Considerations of Conservative Treatment After a Partial Ulnar Collateral Ligament Injury in Overhead Athletes: A Systematic Review

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Context: Ulnar collateral ligament (UCL) reconstructions continue to increase without consensus on an evidence-based treatment protocol for nonoperative management. Currently, there is no consensus on an effective nonoperative protocol for partial UCL injuries that uses return-to-play (RTP) rates in determining the outcome of conservative treatment.

Objective: To systematically review RTP rates after conservative treatment of partial UCL injuries in overhead athletes along with descriptive components of each conservative intervention to identify an effective evidence-based nonoperative rehabilitation protocol.

Data Sources: Articles in PubMed, CINAHL, MEDLINE, Academic Search Complete, and SPORTDiscus were identified in October 2018 based on the following terms: *overhead athlete*, *ulnar collateral ligament*, *nonoperative treatment*, and *return to play*.

Study Selection: Seven retrospective, level 4 studies (n = 196) qualified for analysis.

Study Design: Systematic review.

Level of Evidence: Level 4.

Data Extraction: Study design, level of evidence, demographics, sample size, sports involved, level of competition, grade or type of UCL diagnosis, conservative treatment components, and percentage RTP were extracted.

Results: Overall, RTP rates after conservative treatment ranged between 42% and 100% (mean, 78% ± 20%). The most frequently reported components of rehabilitation protocols were (1) a period of rest, (2) stretching, (3) strengthening, and (4) a throwing program. Platelet-rich plasma injections were included in 5 (71%) of the 7 protocols with a rehabilitation period.

Conclusion: Conservative treatment is a viable option for partial UCL tears in overhead athletes. A successful rehabilitation protocol includes the use of patient-reported outcomes, a sport-specific tailored treatment plan, kinetic chain strengthening, and an interval throwing program. Factors such as age, grading of tear, level of play, sport, and athlete's perceived well-being should all be considered during treatment decisions.

Keywords: sports medicine; orthopedics; nonoperative; ulnar collateral ligament (UCL); rehabilitation

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Overhead athletes are highly susceptible to ulnar collateral ligament (UCL) injuries due to forces generated over the medial elbow.^{3,12} This is a result of the overuse and repetitive nature associated with an overhead sport.^{3,13} Overhead athletes include those who participate in high- and low-risk sports that repeatedly place their arm overhead, such as javelin, water polo, baseball, gymnastics, football quarterbacks, softball, and tennis.^{9,16} Operative management is a commonly sought-after option for complete UCL tears or partial tears refractory to conservative treatment in hopes that the athlete will successfully return to his or her previous level of play.¹⁵ Although outcomes have been favorable, UCL reconstruction (UCLR) usually requires a minimum of 10 to 16 months for full recovery with potential surgical risks and complications, such as fracture, inadequate healing, and nerve injury.^{4,33} Thus, conservative treatment may be considered an option for returning an overhead athlete to play with a partial tear.⁴ Moreover, properly identifying athletes who may successfully be treated conservatively can be a challenge because of factors involved in the treatment decision-making process.^{1,11} Important factors to consider during this process include demand of the sport, level of play, the individual needs of the athlete, and the risks associated with surgery.^{10,17,28}

There is no consensus on a specific nonoperative treatment protocol for UCL injuries or an evidence-based treatment protocol. Although conservative treatment studies include return-to-play (RTP) rates, it is unclear how the rehabilitation programs influence RTP because of a lack of reporting of specific rehabilitation parameters. Surgeons commonly agree that complete UCL tears in overhead athletes should undergo surgery, but opinions are divided on how to treat partial UCL tears.¹⁹ Therefore, the purpose of this review is to provide evidence for RTP rates after conservative treatment of partial UCL injuries in overhead athletes.

METHODS

We conducted a comprehensive systematic review in adherence to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.²¹ These guidelines were followed to evaluate and assess study methodology.

Study Identification

Articles were retrieved in October of 2018 by searching online databases via EBSCOHost and Scopus. The databases searched within EBSCOHost included CINAHL, MEDLINE, Academic Search Complete, and SPORTDiscus. PubMed was also used as a database for searches.

Search terms, which included both full and abbreviated terms, are as follows: (1) patient—overhead athlete, throwing athlete, baseball; (2) ulnar collateral ligament, medial collateral ligament; (3) intervention—nonoperative treatment, conservative treatment, platelet-rich plasma, therapy, rehabilitation, injection; comparison—none; (4) outcome—return to play, return to

sport. Combinations of categories (1) to (4) were also used with “AND” to combine the relevant search terms. The terms and strategy are displayed in Table 1.

Eligibility Criteria

The following describes inclusion and exclusion criteria determined and used by each reviewer. Inclusion criteria were articles that reported on overhead athletes who sustained a UCL injury, had undergone a period of conservative treatment with RTP as an objective outcome measure, were written in English, and were available in full text. Exclusion criteria were abstracts, commentaries, clinical discussions, not having included RTP rates, inclusion of a complete UCL tear, and only reporting on adolescent athletes 12 years old and younger.² The decision to exclude adolescent athletes was due to nonoperative management being a well-established first line of treatment as a result of a lack in skeletal maturity or growth.^{2,4} Avoidance of surgery in an athlete that has not fully developed skeletal integrity is widely supported by orthopaedic surgeons.²

Study Selection

After combining search terms, a total of 129 articles were extracted. Once duplicates were removed, 67 articles remained for review. In addition, 3 articles were handpicked and added to the review list. Two authors reviewed 70 titles and abstracts independently for applicability based on the inclusion and exclusion criteria. Percentage agreement and Cohen κ statistics were calculated to provide absolute agreement between raters. The level of agreement was 95% CI ($\kappa = 0.747$), with only 4 articles left in disagreement. These 4 articles were then further reviewed separately where an agreement was made by consensus. After each relevant full-text article was examined, 7 articles fulfilled the inclusion and exclusion criteria (Figure 1).

Quality Assessment

The Modified Downs and Black⁸ (10-item) checklist was used to assess methodological and reporting quality.^{22,23} This assessment tool is appropriate, as it was created to assess both randomized control trials and nonrandomized control trials in health care.⁸ Previous systematic reviews with similar study characteristics have also used the Modified Downs and Black and therefore allowed for quality comparisons.²⁸ The reviewers independently scored the included studies, and a third reviewer assessed the articles where there was disagreement. For each question, a score of a 0 (no or unable to determine) or a 1 (yes, present) was given. The authors report a moderate strength of recommendation. Studies meeting >75% of the applicable criteria were considered high, 60% to 74% moderate, and <60% low.²² Two articles scored high grades; these included Ford et al¹¹ with an 80% and Frangiamore et al¹² with a 90%. Three articles scored a 70% resulting in a moderate grade.^{27,29,30} The remaining 2 articles scored a low grade of 50% due to not addressing external validity pertaining to study participants.^{5,6}

Table 1. Terms and database results

Search	Terms	CINAHL	Medline	SPORT Discus	Academic Search Complete	PubMed
1	Overhead athlete OR throwing athlete OR baseball	2163	3378	54	114,982	3454
2	Ulnar collateral ligament OR medial collateral ligament	699	2832	982	1153	2012
3	Nonoperative treatment OR conservative treatment OR platelet-rich plasma OR therapy OR rehabilitation OR injection	844,566	4,262,684	141,621	1,469,996	9,000,247
4	Return to play OR return to sport	1785	3204	3527	3150	5987
5	Combine searches 1, 2, 3, and 4 with the term "AND"	15	25	17	12	60

Data Extraction

For the included articles, the following descriptive components were extracted: study design, level of evidence (Oxford 2011 Level of Evidence),²⁶ demographics (eg, age, gender), number of athletes enrolled, athletes who went through a period of conservative treatment (including athletes who underwent surgery after conservative treatment), sports involved, level of competition, and grade or type of UCL diagnosis. A standardized template was used to extract all data. Table 2 displays each study component. Specific components of each conservative intervention were extracted based on a yes or no criteria. It was also indicated if the authors did not report a particular component. These components included a period of splinting or bracing, a platelet-rich plasma (PRP) injection, stretching or range of motion, a strengthening phase, if medication was used or given, if an interval throwing program was followed, and utilization of patient-reported outcomes (PROs). The amount of time taken to complete the conservative treatment plan, overall time to RTP and the RTP rate were also extracted. The characteristics of the intervention can be weighed against the RTP rate. If the authors reported a return to same level of play (RTSP) rate, they were further described within the text. Table 3 displays the components of the conservative interventions organized by the use of PRP injection. There were no statistical values such as odds ratios or treatment effect analysis available for further data extraction.

RESULTS

Study Characteristics

Conservative treatment studies were retrospective in design.^{5,6,11,12,27,29,30} RTP rates were determined in a sample of 196 athletes. Sports included baseball (pitchers and position players), softball,

tennis, volleyball, football, and javelin. Age ranged from 14 to 34 years with an average age of 19 years. Of the 196 athletes, the majority were male (186) with only 10 being female. Level of competition included little league, high school, recreational, junior college, college, and professional. Methods of interventions used for UCL injuries included rehabilitation or rehabilitation combined with PRP injection therapy. PRP injections were used in 5 (71%) of the 7 studies.^{5,6,12,27,29}

Defining RTP

RTP was clearly defined by 3 (43%) of the 7 articles. RTP was defined as "an athlete successfully playing for at least 1 full season" and RTSP as "returning back to previous level or higher."¹¹ Additionally, a modified version of the Conway Scale was utilized to define RTP by reporting either "excellent" (indicated returning to preinjury level of competition or performance), "good" (indicated return to play at a lower level of competition or performance or, specifically for baseball players, ability to throw in daily batting practice), "fair" (able to play recreationally), or "poor" (unable to return to previous sport at any level).⁶

UCL Grading

Studies reported on athletes diagnosed with UCL insufficiency or tear but did not include any specific descriptions or grading scales.³⁰ Magnetic resonance imaging (MRI) gradings 1 through 3 were used; 1, exhibited fluid along the ligament or edema within the ligament; 2, exhibited thinning and/or irregularities of the ligament without complete disruption of the ligamentous fibers; 3, complete tears.²⁹

The same definition for "grade 2 UCL tears" was used by 2 different studies providing some consistency.^{5,29} An MRI grading scale was created by 1 of the articles that classified UCL injuries into 4 grades: 1, intact ligament with or without edema; 2A,

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram of the process on identifying and selecting studies.

incomplete ligament fiber disruption; 2B, chronic healed injury; 3, complete tear.¹¹ The authors also observed proximal and distal tears during grading.¹¹ Furthermore, UCL grades were defined as “partial-thickness” (either proximal or distal based) or “diffuse” tears, but these authors did not provide descriptions of each grade.⁶

UCL tears were graded as “partial” or “high-grade” with a partial tear defined as “increased signals within the ligament with loss of the normal fiber striation pattern and fiber disruption up to 50% in thickness”.¹² High-grade tears were defined as “greater than 50% fiber disruption or full-thickness ligament disruption.”¹² These authors also examined proximal versus distal tears and included descriptive illustrations of each location.¹² Last, in the single case report, the authors defined the grade 1 tear as “a minor tearing of the anterior bundle of the UCL with very mild increase in joint space and laxity and edema within the trochlea.”²⁷

RTP Rates and UCL Diagnosis

Overall RTP rates ranged between 42% and 100% (mean = 78% ± 20%), which largely depended on the type of UCL tear. Grades 1, 2A, and 2B injuries resulted in a 100%, 83%, and 94% RTSP rates, respectively.¹¹ The authors also reported that there were no statistical differences in RTSP rates between proximal and distal tears.¹¹ An RTP rate of 96% was reported in athletes with a grade 2 UCL tear.⁵ Proximal UCL tears were found in 81% of athletes who were able to successfully RTSP when compared with the 19% of those who had distal tears.¹² In partial and diffuse tears, of the 73% who returned to play, only 41% returned to their previous level of play (RTSP).⁶ Two separate articles reported RTP rates of 42%³⁰ and 88%²⁹ but did not distinguish the UCL diagnosis that was associated with the RTP rate, making it difficult to associate the type of grade with rate of RTP. Last, in the single case report, the baseball athlete was able to RTP with a grade 1 UCL tear.²⁷

Table 2. Description of included studies

Study	Study Design/LOE	Athletes Enrolled, n	Nonoperative	Surgery After Enrolled	Gender	Average Age (Range), y	Sport	Competition Level	UCL Diagnosis
Rettig et al ³⁰ (2001)	Retrospective/Level 4	31	31	0	M = 29 F = 2	18	Baseball = 29 -Pitcher = 20 -Infielder = 9 Javelin = 2	Pro = 3 College = 23 HS = 5	Insufficiency or tear = 31
Ford et al ¹¹ (2016)	Retrospective case series/Level 4	43	31	12	M = 43 F = 0	23.38 ± 2.3	Baseball = 31 -Position = 10 -Pitchers = 21	Pro = 31	Grades: 1 = 4 2A = 6 2B = 18
Podesta et al ²⁹ (2013)	Retrospective case series/Level 4	34	34	1	M = 28 F = 6	18 (14-34)	Baseball = 27 Softball = 3 Tennis = 2 Volleyball = 2	Pro = 2 College = 11 HS = 10 LL = 1 Ju-Co = 1 Rec = 2	Grade 1 and 2 partial tears
Dines et al ⁶ (2016)	Retrospective/Level 4	44	44	0	M = 44 F = 0	17.3 (16-28)	Baseball = 44	Pro = 6 College = 14 HS = 24	Partial = 29 Diffuse = 15
Patrick et al ²⁷ (2016)	Retrospective case report/Level 4	1	1	0	M = 1 F = 0	20	Baseball Pitcher = 1	College = 1	Grade 1 = 1
Deal et al ⁵ (2017)	Retrospective/Level 4	25	23	2	M = 23 F = 2	18 (15-22)	Baseball = 23 -Pitchers = 21 -Position = 2 Softball = 2	College = 10 HS = 15	Grade 2 = 23
Frangiamore et al ¹² (2017)	Retrospective/Level 4	39	32	6	M = 39 F = 0	22.3	Baseball Pitchers = 39	Pro = 39	Distal = 4 Proximal = 17

F, female; HS, high school; Ju-Co, junior college; LL, Little League; M, male; Pro, professional; QB, quarterback; Rec, recreational; UCL, ulnar collateral ligament.

Table 3. Characteristics of extracted data

Study	Initial Rest From Throwing (Y/N)	Splint/Brace (Y/N)	PRP Injection (Y/N)	Stretching/ROM (Y/N)	Strength Program (Y/N)	Medicine (Y/N)	ITP (Y/N)	PRO (Y/N)	Length of Rehabilitation, wk	Time to RTP, wk (Range)	% Nonoperative RTP Rate (Ratio)
Rettig et al ³⁰ (2001)	Y	Y	N	Y	Y	Y	Y	NR	12	24.5 (13-54)	42 (13/31)
Ford et al ¹¹ (2016)	NR	NR	N	Y	Y	NR	Y	DASH	12	NR	84 (26/31)
Podesta et al ²⁹ (2013)	Y	NR	Y	Y	Y	NR	Y	KJOC; DASH	12-14	12 (10-15)	88 (30/34)
Dines et al ⁶ (2016)	Y	NR	Y	Y	Y	Y	Y	NR	6	12 (5-24)	73 (32/44)
Patrick et al ²⁷ (2016)	Y	N	Y	Y	Y	N	Y	NPRS; DASH	12	24	100 (1/1)
Deal et al ⁵ (2017)	Y	Y	Y	Y	Y	N	Y	NR	6	11.7	96 (22/23)
Frangiamore et al ¹² (2017)	Y	NR	Y	Y	Y	NR	Y	NR	Minimum 12	NR	66 (21/32)

DASH, Disabilities of the Arm, Shoulder and Hand; ITP, interval throwing program; KJOC, Kerlan-Jobe Orthopaedic Clinic; N, no; NPRS, Numeric Pain Rating Scale; NR, not reported; PRO, patient-reported outcome; PRP, platelet-rich plasma; ROM, range of motion; RTP, return to play; Y, yes.

Intervention and RTP

Studies that included PRP injections as a conservative treatment option underwent a period of physical rehabilitation either before, during, or after injection.^{5,6,12,27,29} Length of rehabilitation intervention ranged between 6 and 14 weeks with an average of 10.5 weeks. Time to RTP ranged between 12 and 54 weeks. Only 3 (43%)^{11,27,29} of the 7 studies used PROs during their intervention, and of the 3, only 2 (25%) authors objectively reported values.^{27,29} The most used PRO was the Disabilities of the Arm, Shoulder and Hand.^{11,27,29} The Kerlan-Jobe Orthopedic Clinic (KJOC) questionnaire was only used by 1 study, which reported a significant ($P < 0.0001$) increase in KJOC scores from 46 ± 15 to 93 ± 7 .²⁹ Studies that examined pitching mechanics prior to RTP reported the highest RTP rates (84%-100%).^{11,27,29}

DISCUSSION

There continues to be a lack in consensus for a nonoperative program for nonoperative UCL rehabilitation.^{4,15,33} An evidence-based nonoperative protocol is essential to the health care field since it is a viable treatment option.^{4,18} This review offers evidence-based data on conservative treatment interventions, outcomes, and RTP rates for partial UCL tears. Partial UCL injuries in overhead athletes have been successfully treated nonoperatively.^{5,6,11,12,27,29,30} Multiple patient factors need to be considered when making this conservative decision.^{4,11,18} The ideal criteria for undergoing conservative treatment includes a partial tear, a professional level of play, and participating in a low demand sport.^{5,6,11,12,27,29,30} Accordingly, nonoperative treatment strategies should be highly dependent on the individual needs of the athletes and their subjective and objective measures at time of evaluation and reevaluation.

Conservative treatment options in general have the advantages of a more rapid recovery time but are ultimately contingent on the athlete's sport and level of play. If given an option for surgery or rehabilitation, players tended to choose rehabilitation because they did not believe they could afford to lose a year of participation after surgery.¹¹ PROs allow athletes to report their physical and mental perceived level of readiness. An athlete may RTP from successful biological healing but may not be psychologically ready, resulting in a less desirable outcome.¹⁴ Therefore, determining if an athlete is ready to RTP is imperative even after biological tissue healing, as this can alter performance outcomes.

To appropriately interpret RTP outcomes, a standard definition is necessary for comparison of studies. Other inconsistencies were commonly seen between grading scales for partial UCL tears.

When considering differences between RTP outcomes, a low percentage could be due to the limited research and understanding of UCL rehabilitation in 1994-1997.³¹ Differences in RTP rates between studies may also largely be due to differences in sport, positions, and competition levels. The demands between high school, college, and professional levels could potentially influence success rates with rehabilitation.

Professional baseball pitchers had the low RTP rate of 66%.¹² This low percentage may be explained by the risks and demands of a professional baseball pitcher. Professional baseball pitchers are required to perform at higher demands, and on average have documented higher fastball velocities that have increased over the past decade.²⁰ This supports the well-known increased risk factors for injury seen at the professional level.¹⁹

Throwing mechanics and PROs in conjunction with all objective clinical measurements are necessary components of a comprehensive protocol.²⁷ UCLRs may not fully address underlying problems if throwing mechanics are not addressed.²⁷ This supports evaluation and education of throwing mechanics. Moreover, the kinetic chain approach is very important to consider in rehabilitation since upper extremity injuries can be reduced in overhead athletes through the development of lower extremity strength, core strength, and stability.^{24,25,31,32,34}

PROs during rehabilitation are advantageous in that they do well at measuring the athlete's satisfaction and performance.⁷ The KJOC is a valid and reliable assessment tool for overhead athletes, is commonly used in UCLR outcomes, and can also be used during conservative treatment.⁷ Last, the rehabilitation interventions in which the entire kinetic chain and pitching mechanics were incorporated tended to have higher RTP rates, between 84% and 100%.^{5,11,27}

Limitations

There are many limitations to this review. The search was restricted to English-language full-text articles, which represents a publication bias. There were no control groups in any of the extracted studies, which highlights the need for either case-control or prospective randomized controlled studies. Because of the variety in definitions of RTP and the inconsistency between UCL grading, interpretation of results may be over- or underrepresented. Patients who underwent surgery with or without an initial course of conservative treatment were excluded, which could potentially create a selection bias in this review. Most important, the review is of a low level of evidence. Last, there was a lack of clarity and transparency in the characteristics of intervention.

CONCLUSION

Current evidence suggests that partial UCL injuries in overhead athletes can be successfully treated nonoperatively with careful consideration of age, grade of tear, level of play, sport, and perceived well-being. A comprehensive rehabilitation protocol incorporates a sport-specific tailored treatment plan, PROs, kinetic chain strengthening, and an interval throwing program.

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