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Microfracture in the Hip

Results of a Matched-Cohort Controlled Study With 2-Year Follow-up

Benjamin G. Domb,*†‡ MD, Asheesh Gupta,† MD, MPH, Kevin F. Dunne,† BS, Chengcheng Gui,† BSE, Sivashankar Chandrasekaran,† MBBS, FRACS, and Parth Lodhia,† MD, FRCSC
Investigation performed at the American Hip Institute, Westmont, Illinois, USA

Background: Microfracture in hip preservation surgery has demonstrated favorable outcomes, but studies with a higher level of evidence assessing microfracture are warranted.

Purpose: To assess 2-year outcomes of patients who underwent hip arthroscopy with full-thickness chondral damage treated with microfracture and compare these outcomes with those of a control group from a similar cohort of patients who did not have full-thickness chondral damage and who were not treated with microfracture.

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

Methods: Between February 2008 and May 2012, prospectively gathered data for patients undergoing microfracture during hip arthroscopy with a 2-year follow-up were reviewed. All patients were assessed pre- and postoperatively at 3 months, 1 year, and 2 years with 4 patient-reported outcome (PRO) instruments. A matched cohort of patients who did not have full-thickness chondral damage and hence did not receive microfracture was selected on a 1:2 ratio. Matching criteria were sex, age within 6 years, workers' compensation status, concomitant labral treatment, and radiographic parameters. Statistical analyses were performed to compare the change in PROs in both groups.

Results: A total of 79 hips were included in the microfracture group and 158 in the control group. There was no significant difference in PRO scores preoperatively between the groups. Both groups demonstrated significant improvement in all postoperative PRO scores at all time points. There was no statistically significant difference in postoperative PRO scores between the microfracture and control groups, except for the visual analog scale (VAS) score at 2 years, which was higher ($P = .02$) in the microfracture group (mean ± SD, 3.63 ± 2.50) than in the control group (2.82 ± 2.76). Patient satisfaction was 7.2 for the microfracture group and 8.04 for the control group, which was statistically different ($P < .05$). The mean change in all PRO scores was similar between groups at 3 months and 1 year postoperatively but significantly lower in the microfracture group at 2 years postoperatively. The greatest improvement in both groups was noted at 3 months postoperatively.

Conclusion: This study showed that patients undergoing microfracture during hip arthroscopy had equivalent PRO scores compared with the control group at 2 years postoperatively. The change in PRO scores from preoperatively to 2 years postoperatively was significantly lower in the microfracture group compared with the control group. The VAS scores and satisfaction were inferior by 0.81 and 0.84 units, respectively, in the microfracture group compared with the control group, likely due to lack of full-thickness chondral defects in the latter. However, both groups showed significant improvement in all PRO scores after surgery, with no significant difference in final PRO scores.

Keywords: hip arthroscopy; microfracture; cartilage; defect

Injuries of the articular cartilage have been a treatment challenge for centuries.[21] Their poor ability to heal, coupled with damage from trauma and degeneration, may result in significant morbidity.[3,50] Moreover, untreated lesions can progress to degenerative changes and arthritis.[3] As such, there have been a variety of techniques invented for cartilage repair. One such technique is microfracture, or bone marrow stimulation.[3,40] It involves perforation of the subchondral plate to recruit mesenchymal stem cells from the bone marrow, which can differentiate into fibrochondrocytes and aid in fibrocartilage repair of the articular cartilage lesion.[1,3,18]

The effects of microfracture have been well studied in the knee.[42-44] As the diagnosis and management of hip disorders continues to improve, hip preservation surgery has seen an increasing use of microfracture to treat chondral lesions.[12,24,31,32,37,38] The indications for microfracture in

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the hip have been extrapolated from the literature in the knee[42] and include focal contained lesions generally less than 4 cm^2 in the setting of minimal arthritis.[15,42,51]

A significant portion of the literature analyzing microfracture in hip preservation has been case series with favorable results using this technique.[12,24,31,37,38] To improve our understanding of the role of microfracture in hip preservation, studies with a higher level of evidence are needed in the literature. A matched-cohort controlled study allows researchers to control confounding factors during the design stage of the study, thereby allowing a stronger correlation between effects and their potential causes. The purpose of this study was to assess 2-year clinical outcomes of patients who underwent hip arthroscopy with full-thickness chondral damage treated with microfracture and to compare these outcomes with those of a matched control group from a similar cohort that did not have full-thickness chondral damage and were not treated with microfracture. We hypothesized that the patients undergoing microfracture would have similar outcomes to a matched control group of patients who did not have microfracture.

METHODS

At our center, clinical and outcome data are collected on all patients undergoing arthroscopic surgery of the hip. The study period was between February 2008 and May 2012. The patient-reported outcome (PRO) scores used included the modified Harris Hip Score (mHHS), the Non-Arthritic Hip Score (NAHS),[10] the Hip Outcome Score–Activities of Daily Living subscale (HOS-ADL), and the Hip Outcome Score–Sport-Specific subscale (HOS-SSS).[30] These were collected preoperatively and at 3-month, 1-year, and 2-year follow-ups postoperatively. All 4 questionnaires are used, as it has been reported that there is no conclusive evidence for the use of a single PRO questionnaire for patients undergoing hip arthroscopy.[29,46] Pain was estimated on a visual analog scale (VAS) from 0 to 10 (10 being the worst). Satisfaction with surgery was measured with the question, "How satisfied are you with your surgery results? (1 = not at all, 10 = the best it could be)." Our institutional review board approved this study.

The inclusion criteria for this study were arthroscopic microfracture during surgery for labral tear and/or femoroacetabular impingement (FAI), with a minimum 2-year follow-up. Exclusion criteria were revision surgeries, Tönnis grade 2 and higher, and previous hip conditions such as Legg-Calves-Perthes disease, avascular necrosis, and prior surgical intervention. The matched-cohort control group was selected on a 1:2 ratio to patients who underwent hip arthroscopy for labral tear and/or FAI who did not undergo microfracture based on sex, age within 6 years, radiographic findings, workers' compensation claim, and labral treatment. The radiographs were analyzed, and the patients were matched by Tönnis grade 0 or 1 and crossover percentage less than 20 or greater than 20. All patients who underwent microfracture had grade IV Outerbridge changes to either the femoral head or acetabulum with lesions that were well shouldered (by creation of perpendicular edges of healthy cartilage or labrum). All sizes of grade IV Outerbridge lesions encountered during hip arthroscopy were treated with microfracture. All patients who did not undergo microfracture had grade III or less Outerbridge changes in either their femoral head or acetabulum.

Imaging

Plain radiographs included an anteroposterior pelvic view, Dunn view, cross-table lateral view, and a false profile view.[13,33,47] Measurements were made from these views, including the Tönnis angle (acetabular inclination angle) using the method described by Jessel et al,[23] the lateral center edge angle of Wiberg,[49] joint space at its lowest point,[47] ischial prominence size in millimeters,[48] crossover sign,[22,39,48] alpha angle (Dunn view),[2] and offset in millimeters.[14] The alpha angle was measured on the Dunn view[13] using the method described by Nötzli et al[35] for magnetic resonance imaging and modified by Meyer et al.[33] Cam impingement was defined as an alpha angle greater than 60°. Hips classified as having pincer impingement had a crossover sign, coxa profunda, or protrusio acetabuli. The crossover sign size was quantified according to its percentage from the superior edge of the acetabulum; for instance, crossover at the middle of the acetabulum was quantified at 50%. The same orthopaedic surgeon (B.G.D.) made all of the measurements using a picture archiving and computer system. All radiographs were evaluated for arthritis and graded with Tönnis classification of osteoarthritis.[47] Magnetic resonance imaging was obtained in all patients to evaluate for labral and articular cartilage injuries.

Surgical Technique

All hip arthroscopies were performed by the senior author (B.G.D.) in a tertiary referral setting dedicated to hip preservation. All surgeries were performed in the modified supine position using a minimum of 2 portals (standard anterolateral and mid-anterior).[6,7,26] After establishment of portals and capsulotomy, a diagnostic arthroscopy was performed.

*Address correspondence to Benjamin G. Domb, MD, Hinsdale Orthopaedics, 1010 Executive Court, Suite 250, Westmont, IL 60559, USA (email: DrDomb@americanhipinstitute.org).

†American Hip Institute, Westmont, Illinois, USA.

‡Hinsdale Orthopaedics, Westmont, Illinois, USA.

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Bony pathologic changes were corrected under fluoroscopic guidance. An acetabuloplasty was performed for pincer impingement, and a femoral neck osteoplasty was performed for cam impingement. Labral tears were repaired when indicated or selectively debrided until a stable labrum was achieved while preserving as much labrum as possible. If there was full-thickness cartilage damage present, the size and location of the lesion were noted using a 5-mm probe and using the clock-face method,[4,37] respectively. For purposes of statistical calculations, we added a value of 12 to anterior clock-face positions (clock-face values of 1-6 were represented as 13-18). A microfracture was performed according to the technique by Steadman et al[44] and Crawford et al.[11] With use of an arthroscopic shaver, loose flaps and portions of delaminated cartilage were removed. A ring curette was used to remove the calcified layer and create stable borders. An angled arthroscopic awl was used perpendicular to the subchondral bone and advanced with a mallet. Multiple holes were made 3 to 4 mm apart with a depth of 3 to 4 mm in the exposed subchondral bone plate adjacent to the healthy cartilage rim.

Rehabilitation Protocol

In the control group, all patients were placed in a hip brace and instructed to be 20 pounds flat-foot weightbearing on the operative extremity for the first 2 weeks postoperatively. Thereafter, they were gradually allowed to return to weightbearing as tolerated. In the microfracture group, the patients were placed in a hip brace and instructed to be 20 pounds flat-foot weightbearing on the operative extremity for the first 8 weeks. All patients started physical therapy on the first postoperative day to initiate range of motion. This was accomplished by using a continuous passive motion machine for 4 hours per day or using a stationary bicycle for 2 hours per day. In the control group, the brace was discontinued 2 weeks postoperatively with emphasis on range of motion exercises. At 8 weeks postoperatively, the patients in both groups started gradually increasing their weightbearing status to full weightbearing.

Statistics

An a priori analysis was performed, and it was estimated that a clinically significant difference between groups for mHHS would be 6.0 with a standard deviation of the preoperative group being 10.[28] Using a Cohen d calculation, the 2-tailed effect size for a Student t test was 0.75. To obtain a power of 0.80 or higher with a ratio of 1:2, we would need a minimum of 45 hips in the microfracture group and 90 hips in the control group. A 2-tailed paired t test was used to assess differences between preoperative and postoperative scores for the individual groups. The independent t test was used to compare the mean change in PRO scores (change from preoperative to postoperative score) between the microfracture group and the matched-cohort control group. A P value of <.05 was considered significant. The size and position of the microfractured lesions were correlated with PRO scores using linear regression analysis. Statistical analysis was performed with Excel 2007 (Microsoft Corp) and SPSS 12.0 for Windows (SPSS Inc).

RESULTS

Patient Population

At the time of review, 84 of 99 (85%) patients who underwent a microfracture were available for 2-year follow-up. Of these, we were able to successfully match 79 patients to a control group. Most patients in the microfracture group were male (59%). The mean age was 44 years (range, 20-67 years) in the microfracture group and 44 years (range, 20-68 years) in the control group. Seventy-one (90%) patients had acetabular microfracture, and the remaining 9 (10%) had femoral microfracture. Ten (12.66%) patients in the microfracture group and 20 (12.66%) patients in the control group were classified as workers' compensation cases. On the basis of the matching criteria, 158 patients were allocated to the control group. The microfracture and control groups showed no significant differences in demographic factors—namely, height, weight, body mass index, and age—or in other clinical factors, including follow-up time and conversion to total hip replacement or Birmingham hip resurfacing (Table 1). All concomitant procedures performed for the microfracture and control groups are described in Table 2. Preoperatively, the mean PRO scores between the 2 groups were not significantly different and are reported in Table 3.

In the microfracture group, the score improvement from preoperatively to 2 years postoperatively was 60.7 to 77.9 for mHHS, 62.0 to 77.6 for HOS-ADL, 39.9 to 63.4 for HOS-SSS, 55.9 to 74.9 for NAHS, and 5.84 to 3.63 for VAS. In the control group, the score improvement from preoperatively to 2 years postoperatively was 59.7 to 81.3 for mHHS, 59.8 to 81.6 for HOS-ADL, 37.5 to 68.1 for HOS-SSS, 54.9 to 79.3 for NAHS, and 6.00 to 2.82 for VAS. All improvements in PRO scores for both groups were statistically significant compared with preoperatively ($P < .001$) (Table 4). Comparing the improvements in PRO scores between the microfracture and control groups, there was no statistical difference at any time point except for the 2-year VAS scores, which were statistically higher in the microfracture group compared with the control group. Postoperative patient satisfaction at 2 years was 7.2 for the microfracture group and 8.04 for the control group, which was statistically significant ($P < .05$) (Table 4). Figure 1 shows the mean PRO scores for both groups at all time points.

The mean change (Δ) in PRO scores was compared between the 2 groups, and there was no statistically significant difference in any PRO score at the 3-month and 1-year time points. However, the mean change was significantly lower for all PRO scores in the microfracture group compared with the control group at the 2-year time point (Table 5). Furthermore, the biggest change was observed in all PRO scores at 3 months postoperatively in both groups, after which point it plateaued in both groups.

TABLE 1
Demographic Factors[a]

	Microfracture Group (n = 79)	Control Group (n = 158)	*P* Value
Sex			
Male	47 (59.49)	94 (59.49)	>.99
Female	32 (40.51)	64 (40.51)	>.99
Workers' compensation	10 (12.66)	20 (12.66)	>.99
Size, mean (range)			
Height, in.	69.33 (58-78)	68.36 (58.5-77)	.2
Weight, lb	188.42 (105-290)	177.29 (0-350)	.2
BMI	27.41 (19.58-43.42)	27.19 (17.71-41.5)	.6
Laterality			
Right	53 (67.09)	89 (56.33)	.1
Left	26 (32.91)	69 (43.67)	.1
Age, y, mean (range)	47.76 (23.24-69.44)	48.24 (27.74-65.21)	.8
Follow-up time, mo, mean (range)	29.14 (21.04-49.05)	27.68 (20.32-49.15)	.7
Conversion to surgical treatment			
THR	9 (11.39)	10 (6.33)	.2
BHR	1 (1.27)	2 (1.27)	.5

[a]Values are expressed as number (%) unless otherwise indicated. BHR, Birmingham hip resurfacing; BMI, body mass index; THR, total hip replacement.

TABLE 2
Prevalence of Procedures Performed During Hip Arthroscopy[a]

Procedure	Microfracture Group	Control Group
Acetabuloplasty (pincer-type FAI)	56	63
Capsular release	81	78
Capsular repair	18	22
Excision of bone cyst from acetabulum	1	1
Excision of bone cyst from femoral neck	6	4
Femoroplasty (cam-type FAI)	80	73
Gluteus medius repair	1	4
Iliopsoas release	29	27
Labral debridement	47	42
Labral repair	51	51
Ligamentum teres debridement	63	52
Notchplasty	10	4
Removal of loose body	27	19
Removal of os acetabulum	9	3
Synovectomy	18	18
Trochanteric bursectomy	9	14

[a]Data are reported in percentages. FAI, femoroacetabular impingement.

Figure 2 shows the mean change in PRO scores for both groups at all time points.

We considered the size and clock-face position of the acetabular chondral defect in the microfracture subgroup. The mean ± SD size of the chondral defect was 189 ± 98 mm^2 (range, 25-500 mm^2). The mean center of the clock-face position was 13.2 ± 0.7 (range, 10.5-14.5). The mean range of the clock-face position, defined as the most anterior position minus the most posterior position, was 2.4 ± 0.8 (range, 1-4). We used linear regression analysis to identify any significant correlations between the size or clock-face position of the acetabular chondral defect and PRO scores at 2 years after surgery. Patients with the center of the acetabular chondral lesion located more anteriorly (higher clock-face number) tended to have higher mHHS (r = 0.4, P = .009) and NAHS (r = 0.3, P = .04) at a 2-year follow-up. Patients with wider chondral lesions in terms of clock-face range tended to have higher HOS-ADL (r = 0.3, P = .02), HOS-SSS (r = 0.3, P = .02), and NAHS (r = 0.3, P = .02) at 2 years. We note that the correlations observed were fairly weak.

TABLE 3
Mean Preoperative Patient-Reported Outcome and VAS Scores[a]

Instrument	Microfracture Group	Control Group	*P* Value
mHHS	60.66	59.71	.66
HOS-ADL	61.97	59.77	.41
HOS-SSS	39.86	37.49	.48
NAHS	55.85	54.86	.69
VAS	5.84	6.00	.56

[a]HOS-ADL, Hip Outcome Score–Activities of Daily Living subscale; HOS-SSS, Hip Outcome Score–Sport-Specific subscale; mHHS, modified Harris Hip Score; NAHS, Non-Arthritic Hip Score; VAS, visual analog scale.

The size of chondral lesion was not correlated with PRO scores ($r < 0.2$, $P > .05$). The change in PRO scores (Δ) at 2 years after surgery was not correlated to either the size or position of the chondral defect ($r < 0.25$, $P > .05$). As with acetabular chondral defects, linear regression showed no correlation between size of femoral chondral defects and all outcome measures at 2 years postoperatively ($r < 0.2$, $P > .05$).

TABLE 4
Mean Preoperative and 2-Year Postoperative Patient-Reported Outcome Scores[a]

Instrument/Time	Microfracture Group		Control Group	
	Mean ± SD	*P* Value	Mean ± SD	*P* Value
mHHS		<.001		<.001
Preoperative	60.66 ± 17.43		59.71 ± 14.48	
2 y postoperative	77.91 ± 17.82		81.34 ± 17.70	
HOS-ADL		<.001		<.001
Preoperative	61.97 ± 19.43		59.77 ± 19.06	
2 y postoperative	77.57 ± 21.48		81.55 ± 21.22	
HOS-SSS		<.001		<.001
Preoperative	39.86 ± 24.06		37.49 ± 23.97	
2 y postoperative	63.40 ± 28.47		68.08 ± 29.65	
NAHS		<.001		<.001
Preoperative	55.85 ± 19.42		54.86 ± 17.71	
2 y postoperative	74.90 ± 20.29		79.26 ± 19.07	
VAS		<.001		<.001
Preoperative	5.84 ± 2.19		6.00 ± 2.01	
2 y postoperative	3.63 ± 2.50		2.82 ± 2.35	

[a]HOS-ADL, Hip Outcome Score–Activities of Daily Living subscale; HOS-SSS, Hip Outcome Score–Sport-Specific subscale; mHHS, modified Harris Hip Score; NAHS, Non-Arthritic Hip Score; VAS, visual analog scale.

TABLE 5
Mean Pre- and Postoperative Patient-Reported Outcome Scores at Various Time Points[a]

Instrument/Group	Preoperative		3 mo Postoperative		1 y Postoperative		2 y Postoperative	
	Mean ± SD	*P* Value	Mean ± SD	*P* Value	Mean ± SD	*P* Value	Mean ± SD	*P* Value
mHHS								
Microfracture	60.66 ± 17.43	.66	75.51 ± 16.39	.46	77.37 ± 17.17	.95	77.91 ± 17.82	.18
Control	59.71 ± 14.48		77.44 ± 16.27		77.57 ± 17.16		81.34 ± 17.70	
Δ Microfracture	NA	NA	14.22 ± 16.67	.35	18.30 ± 16.40	.99	15.68 ± 18.13	.03
Δ Control	NA		16.81 ± 17.54		18.29 ± 17.76		21.55 ± 19.32	
HOS-ADL								
Microfracture	61.97 ± 19.43	.41	79.80 ± 16.87	.91	78.39 ± 20.12	.88	77.57 ± 21.48	.19
Control	59.77 ± 19.06		79.47 ± 17.36		78.94 ± 18.01		81.55 ± 21.22	
Δ Microfracture	NA	NA	16.85 ± 18.58	.43	17.38 ± 17.30	.57	14.02 ± 22.03	.01
Δ Control	NA		19.27 ± 19.18		19.39 ± 19.36		21.88 ± 20.89	
HOS-SSS								
Microfracture	39.86 ± 24.06	.48	57.61 ± 30.90	.18	58.33 ± 29.38	.61	63.40 ± 28.47	.27
Control	37.49 ± 23.97		63.98 ± 27.36		61.19 ± 28.91		68.08 ± 29.65	
Δ Microfracture	NA	NA	15.57 ± 33.38	.02	17.33 ± 24.79	.14	21.22 ± 27.82	.01
Δ Control	NA		27.71 ± 29.97		25.96 ± 31.37		32.04 ± 30.05	
NAHS								
Microfracture	55.85 ± 19.42	.69	72.76 ± 16.17	.90	74.34 ± 18.52	.96	74.90 ± 20.29	.12
Control	54.86 ± 17.71		72.39 ± 18.15		74.52 ± 18.93		79.26 ± 19.07	
Δ Microfracture	NA	NA	15.98 ± 18.26	.79	17.77 ± 16.18	.58	17.49 ± 19.78	.02
Δ Control	NA		16.78 ± 18.69		19.66 ± 18.94		24.20 ± 20.20	
VAS								
Microfracture	5.84 ± 2.19	.56	3.12 ± 2.05	.19	3.07 ± 2.21	.41	3.63 ± 2.50	.02
Control	6.00 ± 2.01		2.66 ± 2.00		3.48 ± 2.76		2.82 ± 2.35	
Δ Microfracture	NA	NA	–2.46 ± 2.27	.21	–2.98 ± 2.57	.24	–2.43 ± 2.85	<.01
Δ Control	NA		–2.99 ± 2.54		–2.39 ± 2.56		–3.17 ± 2.69	
Satisfaction								
Microfracture	NA	NA	7.40 ± 1.93	<.01	7.12 ± 2.31	.23	7.23 ± 2.41	.02
Control	NA		8.33 ± 1.99		7.70 ± 2.54		8.04 ± 2.27	

[a]*P* values compare results of microfracture and control groups at each time point. HOS-ADL, Hip Outcome Score–Activities of Daily Living subscale; HOS-SSS, Hip Outcome Score–Sport-Specific subscale; mHHS, modified Harris Hip Score; NAHS, Non-Arthritic Hip Score; NA, not applicable; VAS, visual analog scale.

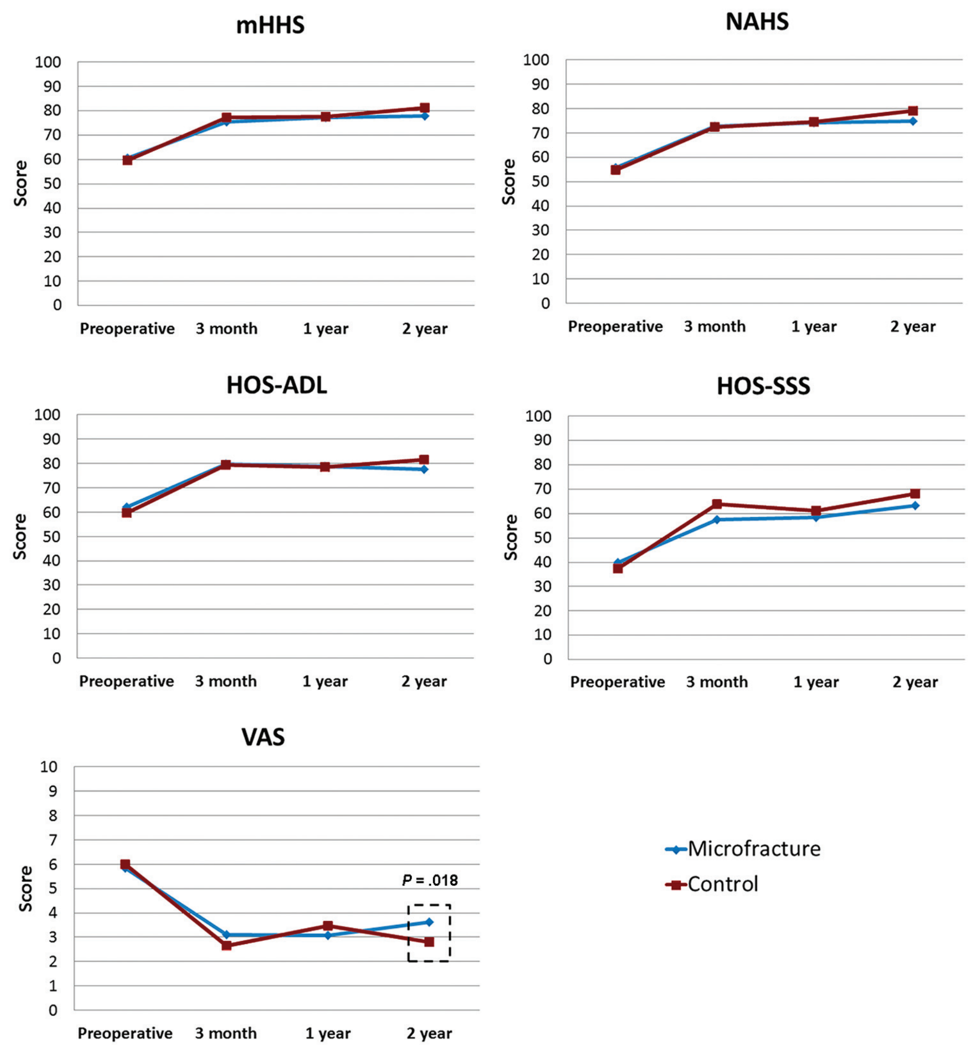

Figure 1. Mean patient-reported outcome scores for microfracture and control groups at preoperative, 3-month, 1-year, and 2-year time points. HOS-ADL, Hip Outcome Score–Activities of Daily Living subscale; HOS-SSS, Hip Outcome Score–Sport-Specific subscale; mHHS, Modified Harris Hip Score; NAHS, Non-Arthritic Hip Score; VAS, visual analog scale.

Patients receiving acetabular microfracture (n = 71) were compared with those receiving femoral microfracture (n = 9). Both groups had similar preoperative and postoperative PRO scores with no significant difference in the mean change at a 2-year follow-up (Table 6).

DISCUSSION

The results of our study improve our understanding of the use of microfracture, a procedure that has been vastly studied in other joints. Our results suggest that patients with microfracture had statistically significant improvements between preoperative and postoperative PRO scores at all time points. Examining the improvements from preoperative to postoperative PRO scores at all time points between the microfracture and matched control groups revealed no statistically significant difference except for the 2-year VAS scores, which were significantly superior in the control group. Patient satisfaction was also significantly lower in the microfracture group, albeit by 0.81 points. Within the microfracture group, patients receiving acetabular microfracture had no significant difference compared with those receiving femoral head microfracture when comparing preoperative or postoperative scores, including the change in scores at all time points. Finally, the mean change in all PRO scores was similar between groups at 3 months and 1 year postoperatively but significantly lower in the microfracture group at 2 years postoperatively. The greatest change in both groups was noted at 3 months postoperatively.

The development of the microfracture technique dates back to the 1980s, beginning in the knee, and has been shown to be cost-effective and technically uncomplicated,

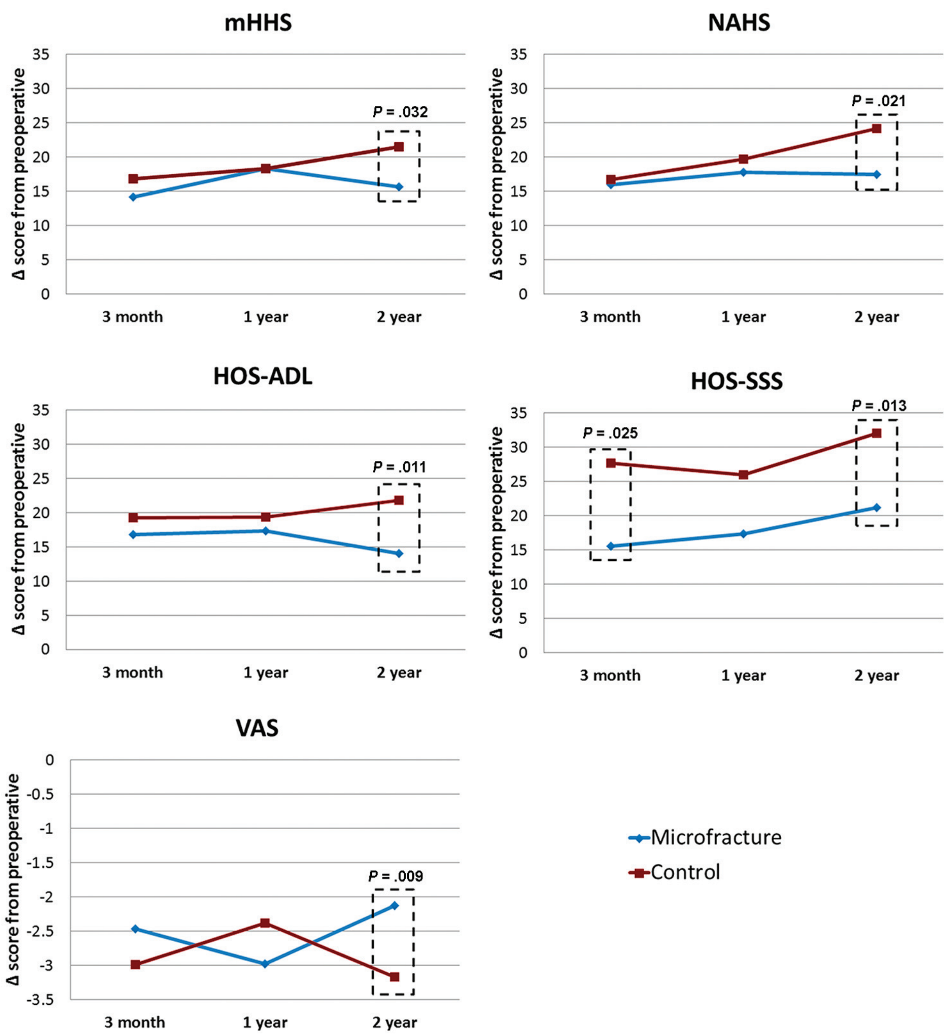

Figure 2. Mean Δ values for patient-reported outcome scores, from preoperative to 3 months, 1 year, and 2 years, for microfracture and control groups. HOS-ADL, Hip Outcome Score–Activities of Daily Living subscale; HOS-SSS, Hip Outcome Score–Sport-Specific subscale; mHHS, Modified Harris Hip Score; NAHS, Non-Arthritic Hip Score; VAS, visual analog scale.

with room for further treatment in the future of a joint.[45] Some of the early outcome studies for microfracture in the knee showed continued functional and symptomatic improvements up to 2 years postoperatively. Moreover, patients gained most of the improvements in the first year postoperatively.[5,42] Further studies looked at success after microfracture of the knee in elite athletes. Steadman et al[44] showed that 19 of 25 National Football League players undergoing microfracture of the knee returned to professional football at an average of 10 months postoperatively. Recently, Steadman et al[43] reported 19 of 20 skiers undergoing microfracture of the knee returned to competitive skiing at an average of 13.4 months postoperatively. Hence, it has been shown to be a safe and effective technique to treat cartilage defects of the knee.

As the techniques and understanding of hip preservation surgery have increased, similar principles have been applied in the hip. Second-look arthroscopy has been used as a means to evaluate the ability of microfracture to repair cartilage. Philippon et al[37] analyzed second-look arthroscopic findings of microfractured lesions of the acetabulum in 9 patients and found an average 91% fill of the lesions. The average time from primary to revision arthroscopy was 20 months. The repair product had a grade 1 or 2 appearance, using a scale described by Blevins et al.[5] Similarly, Karthikeyan et al[24] looked at 20 patients undergoing second-look arthroscopy after being treated with microfracture for acetabular chondral defects and found a mean fill of 96% in 19 patients at average 17-month follow-up. Furthermore, histology of full-thickness biopsy specimens taken at revision arthroscopy from 2 patients revealed that the repair tissue was primarily fibrocartilage with a more hyaline-like appearance under polarized light.

Byrd and Jones[9] applied the technique of microfracture in 3 of 9 patients who were being examined for an inverted labrum and had concomitant grade IV acetabular chondral lesions. All 3 patients demonstrated an average score improvement of 36 points in mHHS scores, the best results

TABLE 6
Mean Pre- and Postoperative Patient-Reported Outcome Scores in Patients With Acetabular and Femoral Head Microfracture at Various Time Points

Instrument/Site of Microfracture	Preoperative Mean ± SD	P	3 mo Postoperative Mean ± SD	P	1 y Postoperative Mean ± SD	P	2 y Postoperative Mean ± SD	P
mHHS								
Acetabular	60.60 ± 17.45	.95	75.75 ± 16.61	.96	77.72 ± 16.86	.84	77.90 ± 18.27	.89
Femoral head	61.00 ± 17.29		75.40 ± 15.10		76.24 ± 19.67		76.98 ± 13.37	
Δ Acetabular	NA	NA	14.84 ± 16.14	.63	19.27 ± 15.71	.38	15.66 ± 18.70	.95
Δ Femoral head	NA		11.55 ± 21.13		12.91 ± 20.35		15.23 ± 11.89	
HOS-ADL								
Acetabular	61.80 ± 19.51	.87	79.25 ± 17.34	.49	78.06 ± 18.20	.24	78.24 ± 21.41	.59
Femoral head	62.95 ± 18.72		83.95 ± 11.27		87.45 ± 14.88		73.90 ± 22.35	
Δ Acetabular	NA	NA	16.45 ± 17.52	.59	16.57 ± 15.92	.22	14.62 ± 21.40	.71
Δ Femoral head	NA		20.47 ± 25.64		25.89 ± 25.21		11.49 ± 27.77	
HOS-SSS								
Acetabular	39.72 ± 24.66	.99	57.22 ± 30.42	.79	56.28 ± 29.95	.13	63.72 ± 28.95	.76
Femoral head	39.61 ± 17.51		60.86 ± 37.69		75.93 ± 19.14		60.41 ± 23.53	
Δ Acetabular	NA	NA	15.90 ± 32.40	.82	16.88 ± 25.01	.32	21.95 ± 28.22	.59
Δ Femoral head	NA		12.27 ± 46.54		28.91 ± 27.53		16.01 ± 22.65	
NAHS								
Acetabular	55.70 ± 19.34	.86	72.96 ± 16.63	.86	74.23 ± 18.04	.69	75.29 ± 20.72	.72
Femoral head	56.92 ± 20.14		71.83 ± 11.68		77.50 ± 22.56		72.53 ± 15.85	
Δ Acetabular	NA	NA	16.65 ± 17.66	.51	18.23 ± 15.42	.91	17.99 ± 19.64	.65
Δ Femoral head	NA		11.76 ± 22.33		17.42 ± 22.32		14.59 ± 20.99	
VAS								
Acetabular	5.80 ± 2.23	.50	3.02 ± 2.10	.25	3.13 ± 2.26	.59	3.66 ± 2.53	.82
Femoral head	6.33 ± 1.80		4.25 ± 0.96		2.50 ± 1.29		3.88 ± 2.53	
Δ Acetabular	NA	NA	–2.56 ± 2.25	.27	–2.98 ± 2.63	.70	–2.08 ± 2.82	.78
Δ Femoral head	NA		–1.25 ± 2.50		–3.50 ± 1.91		–2.38 ± 3.11	
Satisfaction								
Acetabular	NA	NA	7.40 ± 1.97	.92	7.10 ± 2.39	.93	7.16 ± 2.44	.61
Femoral head	NA		7.50 ± 1.73		7.00 ± 0.82		7.63 ± 2.13	

[a]HOS-ADL, Hip Outcome Score–Activities of Daily Living subscale; HOS-SSS, Hip Outcome Score–Sport-Specific subscale; mHHS, modified Harris Hip Score; NAHS, Non-Arthritic Hip Score; NA, not applicable; VAS, visual analog scale.

that were seen at a 2-year follow-up in this case series. The same authors later published a series of 207 hips treated with arthroscopic femoroplasty with cam impingement, 58 of which underwent microfracture for grade IV chondral defects with an intact subchondral plate and healthy surrounding articular edges. Those patients treated with microfracture improved by an average of 20 points in their mHHS scores.[8]

Philippon et al[36] reported on 122 patients undergoing hip arthroscopy for femoroacetabular impingement and chondrolabral dysfunction. Microfracture was performed in 47 patients; 8 microfractures were isolated to the femoral head, 30 to the acetabular surface, and 9 to both surfaces. Patients with microfracture of both surfaces were more likely to undergo a total hip replacement (P = .001). The authors noted no difference in the mHHS scores at a 2-year follow-up between patients treated with microfracture (n = 25) and those treated without microfracture (n = 65). These findings are consistent with those reported in this study.

Recent studies examining return to sports after microfracture specifically capture the speed of recovery as an outcome measure. McDonald et al[32] noted that 30 of 39 elite athletes returned to play after hip microfracture, 93% of whom returned the season of or the season after arthroscopy. These results were comparable with the patients in the control group in their study who did not receive microfracture. The same authors further published findings on a subset of these athletes (professional hockey players) and mentioned that those who underwent microfracture were still able to return to play at a similar performance.[31] Our study showed that the majority of improvement in the PRO scores in both groups was at 3 months postoperatively, with further changes thereafter being incrementally lower. In the microfracture group, the HOS-SSS, mHHS, and NAHS scores continued to improve, albeit with decreasing amounts at 1 and 2 years postoperatively. These results suggest that in addition to the maintenance of improvement, the speed to recovery was comparable between the microfracture and control groups despite the initial lag in the rehabilitation for the microfracture group with a weightbearing restriction for the first 8 weeks postoperatively. Furthermore, there was a decrease in the HOS-ADL score and an increase in the VAS score at 2 years postoperatively compared with 3 months postoperatively (Figure 2). Kelly[25] found that the minimum clinically significant difference in VAS pain scores was 0.9.

The difference at 2 years between the microfracture and control groups was 0.81, which, although statistically significant, may or may not correlate to clinical significance. This small difference in VAS scores may also explain why the satisfaction was diminished in the microfracture group by 0.84 compared with the control group, since the slight increase in pain may have had a negative effect on patient satisfaction. A second reason for this difference could be that the microfracture group had grade IV chondral defects (requiring a microfracture), compared with the control group, which comprised patients who may have had chondral defects no more than grade III in severity.

A recent study by Gobbi et al[20] analyzed long-term clinical outcomes of microfracture of full-thickness chondral defects of the knee in 61 athletes. They found knee-specific PRO scores increased significantly at 2 years postoperatively but gradually deteriorated in the long term. However, the mean scores at a final follow-up of 15.1 years were still significantly above baseline. As such, the effects of microfracture were most prominent in the first 2 years after surgery and gradually reduced. Our study showed favorable PROs in patients undergoing microfracture during hip arthroscopy at 2 years postoperatively, but the longevity of these results remains to be seen with further follow-up studies.

Microfracture is one of many cartilage repair strategies used by orthopaedic surgeons.[3] The literature in the knee suggests it should be used in lesions measuring <4 cm^2, but its technical ease makes it a favorable option to incorporate in lesions up to 6 cm^2 of the hip.[15] Nevertheless, open procedures such as surgical dislocation have been described to address lesions in the hip for autologous chondrocyte implantation (ACI),[17,41] mosaicplasty,[19,34] and osteochondral allograft transplantation (OAT).[16,27] The paucity of literature in open cartilage repair techniques of the hip makes it difficult to define indications of using them. In a recent review, El Bitar et al[15] recommended use of open procedures in chondral lesions of the hip measuring 600 mm^2. In our study, the largest chondral defect requiring microfracture was 500 mm^2.

The strengths of this study include its matched-cohort control design and the measurement of improvement with 4 different PRO instruments. The matched-cohort control design allowed for reduction in confounding variables before data analysis. Four PRO instruments were used to address previous evidence in the literature suggesting that no single PRO instrument is adequate for assessing outcomes in hip arthroscopy.[29,46] To our knowledge, this study represents the largest comparative study on microfracture in hip arthroscopy in the literature to date.

This study has various limitations. A group portraying the natural course of grade IV chondral damage is absent in this study. Our control group was composed of patients without full-thickness chondral damage who therefore did not require microfracture. A more rigorous investigation would include a comparison between patients undergoing microfracture and those treated nonoperatively for full-thickness chondral damage. This would truly capture the change in clinical outcomes with microfracture. Further studies at our institution are under way focusing on longer term follow-up of patients undergoing microfracture. Second, this was a short-term follow-up study, and we are unable to postulate how long the effects of microfracture can be sustained. Further research is under way at our institution as we collect long-term results of microfracture in the hip. Third, the comparison between patients undergoing acetabular and femoral microfracture showed no significant difference in change of PRO scores at 2 years postoperatively. However, this comparison was not adequately powered in this study.

CONCLUSION

This study showed that patients undergoing microfracture during hip arthroscopy had equivalent PRO scores compared with the control group at 2 years postoperatively. The change in PRO scores from preoperatively to 2 years postoperatively was significantly lower in the microfracture group compared with the control group. The VAS scores and satisfaction were inferior by 0.81 and 0.84 units, respectively, in the microfracture group compared with the control group, likely due to lack of full-thickness chondral defects in the latter. However, both groups showed significant improvement in all PRO scores after surgery, with no significant difference in final PRO scores.

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