Return-to-Play Outcomes in Professional Baseball Players After Nonoperative Treatment of Incomplete Medial Ulnar Collateral Ligament Injuries

A Long-Term Follow-up Study

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Background: Medial ulnar collateral ligament (UCL) injuries are common among baseball players. There is sparse literature on long-term results after nonoperative treatment of UCL injuries in professional baseball players.

Purpose: The primary purpose was to assess long-term follow-up on reinjury rates, performance metrics, rate of return to the same level of play or higher (RTP), and ability to advance to the next level of play in professional baseball players after nonoperative treatment of incomplete UCL injuries. The secondary aim was to perform a matched-pair comparison between pitchers treated nonoperatively and a control group without a history of UCL injuries.

Study Design: Cohort study; Level of evidence, 3.

Methods: Twenty-eight professional baseball players (18 pitchers, 10 position players) treated nonoperatively were identified from a previous retrospective review of a single professional baseball organization between 2006 and 2011. UCL reinjury rates and player performance metrics were evaluated at long-term (minimum, 9 years) follow-up. Rates of RTP were calculated. A matched-pair comparison was made between the pitchers treated nonoperatively and pitchers without a history of UCL injuries.

Results: Overall, 27 players (17 pitchers, 10 position players) were available for long-term follow-up at a mean follow-up of 12 years (SD, 2 years). The overall rate of RTP was 85% (23/27), with the rate of RTP being 82% (14/17) in pitchers and 90% (9/10) in position players. Of the 23 players who did RTP, 18 (78%) reached a higher level of play and 5 (21.7%) stayed at the same level. Of the 9 position players who did RTP, the median number of seasons played after injury was 4.5 (interquartile range, 3.3). Of the 14 pitchers who did RTP, the mean number of seasons played after injury was 5.8 (SD, 3.8). In the matched-pair analysis, no significant differences were observed in any performance metrics ($P > .05$). The overall reinjury rate was 11.1% (3/27), with no players requiring UCL reconstruction.

Conclusion: There was a high rate of RTP for professional baseball players treated nonoperatively for incomplete UCL injuries. Compared with a matched cohort with no history of UCL injury, professional baseball pitchers treated nonoperatively had similar performance metrics. Reinjury rates were low, and no player had reinjury requiring UCL reconstruction. Nonoperative treatment of incomplete UCL injuries in professional baseball players, specifically pitchers, is a viable treatment option in the long term.

Keywords: baseball; elbow; clinical assessment/grading scale; ulnar collateral ligament; nonoperative treatment; return to play

Injuries of the medial ulnar collateral ligament (UCL) are commonly seen in overhead throwing athletes, especially baseball pitchers.[4,8,11,16,20] The mechanism of injury can be due to repetitive valgus forces placed on the medial elbow during pitching.[2,3,11,16,18,19,23] In other cases, asymptomatic degenerative fiber wear can eventually lead to an acute rupture. There have also been reports of UCL injury in baseball position players due to repetitive throwing, a traumatic event, and hitting.[6,13,21] UCL injuries can ultimately lead to disabilities that may hinder athletic performance, such as UCL insufficiency and valgus instability.

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Since the introduction of UCL reconstruction in the 1970s, there have been numerous studies showing return-to-play rates of 67% to 95% after surgery.[1,2,4,9,12,17,25,26] However, there is insufficient literature on return-to-play rates after nonoperative treatment of UCL injuries in professional baseball players, and there are no long-term follow-up studies of nonoperative treatment of UCL injuries in professional baseball players, to our knowledge.[22] In a systematic review on return-to-play rates after nonoperative treatment for partial UCL injuries,[5] the authors found that only 2[10,14] of the 7 included studies examined professional players. In 2016, Ford et al[14] reported on professional baseball players' ability to return to play after the nonoperative treatment of UCL injuries based on magnetic resonance imaging (MRI) grade. The authors found that incomplete UCL injuries in professional baseball players can be successfully treated nonoperatively in the majority of cases. Pitchers were more likely to have complete tears leading to surgery, and MRI grading of UCL injuries helped predict return-to-play rates and the need for surgery.[14]

The primary purpose of this study was to assess the long-term follow-up on reinjury rates, performance metrics, the rate of return to the same level of play or higher (RTP), and the ability to advance to the next level of play in professional baseball players after nonoperative treatment of incomplete UCL injuries. Secondary aims were to perform a matched-pair comparison between pitchers treated nonoperatively and a control group without a history of UCL injuries. We hypothesized that having a previous UCL sprain would portend a higher rate of reinjury and lower performance as well as decrease the ability to advance to the next level of play as compared with not having a history of UCL injury. We also hypothesized that professional baseball players who underwent nonoperative treatment of incomplete UCL injuries would be able to RTP.

METHODS

Study Design and Setting

This retrospective study is a long-term follow-up study of previously reported short-term outcomes of the same group of professional baseball players treated nonoperatively for incomplete UCL injuries.[14] After Institutional Review Board exemption was obtained (No. 20-1480), all professional baseball players who underwent nonoperative treatment of incomplete UCL injuries were identified from a previous retrospective review of a single professional baseball organization between 2006 and 2011.[14]

The inclusion criteria for this study were as follows: (1) professional baseball players from a single organization between 2006 and 2011, (2) all players who underwent nonoperative treatment in a previous study,[14] and (3) incomplete UCL tear diagnosed via both physical examination and MRI as described in the previous study.[14] The exclusion criteria for this study included all players who underwent operative treatment for UCL injury in the previous study.[14]

Participants

All professional baseball players who previously underwent nonoperative treatment of UCL injury were identified. Players were then divided into 2 groups: pitchers and position players. A matched-pair comparison was made between the pitchers treated nonoperatively and the pitchers without a history of UCL injuries, with players matched by age, hand dominance, level of play, and draft round.

Data Collection

The following baseline data were collected: player characteristics, imaging findings, and outcomes. Outcomes comprised the rate of reinjury; repeat treatment; and player performance metrics including the rate of RTP, career duration (number of seasons played and innings pitched), pitcher's earned run average, and pitcher's walks plus hits per inning pitched. Success of nonoperative treatment was defined as return to play for $\geq$1 season and no reinjury requiring UCL reconstruction. Rates of RTP were calculated and descriptively presented in the results based on MRI grade, UCL grade, and player position. The level of play was coded as follows: 1 for rookie, 2 for A, 3 for AA, 4 for AAA, and 5 for Major League Baseball.

As described in the previous study,[14] an MRI grading scale was utilized to classify UCL injuries into 4 grades: 1, intact ligament with or without edema; 2A, partial tear; 2B, chronic healed injury; and 3, complete tear. All grades other than grade 3 were considered incomplete injuries.

Nonoperative treatment was individualized depending on the player's specific issues, needs, and responses.[14] Players underwent 10 to 12 weeks of rehabilitation. Based on the severity of the injury, no throwing was allowed for 4

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to 6 weeks. During that time, physical therapy was initiated. The rehabilitation goals were to control pain and regain full range of motion, followed by regaining strength back to the baseline level or better. Strength training consisted of a focused rotator cuff and periscapular program. If the player was pain free and had no discomfort with valgus stress testing after the period of no throwing, an interval throwing program was initiated. Players were usually able to return to play in an additional 4 to 6 weeks.

Statistical Analysis

The presentation of data is descriptive. Categorical variables are presented as frequencies with percentages. Continuous variables with a normal distribution are presented as means (SDs), while nonnormal variables are presented as medians (interquartile ranges [IQRs]). To test for normality of continuous variables, the Shapiro-Wilk test was used in combination with visual inspection. Normally distributed data were compared using paired 2-tailed Student *t* tests. Nonparametric data were compared using the Wilcoxon signed rank test or the Mann-Whitney *U* test. The frequencies of categorical variables were compared using the Pearson χ^2 or Fisher exact test, when appropriate. A P value $<.05$ was considered significant. All analyses and the generation of box plots were conducted using RStudio (Version 1.1.456).[24]

RESULTS

Cohort Characteristics

Overall, 27 of 28 (96.4%) professional baseball players who previously underwent nonoperative treatment of UCL injury (17 of 18 pitchers, 10 of 10 position players) were available for long-term follow-up (minimum, 9 years) at a mean follow-up of 12 years (SD, 2 years) (Figure 1). Overall, the median age at time of injury of the 27 players was 23 years (IQR, 2 years), with the median age of the 17 pitchers being 23 years (IQR, 2 years) and that of the 10 position players being 23 years (IQR, 4.8 years).

In the matched-pair control portion of the study, the 17 pitchers treated nonoperatively were matched to 17 pitchers without a history of UCL injuries based on age at the time of injury, hand dominance, level of play at the time of injury, and draft round. The characteristics of each group are summarized in Table 1. No significant differences were found for age at time of injury, hand dominance, or level of play at the time of injury. No statistical analysis was possible to compare draft rounds.

Return to Play

The overall rate of RTP was 85% (23/27), with the rate of RTP being 82% (14/17) in pitchers and 90% (9/10) in position players. Of note, the 3 pitchers (3/17; 17.6%) who did not RTP were able to return to pitching but retired before playing in a recorded game. The single position player who did not RTP retired after the original UCL injury. The rates of RTP based on MRI grade and UCL injury grade are reported in Table 2.

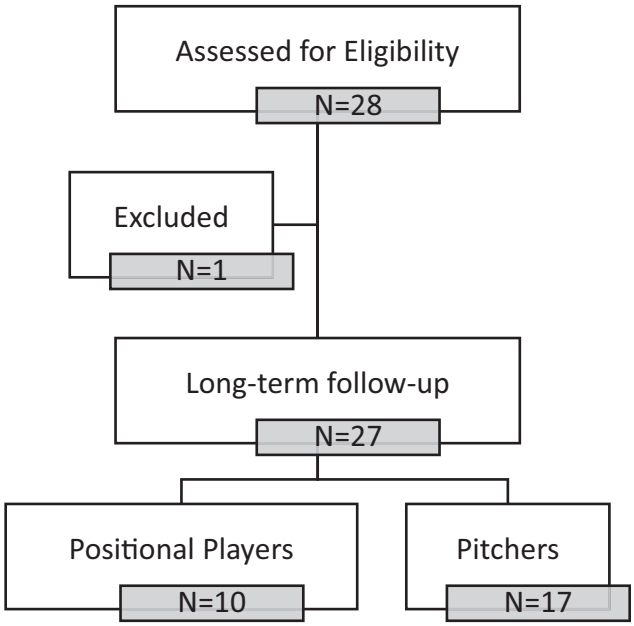

Figure 1. Study flowchart.

Of the 23 players who did RTP, 18 (78.3%) reached a higher level of play, and 5 (21.7%) stayed at the same level (Figure 2). Six (67%) of the 9 position players who RTP reached a higher level of play after injury, and 3 (33%) stayed at the same level.

In the position players who did RTP, the level of play did not significantly increase from the time of injury (median, 2.0 [IQR, 1.0]) to the highest level of play after injury (median, 4.0 [IQR, 2.0]; $P > .05$) (Table 3).

In the matched-pair analysis, there was no significant difference in level of RTP between the pitchers and matched controls, with 86% (12/14) of pitchers and 76% (13/17) of matched controls ($P = .52$) reaching a higher level of play. Figure 3 shows the level-of-play outcomes in pitchers compared with matched-pair controls. In the pitcher group that did RTP, the level of play significantly increased from the time of injury (median, 2.0 [IQR, 0.8]) to the highest level of play after injury (median, 4.0 [IQR, 2.0]; $P = .0009$). Similarly, in the control group, the level of play significantly increased from the initial level of play (median, 2.0 [IQR, 1.0]) to the highest level of play (median, 4.0 [IQR, 1.0]; $P = .001$). However, there was no significant difference in the raw improvement in level of play from the time of injury to postinjury between the pitcher and control groups ($P = .79$).

Performance Metrics

Of the 9 position players who did RTP, the median number of seasons played after injury was 4.5 (IQR, 3.3).

TABLE 1
Participant Characteristics[a]

	Pitchers			
	Treatment	Control	*P* Value	Position Treatment
No.	17	17		10
Age at time of injury, y, median (IQR)[b]	23 (2)	23 (2)	.36	23 (4.8)
Hand dominance				
Right	10 (58.8)	10 (58.8)	.99	5 (50.0)
Left	7 (41.2)	7 (41.2)		5 (50.0)
Level of play at time of injury, median (IQR)[c]	2 (1)	2 (0.8)	.15	2 (1)
1. RK	3 (17.6)	4 (23.5)		4 (40.0)
2. A	7 (41.2)	8 (47.1)		4 (40.0)
3. AA	4 (23.5)	2 (11.8)		0 (0)
4. AAA	3 (17.6)	3 (17.6)		0 (0)
5. MLB	0 (0)	0 (0)		2 (20.0)
Draft round				
Draft round, mean (SD)	14.3 (13.1)	14.8 (12.5)		15.6 (12.0)
ND FA	6 (35.3)	5 (29.4)		2 (20.0)
MRI grade, n				
2	1			3
2A	4			2
2B	12			5

[a]Data are presented as n (%) unless otherwise specified. *P* values compare variables between the treatment group and the matched-pair group. IQR, interquartile range; MLB, Major League Baseball; MRI, magnetic resonance imaging; ND FA, nondrafted free agent; RK, rookie; UCL, ulnar collateral ligament.
[b]The age for the treatment groups is the age at the time of injury, while the age for the control group is the age at the time of injury of the matched pair.
[c]The level of play for the treatment groups is the level of play at the time of injury, while the level of play for the control group is the level of play at the time of injury of the matched pair.

TABLE 2
Rate of Return to Same Level of Play or Higher (RTP)[a]

	Pitchers	Position
RTP based on MRI grade		
1	1 of 1 (100)	3 of 3 (100)
2A	3 of 4 (75)	2 of 2 (100)
2B	10 of 12 (83.3)	4 of 5 (80)
RTP based on UCL injury grade		
Acute	4 of 5 (80)	5 of 5 (100)
Chronic	10 of 12 (83.3)	4 of 5 (80)

[a]Data are presented as RTP n (%). MRI, magnetic resonance imaging; UCL, ulnar collateral ligament.

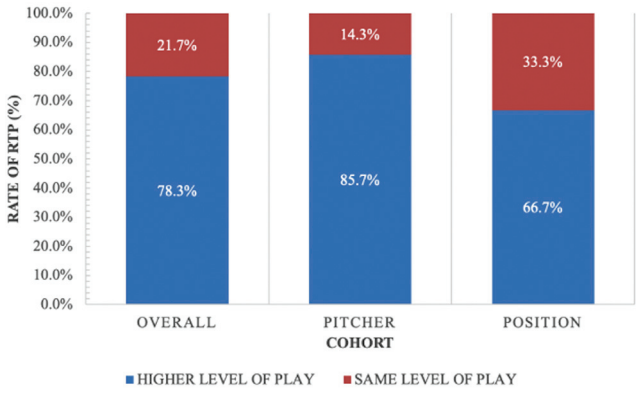

Figure 2. Rate of return to same level of play or higher (RTP) in professional baseball players treated nonoperatively for ulnar collateral ligament injury.

When comparing the pitchers to the matched control group, no significant differences were observed in any performance metrics ($P > .05$ for all) (Figure 4). Further details are included in Table 4.

Reinjury and Repeat Treatment

Overall, the UCL reinjury rate was 11% (3/27), with no players requiring UCL reconstruction (Table 5). The UCL reinjury rate in pitchers was 11.8% (2/17) and in position players was 10% (1/10), with all 3 players being able to RTP after successful repeat nonoperative treatment. Two pitchers underwent elbow arthroscopy later in their careers (4 and 6 years, respectively, after UCL injury) for debridement and returned to play uneventfully.

DISCUSSION

The principal findings of the current study are as follows: high rates of RTP and low reinjury rates were found in professional baseball players treated nonoperatively for

TABLE 3
Level-of-Play Outcomes in Professional Baseball Players Treated Nonoperatively for UCL Injury[a]

	Pitchers			
	Treatment	Control	*P* Value	Position Treatment
Level of play (Δ), median (IQR)[b]	1 (1.8)	2 (1)	.79	1 (2)
Level of play at time of injury, median (IQR)[c]	2 (0.8)	2 (1)	.15	2 (1)
1. RK	3 (17.6)	4 (23.5)		4 (40.0)
2. A	7 (41.2)	8 (47.1)		4 (40.0)
3. AA	4 (23.5)	2 (11.8)		0 (0)
4. AAA	3 (17.6)	3 (17.6)		0 (0)
5. MLB	0 (0)	0 (0)		2 (20.0)
Highest level of play, median (IQR)[d]	**4 (2)**	**4 (1)**	.55	4 (2)
1. RK	0 (0)	1 (5.9)		0 (0)
2. A	2 (14.3)	2 (11.8)		3 (33.3)
3. AA	4 (28.6)	1 (5.9)		1 (11.1)
4. AAA	2 (14.3)	7 (41.2)		3 (33.3)
5. MLB	6 (42.9)	6 (35.3)		2 (22.2)

[a]Data are presented as n (%) unless otherwise specified. *P* values compare variables between the treatment group and the matched-pair group. Boldface indicates significant difference ($P < .05$) compared with the initial value. IQR, interquartile range; MLB, Major League Baseball; RK, rookie; UCL, ulnar collateral ligament.

[b]Δ = the highest level of play post-injury – the level of play at the time of injury.

[c]The level of play for the treatment groups is the level of play at the time of injury, while the level of play for the control group is the level of play at the time of injury of the matched pair.

[d]The level of play for the treatment groups is the highest level of play after injury, while the level of play for the control group is the highest level of play achieved for their career.

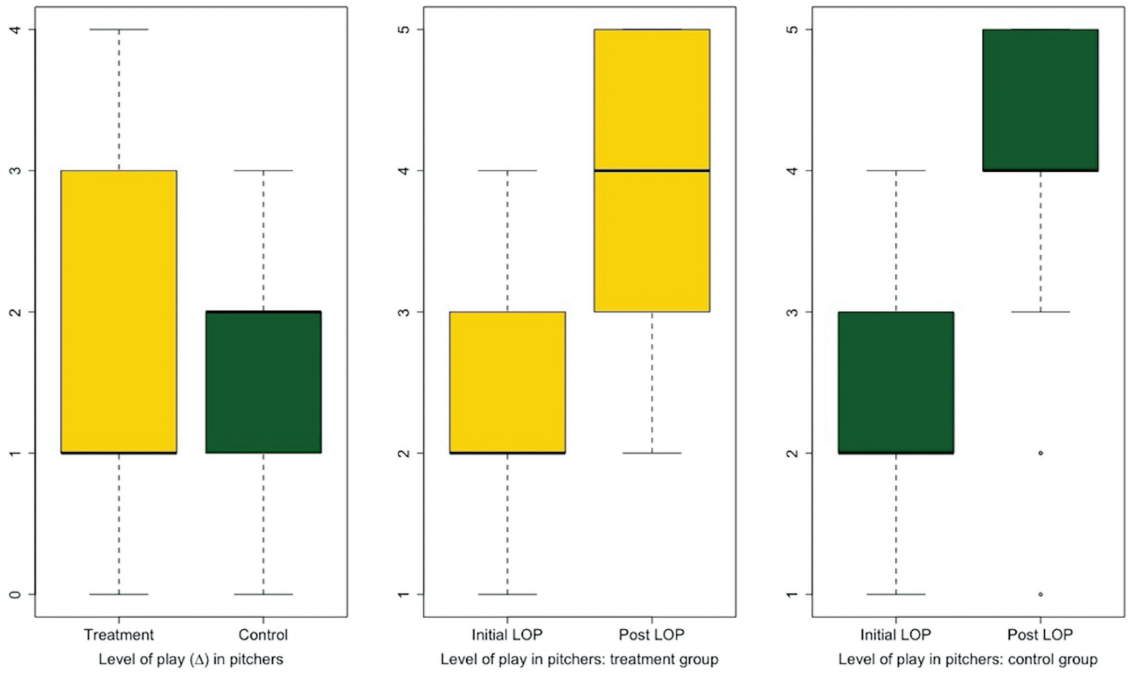

Figure 3. Level-of-play (LOP) outcomes in pitchers treated nonoperatively for ulnar collateral ligament injury compared with matched-pair controls. Initial LOP for the treatment group is the LOP at the time of injury, while initial LOP for the control group is the LOP at the time of injury of the matched pair. Post LOP for the treatment group is the highest LOP after injury, while Post LOP for the control group is the highest LOP achieved for their career. The LOP was coded as follows: 1 for rookie, 2 for A, 3 for AA, 4 for AAA, and 5 for Major League Baseball. Light boxes represent the treatment group, while dark boxes represent the control group. Boxes represent the interquartile range, the central line represents the median, and the whiskers represent the minimum and maximum. Circles represent suspected outliers outside the interquartile range. Δ indicates the highest level of play post-injury – the level of play at the time of injury.

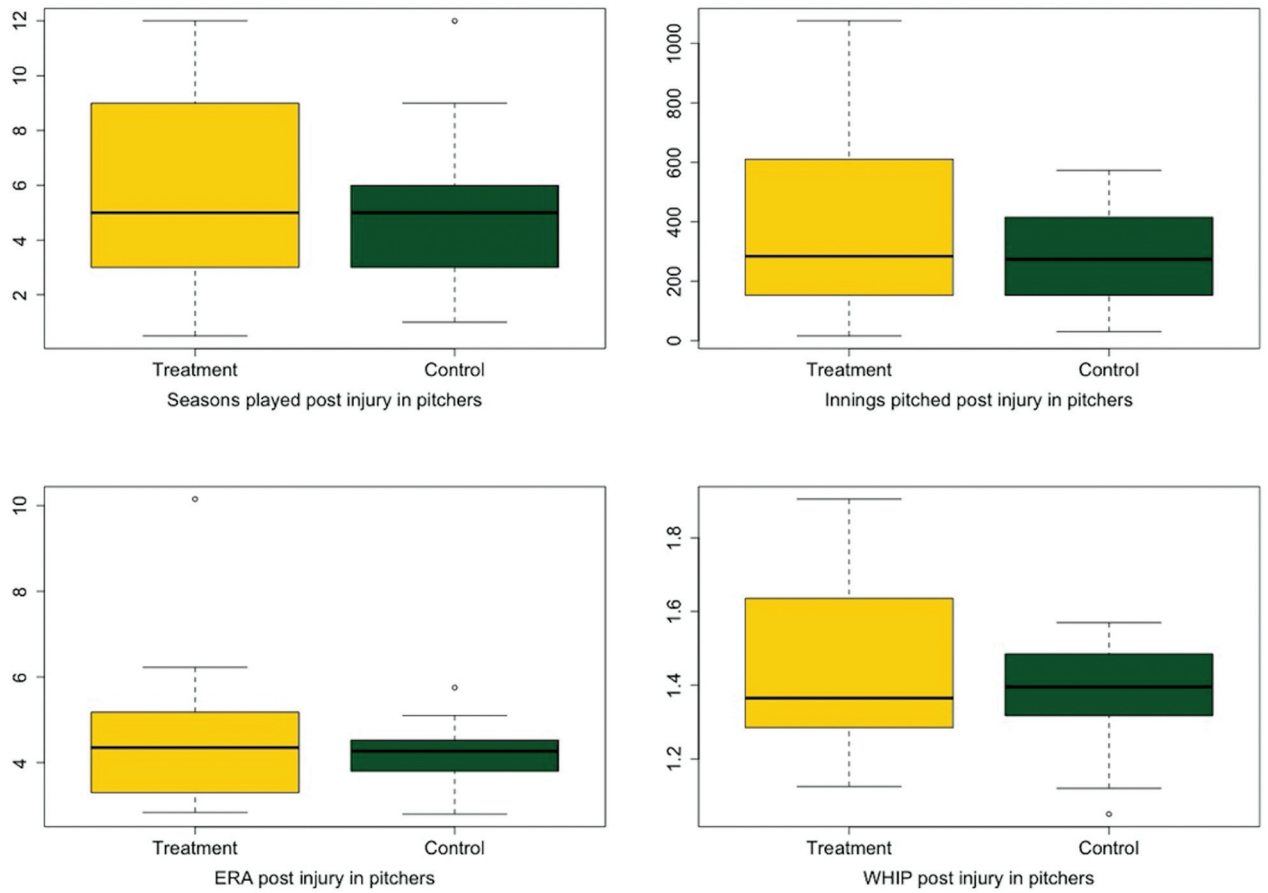

Figure 4. Performance metrics in pitchers treated nonoperatively for ulnar collateral ligament injury compared with matched-pair controls. ERA, earned run average; WHIP, walks plus hits per inning pitched. Boxes represent the interquartile range, the central line represents the median, and the whiskers represent the minimum and maximum. Circles represent suspected outliers outside the interquartile range.

TABLE 4
Performance Outcomes in Professional Baseball Players Treated Nonoperatively for UCL Injury[a]

	Pitchers		
Performance Metrics	Treatment	Control	*P* Value
SP, mean (SD)	5.8 (3.8)	5.1 (3.1)	.90
IP, mean (SD)	392.0 (326.6)	287.7 (185.1)	.48
ERA, median (IQR)	4.4 (1.8)	4.3 (0.7)	.39
WHIP, mean (IQR)	1.4 (0.3)	1.4 (0.7)	.58

[a]*P* values compare variables between the treatment group and the matched-pair group. ERA, earned run average; IP, innings pitched after injury; IQR, interquartile range; SP, seasons played after injury; UCL, ulnar collateral ligament; WHIP, walks plus hits per inning pitched.

TABLE 5
Reinjury and Repeat Treatment Rates in Professional Baseball Players Treated Nonoperatively for UCL Injury[a]

	Pitchers	Position
Reinjury	2 (11.8)	1 (10.0)
Repeat treatment for UCL injury		
UCL reconstruction	0 (0)	0 (0)
Repeat nonop treatment	2 (11.8)	1 (10.0)
Elbow arthroscopy	2 (11.8)	0 (0)

[a]Data are presented as n (%). nonop, nonoperative; UCL, ulnar collateral ligament.

incomplete UCL injuries over a long-term follow-up. Compared with a matched cohort with no history of UCL injury, professional baseball pitchers treated nonoperatively had similar long-term performance metrics. No player had reinjury that required UCL reconstruction, and no player returned to a lower level of play after nonoperative treatment. On the basis of these results, our hypothesis that having a previous UCL sprain would portend a higher rate of reinjury and lower performance compared with not having a history of UCL injury was rejected.

Previous studies[14,15,23] have shown varying rates of RTP after nonoperative treatment of UCL injuries in

throwing athletes. The majority of these studies were limited by short-term follow-up and outcome measures. Rettig et al[23] reported that only 42% of 31 baseball players returned to their previous level of competition after nonoperative treatment. However, the study by Rettig et al[23] did not distinguish between different UCL injury grades. Frangiamore et al[15] found that 66% (21/32) of professional baseball pitchers successfully returned to the same level of play for 1 year without surgical intervention. The previous study by Ford et al[14] demonstrated a higher overall rate of RTP of 84% after nonoperative management in professional baseball players. The current study found an overall high rate of RTP, consistent with the findings published by Ford et al,[14] but is the first to demonstrate these rates over a long-term period and compare them to those of a matched control group.

This is the first study to analyze long-term performance metrics of a matched-pair comparison between professional baseball pitchers treated nonoperatively for incomplete UCL injury and pitchers without a history of UCL injury. We observed no significant differences in any of the performance metrics between the 2 groups. This observation is noteworthy because it shows that pitchers with a history of UCL injury treated nonoperatively can perform equally to their peers with no history of injury over the duration of their careers. To our knowledge, this is the only study to demonstrate these results over a long-term period.

Reinjury is a concern after nonoperative treatment of UCL injuries, especially in professional baseball pitchers. Our study found a low overall UCL reinjury rate of 11%, and no player had reinjury requiring UCL reconstruction. By comparison, this was lower than that reported in other studies in the current literature. Frangiamore et al[15] reported a 34% (11/32) failure rate, requiring ligament reconstruction, after nonoperative management in professional baseball pitchers. There are multiple variables that could contribute to failure of nonoperative treatment, including rehabilitation protocol, pitching mechanics, location and degree of injury, and associated injuries. However, the current study provides evidence that even within the most demanding patient population, long-term reinjury rates after nonoperative treatment can be low given appropriate patient selection and a proper rehabilitation protocol.

Nonoperative treatment augmented with platelet-rich plasma (PRP) or other biologic injections has recently been debated in the literature. A prospective study from 2013 by Podesta et al[22] demonstrated a high rate of RTP (88%) in 34 athletes (27 of whom were professional baseball players) with partial UCL injuries treated nonoperatively via the adjunctive administration of PRP injections into the injured elbow and guided physical therapy. However, a more recent study by Chauhan et al[7] found that PRP did not improve RTP outcomes or ligament survivorship in nonoperative treatment of UCL injuries in professional baseball pitchers and position players. The rehabilitation protocol in the current study did not include augmentation with PRP. Future studies could help further delineate the role of PRP and other biologic injections in the nonoperative treatment algorithm of UCL injuries.

Lastly, it is noteworthy that no player in the current study returned to a lower level of play after nonoperative treatment. This finding, along with the low reinjury rates, high rates of RTP, and comparable long-term performance metrics, could have a significant effect in professional baseball. Specifically, the results of the current study could affect evaluation and scouting of professional baseball players with a history of UCL injury treated nonoperatively. The results of this study show that these players can achieve equivalent performance metrics and low reinjury rates over a long-term period, possibly lowering the risk of drafting/signing these players to a professional baseball organization.

Limitations

The current study has several limitations that should be noted. This was a retrospective study. In general, the number of players (N = 27) was small for assessment, but this is the largest series evaluating long-term outcomes after nonoperative treatment of incomplete UCL injuries. There was an inherent selection bias, as we analyzed the players who were able to return completely after injury versus those who did not and ultimately went on to have surgery or decided to retire after injury. It is also important to note that this study only measured reinjury in regard to the UCL and did not account for players who may have sustained other types of injuries. Despite the design of this study as a matched-pair analysis, we did not match preinjury performance metrics, and therefore individual differences in players still contribute to some uncertainty. Finally, players were all from a single professional baseball organization; however, given the varying levels of play, the results should be representative of a larger cohort.

CONCLUSION

There was a high rate of RTP for professional baseball players treated nonoperatively for incomplete UCL injuries. Compared with a matched cohort with no history of UCL injury, professional baseball pitchers treated nonoperatively had similar performance metrics. Reinjury rates were low, and no player had reinjury UCL reconstruction. Nonoperative treatment of incomplete UCL injuries in professional baseball players, specifically pitchers, is a viable treatment option in the long term.

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