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Performance outcomes after medial ulnar collateral ligament reconstruction in Major League Baseball positional players

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Background: We sought to determine whether professional baseball positional players who underwent medial ulnar collateral ligament (MUCL) reconstruction demonstrate decreases in performance on return to competition compared with preoperative performance metrics and their control-matched peers.

Methods: Data for 35 Major League Baseball positional players who underwent MUCL reconstruction during 31 seasons were obtained. Twenty-six players met inclusion criteria. Individual statistics for the 2 seasons immediately before injury and the 2 seasons after injury included wins above replacement (WAR), on-base plus slugging (OPS), and isolated power (ISO). Twenty-six controls matched by player position, age, plate appearances, and performance statistics were identified.

Results: Of the 35 athletes who underwent surgery, 7 did not return to their preinjury level of competition (return to play rate of 80%). In comparing preinjury with postinjury statistics, players exhibited a significant decrease in plate appearances, at-bats, and WAR 2 seasons after injury but did not demonstrate declines in WAR 1 season after injury. Compared with matched controls, athletes who underwent MUCL reconstruction did not demonstrate significant decline in statistical performance, including OPS, WAR, and ISO, after return to play from surgery. Of all positional players, catchers undergoing surgery demonstrated lowest rates of return to play (56%) along with statistically significant decreases in home run rate, runs batted in, and ISO.

Conclusion: Major League Baseball positional players undergoing MUCL reconstruction can reasonably expect to return to their preinjury level of competition and performance after surgery compared with their peers. Positional players return to play at a rate comparable to that of pitchers; catchers may experience more difficultly in returning to preinjury levels of play.

Level of evidence: Level IV; Case Series; Treatment Study

Keywords: UCL; Tommy John; medial ulnar collateral ligament; return to sport; positional player; pitcher; catcher

This study is exempt from Institutional Review Board approval according to New York University Langone Medical Center Office of Science and Research as it does not contain human subjects research and all data are publicly available.

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The medial ulnar collateral ligament (MUCL), specifically the anterior bundle, functions as the primary stabilizer of the elbow to valgus force.[2,16,24-26] The elbow of the overhead athlete is subject to large degrees of valgus stress during throwing,[3,7,9,19] and insufficiency of the MUCL can be devastating to sport-specific performance.[10,12] Before the popularization of surgical reconstruction, rupture of the MUCL was generally thought to be a "career-ending" injury. However, with the advent of MUCL reconstruction surgery, athletes now have the opportunity to return to play after injury.[19]

Return to play and performance after MUCL reconstruction has been well studied in competitive pitchers.[7,8,11,18,20,21,23] Whereas conflicting results have been reported regarding statistical performance after injury,[11,18,23] pitchers have a high reported return to play rate (67%-97%).[7,11,18,20,21,23] Numerous performance metrics, including earned run average, walks plus hits per inning pitched, batting average against, wins above replacement (WAR), runs above replacement, average and peak velocity, games, games started, innings pitched, wins, losses, saves, strikeouts, walks, hits, runs, and home runs, have been studied for pitchers.[7,11,18,20,21,23] Although a significant amount of literature has examined outcomes of MUCL reconstruction in pitchers, there exists a paucity of data regarding performance outcomes in positional baseball players after MUCL reconstruction. Positional players are defined as any player other than pitcher. To our knowledge, there are no peer-reviewed studies investigating return to play and performance in positional elite baseball athletes after MUCL reconstruction.

The purpose of our study was to evaluate performance before and after injury in Major League Baseball (MLB) positional players who underwent MUCL reconstruction. In addition, the study aimed to compare the performance of these subjects with uninjured, matched controls. We hypothesized that although positional players with MUCL reconstruction would experience a decrease in statistical performance compared with their preinjury levels, they would demonstrate high rates of return to play similar to those observed in pitchers.

Methods

The study group included MLB positional players who sustained MUCL injuries and who subsequently underwent surgical reconstruction. Minor league players were not included. Players were identified during a period of 31 seasons (1984-2015). The injury cohort was identified using a comprehensive online injury database (www.prosportstransactions.com), cross-referenced and confirmed for accuracy with team press releases, online injury reports, and player profiles (www.mlb.com; www.baseballreference.com). This methodology has been previously validated for reporting outcomes and return to play rates for professional and amateur athletes across a variety of different sports.[1,4,6,11,14,15,27]

Thirty-five positional players who underwent MUCL reconstruction were identified. Return to play was defined as returning to at least 1 game of MLB-level competition after return from injury. Seven players did not return to their previous level of competition after surgery and were excluded from formal statistical performance analysis (n = 28). In addition, 1 player returned to the previous level of competition but had <100 plate appearances in the preinjury season and another player had <100 plate appearances in the postinjury season and were excluded from analysis in an effort to limit type II error. The remaining 26 positional players had complete statistical performance data and were included in the study as the injury cohort. A 1-to-1 matched control group was selected on the basis of age, experience, position, performance, time frame, and overall "similarity score" provided by a comprehensive online database (www.baseballreference.com) and a methodology described by James.[17] Efforts were made to select controls without a significant history of injury. Players were designated according to position: infielders (first baseman, second baseman, third baseman, and shortstop), outfielders (left, center, and right fielders), and catchers. Total sample size for all analyses was 52 (26 subjects and 26 controls). An inclusion and exclusion algorithm can be found in Figure 1.

The index year was defined as the season in which the player sustained an injury to the MUCL and underwent surgery. The index year for controls was matched to the age of the injured players at the time of MUCL injury. Study parameters included the season before and after injury and 2 seasons before and after injury in the case of comprehensive statistics. Demographic data including age, body mass index (BMI), hand dominance, position, batting handedness, throwing handedness, and number of seasons of experience were recorded. Performance data recorded included WAR, isolated power (ISO), on-base plus slugging (OPS), batting average, doubles rate, triples rate, home run rate, strikeout rate, base on balls rate, and runs batted in (RBI) rate. Performance data were normalized by at-bats per season and reported as rates per at-bat to control for variations due to player experience and plate appearances.

MLB WAR data were collected for both cohorts. WAR is a new statistical method that summarizes a player's total contributions to the team in 1 statistic. WAR can be used to represent the number of additional wins the team benefits from because of a player compared with a replacement-level player who may be obtained for minimal cost. WAR is a comprehensive statistic that additionally allows comparisons between players, with higher values suggesting that the team is likely to enjoy greater wins because of playing a particular player over another. In addition, ISO was collected for both cohorts. ISO is a statistic that measures a batter's raw power, measuring how many extra bases a player averages per at-bat.

Student *t*-tests and Fisher exact test were used to compare differences in continuous and categorical variables, respectively, between cases and controls. Paired *t*-tests were used to determine significance of preoperative and postoperative performance statistics in players undergoing Tommy John surgery (TJS). Mean difference in preoperative and postoperative performance statistics was calculated between groups, after which Student *t*-tests were used to compare TJS players and matched controls. To determine whether MUCL reconstruction on the dominant or nondominant batting hand affected performance statistics, a subgroup analysis was performed on the MUCL reconstruction group; switch hitters and those who had surgery on the elbow opposite their batting side were compared with patients who had surgery on their designated batting side.

Further subgroup analysis focusing on preoperative and postoperative differences was performed on the basis of position to determine whether variations occurred in outfielders, infielders, and catchers and whether the player was a switch hitter or not. Finally, analysis of variance with subsequent post hoc Tukey analysis when appropriate was performed to determine whether difference in performance statistics varied between outfielders, infielders, and

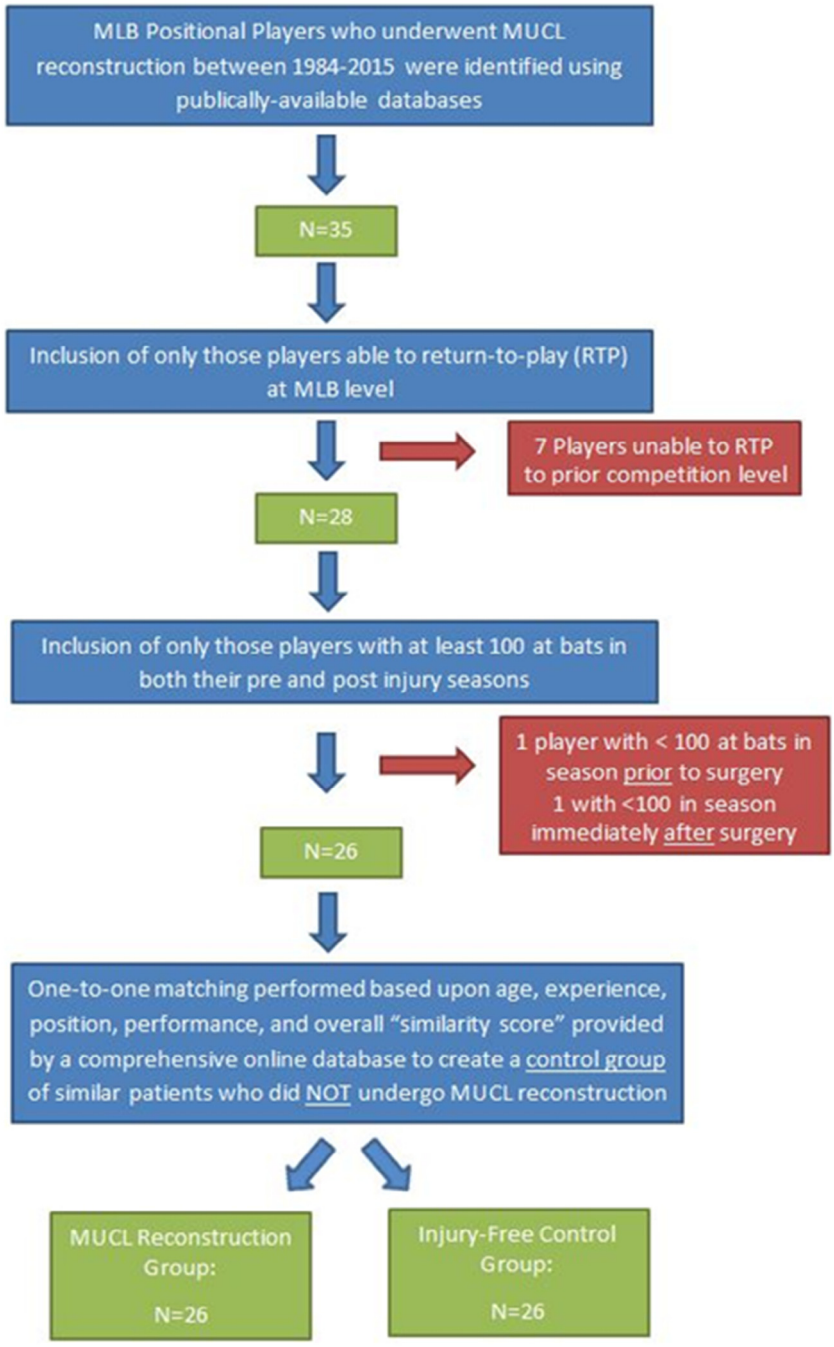

Figure 1 Inclusion and exclusion criteria algorithm. *MLB*, Major League Baseball; *MUCL*, medial ulnar collateral ligament; *RTP*, return to play.

catchers. SAS version 9.3 (SAS Institute, Cary, NC, USA) was used for all statistical analyses.

Results

Thirty-five players who underwent MUCL reconstruction were identified during 31 seasons (1984-2015). All players identified were MLB positional players, and all players underwent surgical MUCL reconstruction. The distribution of the initial cohort was 10 infielders, 16 outfielders, and 9 catchers. Seven athletes did not return to the same level of competition after surgery, corresponding to an overall return to play rate of 80.0% (28/35). Return to play rates by position were as follows: outfielders, 87.5% (14/16); infielders, 90% (9/10); and catchers, 56% (5/9). Because of having <100 plate appearances either in the preinjury or postinjury season, 1 catcher and 1 infielder were excluded from final analysis, leaving a final cohort of 26 players: 14 outfielders, 8 infielders, and 4 catchers.

The average age at the time of surgery was 28.6 years, and the average BMI was 25.9 (Table I). Of the patients undergoing

Table I Baseline demographics of players undergoing Tommy John surgery (TJS) and matched controls

Parameter	TJS group (n = 26)	Control group (n = 26)	*P* value
Age (y)	28.4 (4.2)	28.5 (3.4)	.88
BMI (kg/m^2)	25.9 (2.5)	26.0 (2.4)	.90
Position played			
Catcher	4	4	1.0
Infield	8	8	1.0
Outfield	14	14	1.0
Bats			
Right	13	13	1.0
Left	10	11	1.0
Both	3	2	1.0
Throws			
Right	23	22	1.0
Left	3	4	1.0
Both	0	0	1.0
At-bats	410 (170)	419 (156)	.84
Wins above replacement (WAR)	1.9 (1.6)	2.0 (2.3)	.77
Isolated power (ISO)	0.17 (0.06)	0.14 (0.05)	.17
On-base plus slugging (OPS)	0.78 (0.08)	0.76 (0.10)	.26

BMI, body mass index.
Demographic data and performance values are expressed as mean (standard deviation). Values are calculated for the season preceding surgery in the TJS group and the representative matched season in the control group.

Table II Difference in performance variables for Major League Baseball players before and after Tommy John surgery

Parameter	Preoperative	Postoperative	*P* value
Plate appearances	460 (191)	367 (190)	.02
At-bats	410 (170)	326 (169)	.02
Wins above replacement (WAR) based on ± 1 season	1.9 (1.6)	1.5 (1.7)	.38
Wins above replacement (WAR) based on ± 2 seasons	2.3 (2.0)	1.0 (1.6)	.03
Batting average	0.275 (0.024)	0.256 (0.049)	.06
Isolated power (ISO)	0.166 (0.058)	0.148 (0.067)	.13
On-base plus slugging (OPS)	0.785 (0.076)	0.732 (0.142)	.09
Double rate*	63.9 (43.8)	57.5 (52.2)	.20
Triple rate*	7.91 (9.36)	7.41 (10.1)	.67
Home run rate*	32.2 (20.7)	27.8 (17.8)	.21
Runs batted in rate*	133 (43.0)	119 (50.2)	.16
Strikeout rate*	199 (84.7)	213 (92.4)	.21
Base on balls rate*	96.3 (44.5)	105 (51.0)	.06

Values are expressed as mean difference between the preoperative and postoperative metrics (standard deviation). Preoperative refers to the season immediately before surgery, and postoperative refers to the season immediately after surgery.
* Per 1000 games.

surgery, 27% (7/26) were switch hitters, whereas 73% (19/26) were not. The 26 patients included in the control group had the same distribution for positions and switch hitting as those players undergoing MUCL reconstruction. Table I comparing baseline values between cases and controls demonstrates appropriate matching for all measured baseline demographics. Furthermore, baseline statistics such as at-bats, WAR, ISO, and OPS 1 season before the index season did not differ significantly between the 2 groups.

In comparing preinjury with postinjury statistics among the surgical group (Table II), players demonstrated a significant decrease in plate appearances (460 before injury vs. 367 after injury; $P = .02$) and at-bats (410 before injury vs. 326 after injury; $P = .02$) in the season after injury. Whereas no significant declines in WAR, ISO, or OPS were identified 1 season after injury, the surgical group did demonstrate a significant decrease in WAR (2.3 before injury vs. 1.0 after injury; $P = .03$) 2 seasons after the injury. No significant decline in batting average, doubles rate, triples rate, home run rate, RBI rate, strikeout rate, or base on balls rate was observed.

No differences were found within the TJS group based on whether dominant or nondominant batting side was operated on (Table III).

Compared with matched controls, patients who underwent MUCL reconstruction did not demonstrate a statistically significant difference in plate appearances, at-bats, statistical rates, or advanced performance statistics (Table IV). Strikeout rate, however, did trend toward being much higher in players who underwent MUCL reconstruction compared with controls (+13.8 ± 5.50 vs. −9.88 ± 29.8; $P = .06$).

A subgroup analysis of injured players compared with matched controls separated by position was performed. No significant differences were identified, although catchers undergoing surgery did trend to have greater strikeouts than those who did not (Table V).

Subjects were divided by position, and their preinjury and postinjury performance was compared (Supplementary Table S1). Compared with outfielders and infielders, catchers had significantly greater decreases in home run rate ($P = .013$). Catchers were found to have significantly lower RBI rates ($P = .031$) and ISO ($P = .030$) than outfielders, with no difference noted between other groups. In addition, they trended toward having significantly fewer plate appearances ($P = .063$), fewer at-bats ($P = .066$), and lower OPS ($P = .061$) after MUCL reconstruction compared with infielders and outfielders.

To determine whether switch hitting affected performance metrics, 3 subgroup analyses were performed (Supplementary Table S2). First, switch hitters undergoing MUCL reconstruction were compared with non–switch hitters undergoing MUCL reconstruction; no significant differences were observed. Similarly, no significant differences were observed between switch-hitting controls and non–switch-hitting controls. In focusing only on switch hitters, patients undergoing MUCL reconstruction had significantly lower 2-year WAR than controls (−0.726 vs. + 0.814; $P = .036$). Among all players who

Table III Difference in performance variables within medial ulnar collateral ligament (MUCL) group based on operative elbow being on dominant batting side

Parameter	MUCL reconstruction on dominant batting side (n = 14)	MUCL reconstruction on nondominant batting side (n = 12)	*P* value
Plate appearances	88.2 (157.4)	99.0 (230.4)	.89
At-bats	79.2 (137.5)	89.5 (204.1)	.88
Wins above replacement (WAR) based on ± 1 season	0.443 (1.884)	0.275 (2.344)	.845
Wins above replacement (WAR) based on ± 2 seasons	0.685 (2.672)	1.151 (1.889)	.619
Batting average	0.006 (0.042)	0.033 (0.054)	.369
Isolated power (ISO)	0.011 (0.066)	0.012 (0.106)	.961
On-base plus slugging (OPS)	0.018 (0.141)	0.094 (0.161)	.209
Double rate*	0.002 (0.024)	0.011 (0.025)	.400
Triple rate*	0.0007 (0.005)	0.0002 (0.006)	.789
Home run rate*	0.001 (0.017)	0.008 (0.020)	.375
Runs batted in rate*	0.0003 (0.048)	0.029 (0.045)	.129
Strikeout rate*	17.0 (29.5)	8.4 (49.1)	.588
Base on balls rate*	5.98 (19.5)	7.51 (26.7)	.864

Values are expressed as mean difference between the preoperative and postoperative metrics (standard deviation). Preoperative refers to the season immediately before surgery, and postoperative refers to the season immediately after surgery. Preoperative value is subtracted from postoperative value, such that a positive value represents an increase and a negative value represents a decrease in the stated variable.

* Per 1000 games.

Table IV Difference in performance variables for Major League Baseball players after Tommy John surgery compared with matched controls

Parameter	Subjects (n = 26)	Controls (n = 26)	*P* value
Plate appearances	−93.2 (190)	−59.6 (149)	.48
At-bats	−84.0 (168)	−54.1 (133)	.48
Wins above replacement (WAR) based on ± 1 season	−0.37 (2.1)	−0.74 (2.0)	.52
Wins above replacement (WAR) based on ± 2 seasons	−0.90 (2.3)	−0.03 (0.70)	.13
Batting average	−0.02 (0.05)	−0.01 (0.04)	.51
Isolated power (ISO)	−0.01 (0.09)	0.00 (0.06)	.55
On-base plus slugging (OPS)	−0.05 (0.15)	−0.02 (0.12)	.45
Double rate*	−6.34 (24.5)	2.81 (14.3)	.10
Triple rate*	−0.50 (5.93)	−1.33 (5.23)	.59
Home run rate*	−4.36 (17.4)	−1.47 (17.0)	.55
Runs batted in rate*	−13.9 (48.6)	−2.38 (38.1)	.35
Strikeout rate*	13.8 (5.50)	−9.88 (29.8)	.06
Base on balls rate*	8.95 (23.3)	6.02 (25.8)	.69

Values are expressed as mean difference between the preoperative and postoperative metrics (standard deviation). Preoperative refers to the season immediately before surgery, and postoperative refers to the season immediately after surgery. Preoperative value is subtracted from postoperative value, such that a positive value represents an increase and a negative value represents a decrease in the stated variable.

* Per 1000 games.

were not switch hitters, those who underwent surgery had a higher strikeout rate postoperatively than matched controls (+0.019 vs. −0.014; $P = .040$).

Discussion

Injury of the MUCL is one of the defining injuries associated with elite baseball players. Conte et al found that 25% of major league pitchers and 15% of minor league pitchers have sustained an injury to the MUCL.[8] Before the advent of Tommy John surgery in 1974, the injury was often considered to be career threatening to professional athletes. However, with advancements in surgical technique and popularization of reconstruction, athletes may now expect to have the opportunity to return to play after injury.[19]

Injury to the ligament occurs most often in overhead athletes,[3,9,20] and recent reports have demonstrated significant increases in incidence of MUCL reconstructions.[22] Valgus and extension forces on the MUCL have been demonstrated to be highest when the shoulder is in maximal external rotation and the elbow flexed, as in the late cocking and acceleration phases of throwing.[2,7,9,10,12] The ligament is subject to the greatest internal rotation torque during deceleration. Over time, repetitive exposure to these high forces may result in acute rupture or microtrauma with eventual acute-on-chronic injury.[7]

Outcome after MUCL reconstruction in elite athletes has been examined in several studies. In a study of 1281 patients treated operatively during a 19-year period, Cain et al reported a return to play rate of 83%.[7] Similar studies have reported return to play rates ranging from 67% to 87%.[11,20,21,23] Fleisig et al examined biomechanical performance of elite pitchers with a history of MUCL reconstruction and found

Table V Difference in performance variables for Major League Baseball players after Tommy John surgery compared with matched controls, subgroup analysis by position

Parameter	Outfielders			Infielders			Catchers		
	Subject (n = 14)	Control (n = 14)	*P* value	Subject (n = 8)	Control (n = 8)	*P* value	Subject (n = 4)	Control (n = 4)	*P* value
Plate appearances	−57.6 (162.7)	−54.8 (110.7)	.959	−54.4 (182)	−46.1 (201)	.931	−295.5 (213.6)	−105.5 (160.9)	.205
At-bats	−53.1 (146)	−51.3 (100.5)	.970	−49.6 (158)	−36.4 (174)	.873	−260.8 (183.4)	−102.8 (149)	.2296
Wins above replacement (WAR) based on ± 1 season	0.0857 (1.81)	−0.646 (2.66)	.408	−0.412 (2.118)	−0.855 (1.268)	.6034	−1.850 (2.93)	−0.780 (1.32)	.531
Wins above replacement (WAR) based on ± 2 seasons	−0.993 (2.57)	0.546 (1.389)	.067	−0.450 (2.295)	−0.4333 (2.131)	.987	−1.475 (1.54)	−0.975 (0.861)	.591
Batting average	−0.0084 (0.029)	−0.00069 (0.025)	.472	−0.0161 (0.0624)	−0.0290 (0.044)	.6272	−0.062 (0.066)	−0.0095 (0.027)	.266
Isolated power (ISO)	−0.0150 (0.086)	−0.0032 (0.0445)	.664	−0.0097 (0.055)	0.0156 (0.0657)	.4072	−0.108 (0.069)	0.043 (0.053)	.189
On-base plus slugging (OPS)	−0.0170 (0.1084)	−0.00061 (0.091)	.676	−0.0360 (0.1677)	0.0504 (0.1492)	.853	0.2155 (0.188)	0.0445 (0.151)	.206
Double rate*	−0.322 (1.5)	−0.470 (8.4)	.975	−7.78 (32.7)	3.49 (20.5)	.403	−24.9 (30.3)	11.9 (11.8)	.060
Triple rate*	−0.451 (7.1)	−1.64 (6.3)	.644	0.11 (5.4)	−0.366 (5.7)	.8262	−1.92 (5.7)	0.056 (1.8)	.669
Home run rate*	−1.2 (16.1)	−0.682 (15.8)	.9322	0.130 (4.1)	−1.21 (5.2)	.569	−26.5 (17.6)	−18.2 (13.9)	.486
Runs batted in rate*	−4.34 (44.6)	0.560 (31.3)	.746	−2.76 (48)	3.83 (41.7)	.768	−69.8 (27.3)	−25.9 (51.6)	.1884
Strikeout rate*	3.6 (47.9)	0.24 (19.5)	.813	4.54 (45.8)	−18.3 (37.8)	.2778	68.0 (76.1)	−23.9 (34.3)	.070
Base on balls rate*	6.56 (26.1)	11.1 (26.2)	.654	11.2 (18.2)	−7.78 (24.1)	.089	12.7 (27.1)	20.5 (17.1)	.646

Values are expressed as mean difference between the preoperative and postoperative metrics (standard deviation). Preoperative refers to the season immediately before surgery, and postoperative refers to the season immediately after surgery. Preoperative value is subtracted from postoperative value, such that a positive value represents an increase and a negative value represents a decrease in the stated variable.

* Per 1000 games.

no significant differences in pitching mechanics or passive range of motion in surgical subjects compared with matched controls.[13] Performance after return to play from MUCL reconstruction in pitchers remains controversial. Some studies demonstrate improved performance[11]; others report decreased postsurgical performance metrics.[18,23]

Whereas much attention has been paid to the return to play and performance of elite pitchers after MUCL reconstruction, to the authors' knowledge, this study is the first to examine performance outcomes in positional athletes after surgery. Our results examining 26 positional MLB players who underwent MUCL reconstruction demonstrate that compared with their preoperative values, players undergoing surgery had statistically significant decreases in plate appearances, at-bats, and 2-year WAR. Compared with matched controls, however, no significant differences were observed between players who underwent MUCL reconstruction and those who did not, and this lack of differences persisted when subgroup analysis was performed on the basis of position (infield, outfield, catcher). Analysis of switch hitters demonstrated that switch-hitting players who underwent MUCL reconstruction had significant reductions in their 2-year WAR compared with switch-hitting controls, who demonstrated an increase in WAR at 2 years. The poorest results after MUCL reconstruction were observed in catchers, who demonstrated only a 56% return to play level with statistically significant decreases in ISO, home run rate, and RBI rate after undergoing surgery. Although athletes may individually experience slight statistical decline on return, they are able to maintain performance equal to that of their peers who did not undergo MUCL reconstruction. Our result that both players who underwent surgery and controls demonstrated a decline in performance at 2 years after surgery is interesting and lends credence to our initial matching of groups. In addition, these declines could potentially be due to the natural progression of a player's career, specifically the possibility of a statistically significant decline as a player ages. In our study, the mean age at time of surgery was 28.6 years. This is the same as the average age of MLB players at the beginning of the 2016 season (mlb.com). In their classic study, Schulz et al investigated the effect of age on MLB player performance and demonstrated that performance peaks at 27 years of age.[28] More recently, Bradbury found that both hitters and pitchers peak later, around 29 years of age.[5] Regardless of the exact age at peak performance, given the mean age of players and controls during the follow-up period, we would expect a decline in performance as they exceed their prime age.

In our study, 80% of players returned to play at the MLB level. Of the 7 athletes who did not return to play in the major leagues, 4 were catchers. This corresponds to a relatively low return to play rate of 56% among catchers. This rate is lower than the reported return to play rate in the literature for pitchers after MUCL reconstruction.[11,14,20,21,23] Multiple factors may have contributed to this discrepancy. There are radically different athletic demands placed on pitchers and catchers. Starting pitchers play intermittently on the basis of a rotation schedule and relief pitchers play only a limited number of innings per game. Catchers, on the other hand, generally play more consistently and average more innings per season. Although both pitchers and catchers have throwing demands, catchers have additional pressure on batting performance. These factors may account, at least in part, for the lower return to play rate among catchers relative to pitchers. When preinjury vs. postinjury performance was analyzed according to position, catchers experienced significant decreases in postinjury home run rate, RBI rate, and ISO compared with outfielders and infielders. In addition, catchers had decreased postinjury plate appearances, at-bats, and OPS that trended toward significance. In looking across positions, catchers may be more likely to have worse performance outcomes after MUCL reconstruction compared with outfielders or infielders. Lower return to play, at-bats, and plate appearances suggest decreased playing time and a competitive decline in catchers. In addition, the large drop in advanced batting statistics relative to other positional players could be related to the cumulative physical stresses placed on a catcher during an entire baseball season compared with other positional players. The throwing arm of catchers is subject to greater cumulative stresses than the arm of outfielders or infielders, based on the inherent fact that they perform many more throws per game. As of 2010, the average pitches thrown per 9-inning game was 146 (www.baseballreference.com), and each pitch requires a throw from the catcher to return the ball to the pitcher. Catchers must also be able to perform quick, powerful throws in attempts to throw out base stealers. Although defensive metrics such as caught stealing percentage, ultimate zone rating, and defensive runs saves were not analyzed during this study because of limitations in sample size, future studies examining these parameters as they relate to post–MUCL reconstruction are warranted.

Interpretation of our data regarding switch hitters vs. non–switch hitters shows that although no statistically significant differences were observed, switch hitters who underwent MUCL reconstruction generally had less serious declines in postsurgical performance than non–switch hitters. These results could be representative of inherent skill set or compensations within batting mechanics that switch hitters are able to perform compared with non–switch hitters. Although our data in this area were limited by sample size, continued investigation in this area could be of utility to baseball players and managers alike.

Limitations

Our study is not without limitations. Inherent in the use of public data is a reliance on data of which we had minimal control. In addition, specifics of each injury, the surgical technique of reconstruction, and the rehabilitation protocol were not available. Although all subjects were MLB players, it is possible that team physicians and resources available for rehabilitation varied among players. Similarly, details about past medical and surgical history as well as the presence of concomitant elbow disease, such as ulnar nerve symptoms

or osteophytes, were unknown. We were unable to exclude concomitant injuries, such as rotator cuff tears or superior labral tears anterior to posterior in athletes. In addition, our data represent an exceptionally unique cohort of MLB athletes, and thus we cannot underestimate the effect that professional team dynamics, in-game managerial decisions, or financial contract status had on the ability of players to return to play and to achieve preoperative performance metrics. Furthermore, we were limited in performing fielding analysis at this time because of small sample size with incomplete data and lack of consensus opinion on most accurate fielding metrics. However, this remains an area of future investigation, Finally, because of our focus on MLB positional players only, our analysis may be subject to type II error due to relatively small sample size of data available.

Despite these limitations, we were able to appropriately match subjects and controls according to age, BMI, position, switch-hitting status, experience, and performance, lending credence to our results. Finally, to the best of our knowledge, our study is the first to examine return to play and sport-specific statistical performance in professional positional baseball players after MUCL reconstruction.

Conclusion

Our results in MLB positional players demonstrate an overall 80% return to play rate, which is comparable to or better than return to play rates of MLB pitchers.[7,11,18,20,21,23] Although players demonstrated postoperative declines in plate appearances, at-bats, and 2-year WAR after their MUCL reconstruction compared with preoperatively, their postoperative performance was similar to that of matched controls. Subgroup analysis found that catchers had the lowest return to play rates (56%), along with statistically significant decreases in ISO, home run rate, and RBI rate after undergoing surgery, results that are potentially reflective of the significant stresses associated with playing the MLB catcher position. In summary, whereas positional players may experience slight statistical declines on return to play after MUCL reconstruction, they remain competitive with their peers and can expect minimal significant declines in performance compared with other players of the same experience, position, and performance metrics. Our study provides valuable information to players, managers, and orthopedic team physicians about outcomes of positional baseball players undergoing MUCL reconstruction.

Disclaimer

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Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jse.2017.09.004

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