Return to Play After Anterior Cruciate Ligament Reconstruction in Major League Baseball Athletes

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Purpose: The purpose of the study was to (1) investigate the rate of return to play among Major League Baseball (MLB) athletes after anterior cruciate ligament reconstruction (ACLR), (2) determine the impact of ACL injury on ability to perform baseball-specific planting and pivoting tasks (batting and stealing bases), and (3) to explore the effect of the injured side on these metrics. **Methods:** ACL injury data from 1999 to 2012 were compiled, along with player performance statistics recorded for players with at least 30 games before ACL injury. Predictor variables included side of injury and outcome variables focused on batting average, stolen bases, and number of times caught stealing before injury and after surgery. **Results:** Twenty-three of 26 (88%) players were able to return to at least 30 games after ACLR, although they experienced a decline of 21.2% in number of games played ($P = .004$). Those who had a ACLR for a rear batting leg injury averaged a 12.3% decline in batting average, whereas those who had ACLR for a lead leg injury had a 6.4% increase in batting average ($P = .04$). Side of injury was not predictive of stolen base metrics. **Conclusions:** The overall rate of return to play among MLB position players after ACLR was 88%, although there was a 21.2% decline in the number of games played postoperatively. Injury to the rear batting leg resulted in a lower returning batting average compared with an injury to the lead batting leg. Side of injury had no effect on stolen bases or on the number of times a player was caught stealing. **Level of Evidence:** Level IV, therapeutic case series.

The anterior cruciate ligament (ACL) is commonly injured in sports that require planting and cutting movements and pivoting and jumping.[1-5] ACL injury may subsequently prevent athletes from returning to their previous level of play and increase the risk of premature osteoarthritis.[6] Although functional outcomes and return to sports after ACL reconstruction (ACLR) have been studied, much of these data are limited to the general population and therefore do not pertain to professional athletes.[7-11] In a meta-analysis of 48 studies by Ardern et al.,[8] which evaluated return to sport after ACLR, 82% of the 5,770 patients returned to some level of sports participation: 63% returned to their preinjury level of participation and 44% returned to competitive sport at final follow-up. This study, however, examined the general population and not professional athletes.

Similar data in professional athletes are sparse. Studies regarding outcomes after ACLR in National Football League (NFL) athletes found that 63% to 80% of players with ACL injuries returned to participation in an NFL game.[12,13] Performance in running backs and wide receivers, as measured by their power rating, was reduced by one-third after ACLR.[13] In the National Basketball Association (NBA), return to play rates were found to be 78% after ACLR. Fifteen percent of these players saw an increase in their preinjury player efficiency rating (PER), 19% remained within 1 point of their preinjury PER, and 44% saw a decrease in PER of at least 1 point after return to play. Most performance variables—besides the number of games played, field goal percentage, and turnovers per game—remained similar when returning from ACL surgery.[14]

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To our knowledge, no such study evaluates the impact of ACLR on professional baseball players. This is likely because of the fact that knee injuries compose only 7.7% of all injuries in Major League Baseball (MLB).[15] The purpose of this study was 3-fold: first, to investigate the rate of return to play for MLB athletes after ACLR; second, to determine the impact of ACL injury on the ability to perform baseball-specific planting and pivoting tasks (batting and stealing bases); and third, to explore the effect of the injured side on these metrics. We hypothesized that performance statistics for cutting and pivoting activities (e.g., batting and stealing bases) would deteriorate after ACLR and that injury to the rear (power-generating) batting leg would result in worse batting performance after ACLR than injury to the lead batting leg.

Methods

ACL tear data were retrospectively collected—primarily from the MLB disabled list, MLB game summaries, and injury reports and secondarily from publically available news articles and player profiles. Inclusion criteria were ACL injury with reconstruction from 1999 to 2012 and playing in at least 30 games in the season preceding the ACL injury. This yielded 33 players for potential inclusion into the study. Because of the rarity of ACL injury in pitchers (n = 7), they were excluded from performance analysis to maintain a uniform cohort, although they were evaluated for rate of return to major league play. Position players who played in the MLB the season preceding their ACL tear but who did not return to the MLB after reconstruction for at least 30 games were characterized as "did not return" and were excluded from the final subanalyses comparing performance statistics (n = 3). This left 23 position players who returned to major league play in the final performance analysis. Statistics for each player were collected for the season before the ACL tear as well as for the first season after reconstruction. Predictor variables included player age at the time of injury and injury to the lead batting leg versus injury to the rear batting leg. For switch hitters, it was the opinion of the study surgeons (S.C., S.H.C., A.D.P., J.S.D.) and athletic trainers that the ACL injury would not be considered as being in their rear (power-generating) leg because they have the ability to offload the injured knee by switch hitting. The primary outcome of interest was return to play and number of games played. Secondary outcomes collected for position players included home runs, stolen bases, number of times caught stealing, batting average, and on-base percentage plus slugging percentage. Side of injury was evaluated as a covariable in analyses of base stealing statistics (left *v* right leg) as well as batting statistics (lead *v* rear leg).

Statistical analyses were performed by a member of the research team (P.D.F.) with knowledge of the hypotheses being tested and advanced training in biostatistics. SAS software, version 9.3 (SAS Institute, Cary, NC) was used. Descriptive statistics were used to evaluate the distribution of continuous variables. Player performance statistics were compared for the season before injury and the season after ACLR. Data were assessed for normality, and comparative analyses were performed using paired sample *t* tests and paired sample Wilcoxon tests, as appropriate. This investigation was a retrospective review of all available patients who met inclusion criteria, and therefore an a priori power calculation was not possible.[16] Post hoc power analyses were performed using PS, version 3.1.2 (Vanderbilt University, Nashville, TN) for the primary outcome of interest (paired differences in number of games played between season before injury and season after injury) and indicated 87% power. Post hoc power calculations were also performed on secondary outcome measures which were found not to be statistically significant. All comparative analyses were 2-tailed and used $P = .05$ as the threshold for statistical significance. No external funding was received for this study.

Results

Twenty-three of 26 position players (88%) were able to return for at least 30 major league games after ACLR. The mean age of those 23 players was 29.0 ± 4.2 years. Nine players (40%) injured their rear (power-generating) batting leg, 15 (65%) injured their right leg, and 8 (35%) injured their left leg. There were 4 switch hitters in the study cohort, all of whom remained switch hitters after injury. Six players (26%) sustained concomitant meniscal injuries, although the location, severity, and concomitant procedure data were unavailable. Mean change for each outcome variable for the study cohort is listed in Table 1. The cohort notably exhibited a wide range of change, both positive and negative, in performance after reconstruction. On average, however, there was a significant decrease of 21.2% in the number of games played in the season before injury (mean, 115.2 games; range, 32 to 159) and after injury (mean, 90.8 games; range, 38 to 157) ($P = .004$). There was also a decrease of 29.9% in stolen bases, which trended toward statistical significance ($P = .06$). Although home runs decreased by 21% after ACLR in this cohort, this change was not statistically significant ($P = .38$). There were no significant differences in on-base plus slugging ($P = .86$) after ACLR in this cohort. There were no significant associations noted between player age at the time of injury and any outcome variable.

Although 7 pitchers were excluded from the analysis to focus on performance statistics in position players, it was noted that 4 of 7 (57%) pitchers returned to major league play after ACLR.

Table 1. Mean Changes in Each Outcome Variable for the Entire Study Cohort (Season After ACLR Minus Mean Preinjury Season)

Outcome Variable	Mean Difference ± SD, Before Injury to After Reconstruction	Range	Percent Change, Before Injury to After Reconstruction	*P* Value
Games	−24.3 ± 36.1	−108 to +40	−21.2%	.004*
Home runs	−1.3 ± 7.2	−21 to +10	−21.0%	.38
Stolen bases	−2.9 ± 7.0	−21 to +14	−29.9%	.06
Caught stealing	−1.1 ± 3.5	−10 to +6	−4.8%	.14
Batting average	No change on average	−0.12 to +0.05	No change on average	.68
On-base plus slugging	No change on average	−0.2 to +0.2	No change on average	.86

ACLR, anterior cruciate ligament reconstruction; SD, standard deviation.
*$P < .05$.

Comparative subgroup analyses revealed that those who had ACLR for a rear batting leg injury had a mean 12.3% decline in batting average, whereas those who had ACLR for a lead batting leg injury had a 6.4% improvement in batting average (effect size, 18.7%; paired sample Wilcoxon test $P = .04$). There were no differences in stolen bases or number of times caught stealing between those with left- and those with right-sided ACL injury.

Post hoc power analyses performed for season before injury and season after injury paired differences of secondary outcome measures (Table 1) that were found not to be statistically significant revealed 71% power for stolen bases, 12% power for home runs, and 29% power for number of times caught stealing. Because there were no changes in batting average or on-base plus slugging between the season before and the season after injury (e.g. effect size = 0), post hoc power analyses were unable to be calculated for these variables.

Discussion

In this study, the proportion of MLB players able to return to at least 30 major league games after ACLR was 88% (n = 23 of 26), although there was a 21.2% decrease in the number of games played in the season after surgery. One player never returned to MLB competition after ACLR, whereas a second player returned to play for only 7 games in the MLB. A third player returned to play in 2 MLB games before retearing his ACL. Although the performance statistics of pitchers were not evaluated, it was noted that 4 of 7 (57%) pitchers returned to major league play after ACLR. It is unclear why pitchers had a lower rate of return to play than did position players; this may be a true finding or may represent data aberration given the event rarity.

When evaluated as an entire cohort of MLB position players who returned after ACLR, there was a large range in the change in performance statistics between the season before injury and the season after ACLR, suggesting potential contribution of covariates (e.g., side of injury) to changes in certain performance metrics. Comparative subgroup analyses revealed that those who had ACLR for a rear batting leg injury (n = 9) had a mean 12.3% decline in batting average, whereas those who had ACLR for a lead leg injury (n = 14) had a 6.4% improvement in batting average. A possible explanation for these findings could be that although the players underwent physical therapy to strengthen the affected extremity, the extremity that was not operated on is also strengthened, e.g., when a batter tears the ACL in the lead leg, his rear leg (the leg that generates swing power) is also strengthened in the process. This may not be substantial enough to affect home run or on-base plus slugging numbers, however, because analysis also showed no significant differences in these performance statistics regardless of whether the ACL tear occurred in the batter's lead leg or rear leg.

Although there was a decrease of 29.9% in stolen bases in the overall cohort, there were no differences in stolen bases between those with left ACL injury (n = 8) and those with right ACL injury (n = 15). There were no significant differences in the number of home runs or on-base plus slugging after ACLR in this cohort.

Although no direct comparison can be made because of the study design, when compared with similar studies in other professional sports, the 88% rate of return to play after ACLR in MLB athletes in this study is higher than previously reported return-to-play rates in the NFL (63% to 79%)[12,13] and the NBA (77%),[14] although there was a 21.2% decrease in the number of games played in the season after ACLR. Injury to the rear batting leg was associated with a lower batting average than injury to the lead leg in the first season after returning from ACLR. A higher rate of return to play may be experienced in MLB players compared with those in the NFL and NBA because of decreased planting and cutting movements, pivoting, jumping, and physical contact between players in baseball compared with those in football and basketball. On the whole, performance after ACLR seems to be maintained for professional baseball players compared with the subtle dropoff in performance that is commonly seen in professional football and basketball athletes. Taken together, these data suggest that ACLR may

result in a more predictable return to previous level of athletic participation and performance in athletes competing in baseball compared with those who play football or basketball.

Limitations

Although the current study provides insight and implications into ACL tears in MLB players, we acknowledge that there are limitations to these results. Because information was garnered from public sources, there may be undisclosed concomitant injuries, including meniscal status, that could potentially impact return to play. Although some data sources did note concomitant injuries, the reliability and lack of specific information regarding the type and severity of these injuries may introduce information bias. Information regarding the specific graft, surgical technique, and tunnel positions used for each reconstruction were also unavailable, and this also limits the ability of the current study to make inferences regarding the impact of these variables on outcome or return to play, or both. A study that investigated 5- to 15-year outcomes after ACLR found that the overall International Knee Documentation Committee score was normal or nearly normal for 87% (n = 204 of 235) of patients who maintained both menisci, 70% (n = 52 of 74) of patients who underwent partial or total lateral meniscectomy, 63% (n = 71 of 113) of patients who required partial or total medial meniscectomy, and only 60% (n = 36 of 60) of patients with involvement of both menisci.[17] This suggests that additional details regarding concomitant injuries to the menisci or other ligaments may enhance our study's implications. Furthermore, the final sample size limited study power, and a small variance in player age and few concomitant intra-articular pathologic conditions (e.g., meniscal and cartilage injury) limited the amount of subgroup analyses that could be performed. Rather, a limited subgroup analysis was performed by focusing on the side of ACL injury as the independent variable and metrics of ability to perform planting and pivoting tasks (batting and stealing bases) as the outcome variables. Furthermore, statistical power was limited for several secondary outcome measures; however, the current study importantly had 87% power for the investigation of the primary outcome of interest (games played). Limited statistical power is often unavoidable in specialized cohorts such as professional athletes, in which large samples are unavailable. Follow-up was limited to one season before and one season after injury; however, given the often short careers of professional athletes, this was felt to be more appropriate than a long-term follow-up study. Finally, it was impossible to account for potential sport-related confounders, such as style of play, team composition, varying team base-stealing strategies, ballparks played in, and team coaching staff, all of which have an influence on individual player performance statistics.

Conclusions

The overall rate of return to play among MLB position players after ACLR was 88%, although there was a 21.2% decline in the number of games played postoperatively. Injury to the rear batting leg resulted in a lower returning batting average compared with injury to the lead batting leg. Side of injury had no effect on stolen bases or on the number of times a player was caught stealing.

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