

# Effect of COVID-19 on Ulnar Collateral Ligament Reconstruction in Major League Baseball Pitchers

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**Background:** The coronavirus disease of 2019 (COVID-19) pandemic led to the suspension and shortening of the 2020 Major League Baseball (MLB) season from 162 to 60 regular season games. The effect of this disruption on injury rates, specifically injury to the ulnar collateral ligament (UCL), has not been quantified.

**Purpose/Hypothesis:** The purpose of this study was to compare the rate of UCL reconstruction (UCLR), surgery timing, and pitching workload in MLB pitchers from before and after the COVID-19 pandemic lockdown. We hypothesized that UCLR rates relative to games played would be increased and pitching workload would be decreased in 2020 compared with previous seasons.

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

**Methods:** An extensive online search using publicly available data was conducted to identify all MLB pitchers who underwent UCLR between January 1, 2017, and December 31, 2020. Only pitchers who were competing at the MLB level when undergoing reconstruction were included. Player characteristics and surgery date, as well as career and season of surgery pitching workload, were collected for all included pitchers. All data were compared as a pooled sample (2017-2019 vs 2020).

**Results:** A similar number of pitchers underwent UCLR during or after the 2020 regular season ( $n = 18$ ) compared with the 2017-2019 seasons ( $n = 16, 20,$  and  $16,$  respectively). However, after accounting for the decrease in games played during the 2020 regular season, an MLB pitcher was 2.9 times more likely to undergo surgery per game after the COVID-19 lockdown compared with the previous years ( $P < .001$ ). MLB pitchers who underwent surgery in 2020 threw fewer preseason innings than did pitchers who underwent surgery between 2017 and 2019 (5.98 vs 9.39;  $P = .001$ ).

**Conclusion:** MLB pitchers were almost 3 times more likely to undergo UCLR per game after the COVID-19 lockdown. A decreased preseason pitching workload because of the COVID-19 lockdown may have had an effect on per game UCLR rates.

**Keywords:** ulnar collateral ligament; reconstruction; MLB; COVID-19

The coronavirus disease of 2019 (COVID-19) can significantly affect the pulmonary, cardiac, and neurological systems.<sup>1,3,4,11,29,40,44</sup> However, there is limited literature on the effect of COVID-19 on sporting injuries. After the normal start of spring training during February 2020, on March 12, 2020, the Major League Baseball (MLB) season was suspended indefinitely in an effort to limit the spread of the virus. Players were sent home from spring training without a timeline as to when competitive play would return. After months of lockdown, teams eventually returned to structured practice on July 1. The regular season subsequently began on July 23, which meant an abbreviated spring training, and the season length was adjusted to only 60 games instead of the standard 162 games.

MLB players frequently experience injury, with a mean of 1373 MLB injuries per year.<sup>8</sup> Epidemiologic studies that have analyzed data from the injured player list have demonstrated an increasing injury rate in professional baseball.<sup>15,16,26</sup> In particular, ulnar collateral ligament (UCL) injuries and UCL reconstruction (UCLR) rates have seen a considerable rise.<sup>7,17</sup> Despite often taking 12 to 20 months for recovery, the majority of players are able to return to play after UCLR.<sup>7,19,20,27,35</sup> Whiteside et al<sup>43</sup> and others have identified several risk factors for UCLR in MLB pitchers, including fewer days between consecutive games, a smaller repertoire of pitches, a less pronounced horizontal release location, a smaller stature, greater mean pitch speed, and greater mean pitch counts per game.<sup>13</sup> Further risk factors, such as the beginning of the season and warmer weather climates, have also been noted in similar studies.<sup>18,21</sup> Inadequate off-season preparation can also be a risk factor for injury.<sup>37</sup> Byram et al<sup>6</sup> noted that preseason weakness of external rotation and weakness in

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supraspinatus testing were associated with in-season throwing injury in baseball pitchers. Similarly, Camp et al<sup>9</sup> found that preseason deficits in shoulder external rotation and flexion are independent risk factors for future elbow injuries. Although these studies have provided valuable information for athletes and teams, it is unclear whether this information can be applied to such a unique and shortened MLB season.

To our knowledge, only 1 study has analyzed injury rates after the COVID-19 lockdown, demonstrating that German soccer players were 3.1 times more likely to be injured after the lockdown, with adjustment for games played.<sup>39</sup> Although anecdotally and throughout the media there have been reports of increased UCLR rates after the resumption of MLB play, there has been no formal analysis. The purpose of this study was to compare the UCLR rate in MLB pitchers relative to the number of games played before and after the COVID-19 pandemic lockdown. A secondary purpose was to compare UCLR timing and pitching workload between MLB pitchers before and after the COVID-19 lockdown. We hypothesized that UCLR rates would be increased and pitching workload would be decreased in 2020 compared with previous seasons.

## METHODS

An extensive online search using publicly available data was conducted by 3 of the authors (R.W.P., A.O., B.F.) to identify all MLB pitchers who underwent UCLR between the dates of January 1, 2017, and December 31, 2020. Only pitchers who were competing at the MLB level when undergoing UCLR were included. Excluded were Minor League Baseball pitchers, pitchers who underwent UCL repair with or without internal brace augmentation, pitchers who underwent any other surgery not specific to UCLR, and pitchers who underwent surgery before January 1, 2017, or after December 31, 2020.

Publicly available data were collected using Excel 2016 (Microsoft Corp) from the following sources: www.MLB.com, www.baseball-reference.com, game summaries, play-by-play documents, weekly injury reports, press releases, newspaper archives, and player profiles. UCLR was confirmed using 2 sources; for example, if UCLR was indicated for a pitcher on his player profile, a search using his name and either “Tommy John” or “ulnar collateral ligament” was conducted, and search results were read to either adjust or confirm the surgical intervention.

Pitching position (starting vs relief pitcher), age, height, weight, history of prior UCL injury and/or UCLR, and surgery date were collected as descriptive variables. The following variables were collected as workload variables: professional (MLB + Minor League Baseball) career total innings and games pitched; MLB career pitches thrown; season of UCLR preseason innings pitched (IP) and games pitched; and season of UCLR pitches thrown, IP, and games pitched. Minor League Baseball pitches thrown were not consistently publicly reported and thus were not included in our data collection. Number of pitchers to undergo UCLR was analyzed on 3 levels: per calendar year, during and after the regular season, and after the regular season only. Players were considered to undergo UCLR after the regular season if their surgery data were within 100 days of the last regular season game. Workload data were compared as a per game rate to account for the shortened 2020 MLB season. Descriptive and workload data were compared as a pooled sample (2017-2019 vs 2020).

## Statistical Analysis

Proportion testing was used to compare the number of pitchers who underwent UCLR per year. Chi-square analysis was performed to compare UCLR rates per 162-game season, with the 2020 rate calculated based on the observed UCLR rate over the 60-game season. To minimize outliers, a quantitative workload analysis was only performed on pitchers who underwent UCLR during or after the regular season. Independent-samples *t* tests were used to compare descriptive and workload data from 2017-2019 versus 2020. Mean, standard deviation, and 95% confidence interval were presented for all continuous variables, and categorical variables were presented as percentages. Injury rates were presented as number of UCLRs per MLB game. Statistical significance was set at  $P < .05$ . All statistical analysis was performed with R studio software (Version 3.6.3, Vienna, Austria).

## RESULTS

Overall, 106 MLB players, 95 of whom were pitchers, underwent UCLR between January 1, 2017, and December 31, 2020. There were 21 pitchers who underwent UCLR in 2017, 25 in 2018, 18 in 2019, and 31 in 2020 ( $P = .150$ ) (Figure 1). After isolating pitchers who underwent UCLR during or after the regular season, 16 pitchers were included in the quantitative workload analysis in 2017; 20 pitchers, in 2018; 16 pitchers, in 2019; and 18 pitchers, in 2020 ( $P = .840$ ).

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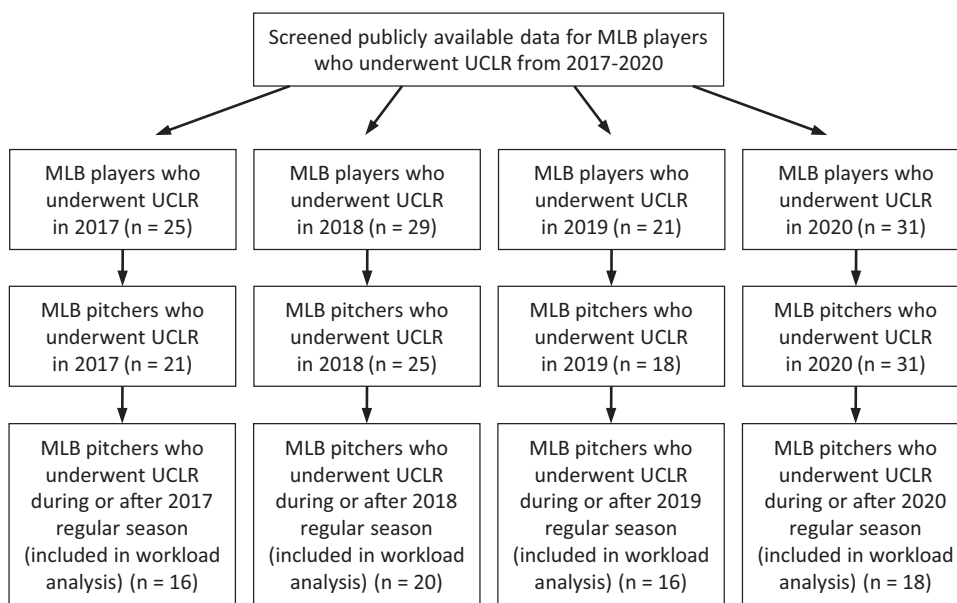
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Ethical approval was not sought for the present study.



**Figure 1.** Flowchart of player inclusion, with 95 MLB pitchers included in the qualitative analysis and 70 MLB pitchers included in the quantitative analysis. MLB, Major League Baseball; UCLR, ulnar collateral ligament reconstruction.

**TABLE 1**  
 Characteristics and Workloads Between Pitchers Who Underwent UCLR: 2017-2019 Seasons Versus 2020 Season<sup>a</sup>

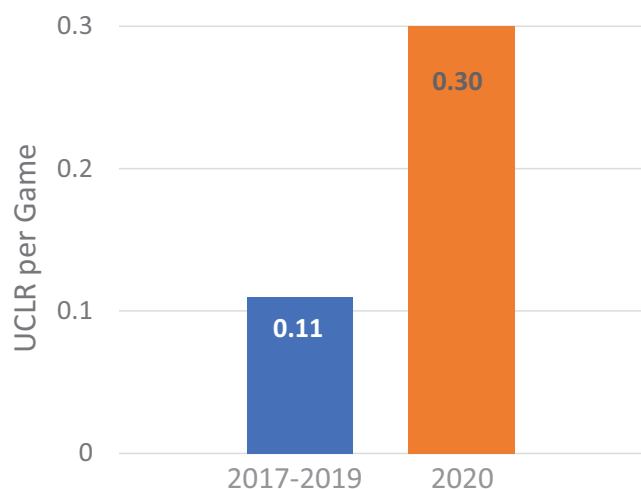
	2017-2019 (n = 52)	2020 (n = 18)	P
<b>Characteristics</b>			
Age, y	27 ± 2.69 (26.2-27.7)	27.4 ± 3.4 (25.7-29.1)	.650
BMI	27.6 ± 2.01 (27-28.2)	27.9 ± 2 (26.9-28.9)	.622
Prior UCLR, %	11.5	22.2	.268
Starting pitcher, %	55.8	44.4	.578
<b>Career workload</b>			
Total IP	671 ± 414 (556-787)	703 ± 630 (389-1016)	.847
Total games	233 ± 137 (195-271)	257 ± 155 (180-334)	.565
Total MLB pitches thrown	4658 ± 5880 (3021-6295)	5782 ± 11,032 (295-11,268)	.684
IP per game	3.43 ± 1.73 (2.94-3.91)	3.10 ± 1.78 (2.22-3.98)	.507
<b>Season of UCLR workload</b>			
Preseason IP	9.39 ± 5.22 (7.93-10.8)	5.98 ± 2.5 (4.73-7.23)	<b>.001</b>
Preseason games	5.23 ± 2.43 (4.55-5.91)	4.39 ± 1.97 (3.41-5.37)	.152
Regular season IP	43.94 ± 30.12 (35.75-52.12)	12.49 ± 12.80 (6.58-18.40)	<b>&lt;.001</b>
Regular season games played	19.06 ± 16.15 (14.67-23.45)	6.47 ± 5.30 (4.02-8.92)	<b>&lt;.001</b>
Regular season pitches thrown	730 ± 491 (596-863)	203 ± 195 (113-293)	<b>&lt;.001</b>
Regular season IP per game	2.45 ± 1.56 (2.01-2.89)	1.81 ± 1.31 (1.16-2.47)	.101
Regular season pitches thrown per game	25.5 ± 21.4 (18.2-32.9)	20.9 ± 20.9 (9.34-32.4)	.478

<sup>a</sup>Data are presented as mean ± SD (95% CI) unless otherwise indicated. Bolded P values indicate statistically significant differences between groups (P < .05). BMI, body mass index; IP, innings pitched; MLB, Major League Baseball; UCLR, ulnar collateral ligament reconstruction.

No significant characteristic differences or pitcher type (starting vs relief pitching) differences were observed between pitchers who underwent UCLR in 2017-2019 compared with 2020 (Table 1). Career pitching workloads before UCLR did not differ based on year of surgery. Pre-season games pitched and relative workload (IP per game and pitches thrown per game) during the season of injury also did not differ based on year of surgery. However, pitchers who underwent UCLR in 2020 threw significantly fewer

preseason innings than did pitchers from previous seasons (P = .001). Pitchers who underwent UCLR in 2020 also had significantly fewer IP, games played, and pitches thrown (all P < .001) compared with pitchers in 2017-2019.

Characteristics and career workloads were similar between starting pitchers who underwent UCLR in 2017-2019 versus 2020. Starting pitchers who underwent UCLR in 2020 did have significantly fewer preseason IP, regular season IP, regular season games, and regular season



**Figure 2.** Number of ulnar collateral reconstructions (UCLRs) performed during or after the regular season per Major League Baseball game, comparing 2017-2019 vs 2020.

itches thrown compared with starting pitchers who underwent UCLR in 2017-2019 ( $P = .003, <.001, .003, \text{ and } <.001$ , respectively). Similar results were observed when comparing relief pitchers; however, relief pitchers who underwent UCLR in 2020 also threw fewer pitches per game ( $P = .024$ ). The rest of the data for starting pitchers and relief pitchers is available in Appendix Tables A1 and A2.

Pitchers underwent UCLR more frequently in 2020 compared with 2017-2019 (2.2% of 2385 pitchers in 486 games in 2017-2019 vs 2.4% of 735 pitchers in 60 games in 2020;  $P < .001$ ). After adjusting for games played instead of comparing the per game UCLR rate, it was found that an MLB pitcher was 2.88 times more likely to undergo UCLR per game after the COVID-19 lockdown compared with previous years ( $P < .001$ ) (Figure 2).

No MLB pitchers underwent UCLR during April or May 2020, as players were sent home in March and no organized training or practices occurred between April and June (Figure 3). Six MLB pitchers then underwent UCLR in July 2020, as the preseason training began on July 1 and the regular season began on July 23. More pitchers underwent UCLR in 2020 compared with previous years in July (6 vs 3), August (5 vs 3.33), and September (7 vs 2.33). These trends were consistent when comparing the timing of UCLRs between all four years (2017-2020) individually and can be viewed in Appendix Figure A1.

Pitchers underwent UCLR during similar times of the regular season when comparing 2017-2019 to 2020 (Figure 4). However, significantly more pitchers underwent UCLR after the 2020 regular season compared with previous years (7 vs 1.33;  $P = .004$ ).

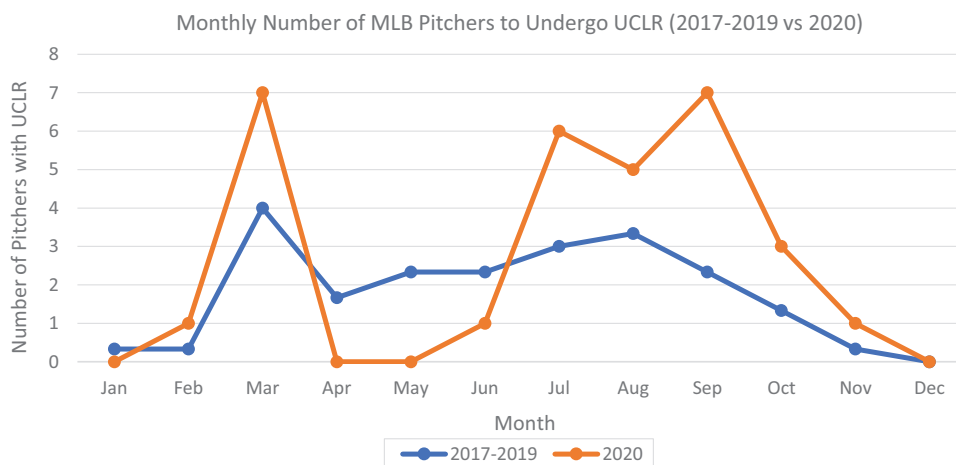
## DISCUSSION

COVID-19 presented a unique set of challenges during the 2020 MLB season, and the effect of the pandemic on injury rates has not been well defined. Our hypotheses were

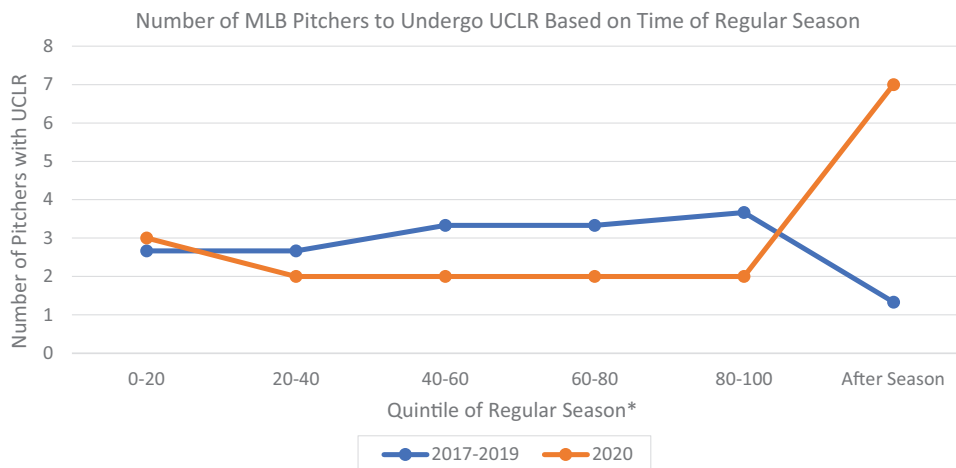
confirmed, as the per game UCLR rate was higher in 2020—MLB pitchers were 2.9 times more likely per game to undergo UCLR after the COVID-19 lockdown compared with previous years. Preseason and regular season workloads were significantly lower after the COVID-19 lockdown compared with previous years, as expected because of the shortened season. Interestingly, many more UCLRs were performed after the 2020 regular season than after the 2017-2019 regular seasons, potentially because of players' attempts to play through injury in a shortened 2020 season.

Annual UCLR rates should be compared cautiously because of the frequency of nonoperative treatment. Chauhan et al<sup>14</sup> evaluated 977 professional baseball players who were diagnosed with a UCL injury and found that 544 (56%) of these players attempted nonoperative treatment, with about half of these players experiencing failed nonoperative treatment and electing to undergo UCLR. Return to play rates after nonoperative treatment range from 54% to 93%, suggesting that nonoperative treatment is a viable option for professional players to return to play while avoiding the risks of surgery.<sup>14,23,24</sup> Thus, a player who sustains a UCL injury and attempts nonoperative treatment may not undergo UCLR until the following year. Without knowing the date of initial UCL injury, one cannot conclude that a UCLR is because of a UCL injury from that same year. To minimize this problem, we only quantitatively assessed players who underwent UCLR after the start of the regular season, as surgeries performed during or after the regular season are more likely to be because of the effects of that season.

Multiple authors have published recommendations to guide training and return to sports after the COVID-19 lockdown by applying traditional training and return to play principles.<sup>2,5,10,36,42</sup> They highlight the importance of maintaining physical health and body composition while away from structured team practice. Athletes who do not train adequately on their own may be at an increased risk of musculoskeletal injury when they fully return to play, as their body may not be prepared to handle the high forces and demands.<sup>2,5,42</sup> Throughout the COVID-19 lockdown, athletes may not have been able to perform their recommended sport-specific training and did not have full access to coaching and sports medicine personnel (athletic trainers, strength and conditioning coaches, etc).<sup>12,28,34</sup> However, only 1 other study has evaluated injury rates after the COVID-19 lockdown. Seshadri et al<sup>39</sup> compared injury rates from before (August 16–March 13) and after (May 16–June 27) the COVID-19 lockdown in an elite German soccer league. After adjusting for games played, players were 3.1 times more likely to sustain an injury after the COVID-19 pandemic. Several factors can contribute to increased injury rates after an absence of competition, such as suboptimal training conditions, a decrease in training duration and frequency, and a lack of preparation at a competitive level.<sup>37,41</sup> A study evaluating Achilles tendon injuries after the 14-week 2011 National Football League lockout suggested that biomechanical and neuromuscular deficits may also result from poor preseason conditioning,



**Figure 3.** Number of Major League Baseball (MLB) pitchers who underwent ulnar collateral ligament reconstruction (UCLR) during each month, the mean of 2017-2019 vs 2020.



**Figure 4.** Annual number of MLB pitchers who underwent UCLR during different times of the MLB season, 2017-2019 vs 2020. Only MLB pitchers who underwent UCLR during or after the regular season were included. \*0-20 represents the first one-fifth of the regular season, 40-60 represents the middle of the regular season, and 80-100 represents the last one-fifth or the end of the regular season. MLB, Major League Baseball; UCLR, ulnar collateral ligament reconstruction.

which also likely played a large role after the COVID-19 lockdown.<sup>30</sup>

Baseball pitchers are a particularly vulnerable group, as it also takes time for their arms to get ready for game competition. Pitchers often require several weeks, or even months, to develop their “arm strength” before the regular season, which requires throwing and pitching. Six weeks of MLB spring training, with about 4 weeks of semicompetitive games, helps pitchers develop their arm strength; however, professional pitchers have lately begun preparing for the season even earlier, with pitchers often arriving at spring training having been throwing for several weeks already. In 2020, MLB suspended spring training after about 3 weeks and sent players home until organized team training returned on July 1. During the COVID-19 lockdown, pitchers may not have had the ability or resources to throw and/or pitch before joining their teams on July 1.

Players then only had about 3 weeks to prepare for the regular season, as opposed to the usual  $\geq 6$  weeks. Even if a player maintained his body composition and strength, his arm strength entering the 2020 MLB regular season was likely diminished unless he had the resources at home to pitch.

To limit the injury risk during a lockdown, clinicians can provide at-home exercises to develop rotator cuff strength and tissue tolerance.<sup>22,25,31-33,38</sup> Maintaining shoulder range of motion and external rotation strength should be the main focus of upper extremity at-home exercises, while maintaining/developing leg and core strength is also valuable for developing an effective kinetic chain. Also, clinicians should talk to their athletes frequently throughout a lockdown to track their training progress and potentially identify injury risks without in-person physical evaluation. Finally, monitoring and potentially

limiting workload throughout the beginning of the regular season can promote proper arm strength and tissue tolerance development, as seen by the decreased IP per game during 2020.

### Limitations

This study has several limitations. First, the use of publicly available data may decrease the validity of our analysis, as the data collected were only as accurate as the information provided. Also, the timing of UCLR may have been affected by the pandemic lockdown restrictions, particularly during the spring, when elective surgeries were halted in many states. Plus, if any MLB pitchers underwent UCLR that was not publicly reported, they would not have been included in this study. The inaccuracy of pitch counts in the lower levels of Minor League Baseball is another limitation of our workload analysis, as we could not properly evaluate pitching workload throughout the full professional career. Finally, this study is observational; thus, the causation of UCLR rate and workload changes cannot be determined.

### CONCLUSION

In this study, MLB pitchers were almost 3 times more likely to undergo UCLR per game after the COVID-19 lockdown. A decreased preseason pitching workload because of the COVID-19 lockdown may have had an effect on per game UCLR rates.

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## APPENDIX

TABLE A1  
Characteristics and Workloads Between SPs Who Underwent UCLR: 2017-2019 Seasons Versus 2020 Season<sup>a</sup>

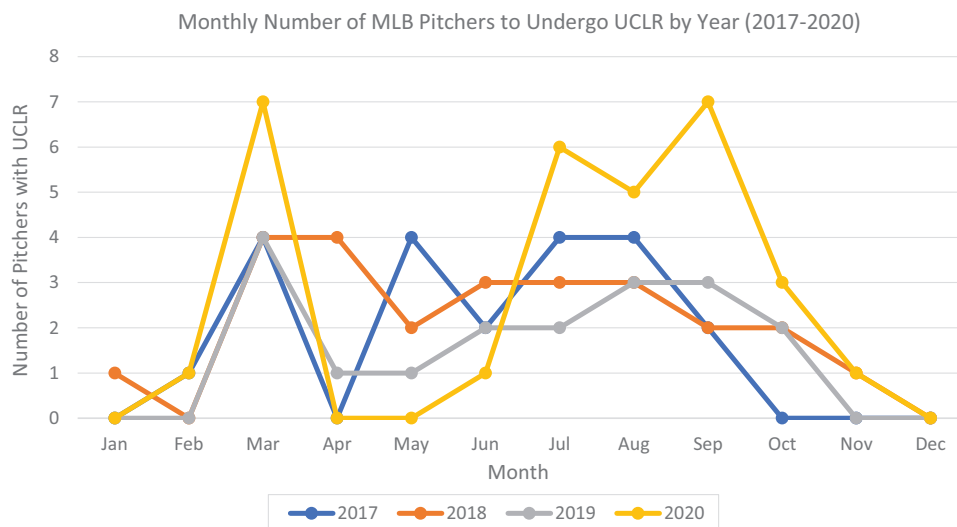
	2017-2019 (n = 29 SP)	2020 (n = 8 SP)	P
<b>Characteristics</b>			
Age, y	26.4 ± 2.4 (25.6 to 27.3)	27.4 ± 4.3 (24.4 to 30.3)	.558
BMI	27.5 ± 2.3 (26.7 to 28.4)	28 ± 2.1 (26.5 to 29.5)	.616
Prior UCLR, %	17.2	12.5	≥.999
<b>Career workload</b>			
Total IP	802 ± 459 (635 to 969)	969 ± 874 (363 to 1575)	.616
Total games	162 ± 80 (133 to 192)	187 ± 122 (102 to 272)	.607
Total MLB pitches thrown	5803 ± 7192 (3185 to 8421)	9446 ± 16,234 (-1804 to 20,695)	.554
IP per game	4.87 ± 0.55 (4.67 to 5.07)	4.88 ± 0.87 (4.28 to 5.48)	.967
<b>Season of UCLR workload</b>			
Preseason IP	11.97 ± 5.24 (10.06 to 13.87)	6.67 ± 3.31 (4.37 to 8.96)	<b>.003</b>
Preseason games	4.48 ± 1.45 (3.95 to 5.01)	3.13 ± 1.81 (1.87 to 4.38)	.081
Regular season IP	57.32 ± 30.31 (46.28 to 68.35)	17.71 ± 15.21 (7.17 to 28.24)	<b>&lt;.001</b>
Regular season games played	13.20 ± 7.54 (10.45 to 15.95)	5.75 ± 4.27 (2.79 to 8.71)	<b>.003</b>
Regular season pitches thrown	944 ± 500 (763 to 1126)	280 ± 232 (119 to 441)	<b>&lt;.001</b>
Regular season IP per game	3.53 ± 1.27 (3.06 to 3.99)	2.87 ± 1.36 (1.93 to 3.82)	.248
Regular season pitches thrown per game	37.19 ± 23.21 (28.74 to 45.63)	32.19 ± 23.43 (15.96 to 48.43)	.620

<sup>a</sup>Data are presented as mean ± SD (95% CI) unless otherwise indicated. Bolded P values indicate statistically significant differences between groups (P < .05). BMI, body mass index; IP, innings pitched; MLB, Major League Baseball; SP, starting pitcher; UCLR, ulnar collateral ligament reconstruction.

TABLE A2  
 Characteristics and Workloads Between RPs Who Underwent UCLR: 2017-2019 Seasons Versus 2020 Season<sup>a</sup>

	2017-2019 (n = 23 RP)	2020 (n = 10 RP)	P
<b>Characteristics</b>			
Age, y	27.7 ± 2.9 (26.5-28.9)	27.4 ± 2.8 (25.7-29.1)	.786
BMI	27.7 ± 1.5 (27-28.3)	27.8 ± 2 (26.5-29)	.885
Prior UCLR, %	4.4	30	.073
<b>Career workload</b>			
Total IP	507 ± 278 (393-621)	489 ± 202 (364-614)	.840
Total games	322 ± 143 (264-381)	314 ± 161 (214-414)	.883
Total MLB pitches thrown	3215 ± 3225 (1897-4533)	2851 ± 1858 (1699-4002)	.687
IP per game	1.60 ± 0.59 (1.36 -1.85)	1.68 ± 0.55 (1.33-2.02)	.741
<b>Season of UCLR workload</b>			
Preseason IP	7.17 ± 3.08 (5.91-8.43)	5.43 ± 1.62 (4.43-6.44)	<b>.043</b>
Preseason games	6.57 ± 2.48 (5.55-7.58)	5.40 ± 1.51 (4.47-6.33)	.109
Regular season IP	27.21 ± 20.39 (18.88-35.54)	6.52 ± 5.89 (2.87-10.18)	<b>.001</b>
Regular season games played	26.38 ± 20.83 (17.86-34.89)	7.29 ± 6.55 (3.23-11.35)	<b>.003</b>
Regular season pitches thrown	462 ± 327 (328-595)	116 ± 94 (58-174)	<b>.001</b>
Regular season IP per game	1.14 ± 0.50 (0.94-1.35)	0.97 ± 0.12 (0.90 -1.04)	.132
Regular season pitches thrown per game	11.73 ± 4.51 (9.89-13.57)	7.95 ± 2.76 (6.24-9.66)	<b>.024</b>

<sup>a</sup>Data are presented as mean ± SD (95% CI) unless otherwise indicated. Bolded P values indicate statistically significant differences between groups ( $P < .05$ ). BMI, body mass index; IP, innings pitched; MLB, Major League Baseball; RP, relief pitcher; UCLR, ulnar collateral ligament reconstruction.



**Figure A1.** Number of MLB pitchers who underwent UCLR during each month, 2017-2020. MLB, Major League Baseball; UCLR, ulnar collateral ligament reconstruction.