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Performance and Injury Characteristics of Pitchers Entering the Major League Baseball Draft After Ulnar Collateral Ligament Reconstruction

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Background: Ulnar collateral ligament (UCL) reconstruction (UCLR) has been studied and shown to be a successful procedure for returning overhead athletes to sport. Many studies of Major League Baseball (MLB) players have shown high levels of return to play with successful statistical performance. No study has followed professional advancement of drafted pitchers who underwent UCLR as amateurs when compared with drafted pitchers who did not undergo the procedure before selection in the MLB draft.

Hypothesis: There would be no difference in professional advancement, statistical performance, or injury rate between the UCLR and control groups.

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

Methods: Thirty-eight pitchers with a UCLR as an amateur and 114 controls were identified in the MLB draft between 2006 and 2010. Highest level of professional baseball achieved was collected from all players, as well as statistical performance metrics including velocity, wins, earned run average (ERA), and walks and hits per inning pitched (WHIP). Additional data on future injuries were analyzed for days on the disabled list (DL), risk of being placed on the DL, and DL assignment for elbow injury.

Results: Thirteen of 38 UCLR pitchers reached the major league level (34.2%) compared with 29 of 114 (25.4%) control pitchers, which was not statically significant ($P = .295$). The UCLR and control groups were similar for average velocity, peak velocity, innings pitched, games, games started, innings per game, ERA, WHIP, wins, losses, saves, batters faced, and innings pitched per year, as well as hits, runs, home runs allowed, strikeouts, batters walked, and batters struck per inning. The UCLR group had a significantly increased rate of DL assignment when compared with controls (86.8% vs 64.0%; $P = .008$); however, days on DL (152.8 vs 135.6; $P = .723$) and DL assignment for elbow injury (45.5% vs 43.8%; $P = .877$) were similar.

Conclusion: There was no difference in the rate of professional advancement among pitchers drafted by the MLB who had undergone UCLR as amateurs compared with controls. Both groups had similar statistical performance. Pitchers in the UCLR group had an increased risk of DL assignment but no increase in the number of days on DL or risk of DL placement for elbow injury.

Keywords: ulnar collateral ligament; Tommy John surgery; Major League Baseball; elbow injury; pitching

The anterior bundle of the ulnar collateral ligament (UCL) is the primary stabilizer to valgus stress in the elbow.^{11,14,26,32,34} Overhead athletes, specifically baseball pitchers, place considerable stress on the ligament during sporting activities. Successful outcomes have been reported with nonoperative treatment.^{9,27,30} However, many overhead athletes cannot return to their previous level of sport with a nonoperative treatment program.^{16,29,30,35} Due to this high failure rate of nonsurgical treatment, operative treatment was investigated.

After Jobe et al¹⁸ initially described UCL reconstruction (UCLR) in 1986, numerous studies have included modifications in techniques.^{1,4,5,9,10,28,31,33}

Many authors have investigated outcomes after reconstruction, with 80% to 90% return to sport.[#] With high levels of return to play reported, performance outcomes (eg, win/loss ratio, earned run average [ERA], walks and hits per inning pitched [WHIP], and velocity) have become important standards for successful outcome. It is important to note that many of these studies focus on pitchers already at the major league level.

Because of the success of UCLR at the professional level, more athletes are undergoing the procedure as amateurs, as reported in a study by Osbahr et al.²⁴ They reported on long-term outcomes of 256 athletes, of which 112 were in the professional ranks at either the major or minor league level, while 144 were amateurs at the college or high school level. Additional reports have documented UCLR being performed on young throwers.²⁵ Reinjury risk in baseball draftees has been studied previously (Lintner D, Jereb S. "Risk for Reinjury in the Baseball Draftee." Presented at the Major League Baseball Team Physicians meeting, New Orleans, Louisiana, 2000). To our knowledge, no studies have reported the rate of professional advancement among baseball players who had undergone UCLR as amateurs.

In the present study, a cohort of players selected in the Major League Baseball (MLB) draft who had undergone UCLR as an amateur player before the draft were compared with a matched cohort of draft picks who had no history of UCLR (control group). We analyzed professional advancement and injury rate, as well as performance metrics similar to those reported by Erickson et al.¹²

Our hypothesis was that players with a history of UCLR would advance through the professional ranks at a rate similar to that of the control group. We also hypothesized that the 2 groups would have similar performance statistics and matching injury rates.

METHODS

Before initiation of the study, permission was obtained from the MLB Medical Committee, and the study was approved by the Scripps Clinic Institutional Review Board. Study data were collected from the MLB database, which maintains statistics on players' injuries and treatments. Additional statistical and performance data were also available from MLB. To protect all players' privacy, the study data were deidentified, and no names were used during any phase of the study. Only 1 author (J.F.) knew specific names and draft information that could be used to recognize the player.

In the drafts from 2006 to 2010, we were able to identify 38 pitchers who had undergone UCLR as amateurs and who subsequently entered the MLB draft. To improve statistical analysis, the 38 athletes were grouped together regardless of surgical technique. For each study player, 3 control players were selected. The control players were pitchers of the same handedness selected within 30 picks in the same draft as each study player and who had matching height and weight. The total number of pitchers drafted and signed could not be calculated. In the MLB draft, players may be drafted annually until they sign, with the same player

TABLE 1
Classification of Professional Levels
Including Major and Minor Leagues

Level	Leagues Included
1	Short A, rookie
2	A, High A
3	AA
4	AAA
5	Major League Baseball

drafted several times. Many players who are drafted never sign with the team. Because of this, we believed that these data would not be accurate for analysis in this study.

Postdraft data were collected in 2014, which would allow for follow-up of 4 to 8 years. Data obtained from MLB included the highest level obtained for each player. For analysis purposes, we collapsed the various groups into 5 categories (Table 1).

To assess the relative injury risk, we analyzed the number of days on the disabled list (DL). We evaluated this further to determine whether the placement on the DL was due to elbow injury.

Performance data were also collected for each player. Total innings, games, and games started were compared. The groups were compared for innings pitched, batters faced, games, games started, wins, losses, and saves per year. In addition, we examined the hits allowed, runs allowed, home runs allowed, strikeouts, walks, and struck batters per inning. Furthermore, ERA, WHIP, and amateur and professional maximum velocity were analyzed.

Statistical analysis was performed using SPSS version 12 (SPSS Inc). Means and frequencies were calculated to summarize the study data. To compare groups on performance and injury variables, chi-square tests were used for categorical data, and independent-samples *t* tests were used for continuous data.^{15,22,23} Mann-Whitney *U* tests were used for continuous variables that had nonnormal distributions.⁶ Significance was set at $P < .05$.

RESULTS

Demographics

Between 2006 and 2010, a total of 38 players drafted in the MLB were identified as having undergone UCLR as an amateur and were included in the study. Within those draft years, 114 controls who had no history of UCLR and who met our matching criteria were also identified and included (Table 2).

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TABLE 2
Number of Players Included by Draft Year^a

	2006	2007	2008	2009	2010	Total
UCLR group	6	7	14	8	3	38
Control group	18	21	42	24	9	114
Total	24	28	56	32	12	152

^aUCLR, ulnar collateral ligament reconstruction.

TABLE 3
Amateur Level at Time of Draft^a

	UCLR	Control	Total
4-year college	30 (19.7)	90 (59.2)	120 (78.9)
Junior college	5 (3.3)	15 (9.9)	20 (13.2)
High school	3 (2.0)	9 (5.9)	12 (7.9)
Total	38 (25)	114 (75)	152 (100)

^aData are n (%). UCLR, ulnar collateral ligament reconstruction.

TABLE 4
Demographics of Athletes Included^a

	UCLR	Control	P Value
Age, y	21.8 ± 1.2	21.4 ± 1.3	.050
Height, in	74.5 ± 2.3	74.3 ± 2.0	.612
Weight, lb	209.6 ± 18.3	203.5 ± 15.7	.046

^aData are mean ± SD. UCLR, ulnar collateral ligament reconstruction.

Most of the players in this study attended a 4-year college, and a relative minority reached the draft from junior college or high school (Table 3).

The result of the case-control matching is reflected in Table 4. At the time of the draft, players in the UCLR group and the control group were similar in height, but the UCLR pitchers were slightly older (approximately a half year) and heavier (approximately 6 lb).

Professional Advancement

The highest level achieved is summarized in Figure 1. There was no statistically significant difference between groups with regard to professional advancement at the highest level achieved overall ($P = .723$) or at each level of advancement (Table 5). While 13 (34.2%) UCLR players reached the major leagues compared with 29 (25.4%) controls, this did not represent a statistically significant difference ($P = .295$).

Performance

Analyzing performance showed that peak velocity as amateur and professional was similar regardless of whether the athlete had undergone UCLR before the draft (Table 6).

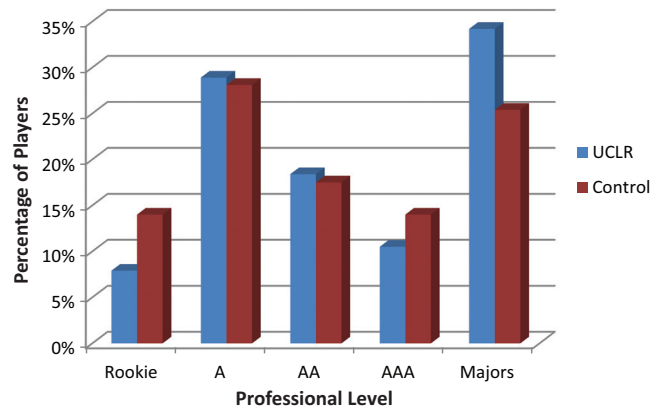


Figure 1. Highest professional level achieved by included athletes. Results are displayed as a percentage of athletes in each group. UCLR, ulnar collateral ligament reconstruction.

TABLE 5
Highest Professional Level Achieved^a

	UCLR	Control	P Value
Rookie	3 (7.9)	16 (14.0)	.406
A	11 (28.9)	31 (27.2)	.834
AA	7 (18.4)	22 (19.3)	.905
AAA	4 (10.5)	16 (14.0)	.579
Majors	13 (34.2)	29 (25.4)	.295

^aData are n (%). UCLR, ulnar collateral ligament reconstruction.

TABLE 6
Pitch Velocity (miles per hour)^a

Velocity	UCLR	Control	P Value
Average	92.7 ± 2.0	92.1 ± 2.3	.148
Maximum	93.1 ± 2.6	92.4 ± 2.8	.257

^aData are mean ± SD. UCLR, ulnar collateral ligament reconstruction.

A variety of performance measures were assessed (Tables 7-9). All measures were similar for all variables in both groups. The statistics represent all athletes at all levels of play for all tables. The study group had 6 starters, 3 relievers, and 29 pitchers with multiple designations. The control group had 17 starters, 12 relievers, and 85 pitchers with multiple roles.

Future Injury

Of the 38 players in the UCLR group, 33 (86.8%) were placed on the DL, while in the control group, 73 of 114 (64.0%) were placed on the DL. This difference was statistically significant ($P = .008$). For those requiring DL assignment, there was no significant difference in the mean number of days spent on the DL (UCLR, 152.8 days vs control, 130.2 days; $P = .723$). In addition, there

TABLE 7
Career Performance^a

Career Statistic	UCLR	Control	P Value
Innings pitched	262.5 (5-1042)	357.5 (7-1239)	.412
Games	119.0 (6-382)	99.5 (8-437)	.836
Games started	15.0 (0-174)	32.0 (0-210)	.359
Innings/game	2.4 (0.8-5.6)	3.0 (0.9-5.7)	.114
ERA	3.98 (2.50-7.20)	4.11 (1.71-9.67)	.442
WHIP	1.41 (1.14-2.60)	1.37 (0.99-2.07)	.137

^aData are median (range). ERA, earned run average; UCLR, ulnar collateral ligament reconstruction; WHIP, walks and hits per inning pitched.

TABLE 8
Performance Statistics per Year^a

Statistic per Year	UCLR	Control	P Value
Games	24.3 (6.0-49.3)	23.3 (4.0-57.1)	.907
Wins	3.3 (0-8)	3.8 (0-12)	.136
Losses	3.3 (0-7)	4.0 (0-9)	.117
Saves	0.30 (0-14)	0.40 (0-31)	.943
Batters faced	257.4 (29.0-527.4)	277.8 (18.5-596.9)	.101
Innings pitched	60.4 (5.3-122.1)	64.8 (3.3-140.9)	.098

^aData are median (range). UCLR, ulnar collateral ligament reconstruction.

was no difference in the likelihood of a DL assignment for elbow injury ($P = .877$). In the UCLR group, 4 of the 38 players (10.5%) had a retear of the UCL graft. In the control group, 18 of the 114 had a UCLR (15.8%), with 1 of those players having a retear and revision surgery ($P = .425$). These results are summarized in Table 10.

DISCUSSION

Since the initial description of the procedure by Jobe et al,¹⁸ UCLR has been studied to determine efficacy and endurance. To our knowledge, no previous work has studied the rate of professional advancement among pitchers drafted with and without UCLR as amateurs. Our results give confidence that players having undergone UCLR before the MLB draft can progress through the minor league ranks with similar success. Interestingly, our UCLR pitchers were slightly older (approximately half year) and heavier (6 lb), in all likelihood related to the additional time spent with surgical treatment, subsequent rehabilitation, and conditioning programs. While this met statistical significance, we do not believe it is clinically significant. We do not believe the slight age or weight difference has a protective effect on future injury. The UCLR players had a significantly greater chance of being assigned to the DL; however, the number of days spent on the DL and the risk of DL assignment for elbow injury were similar whether they had a previous UCLR or not. This could serve as valuable information to counsel players

TABLE 9
Performance Statistics per Inning^a

Statistic per Inning	UCLR	Control	P Value
Hits	0.97 (0.66-1.60)	1.01 (0.52-1.74)	.511
Runs	0.52 (0.32-1.60)	0.54 (0.22-1.15)	.432
Home runs allowed	0.07 (0.02-0.20)	0.08 (0.00-0.18)	.022
Strikeouts	0.85 (0.49-1.27)	0.85 (0.50-1.64)	.563
Walked	0.43 (0.19-1.00)	0.36 (0.19-1.22)	.066
Struck batters	0.05 (0.00-0.10)	0.06 (0.00-0.21)	.189

^aData are median (range). UCLR, ulnar collateral ligament reconstruction.

TABLE 10
Risk of Future Injury^a

Future Injury	UCLR	Control	P Value
DL assignment, n/N (%)	33/38 (86.8)	73/114 (64.0)	.008
Days on DL, median (range)	103.0 (10-521)	94.0 (7-668)	.316
DL for elbow, n/N (%)	15/33 (45.5)	32/73 (43.8)	.877
Tear or retear, n/N (%)	4/38 (10.5)	18/114 (15.8)	.425

^aDL, disabled list; UCLR, ulnar collateral ligament reconstruction.

undergoing this procedure and potentially modifying the postoperative maintenance program. Generalization to all amateur players should be done with caution however, as we studied only the individual players who were drafted and not all who underwent UCLR.

A similar approach to assess the efficacy of UCLR is reflected in a study by Cain et al,⁷ who reported on 1281 consecutive UCLRs over a 16-year period. With a minimum 2-year follow-up, the authors noted 83% return to same or higher level of competition overall. Among amateurs, 5 of 346 collegiate pitchers (1.6%) advanced to major league play and 66 (19%) advanced to minor leagues. It is important to note there were no controls for these players in terms of professional advancement.

Recently published works show a high return to play with longevity of the procedure. Osbahr et al²⁴ demonstrated 90% return to play at equal or higher level at 1 year, with a baseball career average of 3.6 years postoperatively. However, the longevity of the career varied with level of preoperative performance. Professional players (major and minor league) had significantly longer postoperative playing careers than did amateur players undergoing the same procedure at average of 12.6-year follow-up. In addition, higher level of play was associated with increased risk of additional procedures on the elbow. The authors hypothesized that teams have a larger investment in major league players, but that the longevity is more likely to be multifactorial.

Performance data after reconstruction have also garnered interest. Makhni et al²¹ reviewed 147 postoperative pitchers from the major league level. They showed that MLB pitchers returned to the major leagues for at least 1

game 80% of the time, with minimum 1-year postoperative follow-up. Performance metrics including ERA, batting average against, WHIP, innings, and velocity declined from preoperative measures. When compared with controls, however, the decline was similar over time. Erickson et al¹² also reviewed MLB performance after UCLR. Their results showed return to play overall at 97.6% and return to major league level at 83%. In addition, performance improvement was noted postoperatively, with fewer losses, improved winning percentage, lower ERA, and fewer walks, hits, and home runs allowed. When compared with controls, the group showed significantly better performance in these baseball statistics. It is important to note that these studies reviewed only players who had already achieved major league status. Our data show contrary outcomes with regard to performance, as most of the variables revealed no significant difference between pitchers with and without surgery. While these statistics are influenced by the performance of the individual, they also reflect the effect of the entire team and the environmental conditions.

There are limited data published on UCLR in younger athletes. Petty et al²⁵ studied UCLR in high school baseball players and reported a return to play of 74%, with 37% of players advancing to the college ranks. There was no report of performance metrics or reinjury. Jones et al¹⁹ studied UCLR in 55 athletes age 15 to 18 years (average, 17.6 years), with minimum 2-year follow-up. They reported 93% excellent results in the baseball players (47/55 cases) on the Conway score, indicating return to same level or higher for 12 months. No performance data were reported. These studies also did not report a control group for comparison. Our study selected only those players already drafted by the MLB, so direct comparison to other amateur reports is difficult.

Our study had several strengths. To eliminate selection bias, we attempted to identify players from the draft years studied who had UCLR before the draft. Our controls were carefully selected to provide players with similar skill and size (height and weight), which should make the conclusions more accurate. Our 3:1 control-to-subject ratio should also improve the conclusions, as this allowed more data points for comparison. Our analysis of performance metrics was similar to those in previously published works, which adds to the knowledge of this subject.

Our study did have some limitations. The DL is not an ideal measure of the magnitude of injury; however, the same criteria were applied for both the study and control subjects, so we believe this has minimal effect on our conclusions. In addition, all players had been drafted, so generalizing these data to all amateur players undergoing a UCLR should be done with caution. To strengthen our conclusions, more players can be added and longer follow-up included. On average, many players take years to advance to the major league level, and more follow-up would capture players who advanced to the highest level over a longer time. Our data did show statistical significance between groups for age and weight. The UCLR group was approximately 5 months older and 6 lb heavier. The age difference could be attributed to time lost during rehabilitation. For example, collegiate athletes using a medical red shirt year (a year

when athletes with injuries do not compete that does not count against collegiate eligibility) would add an extra year to their amateur career and make them slightly older. We set a range of a 10-lb weight limit when matching study and control athletes. Our results showed a 6-lb difference between groups that reached statistical significance. However, we felt that this was not clinically significant, and this alone would not affect the validity of our outcomes. In addition, during draft evaluations, players may have been downgraded after surgery by a ball club. For example, a player with talent or potential otherwise earning an "A" grade may have been graded a "B" due to the surgical history. He would have been drafted in a later round, with the control players graded a "B" based solely on talent or potential. Draft grades are multifactorial and subjective. Because there is no way to determine how much surgery affected draft grade or position, we believe our criteria are the best available and still give meaningful comparison. Moreover, some players have had stellar careers despite being drafted in the later rounds, while some top draft picks have not lived up to their expectations. We believe that position in the draft still gives a fair comparison taking all variables into consideration.

In summary, undergoing UCLR as an amateur does not appear to limit professional advancement among pitchers drafted in the MLB draft when compared with matched controls. The predraft procedure does not appear to limit performance, and in reference to some of the variables, the UCLR pitchers performed slightly better than controls. While they are more likely to be placed on the DL, the UCLR players appear to spend the same amount of time on the DL as do the unoperated players. In the future, detailed analysis of the performance variables and the injuries will further elucidate the true value of the UCLR procedure.

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