Treatment of Full-Thickness Acetabular Chondral Flaps During Hip Arthroscopy

Bone Marrow Aspirate Concentrate Versus Microfracture

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Background: The optimal treatment strategy for patients with full-thickness chondral flaps undergoing hip arthroscopy is controversial.

Purpose: To compare functional outcomes of patients who underwent bone marrow aspirate concentrate (BMAC) application with those of patients who underwent microfracture.

Study Design: Cohort study; Level of evidence, 3.

Methods: This was a retrospective case series of prospectively collected data on patients who underwent arthroscopic acetabular labral repair by 1 surgeon between June 2014 and April 2020. The inclusion criteria for this study were age $\geq$18 years, preoperative radiographs of the pelvis, arthroscopic acetabular labral repair, exposed subchondral bone with overlying chondral flap seen at the time of hip arthroscopy, microfracture or BMAC to address this lesion, and completed patient-reported outcome measures (PROMs) (International Hip Outcome Tool–33 [iHOT-33], Hip Outcome Score–Activities of Daily Living [HOS-ADL], Hip Outcome Score–Sports Subscale [HOS-Sport], modified Harris Hip Score [mHHS], and visual analog scale [VAS] for pain) at enrollment and 12-month follow-up. Clinical outcomes were assessed using PROM scores.

Results: A total of 81 hips with full-thickness chondral flaps were included in this study: 50 treated with BMAC and 31 treated with microfracture. There were no significant differences between groups in age, sex, body mass index, tear size, radiographic osteoarthritis, or radiographic femoroacetabular impingement. In the BMAC cohort, all PROM scores improved significantly from preoperatively to follow-up: 41.7 to 75.6 for iHOT-33, 67.6 to 91.0 for HOS-ADL, 41.5 to 72.3 for HOS-Sport, 59.4 to 87.2 for mHHS, and 6.2 to 2.2 for VAS pain ($P < .001$ for all). In the microfracture cohort, the score improvements were 48.0 to 65.1 for iHOT-33 ($P = .001$), 80.5 to 83.3 for HOS-ADL ($P = .275$), 59.2 to 62.4 for HOS-Sport ($P = .568$), 70.4 to 78.3 for mHHS ($P = .028$), and 4.9 to 3.6 for VAS pain ($P = .036$). Regarding clinically meaningful outcomes, 77.6% of the BMAC group and 50.0% of the microfracture group met the minimal clinically important difference for iHOT-33 at the 12-month follow-up ($P = .013$).

Conclusion: Patients with full-thickness chondral flaps at the time of hip arthroscopy experienced greater improvements in functional outcome scores at the 12-month follow-up when treated with BMAC as opposed to microfracture.

Keywords: hip arthroscopy; acetabular labral repair; chondral flap; bone marrow aspirate concentrate; microfracture

Femoroacetabular impingement (FAI) has been associated with hip pain, acetabular labral injuries, and chondral lesions of the femoral head and acetabulum.[2,31] In patients with combined FAI (concomitant cam and pincer lesions), shearing forces during flexion and internal rotation cause an asymmetric femoral head to impinge against an overcovered acetabular rim.[21] Initially, acetabular cartilage remains macroscopically intact, but it can eventually become delaminated, fissured, and cracked—a manifestation that has been reported in 44% to 86% of patients with FAI undergoing hip arthroscopy.[3,13,22,30,35,37] In some cases, the acetabular cartilage may completely rupture from underlying subchondral bone starting in the periphery of the joint and progressing centrally to form a full-thickness, "outside-in" chondral flap.[21,23] While severe, widespread cartilage delamination has been associated with poor clinical outcomes after hip arthroscopy,[18] the optimal treatment

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strategy for patients with isolated, full-thickness chondral flaps is controversial.[12,19,26,29,36,38,42]

Currently, few clinical studies have compared functional outcomes for different strategies for the treatment of full-thickness chondral flaps. Some studies have suggested that chondral flaps serve as a source of impingement and their removal by excision, debridement, or abrasion would allow the lesion to heal itself over time.[4,8,10] More recent studies have advised the fixation of the flap using fibrin adhesive, autologous scaffolding material, implanted collagen membrane, or underlying microfracture.[12,20,26,38,42] These preservation techniques are theoretically ideal since chondral flaps have been reported to contain up to 90% viable chondrocytes.[29,43] However, the extracellular matrix (ECM) surrounding the viable chondrocytes is largely disturbed, which warrants the use of a substance to bridge the chondral flap to subchondral bone to allow for long-term attachment and distribution of new ECM.[24,43]

While microfracture has shown favorable results in treating patients with full-thickness chondral damage,[11,25] some studies have suggested downsides, such as a weakened trabecular bone structure leading to an increased risk of conversion to total hip arthroplasty (THA) with extended follow-up.[14,28] Accounting for these concerns, surgeons could use bone marrow aspirate concentrate (BMAC) as a method to bridge the chondral flap to subchondral bone without violating the underlying trabecular bone. BMAC has shown promising results for the treatment of other chondral insults, and its utilization during hip arthroscopy could potentially allow for long-standing reattachment of biologically viable chondral flaps.[1,5,7,40]

The current study aimed to add to the growing body of literature addressing strategies for the preservation of full-thickness chondral flaps during hip arthroscopy by reporting the utilization of BMAC as a unique technique for fixation and comparing these results to those of patients who underwent microfracture. We hypothesized that patients with full-thickness chondral flaps treated with BMAC application would report superior functional outcomes compared with similar patients treated with microfracture.

METHODS

Study Population and Design

This study was approved by our institutional review board and patients provided informed consent. Data for this study were prospectively collected and retrospectively reviewed. All included patients underwent arthroscopic acetabular labral repair by the senior surgeon (S.D.M.) between June 2014 and April 2020 and completed patient-reported outcome measures (PROMs) at enrollment and 12-month follow-up. Inclusion criteria were age $\geq$18 years; preoperative radiographs of the pelvis; arthroscopic acetabular labral repair; and exposed subchondral bone with overlying chondral flap seen at the time of hip arthroscopy, with microfracture or BMAC to address this lesion. Exclusion criteria were previous hip arthroscopy and arthroscopic acetabular labral debridement.

All patients initially evaluated with hip pain at the senior author's (S.D.M.) clinic received hip and pelvis radiographs and a thorough physical examination, including provocation testing of the labrum and evaluation for FAI syndrome.[15] Patients with positive findings on physical examination (ie, pain and/or limited range of motion with flexion, adduction, and internal rotation or flexion, abduction, and external rotation) underwent magnetic resonance arthrogram; diagnostic/therapeutic intra-articular anesthetic/corticosteroid injection; and a trial of at least 3 months of nonoperative therapy, including core-strengthening physical therapy. Patients with persistent hip pain despite nonoperative therapy were offered hip arthroscopy.

The senior surgeon began utilizing BMAC in conjunction with hip arthroscopy in December 2016 as a potential method to address concomitant chondral lesions, and all patients who underwent hip arthroscopy gave consent for BMAC preoperatively from this point forward. Thus, the patients who underwent arthroscopic acetabular labral repair with concomitant microfracture to treat full-thickness chondral flaps between June 2014 and November 2016 were compared with similar patients treated with BMAC between December 2016 and April 2020. For the patients who received BMAC, the costs associated with harvesting and application were paid by the Conine Family Fund for Joint Preservation (a philanthropy organization without affiliations to industry); thus, patients' ability to pay played no role in their receiving BMAC. There were no differences in surgical technique (other than microfracture vs BMAC), indications, means of data collection, or rehabilitation between groups. Moreover, the senior surgeon had already completed >1000 hip arthroscopy procedures by the time of the first microfracture procedure, thus mitigating any risk of expert bias.[27]

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Ethical approval for this study was obtained from Partners Healthcare (Protocol No. 2013P000722/BWH).

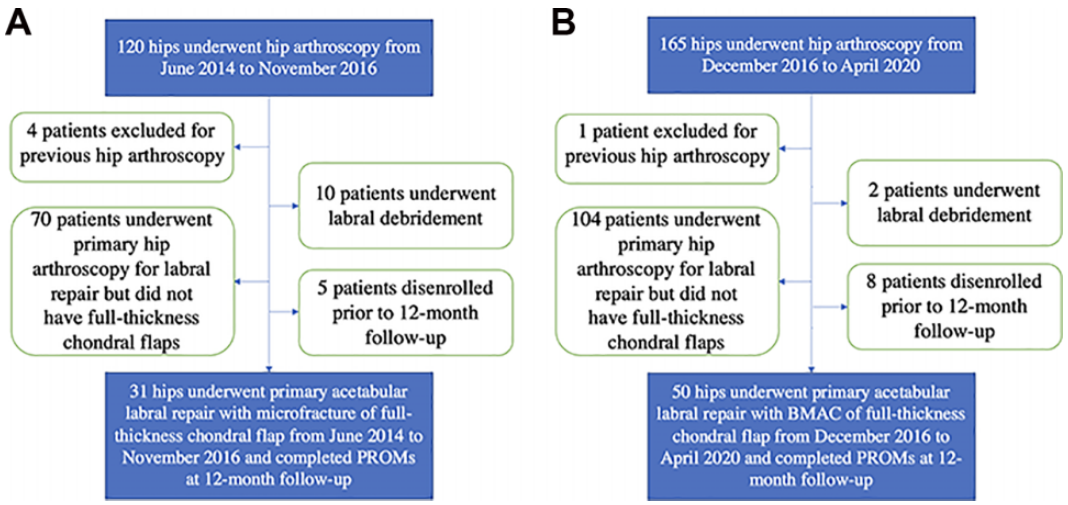

Figure 1. Patient flowcharts for the (A) 31 hips treated with microfracture and (B) 50 hips treated with BMAC included in the study. PROMs, patient-reported outcome measures.

Data Collection

Patient and descriptive data, including age, sex, laterality, body mass index (BMI), Tönnis grade, and radiographic evidence of FAI, were collected. Intraoperatively, tear size was recorded based on the extent of a clock face converted to degrees. Patients in both cohorts prospectively completed the following PROMs at enrollment before surgery and at 3-, 6-, and 12-month follow-up visits: International Hip Outcome Tool–33 (iHOT-33), Hip Outcome Score–Activities of Daily Living (HOS-ADL), Hip Outcome Score–Sports Subscale (HOS-Sport), modified Harris Hip Score (mHHS), and visual analog scale (VAS) for pain. Patients were only included for data analysis if they completed PROMs at enrollment and at the 12-month follow-up. Clinically meaningful outcomes were assessed by calculating the percentage of patients who reached threshold PROM scores for minimal clinically important difference (MCID), patient acceptable symptom state (PASS), and substantial clinical benefit (SCB), as defined by Nwachukwu et al.[33]

Surgical Technique

The technique of surgical arthroscopic acetabular labral repair using a chondrolabral junction preservation technique with intermittent traction and possible FAI decompression has been described in previous technical notes.[6,34,39] Once adequate intra-articular visualization of the lesion was established, a blunt obturator probe was used to evaluate the extent of the labral tear, extension of the tear into the chondrolabral junction, and presence of a chondral flap overlying subchondral bone. Notably, acetabular labral repair was performed before microfracture or BMAC harvesting and application. For patients who underwent microfracture, a 60° microfracture Steadman awl was utilized to carry out perpendicular microfracture into the subchondral plate behind the flap. For patients who underwent BMAC,[32] processing (Arthrex) and application of BMAC were carried out as described in a previous technical note.[40] For all patients in the BMAC cohort, a BMAC megaclot, composed of 20 mL of platelet-poor plasma/platelet-rich plasma and 4 mL of BMAC along with thrombin for adequate coagulation, was applied into the central compartment of the hip. After arthroscopic acetabular labral repair and microfracture or BMAC, traction was released, and the hip was placed through a full range of motion to ensure restored labral seal as well as excellent stability of the flap.

Postoperative Rehabilitation

Patients in both cohorts received the same postoperative protocol. Patients were allowed immediate weightbearing as tolerated using a flat-footed gait with crutches for 6 weeks. At 6 weeks postoperatively, patients could start using a stationary bicycle. At 10 weeks, patients were allowed to swim or use an elliptical trainer. At 4 months, strengthening exercises including hamstring curls and short-arc leg press with low weight and high repetitions were encouraged. At 6 months, patients were permitted to resume impact-loading exercises as tolerated.

Statistical Analysis

Baseline patient factors were compared between the groups using *t* test or chi-square/Fisher exact test, as appropriate. A 2-tailed paired *t* test was used to assess differences between preoperative and postoperative scores for the individual groups. Consistent with the repeated-measures data structure, an independent-samples *t* test was used to compare mean changes in PROMs between the BMAC and microfracture groups. The primary outcome was the mean iHOT-33 score improvement at the 12-month follow-up. All statistics were computed using SPSS statistical software

TABLE 1
Preoperative and Intraoperative Characteristics for the BMAC and Microfracture Groups[a]

	BMAC (n = 50 hips)	Microfracture (n = 31 hips)	*P* Value
Age, y	32.8 (29.8-35.8)	35.9 (31.7-40.1)	.242
Sex			.949
Male	31 (62.0)	19 (61.3)	
Female	19 (38.0)	12 (38.7)	
Laterality			.941
Right	27 (54.0)	17 (54.8)	
Left	23 (46.0)	14 (45.2)	
BMI	25.4 (24.3-26.5)	25.3 (23.9-26.7)	.913
Tear size, deg	69.3 (63.8-74.8)	67.2 (58.2-76.2)	.689
Tönnis grade			.145
0	22 (44.0)	7 (22.6)	
1	25 (50.0)	21 (67.7)	
2	3 (6.0)	3 (9.7)	
FAI			.173
None	1 (2.0)	2 (6.4)	
Pincer	19 (38.0)	14 (45.2)	
Cam	2 (4.0)	4 (12.9)	
Combined	28 (56.0)	11 (35.5)	

[a]Continuous variables are reported as mean (95% CI), and categorical variables are reported as n (%). BMAC, bone marrow aspirate concentrate; BMI, body mass index; FAI, femoroacetabular impingement.

TABLE 2
Comparison of Preoperative and 12-Month Postoperative PROMs Within the BMAC and Microfracture Groups[a]

	BMAC		Microfracture	
	Mean (95% CI)	*P* Value	Mean (95% CI)	*P* Value
iHOT-33		**<.001**		**.001**
Preoperative	41.7 (36.7-46.7)		48.0 (41.3-54.8)	
12-mo follow-up	75.6 (70.7-80.5)		65.1 (56.7-73.5)	
HOS-ADL		**<.001**		.275
Preoperative	67.6 (62.2-73.1)		80.5 (74.9-86.2)	
12-mo follow-up	91.0 (88.6-93.4)		83.3 (77.0-89.6)	
HOS-Sport		**<.001**		.568
Preoperative	41.5 (34.5-48.4)		59.2 (51.8-66.5)	
12-mo follow-up	72.3 (64.9-79.7)		62.4 (51.4-73.3)	
mHHS		**<.001**		**.028**
Preoperative	59.4 (55.2-63.6)		70.4 (66.2-74.6)	
12-mo follow-up	87.2 (84.2-90.1)		78.3 (72.6-84.0)	
VAS pain		**<.001**		**.036**
Preoperative	6.2 (5.4-6.8)		4.9 (4.0-5.9)	
12-mo follow-up	2.2 (1.5-2.8)		3.6 (2.7-4.6)	

[a]Bolded *P* values indicate a statistically significant improvement from preoperatively to follow-up ($P < .05$). BMAC, bone marrow aspirate concentrate; HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-Sport, Hip Outcome Score–Sports Subscale; iHOT-33, International Hip Outcome Tool–33; mHHS, modified Harris Hip Score; PROMs, patient-reported outcome measures; VAS, visual analog scale.

(version 27.0.0; IBM Corp), and $P < .05$ was considered significant.

RESULTS

A total of 81 hips (81 patients) were included in this study: 50 treated with BMAC and 31 treated with microfracture group (Figure 1). Baseline characteristics were not significantly different between patients in the BMAC and microfracture groups (Table 1). Notably, PROMs for all patients were collected from their 12-month follow-up surveys. In terms of disenrollment, 86.2% and 86.1% of patients with BMAC and microfracture completed PROMs at the 12-month follow-up, respectively.

In the BMAC cohort, all scores improved significantly from preoperatively to the 12-month follow-up: 41.7 to 75.6 for iHOT-33, 67.6 to 91.0 for HOS-ADL, 41.5 to 72.3 for HOS-Sport, 59.4 to 87.2 for mHHS, and 6.2 to 2.2 for VAS pain ($P < .001$ for all). In the microfracture cohort, significant improvements were seen in the iHOT-33 (48.0 to 65.1; $P = .001$), mHHS (70.4 to 78.3; $P = .028$), and VAS pain (4.9 to 3.6; $P = .036$) (Table 2).

When comparing results between groups, we found that at baseline, patients who underwent BMAC and microfracture had similar mean iHOT-33 scores (41.7 vs 48.0; $P = .127$), and the BMAC group had nonsignificantly higher mean iHOT-33 scores at the 3-month (63.0 vs 55.4; $P = .066$) and 6-month (70.3 vs 62.4; $P = .075$) follow-up visits. However, at the 12-month follow-up, the BMAC cohort had significantly higher mean iHOT-33 scores compared with the microfracture cohort (75.6 vs 65.1; $P = .025$) (Table 3).

In terms of improvement in mean iHOT-33 scores, the BMAC cohort reported significantly greater improvements from baseline at the 3-month (22.0 vs 7.9; $P = .004$), 6-month (27.7 vs 13.8; $P = .010$), and 12-month (33.9 vs 15.2; $P < .001$) follow-up visits (Table 4).

For HOS-ADL, despite significantly lower baseline scores for the BMAC cohort (68.2 vs 79.1; $P = .007$), the BMAC cohort still outperformed the microfracture cohort at the 12-month follow-up (91.0 vs 83.3; $P = .032$). Similarly, the BMAC cohort reported significantly lower mean mHHS values at baseline (59.4 vs 70.6; $P = .001$) but significantly higher mean mHHS values at the 12-month follow-up (87.2 vs 78.3; $P = .003$). Moreover, the BMAC cohort reported lower mean VAS scores at the 12-month follow-up (2.2 vs 3.6; $P = .012$), despite higher mean pain scores preoperatively (6.1 vs 5.0; $P = .072$).

In terms of clinically meaningful outcomes, 77.6% and 50.0% of hips treated with BMAC application and microfracture achieved 12-month improvements in iHOT-33 scores that reached the MCID threshold, respectively ($P = .013$). Otherwise, the only significant differences between groups for PASS and SCB were the mHHS: BMAC, 58.0% versus microfracture, 25.0% ($P = .008$) for PASS and BMAC, 56.0% versus microfracture, 25.0% ($P = .012$) for SCB (Table 5).

TABLE 3
Comparison of PROM Scores Over Time Between the BMAC and Microfracture Groups[a]

	BMAC	Microfracture	*P* Value
Enrollment	n = 50	n = 31	
iHOT-33	41.7 (36.9-46.5)	48.0 (41.3-54.8)	.127
HOS-ADL	68.2 (62.8-73.6)	79.1 (73.6-84.6)	**.007**
HOS-Sport	42.4 (35.6-49.1)	56.4 (48.8-64.1)	**.010**
mHHS	59.4 (55.2-63.6)	70.6 (66.3-75.0)	**.001**
VAS pain	6.1 (5.4-6.8)	5.0 (4.1-6.0)	.072
3-mo follow-up	n = 44	n = 23	
iHOT-33	63.0 (58.6-67.3)	55.4 (48.4-62.5)	.066
HOS-ADL	82.2 (78.4-85.9)	74.6 (67.8-81.4)	**.042**
HOS-Sport	43.6 (35.0-52.3)	28.5 (19.2-37.8)	**.032**
mHHS	77.6 (74.1-81.2)	72.6 (67.2-78.1)	.127
VAS pain	2.7 (2.0-3.3)	3.0 (2.1-3.9)	.526
6-mo follow-up	n = 46	n = 22	
iHOT-33	70.3 (65.6-75.0)	62.4 (54.9-70.0)	.075
HOS-ADL	87.4 (84.0-90.7)	81.5 (75.9-87.1)	.067
HOS-Sport	63.6 (55.6-71.6)	51.0 (40.7-61.2)	.071
mHHS	81.4 (77.8-85.1)	76.8 (71.0-82.6)	.177
VAS pain	2.4 (1.8-3.1)	3.0 (2.0-3.9)	.377
12-mo follow-up	n = 50	n = 31	
iHOT-33	75.6 (70.7-80.5)	65.1 (56.7-73.5)	**.025**
HOS-ADL	91.0 (88.6-93.4)	83.3 (77.0-89.6)	**.032**
HOS-Sport	72.3 (64.9-79.7)	62.4 (51.4-73.3)	.132
mHHS	87.2 (84.2-90.1)	78.3 (72.6-84.0)	**.003**
VAS pain	2.2 (1.5-2.8)	3.6 (2.7-4.6)	**.012**

[a]Data are reported as mean (95% CI). Bolded *P* values indicate a statistically significant difference between groups ($P < .05$). BMAC, bone marrow aspirate concentrate; HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-Sport, Hip Outcome Score–Sports Subscale; iHOT-33, International Hip Outcome Tool–33; mHHS, modified Harris Hip Score; PROM, patient-reported outcome measure; VAS, visual analog scale.

TABLE 4
Comparison of Changes From Baseline in PROM Scores Between the BMAC and Microfracture Groups[a]

	BMAC	Microfracture	*P* Value
3-mo follow-up	n = 44	n = 23	
Δ iHOT-33	22.0 (16.6 to 27.4)	7.9 (0.1 to 15.8)	**.004**
Δ HOS-ADL	15.3 (10.2 to 20.3)	–3.5 (–12.6 to 5.5)	**<.001**
Δ HOS-Sport	4.2 (–4.1 to 12.4)	–25.0 (–35.7 to –14.2)	**<.001**
Δ mHHS	18.1 (12.9 to 23.2)	1.6 (–5.5 to 8.8)	**<.001**
Δ VAS	–3.4 (–4.2 to –2.5)	–1.9 (–3.0 to –0.8)	**.040**
6-mo follow-up	n = 46	n = 22	
Δ iHOT-33	27.7 (21.8 to 33.5)	13.8 (5.3 to 22.2)	**.010**
Δ HOS-ADL	18.4 (12.6 to 24.1)	2.9 (–2.3 to 8.2)	**<.001**
Δ HOS-Sport	19.4 (9.6 to 29.2)	–4.9 (–15.4 to 5.5)	**.004**
Δ mHHS	20.4 (14.9 to 26.0)	6.4 (–0.2 to 12.8)	**.004**
Δ VAS	–3.5 (–4.3 to –2.6)	–1.7 (–2.7 to –0.6)	**.018**
12-mo follow-up	n = 50	n = 31	
Δ iHOT-33	33.9 (27.8 to 40.0)	15.2 (6.9 to 23.5)	**<.001**
Δ HOS-ADL	23.4 (18.0 to 28.8)	2.8 (–2.1 to 7.7)	**<.001**
Δ HOS-Sport	30.8 (21.8 to 39.8)	3.1 (–7.6 to 13.8)	**<.001**
Δ mHHS	27.8 (22.5 to 33.0)	7.8 (1.2 to 14.4)	**<.001**
Δ VAS	–4.0 (–4.8 to –3.1)	–1.3 (–2.1 to –0.4)	**<.001**

[a]Data are reported as mean (95% CI). Bolded *P* values indicate a statistically significant difference between groups ($P < .05$). BMAC, bone marrow aspirate concentrate; HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-Sport, Hip Outcome Score–Sports Subscale; iHOT-33, International Hip Outcome Tool–33; mHHS, modified Harris Hip Score; PROM, patient-reported outcome measure; VAS, visual analog scale for pain.

DISCUSSION

In the current study, both BMAC and microfracture cohorts experienced significant improvements in mean iHOT-33 score from baseline to the 12-month follow-up; however, the BMAC cohort outperformed the microfracture cohort at 12 months in terms of raw score and improvement at statistically significant levels. Moreover, the difference between groups at the 12-month follow-up was clinically meaningful, as a higher percentage of patients in the BMAC cohort achieved improvements that met the MCID threshold for iHOT-33 scores.[33]

That BMAC and microfracture cohorts experienced significant improvements from baseline is not surprising, as previous studies have reported positive results for other techniques that can preserve chondral flaps that contain up to 90% viable chondrocytes.[17,29,36,43] As described by Levinson et al,[24] the difficulty with preservation of the flap has been more so related to maintaining the integrity of the ECM around the chondrocytes. Once the chondral flap ruptures from the underlying subchondral bone, the ECM becomes disturbed, and remaining chondrocytes are unable to deposit new ECM regardless of their proximity to adjacent bone.[24,43] This phenomenon served as the impetus for the evolution of surgical techniques to replace functional ECM to act as a bridge between viable chondrocytes and exposed subchondral bone.[12,26,38,42] Thus, techniques such as BMAC, microfracture, or a fibrin adhesive would be ideal strategies to reduce the chondral flap and restore its native anatomy while maintaining the survival of viable chondrocytes.

The current study adds to the growing body of literature regarding treatment strategies for full-thickness chondral flaps. Haefeli et al[16] found that subchondral drilling under the chondral flap decreased the rate of conversion to THA when compared with simple debridement of the chondral flap. Similarly, Hevesi et al[19] compared microfracture and debridement and reported mHHS, HOS-Sport, and VAS improvements that were similar to those of the microfracture cohort in our study. However, Hevesi et al[19] did not find a statistically significant difference between groups in terms of functional outcomes or long-term survival with a follow-up of 5 years. Similar to the current study, Ivone et al[20] found that the microfragmented autologous adipose tissue transplantation technique group reported a final mHHS that outperformed the microfracture cohort by >1 MCID threshold. Tahoun et al[41] utilized a chitosan-based scaffold (BST-CarGel) alongside microfracture and found that >90% of patients demonstrated complete restoration of the cartilage defect on magnetic resonance imaging scans with specific cartilage sequences. Lastly, Tzaveas and Villar[42] utilized a fibrin adhesive without

TABLE 5
Comparison of Clinically Meaningful Outcomes Between the BMAC and Microfracture Groups[a]

	BMAC	Microfracture	*P* Value
MCID			
iHOT-33	38 (77.6)	14 (50.0)	.013
HOS-ADL	33 (66.0)	7 (25.0)	**<.001**
HOS-Sport	37 (77.1)	10 (35.7)	**<.001**
mHHS	42 (84.0)	13 (48.1)	**<.001**
PASS			
iHOT-33	32 (66.7)	14 (56.0)	.206
HOS-ADL	33 (67.3)	14 (56.0)	.183
HOS-Sport	29 (60.4)	12 (48.0)	.310
mHHS	29 (58.0)	6 (25.0)	.008
SCB			
iHOT-33	27 (56.3)	10 (40.0)	.243
HOS-ADL	33 (67.3)	14 (56.0)	.450
HOS-Sport	24 (50.0)	12 (48.0)	.871
mHHS	28 (56.0)	6 (25.0)	.012

[a]Data are reported as No. of patients (%). Bolded *P* values indicate a statistically significant difference between groups ($P < .05$). BMAC, bone marrow aspirate concentrate; HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-Sport, Hip Outcome Score–Sports Subscale; iHOT-33, International Hip Outcome Tool–33; MCID, minimal clinically important differences; mHHS, modified Harris Hip Score; PASS, patient acceptable symptom state; SCB, substantial clinical benefit.

microfracture and reported significantly improved clinical outcomes when compared with baseline scores. While microfracture in the aforementioned studies was reported as safe, some studies have found a greater long-term progression to THA and revision arthroscopy in patients undergoing microfracture of the hip than in a control cohort.[9,11,25] Thus, our study introduces an alternative technique for preservation of the chondral flap with better short-term clinical outcomes when compared with a standard treatment that has been associated with a long-term risk of conversion to THA.

While this study has several strengths, including its large sample of patients undergoing hip arthroscopy with BMAC treatment for full-thickness chondral flaps with prospectively collected outcome measures and its utilization of a similar control cohort for comparison, it is not without limitations. First, patients who received BMAC or microfracture did not undergo postoperative magnetic resonance imaging, which could have been used to assess cartilage healing after surgical intervention. Second, while the surgeon was highly experienced at the time the first patient underwent microfracture and there were no differences in surgical technique or rehabilitation between cohorts, unobserved confounders that occurred over time may have contributed to the results. Third, as is the case with survey studies, loss to follow-up and unanswered questionnaires serve as a potential source of bias. Importantly, this source of bias should not differ between groups, as methods of enrollment and survey collection have not changed since the first patient who underwent microfracture. Fourth, while patients in the BMAC cohort experienced greater PROM improvements than did those who underwent microfracture, it is important to note that patients who underwent microfracture had higher scores preoperatively, albeit at a statistically insignificant level. While this may have potentially affected the percentage of patients who reached MCID, the BMAC cohort still reported significantly greater iHOT-33 scores at the 12-month follow-up, despite starting at lower baseline scores. Fifth, BMAC harvesting and application during hip arthroscopy is a relatively novel procedure and, thus, is unavailable to many patients because of financial or logistical limitations. Sixth, because of the novelty of BMAC for the treatment of full-thickness chondral flaps, long-term follow-up is needed to determine sustainable outcomes and progression to THA. Notably, the results of the current study are preliminary and merely suggest an alternative treatment option for full-thickness chondral flaps, as the microfracture cohort still experienced significant improvements, which is consistent with results in the current literature.

CONCLUSION

Patients with full-thickness chondral flaps at the time of hip arthroscopy experienced greater improvements in functional outcome scores at the 12-month follow-up when treated with BMAC as opposed to microfracture. These findings are preliminary, and future, high-level studies examining the long-term utility of BMAC for the treatment of chondral flaps are needed.

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