

# Comparison of Outcomes Based on Graft Type and Tunnel Configuration for Primary Ulnar Collateral Ligament Reconstruction in Professional Baseball Pitchers

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**Background:** Professional baseball pitchers are at high risk for tears of the ulnar collateral ligament (UCL) of the elbow, often requiring surgical reconstruction. Despite acceptable published return-to-play outcomes, multiple techniques and graft types have been described.

**Purpose:** This study compares UCL reconstruction (UCLR) outcomes based on tunnel configuration and graft type.

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

**Methods:** After approval from our institutional review board and Major League Baseball (MLB), 566 professional baseball pitchers who underwent UCLR between 2010 and 2014 were identified and included. The following patient characteristics were analyzed: age, pitching role (starter vs reliever), level of play (MLB vs Minor League Baseball [MiLB]), and throwing side dominance. Surgical factors analyzed included reconstruction technique, graft type, and concomitant procedures. Primary outcome measures consisted of the ability to return to play at any level (RTP), ability to return to the same level of play (RSL), time to return, subsequent elbow injuries, and need for subsequent or revision elbow surgery. The effects of patient and surgical factors on outcomes were analyzed using multivariate linear and logistic regression modeling.

**Results:** The RTP rate was 79.9%, and the RSL rate was 71.2%. Grafts used to reconstruct the UCL included the palmaris longus autograft (n = 361, 63.7%), the gracilis autograft (n = 135, 23.8%), and other grafts (n = 70, 12.5%). Surgical techniques utilized were the docking technique (n = 171, 30.2%), the modified Jobe technique (n = 290, 51.2%), and other techniques (n = 105, 18.6%). There were no significant differences in the time to RTP or RSL based on reconstruction technique or graft type. RTP rates were similar for the docking versus modified Jobe technique (80.1% vs 82.4%, respectively;  $P = .537$ ) and for the 2 primary graft types (83.1% for palmaris longus vs 80.7% for gracilis;  $P = .596$ ). The rate of subsequent elbow surgery was 10.5% for the docking technique versus 14.8% for the modified Jobe technique ( $P = .203$ ), and the rate of revision UCLR was 2.9% versus 6.2% for the docking versus modified Jobe technique, respectively ( $P = .128$ ). Significant trends toward an increasing use of the palmaris longus autograft ( $P = .023$ ) and the docking technique ( $P = .006$ ) were observed. MLB pitchers were more likely than MiLB pitchers to RTP ( $P < .001$ ) and RSL ( $P < .001$ ), but they required a longer time to return (mean difference, 35 days;  $P = .039$ ) and had a higher likelihood of subsequent elbow (odds ratio [OR], 3.58 [95% CI, 2.06-6.23];  $P < .001$ ) and forearm injuries (OR, 5.70 [95% CI, 1.99-16.30];  $P = .004$ ) but not subsequent elbow surgery. No specific variables correlated with the rates of subsequent elbow surgery or revision UCLR in the multivariate analysis. The use of concomitant ulnar nerve transposition did not affect outcomes.

**Conclusion:** Surgical outcomes in professional baseball players are not significantly influenced by UCLR technique or graft type. There was a high rate (46.3%) of subsequent throwing elbow injuries. MLB pitchers were more likely to RTP and RSL, but they had a higher frequency of subsequent elbow and forearm injuries than MiLB pitchers. Both the docking technique and the palmaris longus autograft are increasing in popularity among surgeons treating professional baseball players.

**Keywords:** ulnar collateral ligament reconstruction; revision; Tommy John surgery; return to play; professional baseball

League Baseball (MLB) and 15% of Minor League Baseball (MiLB) players having undergone the surgical procedure at some point in their careers.<sup>7</sup> UCLR has achieved acceptable rates of return to play, approaching 79% to 91%; however, there remains room for improvement in surgical outcomes and time to return to play.<sup>2,9,13,26</sup> Since the original description of UCLR by Jobe, a variety of technique modifications, methods of securing the graft, and graft types have been described.<sup>2,4,9,10,19</sup>

The majority of MLB team physicians utilize either the modified Jobe (figure of 8) or docking technique for UCLR.<sup>16</sup> The modified Jobe technique may include subcutaneous ulnar nerve transposition with placement of the graft in a figure-of-8 fashion. With this technique, return-to-play rates of 83% to 87% and ulnar neurapraxia rates of 16% to 20% have been reported.<sup>1,2,11</sup> In an effort to reduce ulnar neurapraxia and the amount of bone removed from the medial epicondyle during traditional figure-of-8 drilling for the modified Jobe technique, the docking technique was developed in 2002. This technique consists of a muscle-splitting approach and the use of a socket in the medial epicondyle. This technique does not require obligatory ulnar nerve transposition and has demonstrated a 92% return-to-play rate and 2.8% rate of ulnar neurapraxia.<sup>3,24</sup> The palmaris longus and gracilis autografts have been utilized in UCLR, both with acceptable outcomes.<sup>2</sup> Clinical outcome comparisons regarding graft and technique types are lacking, as most studies are produced from a single surgeon or institutional series.<sup>2,9,12</sup> Current clinical studies indicate that the docking technique may have a higher return-to-play rate and lower complication rate, but prospective, clinical head-to-head comparisons are lacking.<sup>4,26</sup>

The creation of the MLB Health and Injury Tracking System (HITS) has provided a robust, reliable resource that includes detailed information regarding all professional baseball players, both in MLB and MiLB.<sup>8</sup> All professional pitchers requiring UCLR are included, with treatment by a multitude of surgeons, surgical techniques, and graft choices available for comparison. This resource now allows for larger scale comparisons that were not previously possible. Accordingly, the primary purposes of this

investigation were to utilize the HITS database to (1) determine current trends in UCLR across all professional baseball pitchers, (2) compare rates of subsequent injuries and revision surgery based on technique and graft type, and (3) evaluate the patient and surgical factors that are most predictive of clinical outcomes.

## METHODS

After gaining approval from MLB, the MLB Research Committee, the MLB Players Association, and the institutional review board, a comprehensive search of the MLB HITS database was conducted to identify all active MLB and MiLB pitchers who underwent UCLR between 2010 and 2014 and had at least 2 years' follow-up. Anonymity was maintained by deidentifying all players and assigning them a random study number before beginning. The following patient characteristics were analyzed: age at the time of surgery, pitching role (starter vs reliever), level of play (MLB vs MiLB), and throwing side dominance. For all players, operative reports were reviewed to obtain the following surgical details: reconstruction technique (docking, modified Jobe, and other), graft type (palmaris longus autograft, gracilis autograft, and other), and concomitant procedures. Primary outcome measures consisted of the ability to return to play at any level (RTP), ability to return to the same level of play (RSL), time to return, subsequent elbow or forearm injuries, and need for subsequent elbow surgery or revision UCLR. Trends in graft type and tunnel configuration over time were analyzed from 2010 to 2016. Pitchers were considered to have achieved RTP if and when they made a postoperative appearance in a professional game. RSL was defined as pitching in at least 1 game that was at or above the level of play (ie, MLB, AAA, AA, or A) before the time of surgery. Subsequent elbow and forearm injuries were defined as those injuries of the operative elbow that presented after the player was able to return to play and resulted in at least 1 day out of play. The need for subsequent elbow surgery in the operative elbow, as well as the need for revision UCLR, was evaluated.

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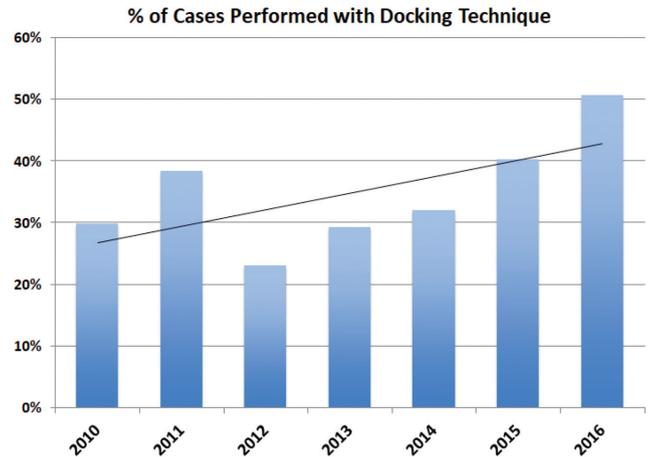
**TABLE 1**  
 Characteristics for All Professional Pitchers Undergoing Primary UCLR<sup>a</sup>

	Mean ± SD (Range)	Median
Age, y	23.5 ± 3.6 (16.5-48.0)	23.1
Time from signing to surgery, d	1339.0 ± 1128.0 (0.0-9534.0)	1071.0
	n (%)	
Handedness		
Right	432 (76.3)	
Left	134 (23.7)	
Primary role		
Starter	379 (67.0)	
Reliever	187 (33.0)	
Level at time of surgery		
MLB	432 (23.7)	
MiLB	134 (76.3)	
Graft type		
Palmaris longus autograft	361 (63.7)	
Gracilis autograft	135 (23.8)	
Other grafts	70 (12.5)	
Tunnel configuration		
Docking technique	171 (30.2)	
Modified Jobe technique	290 (51.2)	
Other techniques	105 (18.6)	
Ulnar nerve transposition		
Docking technique	50 (29.2)	
Modified Jobe technique	215 (74.1)	
Other techniques	76 (72.4)	

<sup>a</sup>MiLB, Minor League Baseball; MLB, Major League Baseball; UCLR, ulnar collateral ligament reconstruction.

**Statistical Analysis**

Descriptive statistics, such as number, mean, and SD, were calculated for continuous data. The significance of the change in trends over time was assessed by analyzing the slope of a best-fit line using linear regression modeling, and corresponding *R*<sup>2</sup> and *P* values are provided. For pairwise comparisons of normally distributed continuous variables such as time to RTP and time to RSL, an unpaired Student *t* test was utilized to assess for statistical significance. All mean differences (MDs) are reported with 95% CIs and their corresponding *P* values. For categorical variables such as RTP, RSL, subsequent elbow injuries, and need for subsequent or revision surgery, a 2-tailed Fisher exact test was used to determine differences in frequencies. Multivariate linear and logistic regression analyses were performed to identify patient and surgical factors, such as age, throwing side dominance, pitching role, and level of play at the time of surgery, that were most predictive of the following outcomes: RTP rate, RSL rate, RTP time, RSL time, development of subsequent injuries, need for subsequent surgery, and need for revision UCLR. Similarly, a multivariate analysis using these outcomes was performed comparing those patients requiring ulnar nerve transposition versus those requiring no ulnar nerve



**Figure 1.** Trends in docking technique over time.

treatment at the time of UCLR and stratified by reconstruction technique, graft type, age, pitching role, throwing side dominance, and level of play. Results are reported with their corresponding odds ratios (ORs), 95% CIs, and *P* values. Only *P* values <.05 were considered to represent statistical significance.

**RESULTS**

Between the years of 2010 and 2014, 566 professional baseball pitchers underwent primary UCLR, had operative reports available for review, and had at least 2 years of follow-up. These pitchers included 432 (76.3%) MiLB and 134 (23.7%) MLB players. The grafts used to reconstruct the UCL were the palmaris longus autograft (*n* = 361, 63.7%), the gracilis autograft (*n* = 135, 23.8%), and other grafts (*n* = 70, 12.5%). The surgical techniques (tunnel configuration) utilized were the docking technique (*n* = 171, 30.2%), the modified Jobe technique (*n* = 290, 51.2%), and other techniques (*n* = 105, 18.6%). Also, 432 (76.3%) pitchers were right-handed, and 134 (23.7%) were left-handed. In terms of primary pitching role, 379 (67.0%) were starting pitchers, while 187 (33.0%) were relief pitchers (Table 1). From 2010 to 2016, the proportion of cases performed with palmaris longus autografts steadily increased (*R*<sup>2</sup> = 0.678, *P* = .023), and a similar trend was noted for the number of procedures performed with the docking technique (*R*<sup>2</sup> = 0.784, *P* = .008) (Figures 1 and 2).

The RTP rate for all 566 professional pitchers was 79.9%, and the RSL rate was 71.2%. For those players who were able to RTP, the mean time was 436.0 ± 146.0 days. For those players who were able to RSL, the mean time was 518.2 ± 202.6 days (Table 2). On average, pitchers required an additional 82.2 days from their first appearance at any level to advance to their prior level of play (MD, 82.8 days [95% CI, 58.6-105.8]; *P* < .001). There were no significant differences in the time to RTP or RSL based on reconstruction technique or graft type. The times to RTP were similar for palmaris longus and gracilis

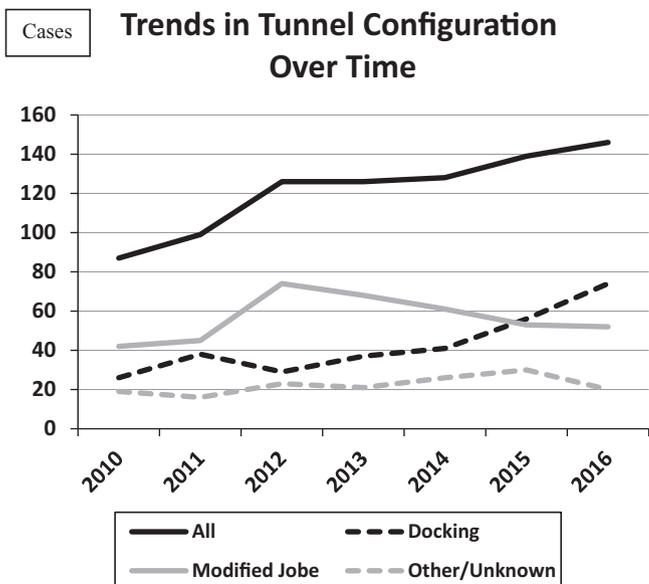


Figure 2. Trends in tunnel configuration over time.

autografts ( $433.5 \pm 135.9$  days vs  $440.7 \pm 179.4$  days, respectively;  $P = .665$ ). No appreciable difference in decreased time to RSL was noted for palmaris longus autografts relative to gracilis autografts ( $509.5 \pm 185.2$  days vs  $542.1 \pm 245.6$  days, respectively;  $P = .179$ ) (Table 3). RTP rates were similar for the docking and modified Jobe techniques (80.1% vs 82.4%, respectively;  $P = .537$ ) and for the 2 primary graft types (83.1% for palmaris longus vs 80.7% for gracilis;  $P = .596$ ). RSL rates were also similar for the docking and modified Jobe techniques (73.7% vs 73.1%, respectively;  $P = .914$ ). No appreciable difference in increased RSL rates was noted for palmaris longus autografts over gracilis autografts (75.4% vs 69.9%, respectively;  $P = .208$ ) (Table 4). After returning to play, 46.3% of pitchers sustained subsequent elbow injuries, while 5.5% had subsequent forearm injuries. The most common subsequent injuries included flexor pronator muscle strains, flexor tendon tendinopathy or tears, ulnar nerve injuries, medial epicondyle and olecranon fractures, ligament sprains and retears, and posterior impingement lesions. There were no differences in the rate of subsequent elbow injuries based on tunnel configuration (43.9% for docking vs 47.9% for modified Jobe;  $P = .440$ ) or graft type (47.1% for palmaris longus vs 48.1% for gracilis;  $P = .841$ ). Rates for subsequent forearm injuries were also similar for the docking and modified Jobe techniques (5.3% vs 5.2%, respectively;  $P = .999$ ) and for the 2 primary graft types (5.0% for palmaris longus vs 6.7% for gracilis;  $P = .506$ ). Ultimately, 12.9% of patients required subsequent elbow surgery, and 4.9% of patients required revision UCLR. The rate of subsequent elbow surgery did not differ by graft type (12.7% for palmaris longus vs 14.1% for gracilis;  $P = .765$ ), and the same was observed for revision UCLR rates (4.2% for palmaris longus vs 6.7% for gracilis;  $P = .247$ ). No appreciable difference in the rates of

TABLE 2  
Outcomes for Pitchers Undergoing Primary UCLR<sup>a</sup>

	Mean $\pm$ SD (Range)	Median
Time to RTP, d	436.0 $\pm$ 146.0 (168.0-1643.0)	392.5
Time to RSL, d	518.2 $\pm$ 202.6 (173.0-1414.0)	438.0
	n (%)	
RTP		
Yes	452 (79.9)	
No	114 (20.1)	
RSL		
Yes	403 (71.2)	
No	163 (28.8)	
Subsequent elbow injury		
Yes	262 (46.3)	
No	304 (53.7)	
Subsequent forearm injury		
Yes	31 (5.5)	
No	535 (94.5)	
Subsequent elbow surgery		
Yes	73 (12.9)	
No	493 (87.1)	
Subsequent revision UCLR		
Yes	28 (4.9)	
No	538 (95.1)	

<sup>a</sup>For RTP, RSL, and subsequent injury/surgery calculations, only players undergoing surgery between 2010 and 2014 were included. RSL, return to same level of play; RTP, return to play at any level; UCLR, ulnar collateral ligament reconstruction.

subsequent elbow surgery (10.5% for docking vs 14.8% for modified Jobe;  $P = .203$ ) and revision UCLR (2.9% for docking vs 6.2% for modified Jobe;  $P = .128$ ) was noted when comparing the techniques. Ulnar nerve transposition was more likely to be performed during surgical treatment with the modified Jobe technique than the docking technique (74.1% vs 29.2%, respectively;  $P < .001$ ).

In the multivariate analysis, MLB pitchers were more likely than MiLB pitchers to RTP (OR, 10.2 [95% CI, 3.6-28.8];  $P < .001$ ) and RSL (OR, 4.3 [95% CI, 2.2-8.6];  $P < .001$ ). However, after evaluating all pitchers who were able to RTP after surgery, MLB pitchers required a longer time to return (MD, 35 days;  $P = .039$ ) and had a higher likelihood of subsequent elbow (OR, 3.58 [95% CI, 2.06-6.23];  $P < .001$ ) injuries but not subsequent elbow surgery. For both MiLB and MLB, for each yearly increase in age, the odds of RSL decreased by 12%; however, the odds of subsequent elbow injuries decreased by 10%. The revision UCLR rate for MLB players was 6.7% and for MiLB players was 4.4% ( $P = .264$ ). No additional specific variables, such as age, throwing side dominance, or pitching role, were noted to be predictive of subsequent elbow or revision surgery in the multivariate analysis. A multivariate analysis comparing the concomitant use of ulnar nerve transposition versus no ulnar nerve treatment at the time of surgery stratified by reconstruction technique, graft type, age, pitching role, throwing side dominance, and level of play did not correlate with the RTP rate, RSL rate, RTP

TABLE 3  
Comparison of Outcomes Based on Graft Type<sup>a</sup>

	Mean ± SD	Mean Difference (95% CI)	P Value <sup>b</sup>
Time to RTP, d		7.2 (-25.5 to 39.9)	.665
Palmaris longus	433.5 ± 135.9		
Gracilis	440.7 ± 179.4		
Time to RSL, d		32.6 (-15.0 to 80.2)	.179
Palmaris longus	509.5 ± 185.2		
Gracilis	542.1 ± 245.6		
	Yes, n (%)	No, n (%)	P Value <sup>c</sup>
RTP			.596
Palmaris longus	300 (83.1)	61 (16.9)	
Gracilis	109 (80.7)	26 (19.3)	
RSL			.208
Palmaris longus	272 (75.4)	89 (24.6)	
Gracilis	94 (69.9)	41 (30.1)	
Subsequent elbow injury			.841
Palmaris longus	170 (47.1)	191 (52.9)	
Gracilis	65 (48.1)	70 (51.9)	
Subsequent forearm injury			.506
Palmaris longus	18 (5.0)	343 (95.0)	
Gracilis	9 (6.7)	126 (93.3)	
Subsequent elbow surgery			.765
Palmaris longus	46 (12.7)	315 (87.3)	
Gracilis	19 (14.1)	116 (85.9)	
Subsequent revision UCLR			.247
Palmaris longus	15 (4.2)	346 (95.8)	
Gracilis	9 (6.7)	126 (93.3)	

<sup>a</sup>RSL, return to same level of play; RTP, return to play at any level; UCLR, ulnar collateral ligament reconstruction.

<sup>b</sup>Unpaired Student *t* test.

<sup>c</sup>Two-tailed Fisher exact test.

time, RSL time, development of subsequent injuries, need for subsequent elbow surgery, and need for revision UCLR. Concomitant procedures are listed in Table 5.

## DISCUSSION

Currently, there is a paucity of clinical data in the literature comparing UCLR techniques and graft types for the subsequent postoperative risk of elbow or forearm injuries, elbow surgery, and revision UCLR in professional baseball players. This study compared the surgical outcomes of the 2 most common UCLR techniques (docking and modified Jobe) and autograft sources (palmaris longus and gracilis) in 566 professional baseball players. Ultimately, surgical outcomes in professional baseball pitchers were not significantly influenced by reconstruction technique or graft type. MLB pitchers were more likely to RTP and RSL than MiLB pitchers, but they had a higher frequency of subsequent elbow and forearm injuries. Although the rate of revision UCLR was low (4.9%) at the time of final follow-up, 46.3% of pitchers sustained subsequent elbow injuries that caused them to miss some time out of play. Surgical trends indicate increasing popularity of the docking technique and palmaris longus autograft for UCLR among elbow surgeons who treat professional baseball pitchers.

The finding of increasing surgeon preference toward the docking technique and palmaris longus autograft for the treatment of professional pitchers with UCL injuries is well in accordance with other studies. Erickson et al,<sup>16</sup> in 2016, evaluated UCLR treatment by MLB team physicians via an online polling system. They found that 56.7% of surgeons preferred the docking technique, while 20% utilized the modified Jobe technique for UCLR; 63.3% of surgeons preferred the palmaris longus autograft, when present, for use in reconstruction.<sup>16</sup> Hurwit et al,<sup>18</sup> in a survey of the American Shoulder and Elbow Surgeons, also demonstrated the docking technique as the preferred method of UCLR among 66% of respondents.

Multiple studies have demonstrated acceptable return-to-play and complication rates for the docking and modified Jobe techniques for the surgical treatment of baseball pitchers with UCL injuries.<sup>2-4,13,20,25</sup> The RTP (79.9%) and RSL (71.2%) rates, after UCLR and postoperative rehabilitation, reported in this investigation are consistent with previous studies on the topic. Makhni et al<sup>22</sup> demonstrated nearly identical figures, with an 80% RTP rate and 67.7% RSL rate in 147 MLB pitchers after UCLR. Similarly, in a study of 43 professional baseball players after UCL injuries in 2016, those requiring reconstruction had an RTP rate of 75% and RSL rate of 63%.<sup>17</sup> With regard to specific evaluations by surgical technique, prior studies have generally

TABLE 4  
Comparison of Outcomes Based on Tunnel Configuration<sup>a</sup>

	Mean ± SD	Mean Difference (95% CI)	P Value
Time to RTP, d		0.1 (−30.9 to 31.3)	.995
Docking	433.8 ± 148.2		
Modified Jobe	433.9 ± 146.5		
Time to RSL, d		19.8 (−24.9 to 64.5)	.384
Docking	505.2 ± 177.4		
Modified Jobe	525.0 ± 215.4		
	Yes, n (%)	No, n (%)	P Value
RTP			.537
Docking	137 (80.1)	34 (19.9)	
Modified Jobe	239 (82.4)	51 (17.6)	
RSL			.914
Docking	126 (73.7)	45 (26.3)	
Modified Jobe	212 (73.1)	78 (26.9)	
Subsequent elbow injury			.440
Docking	75 (43.9)	96 (56.1)	
Modified Jobe	139 (47.9)	151 (52.1)	
Subsequent forearm injury			.999
Docking	9 (5.3)	162 (94.7)	
Modified Jobe	15 (5.2)	275 (94.8)	
Subsequent elbow surgery			.203
Docking	18 (10.5)	153 (89.5)	
Modified Jobe	43 (14.8)	247 (85.2)	
Subsequent revision UCLR			.128
Docking	5 (2.9)	166 (97.1)	
Modified Jobe	18 (6.2)	272 (93.8)	

<sup>a</sup>RSL, return to same level of play; RTP, return to play at any level; UCLR, ulnar collateral ligament reconstruction.

TABLE 5  
Concomitant Procedures Performed With UCLR<sup>a</sup>

Procedure	No. of Pitchers
Subcutaneous ulnar nerve transposition	319
Submuscular ulnar nerve transposition	22
Arthroscopic loose body removal	16
Bone marrow aspirate concentrate injection	3
Removal of posteromedial olecranon osteophyte	43
Excision of intraligamentous ossicle	9
Flexor pronator debridement	11
Platelet-rich plasma injection	7
Radiocapitellar chondroplasty	11
Ulnar nerve in situ decompression	61
Total	532

<sup>a</sup>UCLR, ulnar collateral ligament reconstruction.

favored the docking technique.<sup>4,26</sup> Vitale and Ahmad,<sup>25</sup> in a systematic review from 2008, demonstrated significantly increased Conway-Jobe scores in surgical patients and significantly decreased complications, particularly ulnar neuropathy, with use of the docking technique. In another systematic review of UCLR techniques, Watson et al<sup>26</sup> similarly identified significantly higher RTP and RSL rates, as well as a lower complication rate, when comparing the docking technique with the modified Jobe and classic Jobe techniques. Specifically, the docking technique provided

a 91.3% RSL rate relative to a rate of 77.3% for the modified Jobe technique. In contrast, in our study population of 566 professional baseball pitchers, we did not identify a statistical difference in RTP or RSL by technique or a difference in subsequent elbow or forearm injuries. Studies comparing the surgical outcomes of UCLR by graft type are relatively scarce in the literature. Erickson et al<sup>14</sup> evaluated single-center UCL outcomes by graft type and found no difference in clinical outcomes, return to play, or complications, although this study did include allografts as a graft source. A biomechanical study evaluating tendon grafts for UCLR found no advantage to a larger diameter hamstring graft, relative to the palmaris longus, with respect to cycles to failure, elongation, and stiffness of the graft construct.<sup>23</sup> The current investigation supports the above findings, with no statistically significant clinical difference between palmaris longus and gracilis autografts with respect to the RTP rate, RSL time, subsequent injuries, or need for revision, although a nonsignificant trend toward decreased time to RSL and increased rate of RSL was noted for palmaris longus autografts.

Revision UCLR is expected to rise with the recent increase in primary UCLR. A recent publication by Liu et al<sup>21</sup> demonstrated a 13.2% rate of revision surgery in a cohort of 235 MLB players followed over 7 years. Similarly, 40 of 271 (15%) professional pitchers required revision reconstruction in a retrospective review from 1974 to 2014.<sup>27</sup> Our data more readily support the findings of Erickson et al<sup>15</sup> from 2014 reporting on the surgical results

of 179 pitchers after UCLR in which a 3.9% revision rate was noted. We demonstrated a 4.9% overall revision UCLR rate, with a 2.9% revision rate for the docking technique and a 6.2% revision rate for the modified Jobe technique. One particularly concerning finding in our study was the 46.3% rate of subsequent injuries to the postoperative elbow after returning to pitching. This rate did not vary according to surgical technique and graft choice. Although high, this rate correlates well with previously published data in MLB players showing a 57% rate of return of pitchers to the disabled list for injuries to the throwing arm after UCLR.<sup>22</sup>

There were several limitations to this study. This is a retrospective review of prospectively collected data in the MLB HITS database. It is reliant on the accuracy of information provided to the HITS database by the medical professionals of each professional baseball team in MLB, and there is a potential for errors or omissions in data entry. However, the medical personnel of each team are typically leaders in their respective fields and are generally well trained and thorough. To minimize the potential for data entry errors, all diagnoses and procedures were confirmed by reviewing operative reports of all patients. Given the multitude of surgeons involved in the database, the potential for variance in the preoperative evaluation, postoperative rehabilitation, and criteria for surgical clearance certainly exists. There are also many strengths of this study. To our knowledge, this is the largest study evaluating the surgical techniques and outcomes of UCLR in professional baseball pitchers. The MLB HITS database used for this study is a comprehensive, reliable, and accurate resource that includes detailed information regarding all professional baseball players, both in MLB and MiLB, requiring surgical treatment and provides the opportunity to thoroughly evaluate the outcomes of a multitude of surgeons, techniques, graft choices, and patients. This provides a thorough assessment of the variables for technique and graft comparisons and increased statistical power relative to small, single-center databases.<sup>8</sup>

## CONCLUSION

Surgical outcomes in professional baseball players are not significantly influenced by UCLR technique or graft type. A high rate (46.3%) of subsequent injuries to the throwing elbow occurred postoperatively. MLB players were more likely to RTP and RSL, but they had a higher frequency of subsequent elbow and forearm injuries. Both the docking technique and palmaris longus autograft are increasing in popularity among surgeons treating professional baseball players.

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