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REVIEW ARTICLES

The success of return to sport after ulnar collateral ligament injury in baseball: a systematic review and meta-analysis

Scott D. Peters, DPT[a,*], Garrett S. Bullock, DPT[b], Adam P. Goode, DPT, PhD[c], Grant E. Garrigues, MD[c], David S. Ruch, MD[c], Michael P. Reiman, DPT[c]

[a]*Toronto Blue Jays Baseball Club, Toronto, ON, Canada*
[b]*Mountain River Physical Therapy, Chatham, VA, USA*
[c]*Department of Orthopaedic Surgery, Duke University Medical Center, Durham, NC, USA*

Background: Ulnar collateral ligament injury (UCLI) has significantly increased in overhead sports during the past 2 decades. Differences in return to sport (RTS) and RTS at previous level (RTSP) after UCLI have not been differentiated.

Methods: A computer-assisted literature search of PubMed, CINAHL, Embase, and SportDiscus databases using keywords related to RTS for UCLI was implemented. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were used for study methodology. Quality assessment was conducted using a modified Downs and Black scale.

Results: A total of 22 retrospective, level 3b or 4, studies (n = 2289) qualified for analysis. Overall RTS proportion was 90% (95% confidence interval [CI], 86%-94%) and overall RTSP proportion was 79% (95% CI, 75%-84%), both with significant heterogeneity ($P < .001$, $I^2 = 74\%$-84%). RTS and RTSP proportions were 89% (95% CI, 83%-94%) and 78% (95% CI, 72%-83%) for Major League Baseball players, 91% (95% CI, 77%-99%) and 67% (95% CI, 52%-81%) for Minor League Baseball players, 95% (95% CI, 75%-100%) and 92% (95% CI, 82%-98%) for collegiate players, and 93% (95% CI, 81%-100%) and 83% (95% CI, 77%-89%) for high school players, respectively. Increased earned run average, walks, and hits per inning pitched, decreased innings pitched, and decreased fastball velocity were found after UCLI.

Conclusion: Low-level, high-bias evidence demonstrates overall RTS proportion is higher than RTSP, regardless of treatment type for UCLI. Although RTS proportions remained consistent across various levels of play, RTSP proportions were lower in professional players, particularly Minor League Baseball compared with collegiate and high school players. Pitching performance significantly decreased postoperatively in most studies.

Level of evidence: Level IV; Meta-Analysis

Keywords: return to sport; return to performance; return to play; elbow; UCL; pitching

The incidence and prevalence of injury and subsequent treatment for ulnar collateral ligament injury (UCLI) has increased significantly in overhead sports, particularly baseball, during the past 2 decades.[19] Owing to advancements in

*Reprint requests: Scott D. Peters, DPT, Toronto Blue Jays Baseball Club, 1 Blue Jays Way Ste 3200, Toronto, ON M5V 1J1, Canada.
E-mail address: scottpeters921@gmail.com (S.D. Peters).

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surgical technique, increasing clinical experience, and improved rehabilitation, return to sport in these athletes is reported to have improved.[3,10,12,14,15,25]

The terms *return to sport* (RTS) and *return to play* have been interchangeably used within the research across a variety of injuries and contexts.[7,20,42,45] Differentiation between these terms is necessary to determine the success of UCLI treatment and future surgical decision making.

Despite previous systematic reviews on surgical interventions and RTS after UCLI,[13,37,43,44] no systematic review has analyzed these differences in RTS level or pitching statistics after UCLI. Therefore, the aim of this investigation was to systematically review and compile the current literature, report, and clarify RTS proportions (with and without performance statistics) after UCLI. We hypothesized that the literature would demonstrate a high level of RTS, particularly among more recent studies, with a significantly lower success rate when investigating RTS with pitching statistics.

Materials and methods

Study design

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were followed to evaluate and assess study methodology.[11] This review was prospectively registered with Prospero (CRD42016035693) after completion of preliminary search and initiation of formal screening.

Search strategy

A medical librarian-assisted computerized search was conducted in PubMed, CINAHL, Embase, and SportDiscus from each database inception to October 18, 2016. Medical Subject Headings terms and selected free-text terms were used for "ulnar collateral ligament reconstruction," "Tommy John surgery," "return to sport," "baseball," "performance," "clinical trials," "cohort studies," and "literature review" (Appendix S1). Reference lists for all selected publications were hand searched for missing publications. Citations were tracked in EndNote X7 (Thomson Reuters, Toronto, ON, Canada).

Selection criteria

Articles examining RTS in UCLI athletes that met the following criteria were eligible: (1) baseball players in any age group or competition level (professional, college, high school or middle school, amateur) who incurred a full, partial, or sprained UCLI (as diagnosed by each respective study), (2) surgical and nonsurgical UCLI, (3) prospective or retrospective cohort, or case studies with a population greater than 10 athletes, (4) published in a peer reviewed journal, (5) published RTS criteria or proportions, and (6) written in English. Exclusion criteria included (1) case-control studies and systematic reviews focusing on the UCL surgical procedures, (2) review studies, (3) studies written in a language other than English, (4) cadaveric studies, (5) elbow operations other than UCL, or (6) studies that lacked RTS information.

Study selection

Two authors screened title and abstracts for applicability per inclusion/exclusion criteria. Full-text studies identified by either author as potentially relevant were acquired for further review and were examined for inclusion/exclusion criteria by both authors (Fig. 1). In case of disagreement of study eligibility, a third author settled the discrepancy.

Quality assessment

Two authors independently conducted a quality assessment using a modified Downs and Black scale,[11] a tool that has been shown to be a reliable assessment for case-control and cohort studies. The highest total score available for the modified version is 15, with a stratified score ranking: a score >12 is considered high quality, a score of 10 or 11 is moderate quality, and a score at ≤9 is deemed low quality.[30,31] Disagreements between the 2 authors were discussed, and a third author settled any discrepancies.

Data extraction

Data were extracted into a customized database by a single author and confirmed by a second author. Disagreements between the 2 authors were discussed, and a third author settled any discrepancies. Data elements included sample size, athlete population characteristics, quality elements, RTS criteria, RTS proportion, time to return to competition, athletes' demographic characteristics (eg, age, handedness, sex, competition level), level of evidence, and secondary outcome measures, including walks and hits per inning pitched (WHIP), innings pitched, earned run average (ERA), strikeouts per 9 innings pitched, walks per 9 innings pitched, pitch type, years played preinjury, and years played postinjury.

Definition of RTS and RTS at previous level

Previous definitions of RTS and return to performance[1] are unable to both objectively determine surgical treatment success and actual sport performance. We therefore chose to operationally define RTS and RTS at previous level (RTSP) by the following:

- RTS: Any athlete returning to any level of competitive sport.
- RTSP: Return to competitive sport, at a level the athlete was playing at before injury or higher.

For example, a player who was injured playing Minor League Baseball (MiLB) at the AA level was considered to have met the criteria for RTS and RTSP if he had returned to AA or advanced to AAA or MLB after the injury. He was considered to have only met RTS if he had returned to A or independent league baseball and not met any criteria if he had retired or been unable to return at all. Therefore, if studies only reported data on players who returned to the same level of play, the RTS and RTSP values were reported as the same percentage.

Statistical analysis

Percentage agreement and Cohen κ statistics were calculated to provide absolute agreement between raters. A pooled prevalence