Apprich et al.[6]	AM	48.8 ± 20.4	83.6 ± 9.7								
	AM + MAC	44.3 ± 16.5	77.6 ± 13.2								
Murphy et al.[29]	AM			7.34 ± 1.49	4.30 ± 2-1						
	AM + BMAC			6.82 ± 1.67	3.38 ± 1.8						



Study or Subgroup	AM Mean	AM SD	AM Total	AM + HY Mean	AM + HY SD	AM + HY Total	Weight	Mean Difference IV, Random, 95% CI
Gokay 2015	2.4	0.9	13	4.5	0.9	14	50.6%	-2.10 [-2.78, -1.42]
Shang 2015	3.1	1.6	18	2.1	1.3	17	49.4%	1.00 [0.04, 1.96]
Total (95% CI)			**31**			**31**	**100.0%**	**-0.57 [-3.61, 2.47]**

Heterogeneity: $Tau^2 = 4.62$; $Chi^2 = 26.56$, df = 1 ($P < 0.00001$); $I^2 = 96\%$
Test for overall effect: Z = 0.37 (P = 0.71)

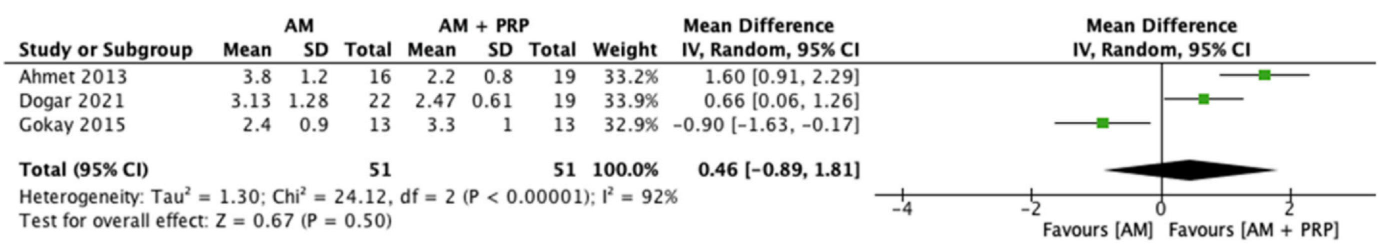
Fig. 2. VAS: Arthroscopic Microperforation (AM) versus AM + hyaluronic acid.



Study or Subgroup	AM Mean	AM SD	AM Total	AM + HY Mean	AM + HY SD	AM + HY Total	Weight	Mean Difference IV, Random, 95% CI
Doral 2012	29.8	9.3	16	31.9	9.1	41	33.5%	-2.10 [-7.44, 3.24]
Gokay 2015	85.1	6.1	13	68.3	10.1	14	32.9%	16.80 [10.56, 23.04]
Shang 2015	80.8	8.5	18	87.6	7.6	17	33.5%	-6.80 [-12.14, -1.46]
Total (95% CI)			**47**			**72**	**100.0%**	**2.54 [-10.86, 15.95]**

Heterogeneity: $Tau^2 = 132.00$; $Chi^2 = 34.08$, df = 2 ($P < 0.00001$); $I^2 = 94\%$
Test for overall effect: Z = 0.37 (P = 0.71)

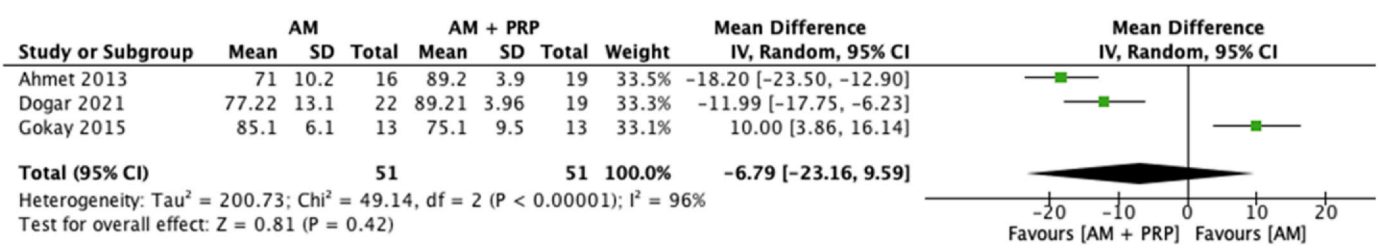
Fig. 3. AOFAS: Arthroscopic Microperforation (AM) versus AM + hyaluronic acid.



Study or Subgroup	AM Mean	AM SD	AM Total	AM + PRP Mean	AM + PRP SD	AM + PRP Total	Weight	Mean Difference IV, Random, 95% CI
Ahmet 2013	3.8	1.2	16	2.2	0.8	19	33.2%	1.60 [0.91, 2.29]
Dogar 2021	3.13	1.28	22	2.47	0.61	19	33.9%	0.66 [0.06, 1.26]
Gokay 2015	2.4	0.9	13	3.3	1	13	32.9%	-0.90 [-1.63, -0.17]
Total (95% CI)			**51**			**51**	**100.0%**	**0.46 [-0.89, 1.81]**

Heterogeneity: $Tau^2 = 1.30$; $Chi^2 = 24.12$, df = 2 ($P < 0.00001$); $I^2 = 92\%$
Test for overall effect: Z = 0.67 (P = 0.50)

Fig. 4. VAS: Arthroscopic Microperforation (AM) versus AM + Platelet-Rich Plasma.



Study or Subgroup	AM Mean	AM SD	AM Total	AM + PRP Mean	AM + PRP SD	AM + PRP Total	Weight	Mean Difference IV, Random, 95% CI
Ahmet 2013	71	10.2	16	89.2	3.9	19	33.5%	-18.20 [-23.50, -12.90]
Dogar 2021	77.22	13.1	22	89.21	3.96	19	33.3%	-11.99 [-17.75, -6.23]
Gokay 2015	85.1	6.1	13	75.1	9.5	13	33.1%	10.00 [3.86, 16.14]
Total (95% CI)			**51**			**51**	**100.0%**	**-6.79 [-23.16, 9.59]**

Heterogeneity: $Tau^2 = 200.73$; $Chi^2 = 49.14$, df = 2 ($P < 0.00001$); $I^2 = 96\%$
Test for overall effect: Z = 0.81 (P = 0.42)

Fig. 5. AOFAS Arthroscopic Microperforation (AM) versus AM + Platelet-Rich Plasma.

the number of studies and analyze the differences in terms of the protocols used in the studies.

10. Conclusion

This systematic review has shown that procedures in addition to arthroscopic microperforations with a cycle of infiltration with hyaluronic acid, PRP, and BMC result in improved postoperative outcomes regarding return to daily activities and improvement in symptoms. The meta-analysis reported better outcomes in patients who benefited from PRP even though without a statistically significant result. The cause of this result may be related to the larger population of the group of patients undergoing microperforation and PRP infiltration compared with the others. However, further large-scale studies with a larger number of patients and an evaluation of the method of administration of injected substances are needed to identify the most effective treatment for this type of injury.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

The authors declare that they have no conflict of interest.

References

[1] Berndt A, Harty M. Transchondral fractures (osteochondritis dissecans) of the talus. J Bone Jt Surg 1959.
[2] Flick A, Gould N. Osteochondritis dissecans of the talus (Transchondral fractures of the talus): review of the literature and new surgical approach for medial dome lesions. Foot Ankle 1985.
[3] Guney A, Akar M, Karaman I, Oner M, Guney B. Clinical outcomes of platelet rich plasma (PRP) as an adjunct to microfracture surgery in osteochondral lesions of the talus. Knee Surg Sports Trauma Arthrosc 2013.
[4] Amouyel T, Barbier O, De L'Escalopier N, Cordier G, Baudrier N, Benoist J, et al. Higher preoperative range of motion is predictive of good mid-term results in

the surgical management of osteochondral lesions of the talus: a prospective multicentric study. Knee Surg Sports Trauma Arthrosc 2022.
[5] Anders S, Lechler P, Rackl W, Grifka J, Schaumburger J. Fluoroscopy-guided retrograde core drilling and cancellous bone grafting in osteochondral defects of the talus. Int Orthop 2012:1635–40.
[6] Apprich S, Trattnig S, Welsch GH, Noebauer-Huhmann IM, Sokolowski M, Hirschfeld C, et al. Assessment of articular cartilage repair tissue after matrix-associated autologous chondrocyte transplantation or the microfracture technique in the ankle joint using diffusion-weighted imaging at 3 Tesla. Osteoarthr Cartil 2012:703–11.
[7] McCullough C, Venugopal V. Osteochondritis dissecans of the talus: the natural history. Clin Orthop 1979:264–8.
[8] Choi WJ, Kim BS, Lee JW. Osteochondral lesion of the talus: could age be an indication for arthroscopic treatment? Am J Sports Med 2012:419–24.
[9] Chona DV, Kha ST, Minetos PD, LaPrade CM, Chu CR, Abrams GD, et al. Biologic augmentation for the operative treatment of osteochondral defects of the knee: a systematic review. Orthop J Sports Med 2021.
[10] Thordarson D. Talar body fractures. Orthop Clin 2001.
[11] Dilley JE, Everhart JS, Klitzman RG. Hyaluronic acid as an adjunct to microfracture in the treatment of osteochondral lesions of the talus: a systematic review of randomized controlled trials. BMC Musculoskelet Disord 2022.
[12] Doğar F, Uzun E, Gürbüz K, Topak D, Akar M, Bilal Ö, et al. Comparison of arthroscopic treatment methods in talar osteochondral lesions: a multicenter, prospective, randomized clinical trial. J Am Podiatr Med Assoc 2021.
[13] Domayer SE, Apprich S, Stelzeneder D, Hirschfeld C, Sokolowski M, Kronnerwetter C, et al. Cartilage repair of the ankle: first results of T2 mapping at 7.0 T after microfracture and matrix associated autologous cartilage transplantation. Osteoarthr Cartil 2012:829–36.
[14] Dombrowski ME, Yasui Y, Murawski CD, Fortier LA, Giza E, Haleem AM, et al. International consensus group on cartilage repair of the ankle. conservative management and biological treatment strategies: proceedings of the international consensus meeting on cartilage repair of the ankle. Foot Ankle Int 2022.
[15] Doral MN, Bilge O, Batmaz G, Donmez G, Turhan E, Demirel M, et al. Treatment of osteochondral lesions of the talus with microfracture technique and post-operative hyaluronan injection. Knee Surg Sports Trauma Arthrosc 2012:1398–403.
[16] Merritt G, Epstein J, Roland D, Bell D. Fresh osteochondral allograft transplantation (FOCAT) for definitive management of a 198 square millimeter osteochondral lesion of the talus (OLT): A case report. Foot (Edinb) 2021.
[17] Gobbi A, Francisco RA, Lubowitz JH, Allegra F, Canata G. Osteochondral lesions of the talus: randomized controlled trial comparing chondroplasty, microfracture, and osteochondral autograft transplantation. Arthroscopy 2006:1085–92.
[18] Görmeli G, Karakaplan M, Görmeli CA, Sarıkaya B, Elmalı N, Ersoy Y. Clinical effects of platelet-rich plasma and hyaluronic acid as an additional therapy for talar osteochondral lesions treated with microfracture surgery: a prospective randomized clinical trial. Foot Ankle Int 2015:891–900.
[19] Hannon CP, Bayer S, Murawski CD, Canata GL, Clanton TO, Haverkamp D, et al. Debridement, curettage, and bone marrow stimulation: proceedings of the international consensus meeting on cartilage repair of the ankle. Foot Ankle Int 2018:16S–22S.
[20] Dipaola J, Nelson D, Colville M. Characterizing osteochondral lesions by magnetic resonance imaging. Arthroscopy 1991.
[21] Farmer J, Martin D, Boles C, Curl W. Chondral and osteochondral injuries. Clin Sports Med 2001.
[22] Jazzo SF, Scribner D, Shay S, Kim KM. Patient-reported outcomes following platelet-rich plasma injections in treating osteochondral lesions of the talus: a critically appraised topic. J Sport Rehabil 2018:177–84.
[23] Orr JD, Dawson LK, Garcia EJ, Kirk KL. Incidence of osteochondral lesions of the talus in the United States military. Foot Ankle Int 2011:948–54.
[24] Pettine K, Morrey BJ. Osteochondral fractures of the talus: a long term followup. Bone Jt Surg 1987.
[25] Lee YK, Young KW, Kim JS, Lee HS, Cho WJ, Kim HN. Arthroscopic microfracture with atelocollagen augmentation for osteochondral lesion of the talus: a multicenter randomized controlled trial. BMC Musculoskelet Disord 2020:716.
[26] Shea M, Manoli A. Osteochondral lesions of the talar dome. Foot Ankle 1993.
[27] Page MJ, Moher D. Evaluations of the uptake and impact of the preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement and extensions: a scoping review. Syst Rev 2017.
[28] Murawski CD, Jamal MS, Hurley ET, Buda R, Hunt K, McCollum G, et al. Terminology for osteochondral lesions of the ankle: proceedings of the International consensus meeting on cartilage repair of the ankle. J Isakos 2022:62–6.
[29] Murphy EP, McGoldrick NP, Curtin M, Kearns SR. A prospective evaluation of bone marrow aspirate concentrate and microfracture in the treatment of osteochondral lesions of the talus. Foot Ankle Surg 2019:441–8.
[30] Ly P, Fallat L. Trans-chondral fractures of the talus: a review of 64 surgical cases. J Foot Ankle Surg 1993.
[31] Powers RT, Dowd TC, Giza E. Surgical treatment for osteochondral lesions of the talus. Arthroscopy 2021:3393–6.
[32] Rajeev A, Ali M, Devalia K. Autologous conditioned plasma and hyaluronic acid injection for isolated grade 4 osteochondral lesions of the knee in young active adults. Cureus 2022.
[33] Ramponi L, Yasui Y, Murawski CD, Ferkel RD, DiGiovanni CW, Kerkhoffs GMMJ, et al. Lesion size is a predictor of clinical outcomes after bone marrow stimulation for osteochondral lesions of the talus: a systematic review. Am J Sports Med 2017:1698–705.
[34] Rinonapoli G, Gregori P, Di Matteo B, Impieri L, Ceccarini P, Manfreda F, et al. Stem cells application in meniscal tears: a systematic review of pre-clinical and clinical evidence. Eur Rev Med Pharm Sci 2021:7754–64.
[35] Canale ST, Belding RH. Osteochondral lesions of the talus. J Bone Jt Surg Am 1980:97–102.
[36] Savage-Elliott I, Ross KA, Smyth NA, Murawski CD, Kennedy JG. Osteochondral lesions of the talus: a current concepts review and evidence-based treatment paradigm. Foot Ankle Spec 2014:414–22.
[37] Shang XL, Tao HY, Chen SY, Li YX, Hua YH. Clinical and MRI outcomes of HA injection following arthroscopic microfracture for osteochondral lesions of the talus. Knee Surg Sports Trauma Arthrosc 2016:1243–9.
[38] Slim K, Nini E, Forestier D, Kwiatkowski F, Panis Y, Chipponi J. Methodological index for non-randomized studies (minors): development and validation of a new instrument. ANZ J Surg 2003:712–6.
[39] Van Bergen CJ, de Leeuw PA, van Dijk CN. Treatment of osteochondral defects of the talus. Rev Chir Orthop Reparatrice Appar Mot 2008.
[40] van Dijk PAD, Murawski CD, Hunt KJ, Andrews CL, Longo UG, McCollum G, et al. International consensus group on cartilage repair of the ankle. post-treatment follow-up, imaging, and outcome scores: proceedings of the international consensus meeting on cartilage repair of the ankle. Foot Ankle Int 2021:68S–73S.
[41] Verhagen RA, Struijs PA, Bossuyt PM, van Dijk CN. Systematic review of treatment strategies for osteochondral defects of the talar dome. Foot Ankle Clin 2003:233–42.
[42] Candela V, Longo UG, Ciuffreda M, Salvatore G, Berton A, Cimmino M, et al. Talar osteochondral size influences outcome after bone marrow stimulation: a systematic review. J ISAKOS 2017:318–24.
[43] Bosien W, Staples O, Russell S. Residual disability following ankle sprains. J Bone Jt Surg 1955.
[44] Erban WK, Kolberg K. Simultaneous mirror image osteochondrosis dissecans in identical twins. Rofo 1981:357.
[45] Taranow WS, Bisignani GA, Towers JD, Conti SF. Retrograde drilling of osteochondral lesions of the medial talar dome. Foot Ankle Int 1999:474–80.
[46] Woods K, Harris IJ. Osteochondritis dissecans of the talus in identical twins. Bone Jt Surg 1995:331.
[47] Yoshimura I, Kanazawa K, Takeyama A, Anghong C, Ida T, Hagio T, et al. Arthroscopic bone marrow stimulation techniques for osteochondral lesions of the talus: prognostic factors for small lesions. Am J Sports Med 2013:528–34.