## Bone Marrow Aspirate Concentrate is Associated with Greater Improvements in Functional Outcomes in Patients with Chondrolabral Junction Breakdown: A Case-Control Study

Kieran Dowley, Nathan J Cherian, Kaveh Torabian, Zachary Logan Laporte<sup>1</sup>, Michael C Dean, Stephen Gillinov, Bilal Sohail Siddiq, Scott David Martin

## <sup>1</sup>Massachusetts General Hospital

INTRODUCTION: In the setting of femoroacetabular impingement (FAI), the importance of chondrolabral junction preservation during arthroscopic labral repair has been increasingly emphasized to reconstitute the physiologic suction seal of the hip. However, the unique histology and variable presentation of breakdown in this region creates an added challenge for surgeons, as the accompanying chondral injury may not always be amenable to microfracture or other variations of cartilage restoration. At the time of hip arthroscopy, preliminary evidence has suggested that augmentation with bone marrow aspirate concentrate (BMAC) may provide functional benefit to patients with moderate cartilage damage. However, to date, no literature has specifically investigated clinical outcomes following BMAC augmentation in patients with chondrolabral junction breakdown and associated chondral injury (i.e., delamination, partial defects, or full-thickness flaps). Thus, the purpose of the present study was to assess 12-month functional outcomes following arthroscopic acetabular labral repair in the presence of chondrolabral junction breakdown and concomitant chondral injury to compare patients receiving a standardized method of BMAC application versus a historical control cohort that did not receive BMAC.

METHODS: A retrospective review was performed to identify patients (age ≥18 years) who underwent arthroscopic acetabular labral repair with minimum 12-month follow up, by a single surgeon employing a uniform surgical technique. Operative notes and arthroscope images were queried to identify patients with labral tears and arthroscopic evidence of chondrolabral junction damage (Beck Transition Zone Cartilage Injury Classification 2 or 3) and concomitant chondral delamination (i.e., "wave" or "carpet" sign), partial-thickness chondral injuries, or exposed subchondral bone with an overlying full-thickness chondral flap. Clinical outcomes were assessed using patient-reported outcome measures (PROMs) to compare patients who received BMAC augmentation between December 2016 to June 2021 to a control cohort of patients that did not receive BMAC between March 2007 to November 2016. Exclusion criteria consisted of labral debridement or incomplete PROMs (International Hip Outcome Tool–33 [iHOT-33], Hip Outcome Score–Activities of Daily Living [HOS-ADL], Hip Outcome Score–Sports Subscale [HOS-SS], modified Harris Hip Score [mHHS], and visual analog scale [VAS] for pain) at enrollment and 24-month follow up. Descriptive data and intraoperative findings were collected and compared between cohorts using t-tests or Chi-square/Fisher's exact tests, as appropriate, while comparisons of outcome scores between cohorts at 3-, 6-, 12-, and 24-month follow up.

RESULTS: Fifty-five hips treated with BMAC were compared to forty-two control hips with no significant preoperative differences identified in terms of mean age (33.8 vs. 37.2 years, p=.142), sex (61.8% vs. 61.9% male, p=.775), body mass index (25.0 vs. 25.6 kg/m<sup>2</sup>, p=.454), radiographic Tönnis grade (p=.087), Tönnis angle (6.6 vs. 5.5 degrees, p=.329), or alpha angle (61.6 vs. 57.8 degrees, p=.295; **TABLE 1**). However, the BMAC cohort was found to have a significantly higher preoperative lateral center edge angle (37.9 vs. 35.3 degrees, p=.050) with a higher distribution of patients with mixed-type FAI (p=.002) that subsequently received a higher frequency of combined femoral acetabuloplasty (p=.002; **TABLE 1**). Additionally, the BMAC cohort encompassed a higher distribution of patients with more severe chondrolabral junction breakdown (Beck Transition Zone Classification, p<.001) and cartilage damage (Outerbridge grade, p<.001; **TABLE 1**). Notably, no significant differences were identified in terms of labral tear quality (Beck Labral Tear Classification, p=.094). In terms of functional outcomes, no differences were identified at baseline between cohorts. However, at 12-month follow up, the BMAC reported significantly higher functional scores assessed via the iHOT-33, HOS-ADL, mHHS, and VAS pain scale. These findings remained consistent through 24-month follow up for all outcomes, except HOS-ADL (**TABLE 2**). Importantly, both cohorts exhibited significant interval improvement in all PROMs across the study period, however the BMAC cohort achieved clinical thresholds at similar or greater rates across all outcome measures at 12- and 24-month follow up (**TABLE 3**).

DISCUSSION AND CONCLUSION: BMAC application in patients with evidence of chondrolabral junction breakdown and concomitant chondral injury experienced greater improvements in functional outcomes scores at minimum 12-month follow up compared to a control cohort that did not receive biologic augmentation. These findings add to the preliminary evidence supporting the use of BMAC during hip arthroscopy, but further higher-power, randomized studies will be needed to corroborate these findings.

Baseline Characteristics	BM	AC (n = 55)	Contro	al (n = 42)	P-Value
Age, years	22.0	± 1.2	17.5	+2.0	0.142
Age, years Sex	33.8	± 1.2	31.2	12.0	0.775
Male	34	(61.8)	26	(61.9)	0.175
Female	21		16		
Pettale BMI, kaim2	25.0	(38.2) + 0.4	25.6	(38.1) ±0.6	0.454
Laterality	2300	± 0.4	25.6	±0.6	0.537
Right	32	(58.2)	21	(50.0)	0.337
Let	23	(41.8)	21		
Radiographic Parameters	25	(+1.6)	21	(30.0)	
Tōenis Grado 0		(47.3)		(38.1)	0.087
1		(34.5) (18.2)		(54.8) (2.1)	
				(2.1) ±0.8	0.329
Tônnis Angle, degrees		± 0.8 ± 0.8		+11	0.329
LCEa, degrees					
Alpha Angle, degrees	01.0	= 2.3	57.8	± 2.7	0.295
Intraoperative Variables					
Labrum (Beck)					0.094
Stage 0	1	(1.8)	0	(0.0)	
Stage 1	12		18	(42.9)	
Stage 2		(50.9)	14		
Stage 3		(25.5)	10		
Stage 4	0	(0.0)	0	(0.0)	
Outerbridge Grade					<.001
0	0	(0.0)	0	(0.0)	
1		(0.0)	0		
II.	1	(1.8)	12		•
ш	46	(83.6)	28	(66.7)	
IV	8	(14.5)	2	(4.8)	
Chondrolabral Junction (Beck)					<.001
0	0	(0.0)	0		
1	0	(0.0)	0	(0.0)	
п	0	(0.0)	29	(69.0)	•
ш	55	(100.0)	13	(31.0)	
IV	0	(0.0)	0	(0.0)	
Type of FAL					0.092
None	0	(0.0)	- 3	(7.1)	
Pincer	12	(30.9)	15	(35.7)	
Can	1	(1.8)	7	(16.7)	
Combined	37	(67.3)	17	(40.5)	
FAI Procedure					0.002
None	0	(0.0)	3	(7.1)	
Acetabuloelasty Only		(30.9)	15	(35.7)	
Femoroplasty Only	ï	(1.8)	7	(16.7)	
Femeroacctabulorhoty	37		17		
Chondral Management					
BMAC	55	(100.0)	0	(0.0)	<.001
Microfracture		(0.0)	13		
None		(0.0)		(69.0)	
				eported as n (?)	

	BMAC (n = 55)	Control (n = 42)	P Va
Presperative			
millis	64.2 (60.7, 67.7)	65.4 (61.3, 69.4)	0.68
HOS-ADL	73.2 (69.6, 76.8)	70.0 (65.8, 74.1)	0.25
HOS-SS	47.8 (41.0, 54.7)	46.5 (38.7, 54.3)	0.79
iHOT-33	44.8 (40.0, 49.7)	42.6 (37.1, 48.1)	0.55
VAS	5.4 (4.9, 6.0)	6.2 (5.5, 6.8)	0.07
3 Month			
mHHS	80.2 (76.5, 83.9)	74.1 (69.3, 78.9)	0.05
HOS-ADL	84.1 (80.3, 87.9)	73.6 (68.7, 78.4)	0.00
HOS-SS	46.9 (39.5, 54.4)	37.9 (29.2, 46.6)	0.12
iHOT-33	61.9 (56.9, 67.0)	55.1 (48.6, 61.6)	0.10
VAS	2.1 (1.5, 2.7)	3.3 (2.5, 4,1)	0.01
6 Meath			
mHHS	82.9 (79.3, 86.6)	80.5 (75.5, 85.6)	0.45
HOS-ADL	88.2 (84.4, 91.9)	84.2 (79.2, 89.1)	0.20
HOS-SS	62.2 (55.2, 69.2)	582(491.67.4)	0.50
iH0T-33	70.0 (65.0, 75.0)	65.6 (59.1, 72.1)	0.28
VAS	2.2 (1.6.2.7)	2.8 (2.1, 3.6)	0.16
12 Month			
mHHS	88.0 (84.5, 91.6)	80.1 (75.7, 84.5)	0.00
HOS-ADL	92.2 (88.5, 95.9)	85.1 (80.7, 89.5)	0.01
HOS-SS	73.5 (66.5, 80.6)	65.0 (56.8, 73.2)	0.12
BIOL33	76.4 (71.4, 81.4)	68.1 (62.2, 73.9)	0.03
VAS	1.8 (1.2, 2.4)	3.0 (2.3, 3.7)	0.00
24 Month			
mHHS	88.3 (84.7, 91.9)	79.7 (75.3, 84.1)	0.000
HOS-ADL	92.7 (89.1, 96.4)	87.2 (82.7, 91.7)	0.06
HOS-SS	79.3 (72.4, 86.2)	68.3 (59.8, 76.8)	0.05
iHOT-33	80.9 (76.0, 85.7)	70.2 (64.3, 76.0)	0.00
VAS	15(10.21)	28(2135)	0.00

Table 3			
Clinically Meaningful O	atcomes for Patients Who Did (BM 12-Mer		erve BMAC <sup>2</sup>
	BMAC (n=55)	Control (n=42)	P Value
MCID	abbite (a-so)		
#101-33	38 (71.7)	22(61.1)	0.056
HOS-ADL	31 (58.5)	18 (50.0)	0.324
HOS-Sport	36 (67.9)	29 (55.6)	0.094
mHHS	42 (79.2)	20 (55.6)	0.051
PASS			
iHOT-33	33 (62.3)	19 (52.8)	0.691
HOS-ADL	35 (66.0)	19 (52.8)	0.143
HOS-Sport	30 (56.6)	16 (44.4)	0.064
mHHS	36 (67.9)	15 (41.7)	0.028
SCB			
iHOT-33	29 (54.7)	16 (44.4)	0.115
HOS-ADL	35 (66.0)	18 (50.0)	0.116
HOS-Sport	24 (45.3)	14 (38.9)	0.210
mHHS	28 (52.8)	10 (27.8)	0.038
MOI alot-33	28 (52.0)	12 (33.3)	0.015
HOS-Sport	29 (54.7)	16 (44.4)	0.092
mHHS	36 (67.9)	14 (38.9)	0.013
			0.015
	24-Mor		
	BMAC (n=53)	Control (n=35)	P Value
MCID			
iHOT-33	43 (81.1)	26 (74.2)	0.342
HOS-ADL	34 (64.2)	22 (62.9)	0.992
HOS-Sport	39 (73.6)	20 (57.1)	0.178
mHHS PASS	45 (84.9)	20 (57.1)	0.007
iHOT-33	38 (71.7)	18 (51.4)	0.043
HOS-ADL	40 (75.5)	20 (57.1)	0.138
HOS-Sport	35 (66.0)	17 (48.6)	0.156
mHHS	41 (77.4)	17 (48.6)	0.007
SCB	41117.41	17(48.8)	0.007
iHOT-33	34 (64.2)	18 (51.4)	0.192
HOS-ADL	35 (66.0)	18 (51.4)	0.279
HOS-Sport	31 (58.5)	16 (45.7)	0.320
mHHS	28 (52.8)	13 (37.1)	0.160
MOL			
iHOT-33	33 (62.2)	18 (51.4)	0.260
HO6 Speri	41 (77.4)	17 (48.6)	0.006
mHHS	37 (69.8)	14 (40.0)	0.006

groups (P < 45). PROM, patient-reported outcome measure; HOT-33, International Hip Outcome Tool-33; HOS-ADL, Hip Outcome Score-Activities of Duby Living: HOS-88, Hip Outcome Score-Speets Subscale; mHHS, modified Hurris Hip Score; VAS, visual analog sede, MCID, minimal clinically important difference; PASS, patient acceptable symptom state; SCB, substantial clinical benefit.