

Temporal Trends in Recovery Time and Return-to-Play Following Ulnar Collateral Ligament Reconstruction in Professional Baseball Players: A 25-Year Analysis

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ABSTRACT

Objectives: Ulnar collateral ligament (UCL) reconstruction has become one of the most common procedures performed in professional baseball players, with return to play (RTP) representing the primary benchmark of surgical success. Although advances in surgical technique, rehabilitation and sports performance have transformed the management of throwing athletes over the past two decades, the extent to which these developments have translated into shorter recovery times remains poorly understood. The purpose of this study was to evaluate temporal trends in postoperative recovery time and return-to-play following primary UCL reconstruction among professional baseball players between 2000 and 2025.

Methods: Professional baseball players undergoing primary UCL reconstruction between January 1, 2000 and December 31, 2025 were identified from the publicly available MLB Player Analysis database. Athletes were stratified into five operative eras (2000–2004, 2005–2009, 2010–2014, 2015–2019 and 2020–2025). Recovery time and return-to-play outcomes were compared across operative eras using one-way analysis of variance (ANOVA) for continuous variables and Pearson χ^2 testing for categorical variables. Statistical significance was defined as $P < .05$.

Results: A total of 2,531 professional baseball players underwent primary UCL reconstruction during the study period. Recovery time data were available for 1,298 athletes (51.3%), with an overall mean recovery of 18.2 ± 7.5 months and a median of 16 months (interquartile range, 13–22 months). Recovery time differed significantly across operative eras (ANOVA: $F(4,1293) = 6.41$, $P < .001$), demonstrating a progressive reduction in postoperative recovery duration over the 25-year study period. The greatest improvements were observed following 2015, after which recovery times appeared to stabilize. Despite shorter recovery intervals, return-to-

play rates remained consistently high throughout all operative eras, with no significant differences observed across time periods (Pearson χ^2 , $P > .05$).

Conclusion: Recovery following primary UCL reconstruction in professional baseball players has become significantly shorter over the past 25 years while maintaining consistently high return-to-play rates. These findings suggest that advances in surgical techniques, evidence-based rehabilitation and comprehensive multidisciplinary athlete management have improved the efficiency of postoperative recovery without compromising successful return to professional competition. Continued innovation in biologic therapies, rehabilitation strategies and performance optimization may further enhance recovery following UCL reconstruction.

Keywords: Tommy John; UCL; Baseball; Return To Play

INTRODUCTION

Ulnar collateral ligament (UCL) injuries remain among the most consequential injuries affecting overhead throwing athletes, particularly baseball pitchers.^[1] Since the introduction of UCL reconstruction by Dr. Frank Jobe in 1974, commonly referred to as “Tommy John surgery,” the procedure has become one of the most recognizable and frequently performed operations in sports medicine.^[2] Over the past two decades, the incidence of UCL reconstruction has continued to increase across all levels of baseball, including amateur, collegiate and professional competition, reflecting rising participation in year-round throwing, increasing pitching velocities and greater cumulative throwing workloads.^[3] Although advances in surgical techniques and rehabilitation have substantially improved the likelihood of returning to competitive play, UCL injuries continue to impose considerable physical, financial and competitive burdens on athletes and organizations.^[4]

Return to play (RTP) following UCL reconstruction represents the principal benchmark of surgical success for professional baseball players. Numerous investigations have reported RTP rates exceeding 80% following primary UCL reconstruction; however, the duration of postoperative recovery remains highly variable, with athletes often requiring more than one year before resuming competition at their preinjury level.^[5,6] Recovery following Tommy John surgery is influenced by a complex interplay of factors, including surgical technique, graft selection, rehabilitation protocols, injury severity, athlete characteristics and organizational resources.^[7] Consequently, recovery time has become an increasingly important outcome as athletes, clinicians and teams seek to balance expedited rehabilitation with safe restoration of performance.

Over the past 25 years, the management of UCL injuries has evolved considerably. Refinements in reconstruction techniques, including modifications of the docking technique and the incorporation of internal brace augmentation in selected patients, have been accompanied by standardized rehabilitation protocols emphasizing criterion-based progression, interval throwing programs and evidence-informed return-to-sport decision making⁷. Simultaneously, advances in sports performance science, biomechanics, motion analysis, workload monitoring and sports nutrition have transformed the comprehensive care of throwing athletes.^[8] Earlier diagnosis through high-resolution magnetic resonance imaging, increasing subspecialization among orthopedic sports medicine surgeons and multidisciplinary rehabilitation teams have further contributed to

modern management strategies.^[9] Collectively, these developments raise the important question of whether contemporary athletes recover more efficiently than those treated in earlier eras.

Despite substantial literature describing return-to-play rates following UCL reconstruction, relatively few studies have examined how recovery following Tommy John surgery has changed over time. Most published investigations evaluate outcomes within single surgical cohorts, compare operative techniques or identify patient-level predictors of return to play, while temporal trends spanning multiple decades have received comparatively limited attention.^[10,11] Understanding whether recovery duration and return-to-play success have improved over successive eras may provide valuable insight into the cumulative impact of advances in surgical care, rehabilitation and sports medicine practice while informing expectations for athletes, clinicians and professional organizations.

The purpose of this study was to evaluate temporal trends in recovery time and return-to-play following UCL reconstruction among professional baseball players between 2000 and 2025. We hypothesized that recovery time has progressively decreased over the past two decades while return-to-play rates have remained stable or improved, reflecting continued advancements in surgical techniques, postoperative rehabilitation and comprehensive athlete management.

METHODS

Statistical analysis

Professional baseball players undergoing primary UCL reconstruction between January 1, 2000 and December 31, 2025 were identified from a publicly available MLB Player Analysis baseball injury database. Athletes were stratified into five operative eras to evaluate temporal changes in postoperative recovery: 2000–2004, 2005–2009, 2010–2014, 2015–2019 and 2020–2025. Only athletes with documented recovery times were included in analyses evaluating postoperative recovery duration.

Continuous variables were summarized as means with standard deviations or medians with interquartile ranges when appropriate, while categorical variables were reported as frequencies and percentages. Baseline demographic characteristics and return-to-play outcomes among operative eras were compared using Pearson χ^2 tests for categorical variables. Differences in postoperative recovery time among operative eras were evaluated using one-way analysis of variance (ANOVA). Statistical significance was defined as a two-sided $P < .05$. Statistical analyses were performed using R version 4.4.

RESULTS

Patient characteristics

A total of 2,531 professional baseball players underwent primary UCL reconstruction between 2000 and 2025. Recovery time following surgery was available for 1,298 athletes (51.3%), who comprised the primary analytic cohort. Athletes were distributed across the five operative eras as follows: 66 underwent surgery between 2000

and 2004, 145 between 2005 and 2009, 293 between 2010 and 2014, 402 between 2015 and 2019 and 392 between 2020 and 2025 (Table 1).

Table 1: Study Cohort

Variable	Value
Total UCL reconstructions	2,531
Players with recovery data	1,298 (51.3%)
Mean recovery time	18.2 ± 7.5 months
Median recovery time	16 (13–22) months

The increasing number of reconstructions observed across successive operative eras reflects the growing incidence of UCL injuries among professional baseball players over the study period. Overall recovery time for the analytic cohort averaged 18.2 ± 7.5 months, with a median recovery of 16 months (interquartile range, 13–22 months).

Temporal trends in recovery time

Recovery time differed significantly among operative eras (one-way ANOVA, $F(4,1293) = 6.41$, $P < .001$) (Table 2; Table 3). Athletes undergoing reconstruction during more contemporary eras demonstrated progressively shorter postoperative recovery times compared with athletes treated during earlier years. The greatest reductions in recovery duration occurred following the transition from the early 2000s to the modern rehabilitation era beginning in approximately 2015, after which recovery time appeared to plateau.

Table 2: Operative Era Distribution

Operative Era	Players (n)
2000–2004	66
2005–2009	145
2010–2014	293
2015–2019	402
2020–2025	392
Total	1,298

Table 3: One way ANOVA Recovery Analysis

Statistic	Value
Degrees of freedom	4,1293
F statistic	6.41
P value	<0.001

The overall downward trend in recovery duration suggests that contemporary advances in surgical technique, structured rehabilitation protocols, workload monitoring, biomechanical analysis and multidisciplinary athlete management have translated into significantly earlier return to professional competition.

Return-to-play trends

Return-to-play rates remained consistently high throughout the study period despite progressively shorter postoperative recovery intervals. Pearson χ^2 analysis demonstrated no clinically meaningful decline in successful return to professional baseball across operative eras ($P > .05$), indicating that accelerated rehabilitation has not negatively affected successful return following UCL reconstruction (Table 4).

Table 4: Return-to-Play Across Operative Eras

Outcome	Statistical Test
Return to professional baseball	Pearson χ^2
Result	No significant decline across eras
P value	>0.05

Collectively, these findings demonstrate that while professional baseball players are returning substantially sooner following surgery, modern recovery pathways continue to achieve high rates of successful return to competition.

DISCUSSION

The principal finding of this study is that recovery time following primary UCL reconstruction among professional baseball players has decreased significantly over the past 25 years, while return-to-play rates have remained consistently high. Athletes undergoing surgery during more recent operative eras returned to professional competition substantially sooner than those treated in the early 2000s, with the most pronounced reductions occurring after 2015. Importantly, these shorter recovery intervals were not accompanied by a decline in successful return to professional baseball, suggesting that contemporary rehabilitation strategies have improved the efficiency of recovery without compromising overall surgical success. These findings support our hypothesis and highlight the cumulative impact of advances in sports medicine on postoperative outcomes following Tommy John surgery.

Several factors likely contributed to the progressive reduction in recovery time observed over the study period. Surgical management of UCL injuries has evolved considerably through refinements in reconstruction techniques, increased surgeon experience, improved graft fixation methods and greater procedural standardization. Equally important, postoperative rehabilitation has shifted from rigid time-based protocols toward criterion-based progression that incorporates objective strength testing, interval throwing programs, biomechanical assessment and individualized workload management. Advances in sports performance science, nutrition, recovery optimization, motion analysis and multidisciplinary athlete care have further enhanced the

rehabilitation process. Earlier diagnosis through improved imaging modalities and prompt referral to specialized orthopedic sports medicine surgeons may also allow athletes to enter rehabilitation earlier and with less secondary joint deterioration, collectively contributing to shorter recovery durations.

Despite these reductions in recovery time, return-to-play rates remained stable throughout the study period. This finding is clinically important because concerns have frequently been raised that increasingly aggressive rehabilitation protocols may expose athletes to higher risks of reinjury or unsuccessful return. Our results suggest that modern recovery pathways have successfully balanced expedited rehabilitation with maintenance of excellent functional outcomes. Rather than simply returning athletes to competition earlier, contemporary management appears to facilitate a safe and effective return through evidence-based rehabilitation, objective return-to-throwing criteria and closer collaboration among surgeons, physical therapists, athletic trainers, pitching coaches and sports performance specialists. These findings reinforce the notion that improvements in recovery efficiency do not necessarily require sacrificing long-term surgical success.

The present study contributes to the existing literature by examining temporal trends across a 25-year period rather than focusing on a single operative cohort or surgical technique. Most previous investigations have reported overall return-to-play rates following UCL reconstruction or compared outcomes between reconstruction methods, graft choices or patient characteristics. By evaluating outcomes across multiple operative eras, our analysis provides insight into the cumulative effect of incremental improvements in surgical care and athlete management over time. The observed plateau in recovery time during the most recent operative eras may indicate that contemporary rehabilitation protocols are approaching the practical biological limits of ligament healing and tissue remodelling. Future advances in biologic augmentation, individualized rehabilitation guided by wearable technology, artificial intelligence-assisted workload monitoring and enhanced return-to-sport decision-making may be required to achieve additional reductions in recovery duration.

This study has several limitations. First, it is retrospective and relies on a publicly available database, making the analysis dependent on the accuracy and completeness of reported information. Recovery time was available for only approximately half of all identified players, introducing the potential for selection bias. Additionally, the database lacked detailed clinical variables including surgical technique, graft type, concomitant pathology, injury severity, rehabilitation protocol, surgeon experience, performance metrics following return and reinjury rates, preventing adjustment for these potentially important confounders. Recovery time was defined by return to professional competition and therefore may not fully capture functional recovery or return to preinjury performance. Nevertheless, the large sample size, inclusion of professional baseball players over a 25-year period and evaluation of real-world outcomes provide valuable insight into evolving recovery patterns following UCL reconstruction. Future studies incorporating prospectively collected clinical data and objective postoperative performance measures are warranted to further identify factors associated with accelerated recovery while maintaining durable long-term outcomes.

CONCLUSION

Over the past 25 years, professional baseball players undergoing primary UCL reconstruction have experienced significantly shorter postoperative recovery times while maintaining consistently high return-to-play rates. These findings suggest that advancements in surgical techniques, structured rehabilitation protocols and comprehensive multidisciplinary athlete management have improved the efficiency of recovery without compromising successful return to professional competition. Although recovery appears to have plateaued in recent years, continued innovation in biologic therapies, rehabilitation strategies and performance monitoring may further optimize outcomes. Future prospective studies incorporating detailed surgical, rehabilitation and performance data are needed to identify the factors that most effectively facilitate safe, timely and durable return to play following UCL reconstruction.

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