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Results and Performance After Microfracture in National Basketball Association Athletes

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Background: Microfracture technique is commonly used to treat symptomatic chondral lesions of the knee. Performance outcomes and attrition rates associated with this injury/surgery in National Basketball Association athletes are unclear.

Hypothesis: National Basketball Association players undergoing microfracture for symptomatic chondral lesions of the knee will have demonstrable differences in performance compared with preinjury and with matched controls.

Study Design: Case control study; Level of evidence, 3.

Methods: We evaluated 24 National Basketball Association players who underwent microfracture between 1997 and 2006. Descriptive data and performance data for the first full season preceding and following the index surgery were collected. Data were obtained from 48 matched controls. Univariate/multivariate statistical methods were used to assess change in performance and return to play.

Results: Thirty-three percent (8 of 24) of National Basketball Association athletes who underwent microfracture surgery never returned to play in the National Basketball Association. Fourteen players returned to play in the National Basketball Association for >1 season. Within-group comparisons revealed that points scored ($P = .008$) and minutes played ($P = .045$) were reduced postoperatively. No performance variables were significantly different when averaged over 40 minutes of play. When compared with controls, cases experienced a significant decline in points per game ($P = .013$). Multiple regression analysis revealed that cases were 8.15 times less likely to remain in the National Basketball Association than controls ($P = .005$) after the index year.

Conclusion: Players undergoing microfracture for knee chondral injuries are at risk for not returning to the National Basketball Association postoperatively. With the exception of points per game, athletes returning exhibited similar performance postoperatively compared with matched controls.

Keywords: microfracture; chondral defect; knee arthroscopy; National Basketball Association

Full-thickness cartilage lesions of the distal femur can cause pain, loss of function, and, ultimately, arthritis. These defects do not heal spontaneously and often require surgical intervention. Although a variety of cartilage-restoring and pain-eliminating procedures have been described, microfracture is a commonly accepted method of treatment with comparable results to other cartilage restoration procedures.[13,16] Recently, microfracture surgery has been portrayed in the media as a procedure that can result in rapid performance decline and/or the termination of a professional basketball player's career.

Although most clinical studies report improvement in knee function in 70% to 90% of patients undergoing microfracture surgery,[9,10,18] studies examining elite athletes and their ability to return to preinjury performance are lacking. Steadman et al[17] investigated outcomes of microfracture surgery in a cohort of National Football League (NFL) players. Although subjective, patient-derived outcomes were improved, performance variables were not reported.

The purpose of this study was to describe preoperative and postoperative performance in a series of National Basketball Association (NBA) players who underwent microfracture surgery to treat chondral lesions. Furthermore, we sought to determine preoperative variables that were predictive for a player not returning to NBA competition.

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MATERIALS AND METHODS

We performed a power analysis to test the hypothesis that the microfracture cases differ from controls with independent-samples *t* tests assuming sample variances differed. The power calculation used an alpha of .05 and a power of .80 to detect a large enough effect size (80% of 1 standard deviation). Under these conditions, one would require a harmonic mean sample of 20 patients in each group. In the present study, we identified 24 cases (16 of which were available for analysis) and 48 controls (43 of which were available for analysis), and our sample therefore exceeded these numbers (harmonic mean = 32 for the entire sample and 21.5 for the sample minus those who had no data for the post–index year), allowing us to proceed with data analysis.

Twenty-seven NBA players who had microfracture surgery between 1997 and 2006 were identified from team injury reports, press releases, and player profiles. Players were included if they had undergone microfracture surgery during the study period. Players were excluded if they had additional diagnoses and were treated for other knee conditions at the time of surgery. In addition, any player who had not played a single game in the NBA before the surgery year was eliminated from the study. After application of these criteria, 24 players remained in the study group. Three players were eliminated because they did not participate in the NBA before the index surgery.

Demographic data, as well as average performance data for the first full year preceding and after surgery were collected. Demographic data included age, position, NBA seasons played preoperatively, body mass index (BMI), time from surgery to return to play, preoperative all-star status, and postoperative inclusion on the injured list due to same-sided knee symptoms in the first full year after return from surgery. Performance data for each player included games played, field goal percentage, average minutes played, points, assists, rebounds, steals, and blocks per game. These variables were analyzed per game and were also recalculated for each 40 minutes of playing time. Player profiles were reviewed throughout the 9-year study period to determine whether a player ever returned to play. It was necessary for a player to participate in more than 20 games in a given postoperative season to be considered to have had a meaningful postoperative career.

For selection of the control group, the 2001 season was used as the index year. A full roster of NBA players from the 2001 season was obtained and age, position, BMI, and years of experience were documented. Players were eliminated if they did not play in the NBA during the previous season or if they were in the microfracture group. An age, position, BMI, and experience-matched group was created, with 2 controls to every 1 case selected to increase study power. The same performance data were acquired for the control group during the pre-index and post-index years.

Statistical analyses were conducted using SPSS, version 15.0 (SPSS Inc, Chicago, Illinois). Demographic statistics were calculated to determine the average BMI, experience, and other characteristics of the group. For players who returned for more than 1 season (n = 14), a 2-tailed paired *t* test was used to determine a significant difference in each player's performance the year before surgery compared with the year after surgery. Performance variables were also compared with those of age, sex, BMI, and position-matched controls using independent-samples *t* tests, equal variances not assumed.

Multiple logistic regression was undertaken to account for potentially significant relationships between observed player characteristics and whether that player returned for a "meaningful" career (>1 season postoperatively). Analysis was carried out using a stepwise backward likelihood ratio method of elimination. Inclusion of a variable required significance of .05 and .10 for elimination, after accounting for other variables in the model. The primary variable of interest was whether a player had undergone microfracture surgery. Variables entered in the multiple regression model included age, BMI, number of pre-index seasons played, all-star status, and position. Age and BMI were each assessed as continuous and binary variables (age < or >30 years and BMI < or >25) in different models. Player positions were considered categorically as centers, forwards, or guards. Guards were used as the reference point because they had the highest numbers in the study. Also considered was whether the player was an all-star (binary) and how many seasons the player played preoperatively (continuous).

RESULTS

The mean age at time of surgery was 28.6 years (range, 21-40). There were 11 guards, 10 forwards, and 3 centers. The mean player BMI was 25.6 (range, 21.9-27.9). On average, athletes played 6.9 preoperative seasons (Table 1); 8 players (33%) had achieved all-star status in at least 1 preoperative season, and 10 players (42%) had previous knee surgery on the same side. Table 2 demonstrates that controls were well matched in terms of average age, BMI, and experience (preoperative seasons played).

In pre-surgery and post-surgery years, players who returned to the NBA for any length of time averaged 67.5 preoperative games played and 61.5 postoperative games played ($P = .370$), respectively. These same players averaged 31.7 preoperative minutes played per game and 25.7 postoperative minutes per game ($P = .014$) (Table 3).

Performance variables (points, rebounds, assists, blocks, assists, and field goal percentage) for cases who returned to any NBA play declined preoperatively to postoperatively (Table 3). The shooting percentage declined from 46.5% preoperatively to 42.5% postoperatively ($P = .137$). When the performance variables were normalized per 40 minutes of play, most of the differences, with the exception of points per 40 minutes ($P = .033$) and rebounds per 40 minutes ($P = .004$), were not statistically significant. Only points per game ($P = .002$) showed a significant decline after Bonferroni correction (Table 3).

When preoperative to postoperative changes in performance data were compared between players in the microfracture group and the control group, nearly all parameters showed a greater mean performance decline in the microfracture group (Table 4). However, only the change in points

TABLE 1
Average Age, BMI, and Experience for All Cases (Patients Who Had Microfracture Surgery) in the Study, Players Who Returned for >1 Season, and Players Who Did Not Return[a]

Variable	All	Returned for >1 Season (n = 14)	Did Not Return >1 Season (n = 10)
Average age (y)	28.6 (21-40)	27.0 (21-35)	30.8 (24-40)
BMI	25.6 (21.9-27.9)	25.6 (21.9-27.9)	25.2 (23.1-27.4)
Preoperative seasons (no.)	6.9 (1-17)	4.6 (1-12)	10.0 (5-17)

[a]Range shown in parentheses. BMI, body mass index.

TABLE 2
Comparison Between Cases and Controls[a]

Variable	Case Mean	Control Mean	*P* Value
Age	28.6	28.6	.967[b]
Pre-index seasons	6.9	6.2	.607[b]
BMI	25.5	25.2	1.000[b]
Position	C: 3	C: 6	.699[c]
	F: 10	F: 20	
	G: 11	G: 22	

[a]BMI, body mass index; C, centers; F, forwards; G, guards.
[b]Performed with independent samples *t* test, equal variances not assumed.
[c]Performed with χ^2 test.

per game (P = .013) and rebounds per 40 minutes (P = .036) were significantly worse in the microfracture group. No parameter was significantly different after correction for multiple tests. Five players in the control group (10.4%) did not return to play in the NBA for greater than 1 season, compared with 10 players (41.6%) in the microfracture group (P = .0056).

When comparing players who did not return from surgery with those who did return, those who did not return tended to be older (P = .024) and more experienced (P = .008) (Table 5). No variable was statistically significant after correction for multiple tests. Fourteen players (58%) returned to NBA play for >1 full season after surgery. These players returned at a mean of 6.3 months (range, 2-16.5) postoperatively. Thirteen players (76%) were placed on the injured list for at least 1 game during the first full postoperative season due to same-sided knee symptoms. Eight players (33%) never returned to an NBA game after surgery and 2 additional players did not return for >1 season.

As Table 5 indicates, only age >30 years and preoperative seasons were related significantly on univariate analysis to whether a player returned to play. After controlling for potential confounding variables in a multiple logistic regression model, only exposure to microfracture surgery for treatment of a chondral defect (odds ratio, 8.85; P = .005) and the number of pre-index seasons played (odds ratio, 1.49; P = 0.001) were significantly predictive of attrition from play after the index season. All-star status was a negative predictor for attrition (odds ratio, 0.19), and although it was included in the model for having a P value < .10, its effect did not reach statistical significance (P = .081) when controlling for other variables (Table 6). No variable in the model was highly correlated with any other variable, which indicates the absence of multicollinearity.

TABLE 3
Difference in Performance Variables Between Pre-index and Post-index Season[a]

Variable	All Who Returned in Any Capacity the Following Season (95% Confidence Interval)	*P* Value
Games played	6.00 (–7.76, 19.63)	.370
Minutes per game	6.00 (1.38, 10.59)	.014[b]
Points per game	3.89 (1.72, 6.06)	.002[b,c]
Points per 40 minutes	2.35 (0.22, 4.49)	.033[b]
Rebounds per game	1.04 (0.21, 1.88)	.018[b]
Rebounds per 40 minutes	2.44 (0.86, 4.02)	.004[b]
Assists per game	0.62 (0.08, 1.16)	.027[b]
Assists per 40 minutes	–0.30 (–1.29,0.68)	.525
Steals per game	0.04 (–0.13, 0.21)	.646
Steals per 40 minutes	–0.81 (–1.95, –0.32)	.146
Blocks per game	0.08 (–0.03, 0.20)	.149
Blocks per 40 minutes	0.04 (–0.32, 0.25)	.790
Shooting percentage	4.0% (–1.4%, 9.5%)	.137

[a]The difference in mean performance variables between the pre-index and post-index season is assessed for each variable using paired-sample *t* tests between seasons. Each player serves as his control for pre-index and post-index years. Mean differences per player are represented as positive or negative values. Positive differences indicate greater numbers preoperatively than postoperatively. Includes only players who returned for meaningful careers (n = 16).
[b]Statistically significant.
[c]Statistically significant after Bonferroni correction for multiple tests ($P \leq .00357$).

TABLE 4
Comparison Between Cases and Controls[a]

Variable	Cases (Postoperative Value – Preoperative Value)	Controls (Post-index Value – Pre-index Value)	*P* Value
Games played	–5.94	–0.81	.521
Minutes per game	–5.98	–1.23	.062
Field goal percent	–4.0%	–1.0%	.317
Points per game	–3.89	–0.80	.013[b]
Points per 40 minutes	–2.35	–0.64	.129
Rebounds per game	–1.04	–0.68	.435
Rebounds per 40 minutes	0.00	–0.95	.036[b]
Assists per game	–0.62	–0.03	.058
Assists per 40 minutes	0.30	0.07	.648
Steals per game	–0.04	–0.09	.553
Steals per 40 minutes	0.55	–0.06	.169
Blocks per game	–0.08	–0.12	.637
Blocks per 40 minutes	–0.13	–0.16	.793

[a]Comparison between cases and controls performed with the 2-tailed independent-samples *t* test, equal variances not assumed.
[b]Statistically significant.

TABLE 5
Univariate Binary Logistic Regression for Variables Considered Possible to Influence Return to Play After Surgery[a]

Variable	Odds Ratio (95% Confidence Interval)	*P* Value
BMI >25	0.27 (0.05, 1.62)	.152
Age >30 y	8.56 (1.33, 54.95)	.024[b]
Center	0.67 (0.05, 8.55)	.755
Forward	0.43 (0.08, 2.37)	.332
Age (continuous)	1.30 (0.99, 1.51)	.054
BMI (continuous)	0.86 (0.52, 1.42)	.550
All-star	0.77 (0.14, 4.39)	.770
Preoperative seasons	1.64 (1.24, 2.36)	.008[b]

[a]Forwards and centers were compared with guards as the reference point, and age and body mass index (BMI) were considered as both continuous and binary variables for the purpose of trying to generate parsimonious models during generation of a multivariate model. All-star is a binary variable as to whether the player was an all-star player, and preoperative seasons is the number of seasons a player played prior to surgery (experience).
[b]Statistically significant.

TABLE 6
Multiple Regression for Return to Play[a]

Variable	Odds Ratio	95% Confidence Interval	*P* Value
Had microfracture surgery	8.85	(1.94, 40.29)	.005[b]
All-star	0.19	(0.03, 1.23)	.081
Preoperative seasons	1.49	(1.18, 1.87)	.001[b]

[a]Multiple regression for return to play using whether or not the player had microfracture surgery as the primary variable of interest and other variables as confounders.
[b]Statistically significant.

DISCUSSION

Microfracture surgery is a common surgical procedure used to treat full-thickness chondral defects.[19] These defects do not heal spontaneously and can be a cause of significant pain, dysfunction, and eventually osteoarthritis.[2,8,12] This study sought to describe outcomes of this surgery in professional basketball players with chondral defects. Many prior studies of microfracture surgery in athletes have shown good outcomes in terms of patient satisfaction and return to play.[1,6,13] Others have shown significant decline in sports participation and have questioned microfracture as the definitive procedure for full-thickness chondral lesions of the athlete's knee.[5,7] Steadman et al[17] conducted a study of microfracture surgery of the knee in NFL players and found that, in a sample of 25 athletes, 76% returned to football the season following microfracture. While self-assessed pain and function were improved, no performance variables were directly considered. Mithoefer et al[15] investigated high-impact athletics after knee microfracture technique in 32 athletes of mainly competitive and recreational participation. Sixty-six percent of athletes reported good and excellent results and 57% thought that they returned to athletics at their preoperative performance level. They noted that return to sports was significantly higher in athletes with age <40 years, lesion size <200 mm^2, preoperative symptoms <12 months, and no prior surgical intervention. No study has evaluated objective performance variables in athletes who have undergone microfracture technique for osteochondral lesions of the knee. As in any sport, athletes may have improved self-reported function and pain relief, yet it is unclear whether they maintain a similar level of athletic performance after surgical intervention.

Performance variables have previously been used as outcomes variables in NFL players after anterior cruciate ligament injury[3] and in Major League Baseball pitchers after ulnar collateral ligament reconstruction.[4]

Our data suggest that 58.3% of players returned to play for >1 season in the NBA after microfracture surgery. This is lower than the return rate found in NFL players. Players who return to play in the first season after microfracture surgery have limitations in terms of minutes played. Players were less productive with respect to average points, rebounds, and assists per game. Although these variables were all statistically significant before correction, preoperative and postoperative differences in assists and rebounds were not high in absolute number (1 rebound, 0.6 assists), thus the clinical significance is questionable. Players averaged 3.9 less points per game and a 4.0% lower field goal percentage, which we considered to be both statistically and clinically significant. When analyzed per 40 minutes played, only points and rebounds were decreased. This suggests that overall productivity in some performance categories appeared worse due to limited time on the basketball court. We assume that the players' reduction in minutes played was influenced by their chondral lesion/microfracture surgery as 76% of returning players were placed on the injured list during the first postoperative year due to same-sided knee symptoms. When compared with an age, position, and experience-matched control group, it is clear that players who have undergone microfracture surgery have a greater decline in performance than is typical of similar NBA athletes who represent a sample of the average, noninjured players from the index year. Compared with their peers, players undergoing microfracture surgery for chondral lesions had a sharper decline in terms of almost all statistical categories and 33.3% never returned to NBA play compared with 10% of the control group.

In addition, our investigation of factors that contribute to a player not returning postoperatively found that only age and experience were significantly related in a univariate analysis to return to play. Players who did not return tended to be older and more experienced (having played more seasons prior to the index year). The small sample size of the current study and the characteristics of our study population may have prohibited us from identifying other variables that contribute to a player not returning. For example, while other studies have identified age >40 years as an indicator of poor outcome,[11,15] our study sample only included 1 player in that age range. In fact, the majority of our sample was below the age of 30 years. Studies have identified increased BMI (>30) as a poor prognostic indicator after microfracture technique[14]; our sample included elite athletes, with no player having a BMI >30.

Our study has other weaknesses, including a lack of preoperative imaging or intraoperative data (microfracture technique). As noted, previous studies have shown that larger lesions may portend poorer outcome. Our lack of intraoperative data prevents us from saying whether this applies to the participants in our study. We are also unable to comment on physical examination parameters in the preoperative or postoperative setting and our methods did not allow for assessment of satisfaction or patient-derived perceptions of outcomes. Although team injury reports, press releases, and player profiles were comprehensively reviewed, it is possible that other players who underwent surgery for chondral lesions were not identified; furthermore, we do not know if players had other surgeries for the same diagnosis. Finally, although some players did not return after surgery and this single factor was significantly associated with lack of return to NBA play, we cannot be certain that microfracture surgery was the only reason for this. In fact, the injury itself cannot be distinguished from the surgery in this study. We do not know the natural history of players who did not have surgery for chondral lesions, and decline in performance and player attrition may be part of the natural history of the injury without direct correlation to surgery or surgical technique.

Despite this, our study has a number of notable strengths. We had a clearly defined study sample and outcomes parameters. We used each player as his own control, eliminating player-to-player variability, and also used a separate control group matched for age, BMI, position, and experience.

This is the first study that uses performance variables in evaluating outcomes of microfracture knee surgery in a cohort of high-demand NBA players. We found that 33.3% of NBA players who underwent this procedure never returned to competitive NBA play during our study period. The 66.7% who returned demonstrated similar performance characteristics per 40 minutes played with the exception of points and rebounds; however, cases experienced limited playing time, declining points scored and field goal percentage, and 76% missed games due to same-sided knee symptoms. Therefore, a chondral knee injury that is treated with microfracture surgery carries a significant risk of ending a player's NBA career. However, it is unclear from this observational study if it is the surgery or the disease process itself (ie, chondral lesion) that is responsible for a player's attrition. Further prospective studies regarding the natural history of this condition in cohorts of high-level athletes are necessary to elucidate this. Further investigation, including patient-derived outcomes assessment and more extensive follow-up, is required to comprehensively evaluate the effect of microfracture technique on these elite-level athletes.

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