

# Using Pitch-Tracking Data to Identify Risk Factors for Medial Ulnar Collateral Ligament Reconstruction in Major League Baseball Pitchers

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**Background:** Approximately 25% of Major League Baseball (MLB) pitchers undergo medial ulnar collateral ligament reconstruction (UCLR) during their careers.

**Purpose:** To identify risk factors for UCLR that are specific to 2 subgroups of MLB pitchers: right (RHPs)- versus left-handed pitchers (LHPs) and starting (SPs) versus relief pitchers (RPs).

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

**Methods:** We included 109 MLB pitchers who had undergone UCLR between 2007 and 2019 and had sufficient preinjury data in the 3 years before surgery (T3, T2, T1). A 2:1 matched control cohort was selected for comparison. Pitch velocity, release location, and ball movement were compared between the UCLR and control cohorts in both subgroups in the years before surgery (RHPs vs LHPs and SPs vs RPs). Binary logistic regression was used to identify independent risk factors for UCLR.

**Results:** The mean horizontal release location for the UCLR group was 5.8 cm more lateral than for the control group ( $P = .028$ ). For all pitchers, every 2.5-cm lateral shift in release location in the years leading up to UCLR equated to a 3.7% increase in the odds of UCLR. For RPs, this risk was more substantial: a 5.8% increase in odds per 2.5 cm. SPs in the UCLR group demonstrated significantly different T1 horizontal release locations compared with SPs in the control group, though not to a statistically significant change over the 3 years before surgery. However, in the 3 years before surgery, the horizontal release location for RPs in the UCLR group moved 2.1 cm more lateral, as compared with 2.7 cm more medial for RPs in the control group ( $P = .007$ ). For LHPs, a decrease in mean pitch velocity by 1 mph (1.6 km/h) in the years leading up to surgery increased the odds of UCLR by 45%.

**Conclusion:** Increasing lateralization of release point in the years before surgery increased the risk of UCLR, specifically for relievers. Our findings add to the growing body of evidence that release location is an important variable in analyzing the risk of UCLR in MLB and that risk stratification may be dependent on pitcher characteristics such as position, handedness, and weight.

**Keywords:** UCLR; MLB; pitch tracking; medial ulnar collateral ligament reconstruction; risk factors

Approximately 25% of Major League Baseball (MLB) pitchers undergo medial ulnar collateral ligament reconstruction (UCLR) at some point during their careers.<sup>6</sup> UCLR has become increasingly prevalent in the amateur and professional levels, with many attributing the rise in UCLR among baseball players to overuse at young ages.<sup>15</sup> Among MLB pitchers, UCLR is generally considered successful, with return-to-play rates ranging from 79% to 87%.<sup>2,3,7,10,12,14,16,17,19,28</sup> Biomechanical studies<sup>4,8,21,24,25</sup> have identified that peak valgus stress of the elbow occurs

during the maximal external rotation and acceleration phases of the pitching motion leading up to ball release. These stresses are estimated to peak at 120 N·m<sup>24</sup> and are supraphysiologic loads to the medial ulnar collateral ligament.

Improved technology, such as SportsVision's PITCHf/x and Statcast's Trackman, at all MLB ballparks has resulted in the ability to track every pitch that is thrown in all MLB games for the past 13 years. Pitches are analyzed using high-speed cameras that track ball trajectory from release out of the pitcher's hand to home plate within 1.02 cm of the ball's precise location.<sup>27</sup> Information about each pitch thrown is stored in publicly available, easily accessible databases that have drastically improved pitching analysis

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capabilities. In previous studies,<sup>18,19</sup> these data demonstrated that pitch release location is more medial after UCLR.

Although previous studies have explored risk factors related to UCLR, there has been limited research on differences in these risk factors among subgroups of pitchers; rather, findings have been generalized to all MLB pitchers. Pitchers are commonly classified by their handedness and/or position. For handedness, pitchers are listed as right-handed pitchers (RHPs) or left-handed pitchers (LHPs) based on their dominant throwing arms. For position, pitchers are listed as starting pitchers (SPs) or relief pitchers (RPs) based on when they typically enter the game. Solomito et al<sup>22</sup> studied mechanical differences in RHPs versus LHPs and found differing biomechanics, including elbow flexion, horizontal glenohumeral abduction, and wrist coronal plane motion, though no study has demonstrated these specific differences in pitchers who underwent UCLR. Additionally, LHPs are typically thought to have lower pitch velocities. Given the natural tendency of right-hand dominance, LHPs are considered high commodities by general managers because of their scarcity. SPs and RPs typically have very different pitch counts over the course of the MLB season, and overuse and fatigue are considered important risk factors for UCLR; thus, it is important to evaluate these types of pitchers differently.<sup>13</sup>

This study aimed to identify risk factors for eventual UCLR that are specific to 2 subgroups of MLB pitchers: RHPs versus LHPs and SPs versus RPs.

## METHODS

### Data Collection

Using a publicly available database,<sup>23</sup> we identified 260 MLB pitchers who underwent UCLR between 2007 and 2019. Each player's age, height, weight, handedness, years of MLB experience before surgery, draft round, birthdate, date of surgery, and date of return to play were collected from 2 online sources (Baseball-Reference.com, Fan-Graphs.com) and stored in a spreadsheet (Excel for Mac 16.39; Microsoft Corp). The date of surgery was used as the index date for data collection for the calendar year before surgery. The calendar year immediately before surgery was labeled T1; the year before that, T2; and the year before that, T3. Pitchers who started in  $\geq 50\%$  of games for the T1 season were designated as SPs. Pitchers who started in  $< 50\%$  of games in the season before UCLR were

identified as RPs. As all data in this study were accessed using publicly available resources, no institutional review board approval was necessary.

### Pitch-Tracking Data

Pitch tracking is done via high-speed cameras that follow the baseball along the trajectory from its release point to home plate, within 1.02 cm of the ball's precise location. SportsVision's PITCHf/x was used to track pitchers between 2007 and 2016, and Statcast's Trackman was used in the 2017-2019 seasons. PITCHf/x and Trackman use algorithms based on ball speed, spin, and movement to classify each pitch that a pitcher throws into known categories for pitch type. The data are compiled by BrooksBaseball.net, among other sources, for analysis. We evaluated the frequencies of the following pitch types: 4-seam fastballs, sinkers (ie, 2-seam fastballs), changeups, curveballs, and sliders. The pitch release location was collected as a pair of horizontal and vertical coordinates measured in feet from the center and top of the mound. The horizontal release location collected for LHPs was normalized to that of an RHP. Because release location and velocity are recorded by individual pitch types, each pitcher's mean release location and mean pitch velocity were then calculated with a weighted mean of all the pitches thrown during the collected period.

### Preinjury UCLR Cohort

Of the 260 pitchers, 109 threw  $\geq 100$  pitches in all 3 calendar years preceding the surgery date (T1, T2, T3), forming the UCLR cohort. The UCLR cohort was subdivided by position and handedness. Of the 109 pitchers in the UCLR cohort, 48 were SPs, and 61 were RPs. Pitchers were labeled RHPs or LHPs based on their dominant pitching arms. The UCLR cohort consisted of 109 pitchers who were matched with 218 pitchers in the control cohort: 85 RHPs (78%) versus 24 LHPs and 48 SPs (44%) versus 61 RPs (Figure 1).

### Control Group

A cohort matched 2:1 by season, age, position, and pitch count was selected as a control. First, the season during which a pitcher in the UCLR cohort underwent surgery was selected. Available controls were narrowed to matching position and handedness, then to age ( $\pm 2$  years), and finally

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Ethical approval was not sought for the present study.

by the most comparable number of pitches in that season. Pitchers were excluded if they had a history of UCLR at any stage of their careers or if they were chosen as controls for a different player. Descriptive and pitch-tracking data for the control pitchers were collected in the same way as for the UCLR cohort (Figure 1).

Statistical Analysis

Unpaired *t* tests and chi-square goodness-of-fit tests were used to compare means and proportions, respectively, between cohorts. Binary logistic regression with backward conditional elimination of variables was undertaken for all pitchers in the preinjury cohorts to determine risk for UCLR. These same methods were used for the following subgroups of pitchers: RHPs, LHPs, SPs, and RPs. The following were included: height, weight, T1 pitch-tracking

variables, and 3-year changes (T1 – T3) in preinjury pitch-tracking variables. All data analysis was performed in Excel for Mac and SPSS Version 26 (IBM Corp). *P* < .05 was considered statistically significant.

RESULTS

Cohort Characteristics

SPs were, on average, drafted 9.5 rounds earlier than RPs in the UCLR cohort (*P* < .001). SPs in the UCLR group were drafted 3.3 rounds earlier than SPs in the control group (*P* = .030). The remainder of their characteristics are shown in Table 1.

Pitch Release Location Before Injury

The mean horizontal release location for the UCLR group was 5.8 cm more lateral than that for the control group (*P* = .028). There was no significant difference in vertical release location. The net change in horizontal release location was significantly different: the UCLR cohort moved 2.4 cm more lateral in the 3 years leading up to surgery, as compared with the control cohort moving 1.5 cm more medial (*P* = .016). SPs who underwent UCLR demonstrated significantly different T1 horizontal release locations than control SPs but not to a statistically significant difference over the 3 years prior. Yet, in the 3 years before surgery, the horizontal release location for RPs who underwent UCLR moved 2.1 cm more lateral, as opposed to 2.7 cm more medial for control RPs (*P* = .007) (Table 2, Figure 2).

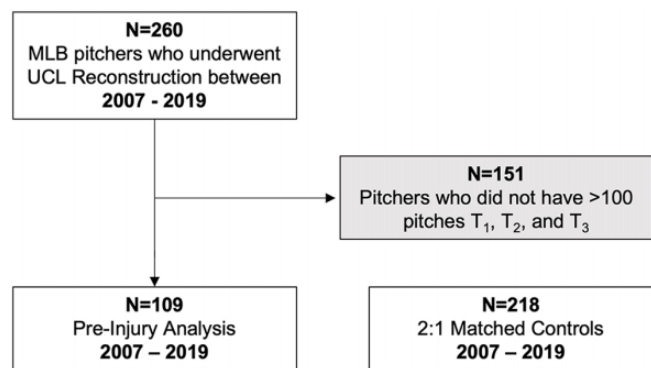


Figure 1. Study flow diagram. MLB, Major League Baseball; UCL, ulnar collateral ligament.

TABLE 1  
Player Characteristics by Cohort<sup>a</sup>

	Age, y	Height, m	Weight, kg	BMI	Draft Round	Experience, y
All pitchers						
Preinjury UCLR (n = 109)	29.7 ± 3.9	1.9 ± 0.1	100.2 ± 9.5	27.6 ± 2.3	8.9 ± 10.7	6.4 ± 3.5
Control (n = 218)	29.9 ± 3.2	1.9 ± 0.1	98.0 ± 10.0	27.0 ± 2.3	8.9 ± 10.4	6.9 ± 3.2
<i>P</i> value	.599	.860	.040	.013	.985	.194
Right-handed pitchers						
UCLR (n = 85)	29.6 ± 3.4	1.9 ± 0.1	101.1 ± 9.1	27.8 ± 2.1	8.3 ± 10.6	6.2 ± 3.0
Control (n = 170)	29.8 ± 3.2	1.9 ± 0.1	98.4 ± 10.4	27.0 ± 2.4	8.6 ± 10.4	6.8 ± 3.2
<i>P</i> value	.547	.905	.029	.013	.821	.159
Left-handed pitchers						
UCLR (n = 24)	29.9 ± 5.2	1.9 ± 0.1	96.6 ± 9.5	27.1 ± 2.8	10.9 ± 10.7	6.9 ± 4.8
Control (n = 48)	30.0 ± 3.5	1.9 ± 0.1	96.1 ± 7.7	26.7 ± 2.0	9.8 ± 10.6	7.1 ± 3.3
<i>P</i> value	.964	.540	.862	.511	.706	.830
Starting pitchers						
UCLR (n = 48)	29.5 ± 4.5	1.9 ± 0.1	101.6 ± 10.4	27.9 ± 2.4	3.5 ± 4.3	7.0 ± 4.1
Control (n = 96)	29.6 ± 3.2	1.9 ± 0.1	98.0 ± 10.4	26.9 ± 2.4	6.8 ± 8.5	7.3 ± 3.2
<i>P</i> value	.795	.915	.056	.023	.030	.561
Relief pitchers						
UCLR (n = 61)	29.8 ± 3.3	1.9 ± 0.1	98.9 ± 8.6	27.5 ± 2.2	13.0 ± 12.1	5.9 ± 2.9
Control (n = 122)	30.0 ± 3.2	1.9 ± 0.1	97.5 ± 9.5	27.0 ± 2.2	10.7 ± 11.5	6.5 ± 3.2
<i>P</i> value	.630	.888	.322	.210	.258	.204

<sup>a</sup>Values are presented as mean ± SD. BMI, body mass index; UCLR, ulnar collateral ligament reconstruction.

TABLE 2  
Mean and Change in Release Location and Pitch Velocity by Cohort<sup>a</sup>

	T1			Δ (T1 – T3)		
	Horizontal Release Location, cm	Vertical Release Location, cm	Pitch Velocity, km/h	Horizontal Release Location, cm	Vertical Release Location, cm	Pitch Velocity, km/h
All pitchers						
Preinjury UCLR	–64.9 ± 20.7 (–67.1 to –62.8)	183.2 ± 14.6 (181.7 to 184.7)	143.4 ± 5.5 (142.9 to 143.9)	–2.4 ± 13.4 (–3.7 to –1.1)	0 ± 6.7 (–0.6 to 0.6)	–0.8 ± 3.4 (–1.1 to –0.4)
Control	–59.1 ± 22.6 (–60.7 to –57.6)	182.9 ± 20.4 (181.4 to 184.4)	141.6 ± 5.0 (140.0 to 141.9)	1.5 ± 14.6 (0.5 to 2.5)	–0.3 ± 5.8 (–0.1 to 0.7)	–0.3 ± 3.7 (–0.5 to 0.0)
<i>P</i> value	<b>.028</b>	.860	.573	<b>.016</b>	.814	.231
Right-handed pitchers						
UCLR	–63.7 ± 19.2 (–65.8 to –61.6)	182.3 ± 14.6 (180.7 to 183.8)	144.5 ± 5.0 (144.0 to 145.0)	–1.2 ± 11.0 (–2.4 to 0.0)	0.3 ± 5.5 (–0.3 to 0.9)	–0.5 ± 3.3 (0.2 to 0.9)
Control	–58.2 ± 22.6 (–60.0 to –56.4)	182.3 ± 21.6 (180.7 to 183.8)	143.6 ± 4.8 (143.2 to 143.9)	1.8 ± 14.9 (0.7 to 3.0)	–0.30 ± 6.1 (–0.8 to 0.2)	–0.5 ± 3.6 (–0.8 to –0.2)
<i>P</i> value	.068	.992	.146	.097	.657	.735
Left-handed pitchers						
UCLR	–68.9 ± 24.7 (–74.1 to –63.7)	186.8 ± 14.0 (184.1 to 189.6)	139.9 ± 5.6 (138.7 to 141.0)	–6.7 ± 19.5 (–10.7 to –2.7)	–0.9 ± 9.8 (–2.9 to 1.1)	–1.0 ± 3.3 (–1.7 to –0.3)
Control	–61.6 ± 23.8 (–64.9 to –58.2)	185.0 ± 14.9 (182.9 to 187.1)	141.6 ± 5.5 (140.8 to 142.4)	0.6 ± 12.8 (–1.3 to 2.5)	–0.6 ± 5.2 (–0.1 to 1.3)	0.8 ± 4.3 (0.1 to 1.4)
<i>P</i> value	.221	.618	.203	.057	.788	.081
Starting pitchers						
UCLR	–65.5 ± 19.8 (–68.3 to –62.8)	185.9 ± 11.6 (184.4 to 187.5)	141.9 ± 4.8 (141.3 to 142.6)	–2.7 ± 15.2 (–5.0 to –0.5)	–1.2 ± 7.9 (–2.4 to –0.1)	–0.5 ± 2.8 (–0.9 to –0.1)
Control	–56.7 ± 22.2 (–58.8 to –54.6)	187.5 ± 11.6 (186.2 to 188.7)	141.6 ± 4.0 (140.3 to 142.1)	0 ± 17.4 (–1.8 to 1.8)	–0.9 ± 5.8 (–1.5 to –0.3)	–0.8 ± 3.3 (–1.1 to –0.4)
<i>P</i> value	<b>.022</b>	.404	.633	.362	.824	.564
Relief pitchers						
UCLR	–64.3 ± 21.3 (–67.1 to –61.6)	181.1 ± 16.2 (178.9 to 183.2)	144.5 ± 5.6 (143.9 to 145.2)	–2.1 ± 11.4 (–3.6 to –0.6)	0.9 ± 5.2 (0.3 to 1.6)	–1.0 ± 3.8 (–1.5 to –0.5)
Control	–61.0 ± 23.2 (–63.1 to –58.8)	178.9 ± 24.7 (176.7 to 181.1)	144.2 ± 5.5 (143.7 to 144.7)	2.7 ± 11.6 (1.7 to 3.8)	0.3 ± 6.1 (–0.3 to 0.9)	0.3 ± 4.1 (–0.1 to 0.6)
<i>P</i> value	.348	.559	.708	<b>.007</b>	.577	.067

<sup>a</sup>Values are presented as mean ± SD (95% CI). Bold *P* values indicate statistically significant difference between groups (*P* < .05). UCLR, ulnar collateral ligament reconstruction; T1, one year prior to surgery; T3, 3 years prior to surgery.

### Pitch Velocity Before Injury

The mean pitch velocity was 143.4 kph (89.1 mph) for the UCLR cohort and 141.6 kph (88.0 mph) for the control cohort. RHPs and RPs threw faster, on average, than their counterparts, but there were no statistically significant differences between the UCLR and control cohorts. There was also no statistically significant difference in the changes in the 3 preinjury years for each cohort. The UCLR cohort demonstrated, on average, a nonsignificant decline in pitch velocity from 0.3 to 0.6 kph (0.2–0.4 mph). The LHPs and RPs in the control cohort actually increased their velocity over the same years, though differences were not statistically significant.

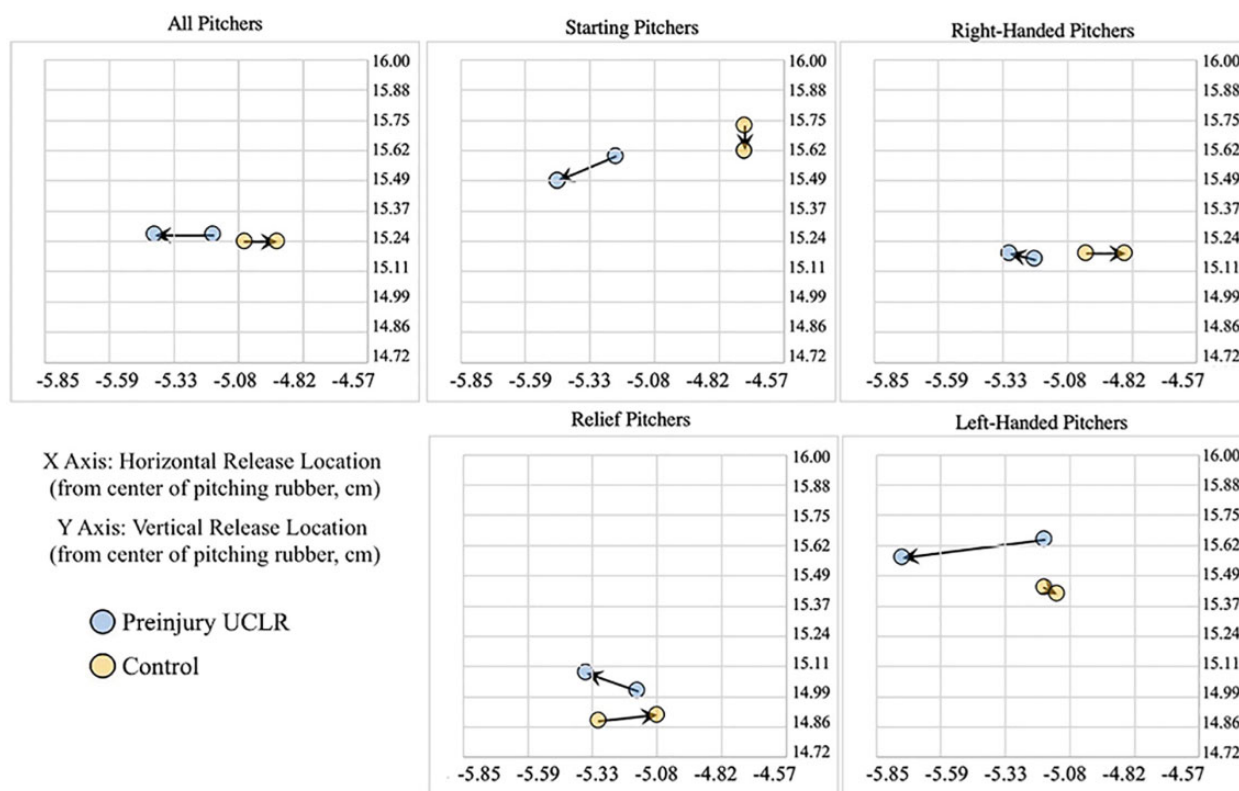
### Risk of UCLR

Before analysis of the various subgroups, the only independent variable that was associated with an increased risk of UCLR was a more lateral change in horizontal release

location in the years leading up to surgery. The odds ratio of 0.551 corresponded to increased odds of about 3.7% for every 2.5 cm lateralized. This change was identified as a significant risk factor for LHPs and RPs with a larger effect; specifically, for every 2.5 cm of lateralization in RPs, the odds of UCLR increased by 5.8%. Heavier body weights were associated with increased odds of UCLR in RHPs and SPs but not in LHPs or RPs. Last, for LHPs, a decrease in mean pitch velocity by 1 mph (1.6 kph) in the years leading up to surgery increased the odds of UCLR by 45% (Table 3).

### DISCUSSION

The purpose of this study was to identify risk factors for eventual UCLR among 2 subgroups of MLB pitchers: SPs versus RPs and LHPs versus RHPs. Our analysis revealed that release location is a strong independent risk factor for UCLR. Pitchers who ultimately needed UCLR had a more lateral release location in the year before surgery when compared with controls. Additionally, the UCLR cohort



**Figure 2.** Release location per cohort by year. The preinjury ulnar collateral ligament reconstruction (UCLR) cohort (blue) demonstrated lateralization in the years leading up to surgery. The control cohort (yellow) did not demonstrate lateralization but rather a net medialization. Also shown are the effects of handedness and position on release location.

**TABLE 3**  
Results of Logistic Regression<sup>a</sup>

	$\beta$	Odds Ratio	P Value
All pitchers			
Weight	0.011	1.011	.054
Δ Horizontal release location	-0.597	0.551	<b>.028</b>
Left-handed pitchers			
Δ Velocity	-0.605	0.546	<b>.012</b>
Δ Horizontal ball movement	-0.638	0.528	<b>.013</b>
Right-handed pitchers			
Weight	0.013	1.013	<b>.041</b>
Year 1 horizontal release location	-0.321	0.726	.096
Starting pitchers			
Height	-0.187	0.829	.067
Weight	0.024	1.024	<b>.015</b>
Year 1 horizontal release location	-0.690	0.501	<b>.012</b>
Δ Velocity	0.271	1.312	.099
Relief pitchers			
Δ Velocity	-0.186	0.830	.081
Δ Horizontal release location	-1.192	0.304	<b>.010</b>

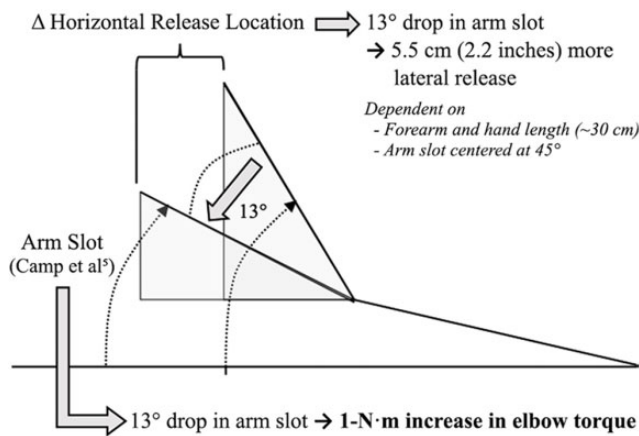
<sup>a</sup>Bold P values indicate statistical significance ( $P < .05$ ).

demonstrated a trend of increased lateralization in the 3 years leading up to UCLR. These results are consistent with the findings from Portney et al<sup>18</sup> when examining release location among MLB pitchers in the years

preceding UCLR. However, this study is the first to suggest that lateralization of release point may contribute more to UCLR risk in RPs than SPs, which can inform future injury prevention strategies.

With more pitchers than in previous studies, this study adds to the current evidence that a more lateral horizontal pitch release location is a risk factor for UCLR.<sup>18</sup> Aguineldo and Chambers<sup>1</sup> reported that increased elbow extension, sidearm delivery, and early trunk rotation increased valgus torque in MLB pitchers. Specifically, we believe that release point is a surrogate for elbow flexion and extension during the pitching motion, though our methods cannot sufficiently prove this relationship. Elbow flexion at stride foot contact and that at pitch release are 2 important variables associated with elbow valgus stress.<sup>1,25,26</sup> The horizontal release location is a function of numerous variables—specifically, where the player is positioned according to the center of the mound, trunk inclination at release, shoulder abduction angle at release, and elbow flexion angle at release. There is no evidence that the former has any relationship with UCL injury; however, since this study is not a true biomechanics analysis, we cannot rule this out as a contributor of confounding. In a more recent study, Camp et al<sup>5</sup> found that arm slot, defined as the angle of the forearm with respect to the ground, was 1 of 3 variables associated with increased stress on the elbow. While it is not possible to delineate elbow flexion angle from





**Figure 3.** Trigonometric model displaying the relationship of arm slot, elbow flexion angle, and horizontal release location with increased elbow torque. This simplified model does not take into account how trunk inclination and shoulder abduction factor into the arm slot calculation.

the other 2 determinants of pitch release location, we suspect that all 3 are interrelated and pose increased stress on the elbow. In that study, a 13° drop in arm slot was associated with a 1-N·m increased torque at the elbow.<sup>5</sup> Using average arm lengths and flexion angles, that amounts to a change of 5 to 8 cm in lateral release location (Figure 3).

The difference in workloads and usage patterns between SPs (large number of pitches thrown in regular 5- to 6-day intervals) and RPs (small number of pitches thrown in irregular intervals) may explain some of the variation in risk factors for UCLR observed between these groups. Freehill et al<sup>9</sup> reported that SPs showed an increase in internal rotation and total range of motion over the course of the season, whereas RPs had significant worsening of glenohumeral internal rotation deficit as the season progressed. The authors hypothesized that the increased structure of a 5-day rotation and the associated training protocols may have been protective against increased glenohumeral internal rotation over the course of the season. It is difficult to directly extrapolate how this may relate to the observed differences of pitch release location. However, it is plausible that the increased structure that SPs have allows trainers to identify and address pitching mechanics changes and prevent lateralization of the release location.

Additionally, we hypothesize that there may be a difference in how SPs and RPs weigh the risk of lateral release locations on valgus stress and fatigue with the benefits offered by a more lateral release. More horizontal release locations were associated with more horizontal ball movement and may improve pitcher success. Furthermore, SPs typically have 3 or 4 frequently thrown pitch types, whereas relievers often focus on throwing 2 or 3 pitch types.

Despite the fact that studies<sup>10,11</sup> have indicated higher pitch velocity among pitchers who ultimately need UCLR, this study did not identify increased mean pitch velocity as an independent risk factor. These findings are consistent with what Prodrromo et al<sup>20</sup> reported in a study that

examined pitch characteristics before UCLR surgery in MLB pitchers. Finally, binary logistic regression indicated that pitchers with UCLR tended to be heavier and have a higher body mass index than control pitchers. Future biomechanical analysis should explore the effect of increased weight and body mass index on valgus stress to the ulnar collateral ligament that often leads to rupture.

## Limitations

There are several limitations to our study. First, pitch-tracking data were obtained from publicly available internet sources and thus are as accurate as those sources. However, this type of pitch-tracking data has been used in many peer-reviewed studies.<sup>18,19</sup> Second, the pitch-tracking tool used for the analysis provides release location as a coordinate pair from the center of the pitching mound; yet, as mentioned, this tool does not take into account joint angles at the shoulder and the elbow when the ball is released and does not account for where the pitcher stands relative to the mound, which can change from batter to batter and over time. Third, our selection criteria included pitchers with UCLR who had sufficient MLB pitch counts in at least 3 years studied; therefore, our results may not be generalizable to players with less experience. Finally, we classified pitchers as SPs or RPs based on the percentage of games started in the year before UCLR. Nonetheless, pitchers may transition from an SP to an RP and vice versa. If pitchers started in  $\geq 50\%$  of games during the T1 season, they were classified as SPs in our study, although it is possible that in T2 or T3, pitchers would have qualified as RPs using the same criteria. There is no precedent to deal with positional variation in the literature. Despite these limitations, our study findings revealed a relationship between horizontal release location and risk for UCLR and suggested that significant differences exist when examining risk factors for UCLR in SPs versus RPs and LHPs versus RHPs.

## CONCLUSION

Although previous studies have identified increasing lateralization of release point in the years before surgery as a risk factor for UCLR, our study found that this may be the case among RPs, not starters. These data add to the growing body of evidence that release location is an important variable in analyzing the risk of UCLR in MLB and that risk stratification may be dependent on pitcher characteristics such as position and weight.

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