Advanced Analytic and Pitch-Tracking Risk Factors for UCL Injury in Major League Baseball Pitchers

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INTRODUCTION:

UCL injury rates have been rising steadily over the past decade, while the recent development of advanced analytics and pitch-tracking analysis has been widely embraced throughout Major League Baseball (MLB). These new metrics now drive player development and personnel decisions in MLB. Therefore, the primary objective of this study was to evaluate the effect of various advanced analytic and pitch-tracking metrics on UCL injury rates in MLB pitchers for the first time. Our secondary objective was to analyze the effect of large changes in these values in the seasons prior to injury, providing insight into how rapid improvement may influence UCL injury rates. Ultimately, we hope this study better informs players and teams on safe player development protocols.

METHODS:

We performed a retrospective case-control study on all MLB pitchers who underwent primary UCL reconstruction or repair from April 2018 to November 2023. Exclusion criteria included pitchers without two qualifying seasons of pre-operative pitch-tracking data or previously underwent UCL surgery. Matched controls were identified in a 2:1 manner by using season, age, position, handedness, and pitch count as covariates. Advanced analytic and pitch-tracking metrics used commonly in MLB player evaluation were collected entirely from public web sources sponsored by MLB and used in previous studies. Statistical analysis consisted of unpaired t-tests comparing cases and controls and binary logistic regression.

RESULTS:

115 MLB pitchers who underwent UCLR or UCL-repair were compared to 234 matched controls. Mean age was 27.9 \pm 3.3 years for cases and 28.4 \pm 3.2 years in controls, with 73% being right-handed and 32% being starting pitchers. During both the pre-index and/or index season, cases had significantly superior velocity, fWAR, xFIP, overall pitching ability (Pitching+), and strike-zone command (Location+) compared to controls. More horizontal release points and approach angles were found to be protective against UCL injury (p=0.04), while there was no difference in pitch counts, active spin, spin axis, vertical release points or approach angles, release extension, or overall pitch movement between cases and controls (p>0.05). Binary logistic regression identified velocity, Pitching+, vertical release poin, and decreased fastball usage as being associated with increased risk of UCL injury (p < 0.10). Despite being significantly different in unpaired t-tests, when controlling for the remainder of our variables, change in Pitching+ in the seasons prior to injury, horizontal release point, and HAA AA were no longer significantly associated (p > 0.10).

DISCUSSION AND CONCLUSION: Overall, this study found that MLB pitchers who throw harder with less fastball usage, have superior overall pitching ability (Pitching+) and strike-zone command (Location+), and a more vertical release point were more associated with UCL injury. Superior performance-based metrics such as fWAR and xFIP were also associated with injury, while there was no difference in pitch counts, spin, active spin, spin axis, horizontal release points, approach angles, release extension, or overall pitch movement between cases and controls. In this analysis, several advanced analytic and pitch-tracking metrics used widely throughout MLB to drive player evaluation and development were examined as potential risk factors for UCL injury for the first time. Ultimately, we hope this study better informs players and teams on safe player development protocols.

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