Performance and Return to Sport After Hip Arthroscopic Surgery in Major League Baseball Players

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Background: Femoroacetabular impingement (FAI) is a common cause of hip pain that may lead to decreased performance in Major League Baseball (MLB) players.

Purpose: To determine the (1) return-to-sport (RTS) rate in MLB players after hip arthroscopic surgery for FAI; (2) postoperative career length, innings pitched (IP) (pitchers), and plate appearances (PA) (position players); (3) preoperative and postoperative performance; and (4) postoperative performance compared with control players matched by position, age, years of experience, and performance.

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

Methods: MLB athletes who underwent hip arthroscopic surgery for FAI and matched controls were identified. Demographic and performance data were collected. RTS was defined as playing in at least 1 MLB game after surgery. Continuous variables of each group were compared using a 2-tailed paired-samples Student *t* test for normally distributed data. The chi-square test was used to analyze categorical data. The Bonferroni correction was used to control for multiple comparisons, with statistical significance defined by a *P* value of $\leq$.007.

Results: A total of 50 players (57 surgeries) were analyzed (mean age, 30.4 $\pm$ 3.9 years; mean MLB experience at the time of surgery, 7.0 $\pm$ 4.6 years). Pitchers (31 surgeries; 54.4%) represented the largest proportion of players analyzed. Of these players, 42 (47 surgeries; 82.5%) were able to RTS at a mean of 8.3 $\pm$ 4.1 months. The overall 1-year MLB career survival rate of players undergoing FAI surgery was 78.9%. Players in the control group were in MLB a similar number of years (4.0 $\pm$ 2.9 years) to players who underwent surgery (3.3 $\pm$ 2.4 years) ($P > .007$). There was no significant decrease in IP or PA per season after surgery ($P > .007$). There was no significant difference in performance for pitchers and nonpitchers compared with matched controls after surgery ($P > .007$).

Conclusion: The RTS rate for MLB athletes after hip arthroscopic surgery for FAI was high. There were similar IP, PA, and career lengths postoperatively compared with preoperatively and with matched controls. There was no significant difference in performance for pitchers and nonpitchers compared with matched controls after surgery.

Keywords: femoroacetabular impingement; FAI; MLB; baseball; surgery; return to sport

Femoroacetabular impingement (FAI) is a common cause of hip pain due to abnormal joint morphology, leading to aberrant contact between the proximal femur (cam) and acetabular rim (pincer).[1,3,4,11,13] This can lead to decreased function and performance in elite athletes.[11,14] Overhead athletes are at particular risk for developing symptoms because of the significant rotational forces across the hip while throwing.[8] During the phases of throwing, the lower extremity generates energy that is transferred through the kinetic chain to the upper extremity before ball release.[19,31] Disruption anywhere along the chain can lead to decompensation in athletic performance, as seen in baseball players with FAI.[11] Radiographic findings of FAI have been found in between 51% and 66% of high-level athletes.[23] Specifically in baseball players, 1 study found a radiographic prevalence of 76.6%.[12]

Previous studies have examined the epidemiology and outcomes of surgery for FAI in elite athletes including baseball players.[2,6,18,20,24,26] The return-to-sport (RTS) rate in these high-level baseball players has been reported to range from 88% to 100% at an average of 4.3 to 12 months postoperatively, with significant improvement in several patient-reported outcome measures.[2,6,18] However, there are few studies investigating RTS and performance in

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Major League Baseball (MLB) players after hip arthroscopic surgery for FAI. Given this limited evidence and the increasing popularity of professional baseball, it is important to understand surgical outcomes in these patients.

The purpose of this study was to determine the (1) RTS rate in MLB players after hip arthroscopic surgery for FAI; (2) postoperative career length, innings pitched (IP) (pitchers), and plate appearances (PA) (position players); (3) preoperative and postoperative performance; and (4) postoperative performance compared with control players matched by position, age, years of experience, and performance. We hypothesized that MLB players who underwent hip arthroscopic surgery would have (1) a greater than 85% RTS rate; (2) no significant difference in postoperative career length, IPs (pitchers), and PAs compared with matched controls; (3) no significant difference in postoperative performance compared with preoperative performance; and (4) no significant performance difference postoperatively when compared with matched controls.

METHODS

Professional athletes from MLB who underwent hip arthroscopic surgery for FAI between 2000 and 2017 were identified through team websites, publicly available internet-based injury reports, player profiles and biographies, and press releases. The search was manually conducted by 2 orthopaedic surgery residents (postgraduate year 4; R.A.J., K.R.S.) in December 2017. Searches were performed for all professional baseball teams. This method of data collection has been used successfully in multiple prior studies of professional athletes, including those in MLB.[9,15-17,22,29,30]

All players identified were included in this study as it related to the RTS rate. A player was deemed to have returned to sport if he played in at least 1 regular-season MLB game after surgery. Thus, if players returned only to Minor League Baseball, this was not considered RTS. Inclusion criteria were any player on an active roster before hip arthroscopic surgery for FAI. Players were included if they were found to have undergone hip arthroscopic surgery for FAI as reported by at least 2 separate sources. Information from these databases was verified against each other and through independent web-based searches of team press releases that confirmed the date of surgery for each player. If this information was unclear, unverified, or unable to be obtained, then the athlete was excluded. Athletes who were injured and underwent procedures before completing their first regular season were excluded because no preoperative data would be available for comparison. In addition, players who underwent hip arthroscopic surgery for FAI in the 2017 season were excluded from analysis because they had less than a 1-year opportunity to RTS and to obtain postoperative statistics.

Demographic variables were recorded, including player age, hand dominance (throwing hand), batting preference (right/left/switch), position, prior professional experience, and date of surgery. Players were categorized by their position: catcher, infielder (including first baseman, second baseman, shortstop, and third baseman), outfielder (including left fielder, center fielder, and right fielder), and pitcher.

Performance statistics were collected from Baseball-Reference.com for each player identified before and after FAI surgery. Statistics were collected for regular-season MLB games only, with spring training, minor league, and playoff games excluded. The performance data used in this study included IP, PA, batting average, on-base percentage, slugging percentage, on-base plus slugging (OPS), earned run average, and walks plus hits per inning pitched (WHIP). PAs and IPs were used as surrogate measures for games per season.

Because of the possible benefits or detriments of aging and/or experience on player performance and number of games played, matched control players were selected to use for comparison with postoperative performance in the surgically treated players. Controls were matched to players who underwent surgery based on position, age (±1 year), years of experience (±1 year), body mass index, and performance data before the surgery date. Each control was given an index date that matched the operatively treated player's surgery date to compare postoperative or postindex performance. For example, if a player underwent surgery 3 years into his career, the control's index date was 3 years into his career.

Statistics for players in the surgical group (preoperatively and postoperatively) and controls (before the index date and after the index date) were collected and aggregated. Each statistical category was divided by seasons played to account for discrepancies in the number of total seasons played. Performance was compared based on OPS for nonpitchers and WHIP for pitchers, as previously described.[21]

A Kaplan-Meier survivorship curve with "retirement" as the endpoint was constructed postoperatively for players in the surgery group and after the index date for controls. The continuous variables of each group were compared using a 2-tailed paired-samples Student *t* test for normally distributed data. The chi-square test was used to analyze

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Ethical approval was not sought for the present study.

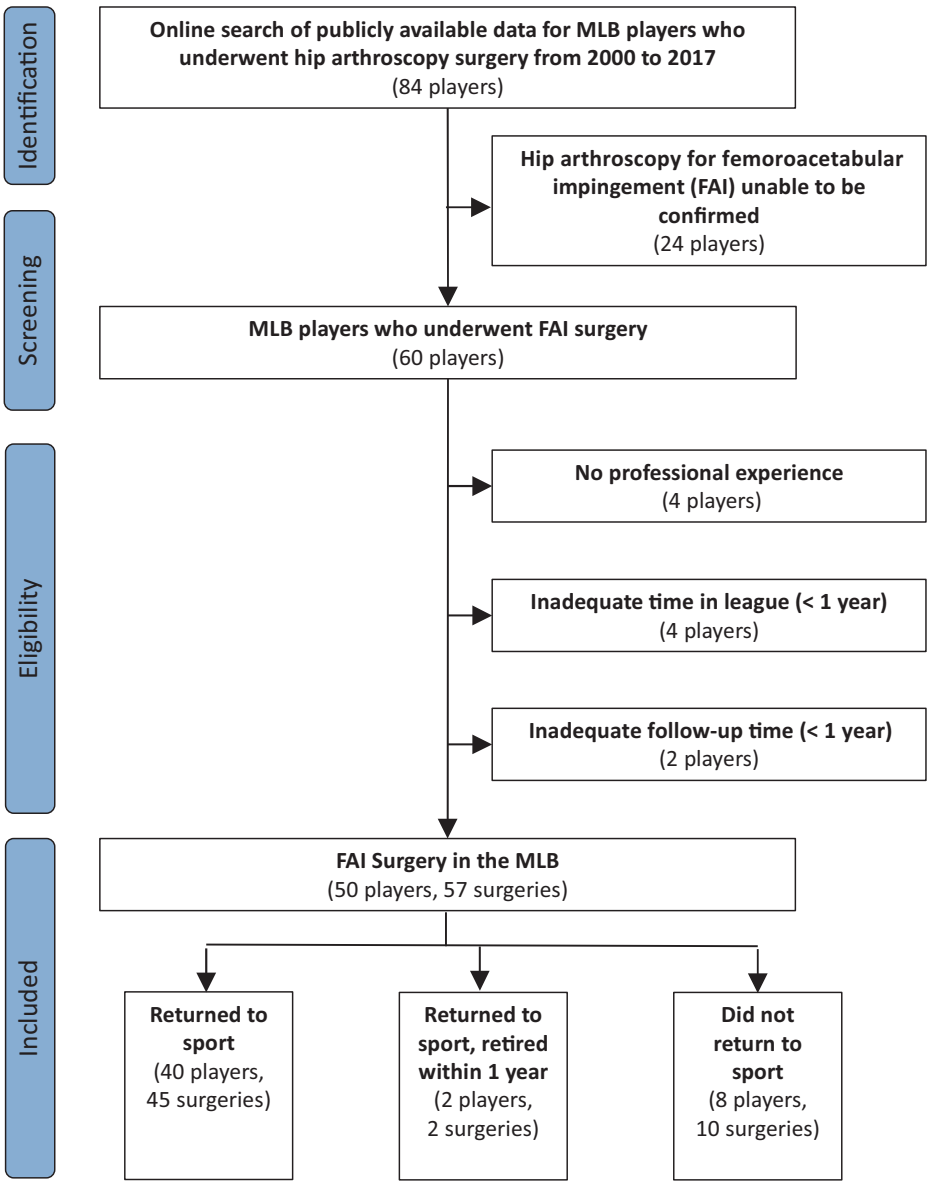

Figure 1. Flowchart illustrating the application of exclusion criteria. MLB, Major League Baseball.

categorical data. The Bonferroni correction was used to control for multiple comparisons, with statistical significance defined by a P value of $\leq .007$.

RESULTS

A total of 50 players (57 surgeries) underwent hip arthroscopic surgery for FAI from 2000 to 2017 (Figure 1). The mean age was 30.4 ± 3.9 years, and the mean experience in MLB was 7.0 ± 4.6 years at the time of surgery. Nineteen surgeries (33.3%) were performed in the off-season. Four players underwent bilateral surgery, and 3 players underwent revision surgery. Pitchers (31 surgeries; 54.4%) represented the largest proportion of players who underwent FAI surgery (Table 1). There were no significant differences in demographic, performance, and games-per-season data between surgically treated players and matched controls preoperatively and before the index date ($P > .007$).

TABLE 1
RTS by Position for Surgically Treated Players[a]

Position	No. of Surgeries	RTS Rate, %	Months to RTS, Mean ± SD
Pitcher	31	77.4	9.5 ± 5.2
Nonpitcher	26	88.4	7.2 ± 2.2
Catcher	4	75.0	8.2 ± 2.1
Infielder	16	87.5	7.2 ± 2.6
Outfielder	6	100.0	6.6 ± 1.0
Overall	57	82.5	8.3 ± 4.1

[a]RTS, return to sport.

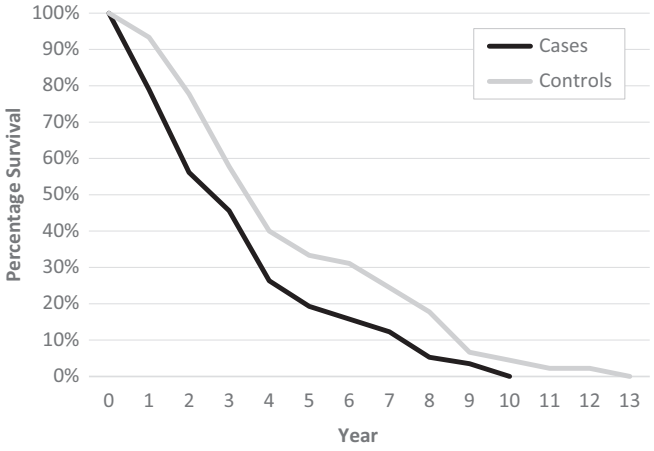

Figure 2. Kaplan-Meier survival analysis for players in the surgery and control groups. Year 0 signifies the year of surgery for players in the surgery group and the index year for players in the control group.

RTS and Career Length

Of the 50 surgically treated players, 42 (47 surgeries; 82.5%) were able to RTS at a mean of 8.3 ± 4.1 months. There was no significant difference in RTS rates between positions ($P > .007$). Sixteen pitchers (51.6%) underwent surgery on their back leg and had a similar RTS rate (81.3% vs 76.9%, respectively) and RTS time (10.3 ± 5.4 vs 8.7 ± 5.2 months, respectively) ($P > .007$ for both) compared with the 15 pitchers who underwent surgery on their lead leg. The overall 1-year MLB career survival rate of players undergoing FAI surgery was 78.9% (Figure 2). Players in the control group were in MLB a similar number of years to players who underwent FAI surgery (4.0 ± 2.9 vs 3.3 ± 2.4 years, respectively) ($P > .007$).

Games and Performance Outcomes After Surgery

There was no significant decrease in IP or PA preoperatively versus postoperatively and between players in the surgery group postoperatively versus controls after the index date ($P > .007$ for both) (Tables 2 and 3). There was a significant decrease ($P = .003$) in OPS for controls from before to after the index date, but pitchers and nonpitchers had similar performance after surgery compared with matched controls ($P > .007$) (Tables 2 and 3). There were no significant performance differences ($P > .007$) in pitchers or nonpitchers based on RTS time.

DISCUSSION

The study hypotheses were partially confirmed, with the result of an 82.5% RTS rate after hip arthroscopic surgery for FAI. MLB athletes had similar IP, PA, and career lengths postoperatively compared with preoperatively and with matched controls. There was no significant difference in performance for pitchers and nonpitchers after surgery compared with matched controls.

The most common position undergoing hip arthroscopic surgery for FAI was pitchers (31 surgeries; 54.4%), followed by infielders (16 surgeries; 28.1%). This is similar to previous studies, in which pitchers and infielders made up a majority of the elite baseball players undergoing hip arthroscopic surgery.[2,6] The high prevalence of these positions is likely because of the significant flexion and rotational forces across the hip in flexion while throwing for pitchers and the crouched position of infielders while fielding a ball.[5,8] Conversely, one would expect catchers to have a higher prevalence of symptomatic FAI because of the repetitive hip flexion necessitated by the position, as observed by Byrd and Jones[2] and Degen et al.[6] Additionally, one may expect catchers to have a greater chance of a poor postoperative outcome because of the nature of their position (chronic flexed and rotated hips). However, these facts were not observed in the present study of MLB players. The prior studies included baseball players from high school, collegiate, and professional levels, while the current study only included MLB players. This indicates that MLB catchers may be self-selected for players without symptomatic FAI because they would be unable to play at a high level, forcing them to either change positions or quit playing.

The RTS rate in high-level baseball players has been previously reported to range from 88% to 100% at an average of 4.3 to 12 months postoperatively.[2,6,10,18,27] This is similar to the current study, with an RTS rate of 82.5% at 8.3 months. The slightly lower RTS rate in the current study may be attributable to us only including MLB players, while other studies included high school, collegiate, and professional baseball players. Additionally, the definition of RTS was unclear in the prior studies, while the current study only considered a player to RTS if he played in an MLB game after surgery, with minor league and spring training not counting toward RTS. Although similar to the study by Degen et al,[6] the current RTS time is longer than the 4.3 months reported by Byrd and Jones.[2] In the current study, only 3 MLB players were able to RTS in the same season as their surgery, and 92.1% of MLB players were in the off-season when they were expected to return. Therefore, the RTS time is likely higher than it would have been if the players were not in the off-season.

There are limited data regarding career length, IP, and PA for MLB players undergoing hip arthroscopic surgery for FAI. The overall 1-year MLB career survival rate of players undergoing FAI surgery was 78.9%, with no significant differences in career length, IP, and PA between players undergoing hip arthroscopic surgery and control players after the index date. This same trend was seen in National Football League (NFL) players undergoing hip arthroscopic surgery for FAI, with hip arthroscopic surgery having no significant effect on career length and games per season after surgery compared with preoperatively and with matched controls.[26]

Additionally, pitchers and nonpitchers had similar performance after surgery compared with preoperatively and with matched controls. This is similar to a recent study in NFL players after hip arthroscopic surgery that found no

TABLE 2
Statistics for Players by Surgery/Index Date[a]

	Surgery			Control		
Statistic	Preoperative	Postoperative	*P* Value	Before Index	After Index	*P* Value
Pitchers						
Innings pitched	76.9 ± 40.4	68.6 ± 44.6	.413	76.9 ± 47.7	68.2 ± 43.9	.502
Walks plus hits per inning pitched	1.38 ± 0.19	1.30 ± 0.35	.514	1.37 ± 0.19	1.30 ± 0.36	.945
Nonpitchers						
Plate appearances	382.2 ± 147.7	327.0 ± 168.9	.100	420.8 ± 145.3	376.8 ± 171.2	.234
On-base plus slugging	0.771 ± 0.109	0.753 ± 0.088	.019	0.780 ± 0.061	0.715 ± 0.120	.003[b]

[a]Data are shown as mean ± SD. *P* value as determined by a 2-tailed paired Student *t* test between preoperative and postoperative and before index versus after index.
[b]Statistically significant difference from before index to after index ($P < .007$).

TABLE 3
Statistics for Players by Position[a]

	Pitchers			Nonpitchers		
Statistic	Surgery	Control	*P* Value	Surgery	Control	*P* Value
No. of seasons	3.8 ± 2.3	4.8 ± 3.0	.013	2.9 ± 2.4	3.0 ± 2.5	.505
Innings pitched	68.6 ± 44.6	68.2 ± 43.9	.961			
Plate appearances				327.0 ± 168.9	376.8 ± 171.2	.334
Walks plus hits per inning pitched	1.30 ± 0.35	1.30 ± 0.36	.740			
On-base plus slugging				0.753 ± 0.088	0.715 ± 0.120	.347

[a]Data are shown as mean ± SD. *P* value as determined by a 2-tailed paired Student *t* test.

significant performance differences postoperatively compared with matched controls.[26] However, there was a significant decrease in OPS for nonpitcher controls after the index date compared with before the index date ($P = .003$). This indicates that hip arthroscopic surgery for FAI may mitigate the career-based performance decline that is typically seen in professional baseball players.

There are limitations to this study and other studies with a similar methodology. The use of publicly available data to identify players who underwent hip arthroscopic surgery for FAI may be prone to selection, reporting, and observer bias. However, this method of data acquisition has been used in multiple previous studies.[9,15-17,29,30] By only including the highest level of professional players, these data may only apply to elite-level athletes. Professional players have a higher rate of RTS compared with nonprofessional players.[25] This is believed to be caused by the inherently high talent and determination present at this level, with a higher income potential.[24] Additionally, players may retire because of other non–performance related reasons that are not able to be accounted for in this type of study. We may not have been able to identify all previous hip surgeries for the included players, which has been shown to have an effect on the outcomes of hip arthroscopic surgery for FAI.[7,28] Also, career length and performance were not adjusted for "time missed" for players who underwent hip arthroscopic surgery for FAI.

Inherent to this type of study, there are multiple unknown confounding variables such as no direct physical contact, patient-reported outcomes, or medical record access to corroborate diagnosis and treatment. The use of public data limited our ability to determine the chronicity and severity of the injury. Further, we were unable to reliably determine the surgeon who performed the operation or the exact operative procedure conducted in each hip arthroscopic surgery (labral debridement vs repair vs reconstruction, degree of cam/pincer correction/undercorrection/overcorrection, chondral treatments for variable degrees of articular cartilage damage/arthritis, or capsular closure/repair/plication/shift, periarticular/extra-articular/peritrochanteric, deep gluteal space, or athletic pubalgia/core muscle injury). The heterogeneity of surgeon skill or surgeon experience is also a limitation. Other limitations include the absence of patient-reported outcomes and incomplete follow-up and career length for players still in their respective leagues.

CONCLUSION

The RTS rate for MLB athletes after hip arthroscopic surgery for FAI was high. There were similar IP, PA, and career lengths postoperatively compared with preoperatively and with matched controls. There was no significant difference in performance for pitchers and nonpitchers compared with matched controls after surgery.

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