JB&JS
JOURNAL OF ORTHOPAEDICS FOR PHYSICIAN ASSISTANTS

Rate of Return to Play and Postoperative Pitching Performance Following Ulnar Collateral Ligament Injuries

A Comparison of the Modified Jobe Technique and the Docking Technique

Briannon Yadrick, PA-S

Baseball pitchers frequently sustain injuries to the medial ulnar collateral ligament (UCL) of the elbow[1]. The mechanics of overhead throwing produce tremendous valgus force at the medial aspect of the elbow, which must be offset by the UCL and its surrounding structures, including the flexor-pronator mass and the osseous restraint of the olecranon and trochlea, to avoid injury[2,3]. Jones et al. divided the overhead throw into the following 6 phases: windup, early cocking, late cocking, acceleration, deceleration, and follow-through[3] (Fig. 1). The UCL is composed of an anterior bundle, a posterior bundle, and a transverse ligament; the anterior bundle serves as the primary contributor of valgus stability during the late cocking and acceleration phases of throwing[1-4]. Regan et al.[5] reported that during these 2 phases, forces of nearly 290 N are generated at the medial aspect of the elbow, exceeding the UCL's average load to failure of 260 N.

Elite pitchers, defined in this article as Major League Baseball (MLB), Minor League Baseball, and collegiate pitchers, undergo years of extensive training to achieve this level of mastery. However, engaging in repetitive throwing at this exceptional level often causes microtrauma to the medial UCL, leading to inflammation, attenuation, and potential failure of the ligament[1,4]. The flexor-pronator mass, which is responsible for dynamic elbow stabilization, is more susceptible to injury if the UCL becomes weakened, and such injury accompanies 4.3% to 12.8% of UCL injuries[3]. Incompetence of the UCL and the flexor-pronator mass further modifies the rotational mechanics of the elbow, resulting in osseous impingement within the olecranon fossa and the development of chondral lesions and osteophytes, which is termed *valgus extension overload*[1,3]. Additionally, the ulnar nerve is predisposed to damage with repetitive overhead throwing[3]. Aoki et al.[6] demonstrated that the elastic limits of the ulnar nerve and its vascular supply were approximately met during the acceleration phase, suggesting that repetitive throwing may cause intraneural injury, ischemia, and ulnar neuropathy in this subset of athletes.

UCL injury decreases the elbow's valgus stability, disrupts the joint's anatomic integrity, and potentiates additional damage to surrounding structures. More importantly, these changes translate into decreased throwing velocity, accuracy, stamina, and strength[3]. For elite baseball pitchers with UCL injuries, their athletic career and, often, their livelihood depend on their ability to return to or exceed their preinjury level of performance. According to *USA Today*[7], the average annual salary of an MLB pitcher in 2017 was $3,993,145, which emphasizes the importance of extending a player's career following a UCL injury.

Disclosure: The author indicated that no external funding was received for any aspect of this work. The **Disclosure of Potential Conflicts of Interest** form is provided with the online version of the article (http://links.lww.com/JBJSJOPA/A40).

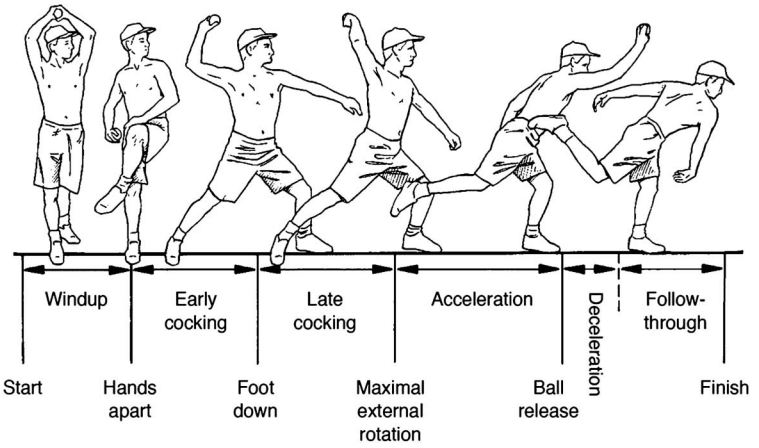

Fig. 1
The 6 phases of overhead throwing: windup, early cocking, late cocking, acceleration, deceleration, and follow-through. (Reproduced, with permission, from Elsevier, from: DiGiovine NM, Jobe FW, Pink M, Perry J. An electromyographic analysis of the upper extremity in pitching. J Shoulder Elbow Surg. 1992;1(1):15-25.)

The first successful UCL reconstruction was performed in 1974 by Dr. Frank Jobe on Los Angeles Dodgers pitcher Tommy John. On completion of the procedure, the professional pitcher returned to MLB for 14 more seasons, earning the procedure the nickname "Tommy John surgery."[8] In 1986, Jobe et al.[9] published their initial results, which showed that UCL reconstruction allowed 63% of athletes to return to play (RTP) at their preinjury level or better. While this technique provided a new treatment approach for a previously career-ending injury, there were several concerns with the surgical procedure, most notably, a postoperative complication rate of 32%[10]. With hopes of improving clinical outcomes and minimizing complications, several modifications have been made to the original Jobe technique over the past 4 decades; 2 of these modifications are termed the modified Jobe technique and the docking technique[1-4,8,11]. The purpose of this article is to compare the rate of RTP and postoperative pitching performance in elite baseball pitchers who underwent the modified Jobe technique with those who underwent the docking technique after sustaining a UCL injury.

Materials and Methods

A computerized literature search was performed through the PubMed database using the keywords "ulnar collateral ligament" and "athletes," which yielded 143 results. An additional search was conducted through the MEDLINE database using the keywords "docking technique" and "throwing," which yielded 15 results. To depict the most up-to-date information, the date range for both searches included published studies from the year 2000 to October 1, 2017. A hand search for additional data also was conducted to supplement the referenced electronic sources. Inclusion criteria included elite male baseball pitchers, defined in this article as those playing at the MLB, Minor League Baseball, or collegiate level, who underwent UCL reconstruction using either the modified Jobe technique or the docking technique. Exclusion criteria included athletes who underwent UCL revision surgery, those who underwent UCL reconstruction using a different surgical technique than the modified Jobe or docking technique, high school or recreational baseball players, male athletes of any sport besides baseball, and all female athletes. Of the 158 resulting studies, 7 met the previously described criteria[1-4,8,10,11].

Results

The original Jobe technique for UCL reconstruction entailed harvesting an autograft tendon and creating multiple bone tunnels in the distal aspect of the humerus and the proximal aspect of the ulna. The tendon then was passed through the tunnels in a figure-of-8 fashion and sutured to itself (Fig. 2-A) to provide medial elbow stability in place of the attenuated UCL ligament. The Jobe technique also involved detachment of the flexor pronator mass from the medial epicondyle and a submuscular ulnar nerve transposition. Despite successful outcomes, the Jobe technique posed several areas of concern, most notably a high rate of ulnar nerve complications, leading Rohrbough et al.[1] to develop the docking technique. The docking technique utilizes a muscle-splitting approach, avoids the obligatory transposition of the ulnar nerve, uses

Fig. 2-A

Fig. 2-B

Figs. 2-A and 2-B A comparison of autograft tendon placement. (Images courtesy of eOrthopod.com.) **Fig. 2-A** The figure-of-8 placement used in the original Jobe technique. **Fig. 2-B** The anterior-to-posterior placement used in the docking technique.

fewer bone tunnels, and utilizes an anterior-to-posterior graft placement (Fig. 2-B). In an uncontrolled retrospective review, Rohrbough et al. hypothesized that use of the docking technique would yield improved results[1]. The purpose of their study was to describe the docking technique and to evaluate the preliminary results in the first 36 patients who were treated with this technique. Sampling was obtained with 36 consecutive athletes who had been diagnosed with medial UCL insufficiency between October 1995 and February 1999. Author David W. Altchek, MD, performed the docking technique on each patient. Twenty-one of the 36 athletes included in this study were elite baseball pitchers: 4 MLB pitchers, 5 Minor League Baseball pitchers, and 12 collegiate pitchers. The inclusion criterion for surgical reconstruction was medial elbow pain due to UCL incompetence that prevented the athletes from throwing or performing at their normal athletic level. The exclusion criteria were not specified. The independent variable was the docking technique. The dependent variables were the Conway-Jobe classification, the postoperative range of motion, and the rate of postoperative complications. The Conway-Jobe rating was graded as "excellent" if the patient was able to RTP at the same or higher level than the preinjury status for >12 months. Data analysis and results were as follows:

- 92% of the outcomes were rated as "excellent" using the Conway-Jobe classification.
  - 100% of the elite baseball pitchers returned to play at the same level or higher than their preinjury status.
- There was no loss in range of motion at the time of the follow-up examination.
- 6% had minor postoperative complications:
  - 3% had a wound hematoma that resolved within 3 weeks.
  - 3% had mild ulnar nerve paresthesia that resolved within 3 weeks.

The docking technique involves several modifications that address concerns associated with the original Jobe technique. By longitudinally splitting the flexor carpi ulnaris muscle, the anterior bundle of the UCL can be exposed without detachment of the flexor-pronator mass or the obligatory transposition of the ulnar nerve. These changes resulted in improved outcomes and decreased postoperative nerve-related complications. Additionally, the docking technique utilizes a single bone tunnel in the humeral epicondyle rather than the 2 tunnels that are used in the Jobe technique. This preserves osseous integrity and allows the tendon graft to be placed in a longitudinal fashion rather than the figure-of-8 fashion, resulting in strong fixation and good graft tensioning. Based on the results described above, use of the docking technique for UCL reconstruction can achieve similar or even improved outcomes when compared with previous studies regarding the original Jobe technique. Of the 7 studies that were analyzed for this article, the retrospective review by Rohrbough et al. was the only one to yield "excellent" results in 100% of the elite baseball pitchers. Although 2 of the 36 patients experienced postoperative complications, they were considered minor issues, and both resolved completely within 3 weeks.

The case series by Cain et al.[8] is one of the largest published studies that exists regarding UCL reconstruction in athletes. The purpose of the study was to evaluate the results of UCL reconstruction in a large cohort of patients with a minimum follow-up of 2 years. The authors hypothesized that UCL reconstruction with use of a modified Jobe technique would allow the majority of athletes to RTP at the same competitive level. Author James R. Andrews, MD, performed UCL reconstruction or repair using a modified Jobe technique on 1,281 athletes; 743 had follow-up results. The modified Jobe technique is similar to the original Tommy John surgery with 2 modifications: the flexor-pronator mass is not detached, and the ulnar nerve is transposed subcutaneously rather than submuscularly. Sampling was obtained by analyzing 1,266 patients who had UCL reconstruction with the modified Jobe technique by Dr. Andrews between 1988 and 2006. The remaining 15 patients underwent UCL repair and were excluded from this analysis. Of the 1,266 patients, 969 were elite baseball players: 86 MLB players, 300 Minor League Baseball players, and 583 collegiate baseball players. Inclusion criteria for surgical reconstruction included elbow pain while athletically active, failure of nonoperative treatment, and diagnostic arthroscopy to confirm valgus instability. Exclusion criteria was not specified.
The independent variable was the modified Jobe technique. The dependent variables were the rate of RTP, the average time to initiate throwing, the average time to return to full competition, and the rate of postoperative complications. After a minimum of 2 years, follow-up data were available for 743 athletes, 646 of whom were elite baseball players. The data analysis and results were as follows:

- 83% of the athletes returned to their previous level of competition or higher.
- 74% of the elite baseball players returned to their previous level of competition or higher, including 76% of the MLB players, 73% of the Minor League Baseball players, and 74% of the collegiate baseball players.
- The average time to initiate throwing was 4.4 months.
- The average time to return to full competition was 11.6 months.

- 20% of athletes had postoperative complications: 16% had minor complications and 4% had major complications.

Based on these results, UCL reconstruction using the modified Jobe technique allowed 74% of elite baseball players to RTP at their previous level of competition or higher in <1 year. The complication rate in this study, while not specific to elite baseball players, was 20%; the majority of players with complications had temporary sensory neurapraxia of the ulnar nerve. These results show that improved outcomes may be achieved when the flexor-pronator mass is not detached; however, subcutaneous transposition of the ulnar nerve may continue to result in frequent postoperative neurologic complications.

In a systematic review by Vitale and Ahmad, various surgical techniques for UCL reconstruction were discussed to determine which procedures were associated with the best postoperative outcomes[10]. One report estimated that 1 in 9 MLB pitchers have undergone UCL reconstruction since 2001, exemplifying the importance of understanding the strengths and weaknesses of each surgical option. A search of the existing literature that assessed UCL reconstruction in athletes was performed using the Ovid MEDLINE database from 1950 to November 1, 2007. Keywords for the search included "ulnar collateral ligament," "UCL," "medial collateral ligament," "MCL," "elbow instability," "valgus instability," "medial instability," "ligament reconstruction," "Tommy John surgery," "athletes," and "overhead." All studies with a cohort of athletes (ranging from recreational to professional) who underwent UCL reconstruction with a minimum follow-up of 1 year were included. Studies that were merely presented as abstracts were excluded from the analysis. Although 11 studies met the criteria, 3 were excluded for the following reasons: results from a later study included all of the patients from the initial study with a longer follow-up period and additional subjects (2 of the 3 studies) and only 1 of the 19 patients had UCL reconstruction versus UCL repair (1 of the 3 studies). The remaining 8 studies, which included 405 participants, were analyzed in this systematic review. The independent variable was UCL reconstruction. The dependent variables were the Conway-Jobe rating, the average time to RTP, the postoperative range of motion, and the rate of postoperative complications. The data analysis and results were as follows:

- 83% of outcomes were rated as "excellent" using the Conway-Jobe rating scale.
- The average time to RTP (analyzed in 6 studies) ranged from 9.8 to 26.4 months.
- The approach to the flexor-pronator mass yielded various outcomes:
  - 70% of patients with detachment of the flexor-pronator mass had "excellent" results.
    - Original Jobe technique.
  - 87% of patients with the muscle-splitting approach to the flexor-pronator mass had "excellent" results.
    - Modified Jobe technique and docking technique.
- Postoperative range of motion (analyzed in 3 studies[10]):
  - Conway et al.: The average loss of extension was 17°.
  - Thompson et al.: The average loss of extension was 4°, and the average loss of flexion was 3°.
  - Paletta and Wright: The average loss of extension was 3°, and the average loss of flexion was 5°.
- A lower complication rate in patients without detachment of the flexor-pronator mass:
  - 23% with detachment of the flexor-pronator mass had some type of postoperative complication.
    - Original Jobe technique.
  - 7% with the muscle-splitting approach to the flexor-pronator mass had some type of postoperative complication.
    - Modified Jobe technique and docking technique.
- Less postoperative ulnar neuropathy in patients without detachment of the flexor-pronator mass:
  - 20% with detachment of the flexor-pronator mass had postoperative ulnar neuropathy.
    - Original Jobe technique.
  - 6% with the muscle-splitting approach to the flexor-pronator mass had postoperative ulnar neuropathy.
    - Modified Jobe technique and docking technique.
- The method of graft fixation influenced the Conway-Jobe rating as follows:
  - 76% with figure-of-8 graft fixation had "excellent" results.
    - Original Jobe technique and modified Jobe technique.
  - 90% with the docking technique of graft fixation had "excellent" results.
    - Docking technique.
- Lower rate of postoperative ulnar neuropathy in patients without the figure-of-8 graft technique:
  - 8% with a figure-of-8 technique had postoperative ulnar neuropathy.
    - Original Jobe technique and modified Jobe technique.
  - 3% with the docking technique had postoperative ulnar neuropathy.
    - Docking technique.
- Obligatory ulnar nerve transposition influenced the Conway-Jobe rating as follows:
  - 75% with obligatory ulnar nerve transposition had "excellent" results.
    - Original Jobe technique and modified Jobe technique.

  - 89% without obligatory ulnar nerve transposition had "excellent" results.
    - Docking technique.
- Obligatory ulnar nerve transposition influenced postoperative ulnar neuropathy as follows:
  - 9% with obligatory ulnar nerve transposition developed ulnar neuropathy.
    - Original Jobe technique and modified Jobe technique.
  - 4% without obligatory ulnar nerve transposition developed ulnar neuropathy.
    - Docking technique.

Based on the above results, the novel UCL reconstruction techniques that incorporate the muscle-splitting approach and avoid obligatory ulnar nerve transposition have demonstrated improvements in clinical outcomes and a reduction in postoperative complications when compared with the original Jobe technique. The docking technique integrates both methods, yielding the highest Conway-Jobe rating and the lowest rate of postoperative ulnar neuropathy. While utilization of the muscle-splitting approach gives the modified Jobe technique an advantage over the original Jobe technique, both methods involve a figure-of-8 graft placement and obligatory ulnar nerve transposition, resulting in a lower Conway-Jobe rating and a higher rate of postoperative complications in comparison with the docking technique. With the success of the docking technique, the modified Jobe technique, and other novel surgical modifications, RTP for overhead athletes who sustain a UCL injury is highly likely. On average, 83% of patients who underwent UCL reconstruction were rated as "excellent" on the Conway-Jobe scale, indicating that the athletes were able to RTP at the same or a higher level than their preinjury status for >12 months. A notable disadvantage with the systematic review by Vitale and Ahmad, unlike the previously analyzed studies, is that the results were not specific to elite baseball pitchers, which is the population of interest in this article.

Discussion

Current studies show that the docking technique yields higher rates of RTP and postoperative pitching performance than the modified Jobe technique in elite baseball pitchers with UCL injuries. According to Rohrbough et al., 100% of elite baseball pitchers who underwent UCL reconstruction with the docking technique had "excellent" results on the Conway-Jobe scale[1], whereas 74% of elite baseball players who had UCL reconstruction using the modified Jobe technique had "excellent" results according to Cain et al.[8]. Both techniques utilize a muscle-splitting approach to expose the anterior bundle of the UCL without the need to detach the flexor-pronator mass[1,8]. Using the muscle-splitting technique leads to "excellent" outcomes in 87% of patients compared with "excellent" outcomes in 70% of patients when the flexor-pronator mass is detached[10]. While this approach makes transposition of the ulnar nerve optional, the modified Jobe technique continues to utilize obligatory subcutaneous ulnar nerve transposition[1,8]. The docking technique reserves ulnar nerve transposition for athletes with preoperative neurologic symptoms. By avoiding obligatory nerve transposition, the docking technique yields a 4% rate of postoperative ulnar neuropathy, while obligatory transposition yields a 9% rate[10]. The modified Jobe technique places the tendon graft in a figure-of-8 fashion, as did Jobe in the original procedure, while the docking technique fixates the graft in an anterior-to-posterior longitudinal fashion[1,8]. This modification addresses the concern regarding adequate strength and tension of the graft with the figure-of-8 fixation[1]. Longitudinal graft fixation using the docking technique yielded "excellent" results in 90% of patients, whereas the figure-of-8 fixation yielded "excellent results" in 76% of patients[10].

While the results of these studies are encouraging for athletes who sustain UCL injuries, they are not without limitations. Two of the limitations were the small sample sizes when exclusively elite pitchers were analyzed and a lack of clarification in the results regarding player position. The studies by Rohrbough et al.[1] and Koh et al.[11] involved 21 and 19 elite pitchers, respectively. The case series by Dodson et al.[4] involved 76 elite pitchers; however, their results reflected all 100 patients without a separate breakdown for the pitchers. Similarly, studies by Cain et al.[8] and Azar et al.[2] involved 646 and 78 elite baseball players, respectively; however, neither study provided separate statistical results for the pitchers. Additionally, the systematic review by Vitale and Ahmad[10] provided a comprehensive overview and comparison of the surgical options for UCL reconstruction, but the patient population included men and women, baseball players of all skill levels and positions, and athletes who participated in other sports. Future research should involve sampling a larger cohort of athletes with the same skill level, involvement in the same sport, and with the same position to allow for an objective comparison of RTP, postoperative complications, and pitching performance after surgery.

Briannon Yadrick, PA-S[1]

[1]Department of Physician Assistant Studies, King's College, Wilkes-Barre, Pennsylvania

ORCID iD for B. Yadrick: 0000-0003-2866-7651

References

1. Rohrbough JT, Altchek DW, Hyman J, Williams RJ 3rd, Botts JD. Medial collateral ligament reconstruction of the elbow using the docking technique. Am J Sports Med. 2002 Jul-Aug;30(4):541-8.

2. Azar FM, Andrews JR, Wilk KE, Groh D. Operative treatment of ulnar collateral ligament injuries of the elbow in athletes. Am J Sports Med. 2000 Jan-Feb;28(1):16-23.

3. Jones KJ, Osbahr DC, Schrumpf MA, Dines JS, Altchek DW. Ulnar collateral ligament reconstruction in throwing athletes: a review of current concepts. AAOS exhibit selection. J Bone Joint Surg Am. 2012 Apr 18;94(8):e49.

4. Dodson CC, Thomas A, Dines JS, Nho SJ, Williams RJ 3rd, Altchek DW. Medial ulnar collateral ligament reconstruction of the elbow in throwing athletes. Am J Sports Med. 2006 Dec;34(12):1926-32. Epub 2006 Aug 10.

5. Regan WD, Korinek SL, Morrey BF, An KN. Biomechanical study of ligaments around the elbow joint. Clin Orthop Relat Res. 1991 Oct; (271):170-9.

6. Aoki M, Takasaki H, Muraki T, Uchiyama E, Murakami G, Yamashita T. Strain on the ulnar nerve at the elbow and wrist during throwing motion. J Bone Joint Surg Am. 2005 Nov; 87(11):2508-14.

7. USA Today. MLB player salaries 2017 season. 2017. https://www.usatoday.com/sports/mlb/salaries/2017/player/p/. Accessed 2017 Oct 7.

8. Cain EL Jr, Andrews JR, Dugas JR, Wilk KE, McMichael CS, Walter JC 2nd, Riley RS, Arthur ST. Outcome of ulnar collateral ligament reconstruction of the elbow in 1281 athletes: Results in 743 athletes with minimum 2-year follow-up. Am J Sports Med. 2010 Dec;38(12): 2426-34. Epub 2010 Oct 7.

9. Jobe FW, Stark H, Lombardo SJ. Reconstruction of the ulnar collateral ligament in athletes. J Bone Joint Surg Am. 1986 Oct; 68(8):1158-63.

10. Vitale MA, Ahmad CS. The outcome of elbow ulnar collateral ligament reconstruction in overhead athletes: a systematic review. Am J Sports Med. 2008 Jun;36(6):1193-205.

11. Koh JL, Schafer MF, Keuter G, Hsu JE. Ulnar collateral ligament reconstruction in elite throwing athletes. Arthroscopy. 2006 Nov; 22(11):1187-91.