Return to Performance Following UCL Surgery in Major League Baseball Pitchers

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Introduction: The recent development of advanced analytics and pitch-tracking analysis has been widely embraced throughout Major League Baseball (MLB), driving player development and personnel decisions over the past decade. While return to play is important for players and teams, return to performance following UCL surgery using several advanced metrics has not been studied in MLB pitchers. The primary objective of this study is to evaluate return to performance in MLB pitchers using advanced analytic and pitch-tracking outcomes at one and two years post-operatively following UCL surgery. The secondary objective is to provide an updated return to play analysis from the most recent five MLB seasons.
Materials & Methods: We performed a retrospective return to play analysis on 119 MLB pitchers who underwent primary UCL reconstruction or repair from April 2018 to November 2023 and reported return to play rates at 1-, 2-, and 3-years. For return to performance analysis, exclusion criteria included pitchers without two qualifying seasons of post-operative pitch-tracking data except for analysis of Stuff+, Location+, and Pitching+. Advanced analytic and pitch-tracking metrics used commonly in MLB player evaluation were then collected for 54 total MLB pitchers from public web sources sponsored by MLB and used in previous studies. Statistical analysis consisted of paired t-tests comparing pre- to post-operative metrics. A large subgroup analysis on pitch-specific outcomes for fastballs, curveballs, sliders, cutters, changeups, and splitters was also conducted.
Results: Mean age was 26.8 + 3.6 years, 74% of included pitchers were right-handed, and 42.6% were starting pitchers. Only 4% returned to play at 1-year post-operatively, 79% at 2-years, and 99% at 3-years with a mean of 558 + 159 days. There was a significant decrease in cumulative statistics such as innings pitched, pitch count, and fWAR in pre-injury T1 compared to post-operative M1 and M2 ($p < 0.001$), however rate-based ERA metrics such as xFIP and SIERA were similar. At 2-years post-operatively, pitchers maintained their Stuff+ but showed worse Location+ and Pitching+ ($p < 0.01$). MLB pitchers retained their overall velocity, spin and spin axis, vertical and horizontal movement, horizontal release points, and VAA. Pitches most negatively impacted by UCL surgery included fastballs and sinkers, with significant differences in Stuff+, Pitching+, and Location+ at 1- and/or 2-years post-operatively. Various pitches had significant differences in certain pitch-tracking metrics, illustrating how pitch mechanics change after surgery.
Discussion: In the past four years, 79% and 99% of MLB pitchers returned to play in the MLB at two and three years respectively with a mean of 558 days following UCL surgery. Pitchers showed a mild but statistically significant decrease in cumulative performance metrics, strike zone command (Location+), and overall pitching ability (Pitching+) post-operatively. UCL surgery restored pitcher's velocities, movement, and spin while pitches such as fastballs and sinkers were most negatively impacted. Overall, surgery remains an effective option for MLB pitchers to return to both play and performance following a UCL injury.

References:

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Table 1: Demographics and Return to Play	
	Cases (n=119)
Age	26.5 ± 3.4
Height	189.0 ± 5.9
Weight	96.9 ± 6.0
% Right-handed	70.6%
% Starting Pitchers	43.1%
Draft Position	280.3 ± 323.4
% IFA	17.6%
Mean days until RTP (SD)	558 (159)
% RTP at 1-year post-op	4%
% RTP at 2-year post-op	79%
% RTP at 3-year post-op	99%

Table 1: Demographics and return to play of MLB pitchers who underwent a UCL repair or reconstruction in the past five seasons. IFA = signed as an amateur international free agent rather than via draft, RTP = return to play since date of surgery, T1 = the season prior to index season of injury. Exclusion criteria for further data analysis included pitchers without two qualifying seasons (i.e. >100 pitches in a calendar year) of post-operative pitch-tracking data except for analysis of Stuff+, Location+, and Pitching+ secondary to power limitations.

Season		Innings pitched	fWAR	xFIP	SIERA	Stuff+	Pitching+	Location+
*Pre T1	Mean ± sd	86.13 ± 59.70	1.57 ± 1.68	4.29 ± 1.19	4.19 ± 1.12	103.73 ± 16.20	101.98 ± 5.54	100.86 ± 4.20
Post M1	Mean ± sd	26.11 ± 30.20	0.35 ± 0.59	4.27 ± 1.20	4.04 ± 1.21	101.78 ± 15.40	100.76 ± 6.65	99.62 ± 6.00
	p-value	**< .01**	**< .01**	.83	.85	.56	.34	.24
Post M2	Mean ± sd	58.00 ± 49.89	0.82 ± 1.13	4.22 ± 0.85	4.08 ± 0.84	103.34 ± 13.23	98.33 ± 6.30	97.82 ± 4.55
	p-value	**< .01**	**<.01**	.85	.77	.90	**<.01**	**<.01**

Table 2: Pre- and Postoperative Advanced Analytic Performance Data following UCL Injury. fWAR = Fangraphs Wins Above Replacement, M = post-operative year, SIERA = Skill-Interactive Earned Run Average, sd = standard deviation, T = pre-operative year, UCL = ulnar collateral ligament, xFIP = expected fielding-independent pitching. Stuff+, Pitching+, and Location+ are all scaled similarly to IQ — a score of "100" is graded out as league average. *Highlighted Season Pre T1 is the season to which all other time points were compared, establishing PreT1 as the "baseline" season. Significant p-values (i.e., <.05) in bold

Season		Velocity (mph)	Spin Rate (RPM)	Active Spin	Spin Axis (degrees)	Horizontal Movement (inches)	Vertical Movement (inches)	Horizontal Release Point (feet)	Vertical Release Point (feet)	HAA (degrees)	HAA above average	VAA (degrees)	VAA above average	Release Extension (feet)
*Pre T1	Mean ± sd	90.06 ± 3.19	2261.26 ± 207.86	78 ± 3%	174.55 ± 29.63	9.55 ± 3.16	8.09 ± 3.02	1.87 ± 0.76	5.97 ± 0.45	-1.50 ± 0.93	0.13 ± 0.97	-6.60- ± 0.57	-0.02 ± 0.55	6.10 ± 0.43
Post M1	Mean ± sd	89.85 ± 2.60	2250.33 ± 230.48	79 ± 9%	177.03 ± 24.95	9.68 ± 3.15	8.44 ± 3.36	1.88 ± 0.65	5.92 ± 0.45	-1.02 ± 1.55	-0.07 ± 0.72	-6.53 ± 0.59	0.03 ± 0.56	6.28 ± 0.43
	p-value	.25	**.03**	.57	.80	.49	.88	.65	.77	**.02**	0.10	.77	.86	**<.01**
Post M2	Mean ± sd	89.85 ± 2.78	2271.64 ± 216.19	74 ± 11%	173.48 ± 25.90	9.64 ± 3.45	7.72 ± 2.97	1.86 ± 0.65	5.87 ± 0.43	0.16 ± 1.87	-0.11 ± 0.52	- 6.49 ± 0.58	-0.04 ± 0.56	6.38 ± 0.39
	p-value	.39	.41	.27	.47	.36	.09	.89	**<.01**	**<.01**	0.11	.43	.34	**<.01**

Table 3: Pre- and Post-Operative Pitch-tracking Data following UCL Injury. HAA = horizontal approach angle, M = post-operative year, mph = miles per hour, T = pre-operative year, RPM = revolutions per minute, sd = standard deviation. UCL = ulnar collateral ligament, VAA = vertical approach angle. *Highlighted Season PreT1 is the season to which all other time points were compared, establishing PreT1 as the "baseline" season. Significant p-values (i.e., <.05) in bold. Horizontal release point and approach angles were normalized to right-handers, yielding negative values.