



ELBOW

# Major League pitching workload after primary ulnar collateral ligament reconstruction and risk for revision surgery



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**Background:** Literature has attempted to correlate pitching workload with risk of ulnar collateral ligament (UCL) injury; however, limited data are available in evaluating workload and its relationship with the need for revision reconstruction in Major League Baseball (MLB) pitchers.

**Methods:** We identified 29 MLB pitchers who underwent primary UCL reconstruction surgery and subsequently required revision reconstruction and compared them with 121 MLB pitchers who underwent primary reconstruction but did not later require revision surgery. Games pitched, pitch counts, and innings pitched were evaluated and compared for the seasons after returning from primary reconstruction and for the last season pitched before undergoing revision surgery.

**Results:** The difference in workload between pitchers who did and did not require revision reconstruction was not statistically significant in games pitched, innings pitched, and MLB-only pitch counts. The one significant difference in workload was in total pitch counts (combined MLB and minor league), with the pitchers who required revision surgery pitching less than those who did not (primary: 1413.6 pitches vs. revision: 959.0 pitches,  $P = .04$ ). In addition, pitchers who required revision surgery underwent primary reconstruction at an early age (22.9 years vs. 27.3 years,  $P < .001$ ) and had less MLB experience (1.5 years vs. 5.0 years,  $P < .001$ ).

**Conclusions:** There is no specific number of pitches, innings, or games that place a pitcher at an increase risk for injury after primary UCL reconstruction. However, correlations of risk may be younger age and less MLB experience at the time of the primary reconstruction.

**Level of evidence:** Level II; Retrospective Design; Prognosis Study

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**Keywords:** UCL; pitcher; pitch count; innings pitched; MLB; baseball; revision

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Injury to the medial ulnar collateral ligament (UCL) of the elbow is a devastating reality for many Major League Baseball (MLB) pitchers. Recent data suggest that pitchers requiring UCL reconstruction have been increasing.<sup>20</sup> A study by Conte et al<sup>1</sup> presents data that up to 25% of MLB pitchers have

undergone a UCL reconstruction. Although the number of pitchers requiring reconstruction is increasing, there is a track record for success after primary reconstructive surgery, with 70% to 80% of pitchers returning to sport.<sup>2,4,6,16</sup> However, multiple studies have suggested decreased performance after pitchers return from primary reconstruction.<sup>10,11,13</sup>

With the success of return to play after primary UCL reconstruction, there continues to be a number of pitchers who require revision UCL reconstruction. Evaluations of these cohorts of pitchers in the current literature have found that pitchers have lower rates of return to sport after revision surgery, with only approximately 65% returning to MLB play, as well as significant effects to career longevity if they do return.<sup>11,14</sup> Thus, physicians continue to evaluate different methods to limit reinjury after primary UCL reconstruction.

One method team physicians and trainers have used with the aim to prevent reinjury is to limit a pitcher's workload by instituting innings and pitch count limits. However, there has been no specific literature that helps treating medical professionals in advising players on appropriate workload after undergoing primary UCL reconstruction. The current literature does support that fatigue may play a role in injury, with multiple studies suggesting that players undergo alteration in pitching mechanics with increased fatigue.<sup>3,5</sup> Previous studies have also evaluated subjective arm pain and found correlations of a greater number of episodes of shoulder and elbow pain with increases in pitch counts.<sup>12</sup>

Although previous research has attempted to correlate pitching workload with risk of injury, no study has specifically attempted to evaluate workload after UCL reconstruction and the correlation with future injury and need for revision UCL reconstruction. The purpose of this study was to compare the workload of pitchers who required revision UCL reconstruction to those who did not require revision UCL reconstruction. We hypothesized that pitchers whose primary UCL reconstruction occurred an earlier age would be at a greater risk for revision surgery and that pitchers who had increased workloads would be more likely to require a revision surgery.

## Materials and methods

### Revision UCL reconstruction pitchers

We conducted a retrospective, case-controlled study of a cohort of 46 MLB players who had originally undergone primary UCL reconstruction and then subsequently required revision reconstruction while in MLB between 1996 and 2015. Of these 46 players, 17 did not meet the inclusion criteria. A final cohort of 29 MLB pitchers was identified.

The players who underwent revision reconstruction were identified by using methods similar to those of previous studies<sup>2,10-13</sup>; via team Web sites, press releases indicating players had undergone UCL reconstruction, personal Web sites, and baseball statistical Web sites, including [baseballreference.com](http://www.baseballreference.com) and [fangraphs.com](http://www.fangraphs.com). In finding the cohort, "Tommy John" surgery was considered an acceptable reference. To verify each pitcher's year of surgery, we

cross-referenced each player's reported surgical date with a gap in pitching statistics.

The year of primary reconstructive surgery and revision surgery was collected for each pitcher. Statistics were obtained using 2 independent statistical sources (<http://www.baseballreference.com> and <http://www.fangraphs.com>) to maximize completeness and accuracy. Pitcher demographics included height, weight, body mass index (BMI), date of birth, age at primary and revision surgery, MLB experience at primary reconstruction, and position (relief or starter).

To determine workload after primary reconstruction, a pitcher's first full season after returning from primary UCL reconstruction was evaluated. A "first full season" was defined as the first season after undergoing primary reconstruction in which the pitcher was considered active for greater than 80% of the MLB regular season. Statistics included both Minor and Major League statistics. Minor League statistics were included because many pitchers pitched rehabilitation appearances in the Minor Leagues. These Minor League outings were important to include because similar workload and stresses are placed on the throwing elbow as in Major League outings (same mechanics, distance from mound to plate, attempt to retire batters, etc). Data collected included games pitched, innings pitched, pitch counts, percentage of fastballs thrown, and average fastball velocity.

Beyond evaluating workload in the first season back from primary UCL reconstruction, our revision cohort workload was also evaluated for the last full season pitched before requiring UCL revision surgery to evaluate for changes in workload before reinjury. Statistics included both Minor and Major League statistics.

Finally, we evaluated the workload for all revision pitchers for the entire time between their primary reconstruction and their revision, up to 10 years, to ensure no significant change occurred in workload that could explain need for revision.

### Primary UCL reconstruction-only pitchers

A subsequent cohort of 181 MLB pitchers that underwent primary reconstruction and did not require revision reconstruction was identified. Of these 181 players, 60 were excluded because they later required revision reconstruction ( $n = 29$ ) or did not return to MLB competition ( $n = 31$ ). A final cohort of 121 MLB pitchers was identified. Data were collected similar to the revision cohort, with evaluation of pitching workload for the first full season after primary reconstruction. Data collected included height, weight, BMI, date of birth, age at primary reconstruction, MLB experience at primary reconstruction, position (relief or starter), and workload (games pitched, innings pitched, and pitch counts).

To give comparison to the workload of the revision reconstruction pitchers the year before reinjury, we evaluated an appropriate year after injury of our primary-only UCL reconstruction pitchers. Because this group did not subsequently undergo revision surgery, the year used for data collection, noted as the index year, was the average year that UCL revision pitchers pitched their final full season before undergoing revision surgery. The average year for revision reconstruction after primary reconstruction was 4.8 years. Thus, the fourth year after primary reconstruction was used, because this was the last full season before UCL revision reconstruction. This was done to ensure that workload did not differ as a result of or subsequent years of experience. Of the 121 pitchers evaluated who did not require revision surgery, 64 players were still pitching at 4 years after their primary UCL reconstructive surgery. Data evaluated included games pitched, innings pitched, and pitch counts.

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