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Outcomes After Shoulder and Elbow Injury in Baseball Players

Are We Reporting What Matters?

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Investigation performed at Rush University Medical Center, Chicago, Illinois, USA

Background: Return to play, as well as time to return to play, are the most important metrics considered by athletes when attempting to make treatment decisions after injury. However, the consistency of reporting of these metrics in the scientific literature is unknown.

Purpose: To investigate patterns of outcomes reporting in the medical literature of shoulder and elbow injuries in active baseball players.

Study Design: Systematic review.

Methods: A systematic review of literature published within the past 10 years was performed to identify all recent clinical studies focusing on shoulder and elbow injuries in baseball players across all levels. Review articles, case reports, and laboratory/biomechanical studies were all excluded.

Results: A total of 49 studies were included for review. The majority of studies were either level 3 or level 4 evidence (96%). In total, 71% of studies reported on rates of return to preinjury level of play, whereas 31% of studies reported on time to return to preinjury level of play. Only 47% of studies reported on both rate and time of return to preinjury level of play. A minority of studies (8%) reported patient satisfaction rates. Finally, 27 different subjective and patient-reported outcomes were reported, and none of these appeared in more than 14% of all studies.

Conclusion: Time to return to preinjury level of play is inadequately reported in studies of shoulder and elbow injury in baseball players. Similarly, satisfaction rates and scores are underreported. Finally, the significant variability of subjective and patient-reported outcomes utilized may undermine the ability of clinicians to accurately compare results from different studies.

Keywords: baseball; outcomes reporting; shoulder and elbow; return to play

Despite heightened awareness and injury prevention measures, the rate of overuse injuries to the shoulder and elbow in baseball players continues to rise to epidemic proportions.² Recent literature indicates that rates of ulnar collateral reconstruction are increasing among the sport's highest tier of players⁵ and among recreational players alike.⁶ Moreover, adolescent baseball players are continuing to throw with

pain,¹³ even in the setting of increased regulations toward pitch counts and pitch types in this population.^{10,17}

Once these players are injured, the goal of treatment is to restore their ability to compete at the preinjury level. However, return to play is just one of many outcome metrics that are available for measurement, because a variety of objective measures (ie, range of motion, strength, stability) and subjective measures (satisfaction scores and patient-reported outcome [PRO] measures) exist. For professional athletes, advanced performance metrics have also become increasingly utilized.^{9,11,12,15} Examples of such metrics include earned run average (ERA), batting average against, walks plus hits per inning pitched, and several others that are routinely collected during pitching performances of (typically) collegiate and professional players. Unfortunately, an excess of outcome reporting options may also lead to confusion when trying to compare the results of clinical studies of a given intervention that report 2 different outcome scores. Moreover, given the

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high level of performance and demands placed on these players' upper extremities, traditional reporting scores (eg, the Disabilities of the Arm, Shoulder and Hand [DASH] or Short Form scores) may exhibit a prohibitive "ceiling effect," forcing clinicians to incorporate less widely used scores.¹ Prior studies of patients undergoing anterior cruciate ligament (ACL) reconstruction have demonstrated that, despite all having a common diagnosis, significant variability in outcome reporting patterns exists, rendering comparisons across different studies challenging.¹⁴

The goal of this study was to identify the variability in reporting of outcomes among studies of shoulder and elbow injuries in baseball players. We hypothesized that there will be significant variability in reporting of outcomes across studies. Moreover, we hypothesized that time to return to preinjury level of play and satisfaction scores will be underreported in the literature.

METHODS

Study Inclusion

A systematic review of the available literature was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. To provide a relevant sampling of studies, 2 independent reviewers completed the search separately using the PubMed database from the August 23, 2005 to August 23, 2015. The algorithm for the electronic search was as follows: ("baseball" OR "pitcher" OR "thrower") AND ("outcome" OR "performance") AND ("shoulder" OR "elbow"). Any study with evidence levels 1 to 4 that provided outcomes of active baseball athletes of any competition level with management of shoulder or elbow injuries was eligible for inclusion. Articles were excluded for the following reasons: non-outcome studies (ie, incidence/predictive studies), review/systematic review articles, letters to the editor, non-baseball athletes, non-shoulder or elbow pathologic conditions, editorials, and laboratory or biomechanical studies.

After application of the aforementioned inclusion and exclusion criteria, 49 studies were appropriate for analysis (Figure 1 and Appendix 1, available in the online version of this article and at <http://ajsm.sagepub.com/supplemental>). These studies had their reference lists reviewed for additional articles appropriate for inclusion, with no additional studies selected. Each study was reviewed by an orthopaedic surgery resident and orthopaedic sports medicine fellow, and any data collection conflicts were resolved through mutual agreement. Basic information including journal and year of publication, level of evidence, study type, country of publication, competition level of included players, position played by included players, shoulder and/or elbow pathologic condition reported, and management strategies that were assessed (operative or nonoperative and specifics) was recorded for each study.

Outcome Reporting

The following outcomes were recorded from each individual study: return to play, time to return, baseball statistics (ie,

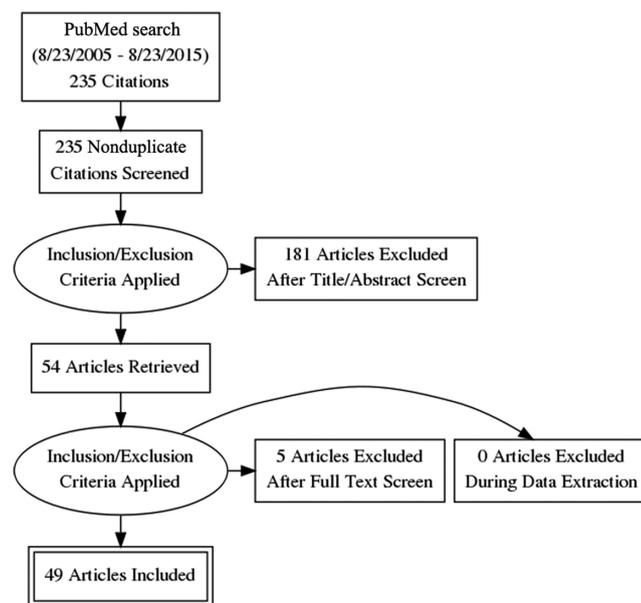


Figure 1. Flowchart of study inclusion according to PRISMA guidelines. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

ERA for pitchers), satisfaction, reported outcome scoring scales, and complication/reoperation reporting. The return-to-play questions from each study were ultimately grouped into 5 distinct categories: return to preinjury level of play or higher, return to active participation without specifics on level or limitations, inability to return to play, return to a lower participation level, and return to play with limitations including performance decline or pain. The time-to-return questions from each study were grouped into 3 distinct categories: time to return to throwing program or rehabilitation, time to return to competition at unspecified level, and time to return to preinjury or higher level of competition.

RESULTS

Included Studies

A total of 49 studies reporting on outcomes of baseball players with shoulder or elbow pathologic conditions met the inclusion criteria for this systematic review. These articles were published between 2006 and 2015. The majority of the articles were published by authors in the United States (36 of 49; 74%), with Japan (12 of 49; 25%) and Korea (1 of 49; 2%) representing the other countries of authorship. Regarding evidence level, there were 0 level 1 studies (0%), 2 level 2 studies (4%), 10 level 3 studies (21%), and 37 level 4 studies (76%) (Figure 2).

Eighteen studies (37%) reported on a cohort of players from multiple levels of competition (recreational, high school, collegiate, professional, or not delineated), whereas 15 studies (31%) and 16 studies (33%) reported on isolated cohorts of elite-level (collegiate or professional) or amateur (high school, recreational, or adolescent) baseball throwers,

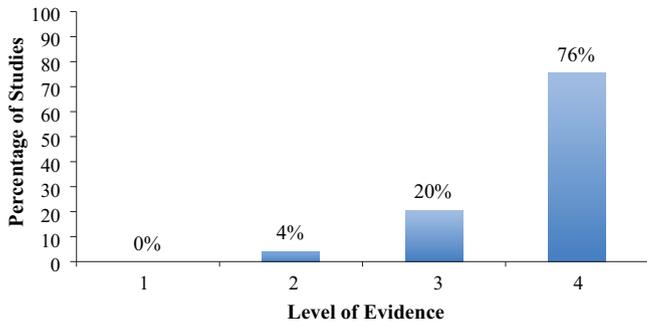


Figure 2. Level of evidence of included studies. A majority of studies were evidence levels 3 and 4.

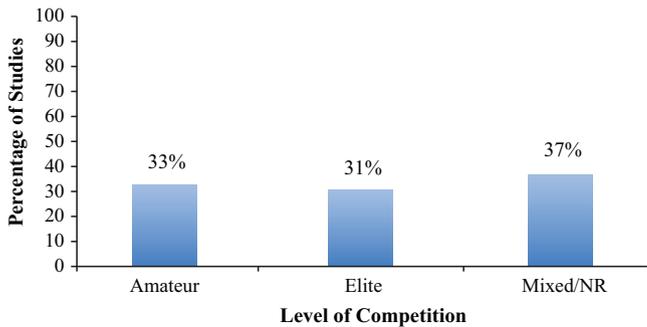


Figure 3. Level of competition from included studies. Competition levels included those of amateur (high school, adolescent, or recreational) athletes as well as elite-level (collegiate or professional) players. NR, not reported.

respectively (Figure 3). The majority of studies (29 of 49; 59%) reported on a cohort of players that included both pitchers and position players. Twelve studies (25%) reported on treatment for shoulder conditions. Thirty-six studies (74%) reported on the treatment of elbow conditions, whereas the remaining study (2%) reported on the treatment of both elbow and shoulder pathologies. The most commonly reported shoulder condition was labral injury, whereas the most commonly reported elbow condition was ulnar collateral ligament tear (see Appendix 2, available online). Forty-two studies (86%) presented outcomes after operative treatment, 5 (10%) presented outcomes after non-operative therapies, and 2 (4%) presented on baseball player cohort comparisons of operative and nonoperative management for the index injury. The majority of studies (24 of 49; 49%) reported on a cohort isolated to adult baseball players, whereas the remainder of studies reported on adolescent athletes (13 of 49; 27%) or a mixed group of adult and adolescent athletes (12 of 49; 24%).

Return-to-Play Reporting

Among all included studies, a total of 16 discrete qualitative variations of return-to-play questions were reported for baseball players. Figure 4 demonstrates a summary of the percentage of studies reporting major categories of return-

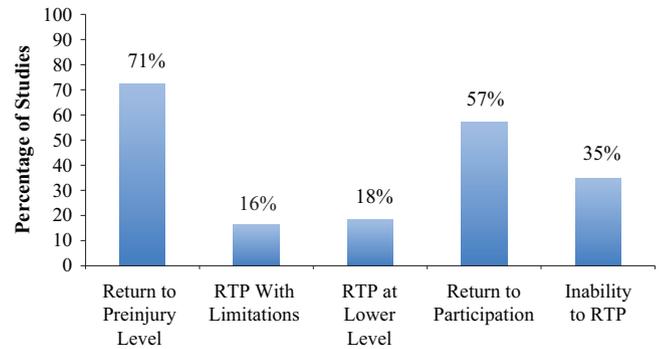


Figure 4. Return-to-play (RTP) outcomes of included studies. Although a majority of studies did report RTP, there was a high variability in reporting of this metric.

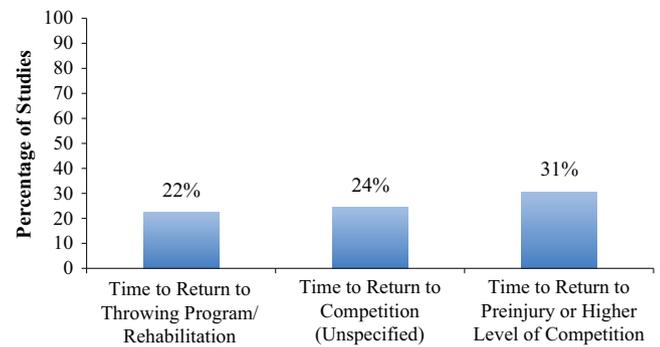


Figure 5. Time to return to play. A minority of studies reported on time to return to play after treatment.

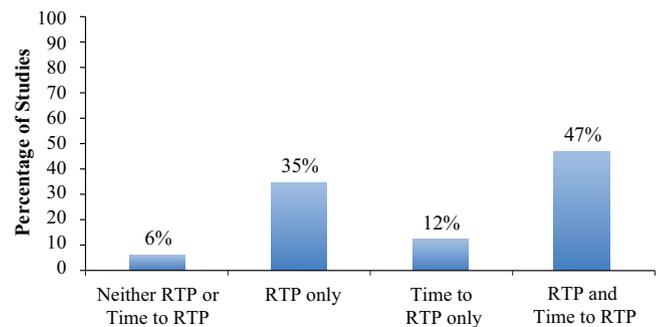


Figure 6. Time and likelihood of return to play (RTP). Less than one-half of all studies reported both the time and likelihood of RTP.

to-play questions. The majority of studies (35 of 49; 71%) reported on whether patients returned to their preinjury level of play or higher. Overlap existed in the reporting of these outcomes because some studies reported multiple return-to-play endpoint variables.

Studies were also investigated for reporting of time to return to play (Figure 5). Reporting included time of return to a throwing program or rehabilitation (11 of 49 studies;

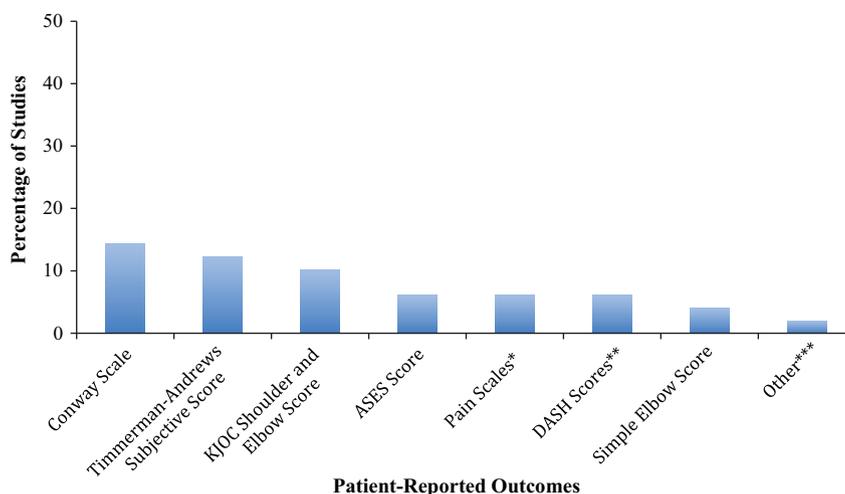


Figure 7. Subjective and patient-reported outcomes reported. Significant variability was found among included studies with regard to subjective outcome reporting. *Pain scales include visual analog scale (VAS), numeric analog pain scale, and elbow pain score. **DASH scores include QuickDASH, the DASH Sports module, and the DASH Work module. ***Other patient-reported outcomes each reported in only 1 study (2% of included studies) include the Athletic Shoulder Outcome Rating Scale, Andrews-Carson rating scale, Conway-Jobe score, modified elbow scoring system (0 to 100 scale), sport activity score, modified Timmerman subjective elbow rating score, Timmerman objective elbow rating score, athletic elbow score, VAS total (0 to 100 scale), VAS satisfaction (0 to 10 scale), elbow pain score, Japanese Orthopaedic Association sports score, Short Form-12, Mayo Elbow Performance Index, Tivnon's evaluation of elbow function, and overall subjective feeling of recovery (%). ASES, American Shoulder and Elbow Surgeons; DASH, Disabilities of the Arm, Shoulder and Hand; KJOC, Kerlan-Jobe Orthopaedic Clinic; PRO, patient-reported outcome.

TABLE 1
Frequency of the Most Commonly Reported PROs Across 2 Set Time Points in This Systematic Review^a

2006 to 2010 (n = 22 studies)		2011 to 2015 (n = 27 studies)	
PRO	No. of Studies	PRO	No. of Studies
Conway scale	4	KJOC score	5
Simple elbow score	2	Timmerman-Andrews subjective scoring system	4
Timmerman-Andrews subjective scoring system	2	DASH score	3
All other scores reported <2 times		ASES score	3
		Conway scale	3

^aASES, American Shoulder and Elbow Surgeons; DASH, Disabilities of the Arm, Shoulder and Hand; KJOC, Kerlan-Jobe Orthopaedic Clinic; PRO, patient-reported outcome.

22%), time to return to competition at unspecified level (12 of 49 studies; 24%), and time to return to preinjury or higher level of competition (15 of 49 studies; 31%). Overlap existed in the reporting of this outcome because some studies reported timing of more than 1 return variable. Finally, studies were assessed for the presence or absence of reporting of both return to play as well as time to return to play (Figure 6). Only 47% of studies (23 of 49) reported both of these outcomes in conjunction, whereas 6% of studies (3 of 49) failed to report either variable.

Outcome Reporting

Outcome reporting metrics included patient satisfaction, performance after return, subjective reporting (PROs), and rates of complication. Of all 49 studies, only 4 (8%) reported

patient satisfaction rates. One study reported rates of overall satisfaction with the procedure (on a 10-point scale), whether the patient would undergo the procedure again, and whether the patient would recommend the procedure to others. A second study reported rates of whether the patient would undergo the procedure again and whether the patient felt better after the procedure. A third study reported subjective satisfaction scores regarding the procedure. Finally, the fourth study reported rates of patient satisfaction with the procedure.

There were a total of 8 studies (16%) that reported advanced performance statistics related to pitching after return to injury. All of these studies included pitchers at the professional level.

Twenty-seven validated and nonvalidated PRO measures were reported among the 49 included studies to

demonstrate the included baseball players' performance after intervention (Figure 7). These most commonly included the modified Conway scale (7 of 49 studies; 14%), the Timmerman-Andrews subjective scoring system (6 of 49 studies; 12%), and the Kerlan-Jobe Orthopaedic Clinic (KJOC) Shoulder and Elbow score (5 of 49 studies; 10%). When comparing the first 5 years covered in this review (2006 to 2010) with the last 5 years (2011 to 2015), there seems to be a trend toward increasing consistency of outcome measures utilized (Table 1). In the last 3 years of studies, the Timmerman-Andrews subjective scoring system, the KJOC Shoulder and Elbow score, and the DASH or QuickDASH scales have been the most commonly reported outcome measures.

Complications were definitively reported in 19 studies (39%), whereas reoperation rates were explicitly reported in 20 studies (41%).

DISCUSSION

The goal of this study was to document the variability of reporting patterns within studies of shoulder and elbow injuries in baseball players. Although a majority of studies report return-to-play statistics, only a minority of studies report time to return to preinjury level of play. Moreover, significant variability remains regarding types of outcomes reported, such as utilization of various PRO measures and reporting of treatment complications.

Return to preinjury level of performance remains the most important outcome metric among athletes recovering from injury.^{3,18} A significant number of studies report return to play in nonspecific terms, such as "return to participation" and "inability to return to play," which were found in 57% and 35% of studies, respectively. More importantly, less than one-half of all studies reported both the likelihood of return to preinjury level of play as well as time to return to this level of play. It is our experience that athletes, regardless of skill level, are most interested in these 2 outcome metrics (in conjunction) when considering treatment options or whether to undergo elective surgery. Therefore, reporting of both of these metrics is integral in providing adequate patient counseling and should be emphasized in future studies of these athletes.

As with time to return to play, a minority of studies reported satisfaction rates among patients. Regardless of objective or subjective outcomes, satisfaction with treatment remains a powerful measure in determining the relative success of a given treatment.⁷ Moreover, satisfaction questions may be administered efficiently, because they are not dependent on lengthy outcome questionnaires or patient visits. Although formal PRO scores offer opportunities for validated patient metrics, they are lengthy to administer¹⁶ and may not be appropriate for competitive athletes, given concerns of a ceiling effect.^{1,8} Given this ceiling effect with the DASH and American Shoulder and Elbow Surgeons (ASES) scores, they may not be useful in studies of competitive throwing athletes. The use of PRO measures should instead be focused on measures that

have been validated in similar patient populations (eg, the KJOC score⁴ and other similar metrics).

Additional concerns focus on the variability of PROs utilized. We identified a high number of different scores utilized in low frequencies across all studies. This variability undermines attempts to compare results of patients from different studies. Previous research has identified similar trends in outcome reporting from ACL reconstruction.¹⁴ However, in this study, there is a relatively uniform cohort of patients in competitive baseball players. Therefore, there remains even more potential benefit in consolidation of outcome scores to provide comprehensive counseling regarding return to play, subjective outcomes, and complication rates.

This study is not without limitations. Despite appropriate PRISMA criteria utilized, there is a likelihood of omission of relevant studies for inclusion. However, selection bias for included studies is similarly minimized because of utilization of PRISMA guidelines for study identification. Second, not all outcomes reported were included in this study. Many studies reported additional outcomes, such as those of imaging findings, physical examination findings, and performance metrics. However, because of significant heterogeneity in study design and reporting, not all outcomes could be cataloged in this review. In addition, because this study included review of shoulder and elbow injuries, some variability of outcome reporting is inherent as a result of shoulder- and elbow-specific reporting. However, documentation of this variability is still needed to highlight the potential use for more standardized reporting scales that are not joint specific. Finally, there may be a temporal bias in reporting, because some newer scores (eg, the KJOC) may not have been utilized in studies from the earlier reference range in this report. Identification of this variability will help clinicians in minimizing reporting variability in the future.

In conclusion, outcome reporting for competitive baseball players with shoulder and elbow injuries contains significantly high variability, despite the relative uniformity of these patients. Such variability impedes comparison of results from different studies of these competitive athletes. Moreover, many studies utilize PRO measures (eg, DASH and ASES) that have known ceiling effects in this patient population. We recommend an increased emphasis on reporting of time to return to preinjury level of performance as well as complication reporting, because these may be the most relevant outcomes for competitive baseball players. In addition, satisfaction scores should also be reported in future studies, because this outcome may be universally applied to all patients, regardless of sport or skill level.

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