

Incidence and Return to Play After Biceps Tenodesis in Professional Baseball Players

Peter N. Chalmers, M.D., Brandon J. Erickson, M.D., Nikhil N. Verma, M.D.,
John D'Angelo, B.S., and Anthony A. Romeo, M.D.

Purpose: To determine return to play (RTP) rates after biceps tenodesis (BT) in professional baseball players. **Methods:** Major League Baseball has maintained a prospective database containing all major and minor league baseball players who have undergone shoulder surgery since 2010. All players who had undergone BT were included. Minimum follow-up was 24 months, and thus we included data from 2010 to 2013. Using this database we determined the incidence, demographics, prior surgery history, concomitant procedures, RTP rates, and time to RTP. **Results:** Between 2010 and 2013, 17 professional baseball players underwent BT. Seventy-one percent of the 17 were pitchers, and 29% of the 17 were in the major league. Forty-seven percent of the 17 had a history of a prior shoulder surgery and 47% of the 17 underwent concomitant labral repair. For all players, RTP after BT was 35%, whereas RTP after BT without a concomitant reconstructive procedure was 44% in 10 ± 6 months, and 25% for those who underwent both BT and a concomitant reconstructive procedure ($P = .620$). All players who RTP were able to return to at least 20 games at their preoperative level of play. Return to professional play was 80% among position players and 17% among pitchers ($P = .028$). For those pitchers who RTP, performance was not statistically changed. **Conclusions:** Professional baseball players who undergo BT have a 35% rate of return to their prior level of play. Whereas pitchers have only a 17% rate of RTP, position players have an 80% rate of RTP. Of those who returned, all returned to their prior level of play. The pitchers who returned had no significant change in performance statistics. **Level of Evidence:** Level IV, therapeutic study, a case series.

From the Department of Orthopaedic Surgery, University of Utah (P.N.C.), Salt Lake City, Utah; Department of Orthopaedic Surgery, Rush University Medical Center (B.J.E., N.N.V., A.A.R.), Chicago, Illinois; and Commissioner's Office, Major League Baseball (J.D.), New York, New York, U.S.A.

The authors report the following potential conflicts of interest or sources of funding: A.A.R. is the board member of AOSSM, ASES, Orthopedics, Orthopedics Today, SAFE, SLACK, and LWW; receives consultancy fees from Arthrex; has grants/grants pending from Arthrex, DJO, Ossur, and Smith & Nephew; receives payment for lectures including service on speakers bureaus from Arthrex; and receives royalties and other support from Arthrex, Saunders, and SLACK. N.N.V. is the board member of AOSSM, ASES, Arthroscopy, AANA, JKS, and SLACK; receives consultancy fees from Minvasive, Orthospace, and Smith & Nephew; provides expert testimony to various; has grants/grants pending from Arthrex, ArthroSurface, DJ Orthopaedics, Ossur, Smith & Nephew, Athletico, ConMed Linvatec, Miomed, and Mitek; receives royalties from Arthroscopy, Smith & Nephew, and Vindico Medical; has stock/stock options in Cymedica and Omeros; and receives other support from Arthroscopy and Vindico Medical. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

Received April 27, 2017; accepted August 11, 2017.

Address correspondence to Peter N. Chalmers, M.D., Department of Orthopaedic Surgery, Rush University Medical Center, 1611 W. Harrison, Suite 300, Chicago, IL 60612, U.S.A. E-mail: p.n.chalmers@gmail.com

© 2017 by the Arthroscopy Association of North America
0749-8063/17576/\$36.00

<https://doi.org/10.1016/j.arthro.2017.08.251>

Overhand baseball pitching places significant stress on the shoulder and elbow.¹⁻³ Shoulder and elbow pain occurs in 30% of youth baseball pitchers, and 31% of youth baseball pitchers describe a prior history of injury.⁴ In particular, pitching has been implicated in the creation of SLAP tears.⁵⁻⁸ This lesion is identified on magnetic resonance imaging in up to 48% of pitchers,^{9,10} and has been implicated as a source of pitching-related pain.¹¹

The operative treatment of SLAP tears remains controversial.^{12,13} SLAP repair in overhead athletes does not predictably return them to play (RTP).^{12,14-17} Biceps tenodesis (BT) has been proposed as an alternative or adjunct to SLAP repair.^{12,18} A SLAP repair preserves the glenohumeral function of the long head of the biceps tendon (LHBT), whereas BT removes the intra-articular portion of the LHBT and with it any function that this tendon may serve in glenohumeral kinematics.¹⁹ The long head of the biceps has been suggested to have a role as a head depressor²⁰ or as a static stabilizer of the glenohumeral joint.^{21,22} The kinematic consequences of BT within the pitching motion remain largely unknown.^{18,23} To date no study has described rates of RTP in high-level baseball players after BT for any indication, and thus it remains

unknown whether BT may have kinematic consequences that preclude RTP in this population. The purpose of this study was to determine the RTP rates after BT among professional baseball players. We hypothesized that RTP rates after BT among professional baseball players would be less than 50%.

Methods

This study was a retrospective case series. Major League Baseball (MLB) has maintained a prospective database containing all major and minor league baseball players who have undergone shoulder surgery since 2010. Within this study, we included all players who had undergone BT and had a minimum of 24 months of follow-up, such that players from 2010 to 2013 were included. Some of these players had undergone concomitant rotator cuff repair, labral repair (including superior labral repair), capsulorrhaphy, or other reconstructive procedures, and we analyzed the effect of inclusion of these multiple procedures. We included those players who had undergone non-reconstructive procedures such as debridement, subacromial decompression, and acromioplasty. The individuals at MLB who maintain the database determined the specifics of each procedure (i.e., a subacromial decompression vs an acromioplasty) based on the operative reports.

To protect players, access to these data is very limited and requires a compelling hypothesis and lengthy approval process for publication, which the authors have completed over a 24-month timespan. Deidentified, preanalyzed data were provided by MLB for the purpose of this study. Because only deidentified data were provided, Institutional Review Board's approval was not needed. This study did not receive any funding.

Demographic information was collected: age, position, level of play, concomitant procedures, prior ipsilateral shoulder procedures, whether the players had a history of shoulder surgery and if so how many months before BT, and prior presence on the disabled list (DL). Outcome information was collected: whether the players RTP and if so how long after the BT, whether the players returned to at least 1 game at their preoperative level of play and if so how long after the BT, and whether the players returned to at least 10 games at their preoperative level of play and if so how long after the BT. The level of play was defined based on the stratified leagues within Major and Minor League Baseball: Rookie, Foreign, Short-Season A, Single-A, Double-A, Triple A, Major League. The following performance data were collected for each pitcher for each season: earned run average, games, game starts, inning's pitched, losses, wins, walks and hits per inning pitched, shutouts, saves, strikeouts, base-on balls, hits surrendered, and home runs surrendered. All available performance data were included and averaged to

include a complete baseline from up to 144 months preoperatively and to provide a full postoperative view for up to 36 months postoperatively. For this dataset, performance data were only available for pitchers. This dataset does not include the indication for surgery nor the surgical technique.

Statistical Analysis

Data are reported as means with 1 standard deviation. Rates of RTP were compared between position players and pitchers, between minor league players and major league players, between players with concomitant reconstructive procedures (CRP) and those without, and between players with prior shoulder surgery and those without using χ -square tests and Fisher's exact tests (Table 1). The former were used if all cell populations were >5 , and the latter were used if any cell populations were <5 . Given the potential kinematic connection between shoulder and elbow injuries, we also analyzed time on the DL for an elbow injury. Because of the wide variety of lower extremity injuries, the authors did not analyze time on the DL for a lower extremity injury. Pre- and postoperative performance data, normalized to the preoperative mean performance, were compared using Student's *t*-tests after confirming data normality using the Komolgorov-Smirnov test. All analyses were performed in Excel X (Microsoft, Redmond, WA) and SPSS 21 (IBM, Armonk, NY). Because this is a retrospective study of an uncommon procedure in a specific population subgroup, no a priori power analysis was conducted and all available patients were included.

Results

Between 2010 and 2013, 17 professional baseball players underwent BT. Seventy-one percent of these 17 were pitchers and 29% of these 17 were major league players. No players were excluded because of loss of follow-up. The position players included 1 short stop, 1 third baseman, 1 center fielder, 1 left fielder, and 1 first baseman. Of the pitchers, 67% were starters and 33%

Table 1. Rates of Return to Play

Variable	Return to Play	<i>P</i> Value
Position		
Pitcher	17%	
Position player	80%	.028
Level of play		
Major league	40%	
Minor league	33%	.605
Prior surgical procedures		
Yes	13%	
No	56%	.131
Concomitant reconstructive procedures		
Yes	25%	
No	44%	.620

NOTE. All rows describe both pitchers and position players.

were relievers or closers. Of the pitchers, 92% were right-hand dominant. The average player age was 28.0 ± 3.2 years. All players underwent concomitant procedures. Eight players underwent reconstructive procedures, which included 7 superior labral repairs, 1 rotator cuff repair, 1 capsular repair, and 1 antero-inferior labral repair. The remaining 9 players underwent non-reconstructive procedures including labral debridement, rotator cuff debridement, subacromial decompression, acromioplasty, and glenohumeral debridement.

Forty-seven percent of players had had prior shoulder surgery, and 17% of players had had 2 or more prior shoulder surgeries. Four players had prior SLAP repairs, 1 player had a prior rotator cuff repair, 4 players had a prior subacromial decompression/bursectomy, 6 players had a prior labral debridement, 4 players had prior rotator cuff debridement, and 1 player had a prior coracoacromial ligament release. These procedures were performed an average of 20 ± 25 months before BT. There was no difference in the percentage of pitchers versus position players with prior surgery (50% vs 40%, $P = 1.000$).

Seventy-two percent of players had a history of being on the DL for a shoulder injury, with 53% of players having multiple appearances on the DL for a shoulder injury. Laterality is not provided by the database. The first appearance on the DL for a shoulder injury was an average of 36 ± 24 months before BT. Forty-one percent of players had a history of being on the DL for an elbow injury, with 12% of players having multiple appearances on the DL for an elbow injury. The first appearance on the DL for an elbow injury was an average of 48 ± 36 months before BT. Four players did not have any history of being on the DL for any upper extremity injury. Rates of return to any level of professional play did not differ between those players with a history of being on the DL for a prior shoulder injury and those without a history of being on the DL for a prior shoulder injury (23% vs 75%, $P = .099$). Among those pitchers who did return to their prior level of play, preoperative and postoperative performance was unchanged (Table 2).

Overall, 35% of players who underwent BT subsequently returned to any professional play within 11 ± 7 months. All of these players returned to at least 20 games at their preoperative level of play, with a mean number of postoperative games of 234 ± 184 at any level and 182 ± 196 at their preoperative level. Among those who underwent CRP, 25% returned to play, whereas 44% of those who underwent BT without a CRP returned to play ($P = .620$). Return to professional play was significantly more common among position players than pitchers (80% vs 17%, $P = .028$). RTP was not different between minor leaguers and major leaguers (33% vs 40%, $P = 1.000$).

Table 2. Pre- and Postoperative Performance Data for Pitchers That Returned to Play After Biceps Tenodesis

	Preoperative	Postoperative	<i>P</i> Value
ERA	3.7 ± 2	4.2 ± 1.7	.154
G	28 ± 22	18 ± 11	.111
GS	5.9 ± 9.5	5.4 ± 7.2	.733
IP	61 ± 52	41 ± 35	.204
L	3.1 ± 3.2	1.8 ± 2.5	.169
W	3.7 ± 3.7	2.3 ± 1.7	.205
WHIP	1.3 ± 0.4	1.4 ± 0.3	.473
SHO	0.1 ± 0.4	0 ± 0	.286
SV	1.5 ± 4.1	1.3 ± 2.4	.509
SO	44 ± 34	25 ± 18	.115
BB	20 ± 17	10 ± 8	.059
H	60 ± 57	44 ± 43	.308
HR	5.3 ± 6.1	2.8 ± 3.6	.124

BB, base on balls; ERA, earned run average; G, games; GS, game starts; H, hits; HR, home runs; IP, innings pitched; L, losses; SHO, shutouts; SO, strikeouts; SV, saves; W, wins; WHIP, walks and hits per inning pitched.

Although RTP was less common among players with prior shoulder surgery, this difference was not statistically significant (56% vs 13%, $P = .131$).

Discussion

Professional baseball players who undergo BT have a low rate of return to their prior level of play. Among pitchers, this rate is even lower. Those who did return played a mean of 182 ± 196 games at their previous level of play. Among those pitchers who returned, there were no significant changes in performance statistics.

BT is an uncommon procedure in professional players. In our study between 2010 and 2013, only 17 professional baseball players in the professional injury database underwent BT. As a result, this condition is difficult to accurately study in players at this level and the outcomes have remained largely unknown. Sports surgeons have been reluctant to consider BT as a treatment option for overhand throwing athletes because of the unknown effects of the procedure on the throwing motion and the ability to RTP. Although the functional role of the LHBT has not been completely elucidated, many surgeons remain concerned that the removal of the intra-articular segment of the biceps may adversely affect the overall function of the shoulder. Several clinical studies have reported favorable results for BT performed for an indication of a SLAP tear.^{12,18,24-27} It remains controversial whether BT provides better outcomes than repair for a SLAP tear, with some studies suggesting superior outcomes for BT,¹² and others reporting no differences.^{24,27} In addition, most of the studies do not include a significant number of overhead throwing athletes. A comparative motion analysis study suggested more differences in throwing kinematics between normal pitchers and

pitchers status post SLAP repair than between normal pitchers and those status post BT for a SLAP tear.¹⁸

Within our study, the majority of professional baseball players who underwent BT were not able to RTP. Of those who were able to return, all were able to return to their prior level of play and all were able to return to at least 20 games at that level, with the mean number of postoperative games at their prior level of play being 182 ± 196 . Performance statistics for pitchers were also not statistically changed. Rates of RTP were the highest for position players (80%) and the lowest for pitchers (17%). The explanation for this finding is unclear, but may be related to the higher demand pitchers place on the arm, which makes RTP more challenging. In addition, the indications for BT, the injury mechanism, and/or pathology of the shoulder may differ between position players and pitchers. The low rates of RTP in pitchers are certainly concerning, although given the high incidence of prior injuries, prior shoulder surgeries, concomitant procedures, and high level of postoperative demand, this population is particularly challenging to RTP. RTP rates were not different between minor and major leagues and between those with CRP and those without CRP. Overall, these rates of RTP are similar to those previously described for professional baseball players undergoing SLAP repair. Fedoriw et al.²⁸ reported a 48% rate of RTP in 27 professional baseball pitchers who underwent the surgical treatment of a SLAP tear, but only a 7% rate of return to their preoperative level of play. Similarly, Neri et al.²⁹ reported a 57% rate of RTP after SLAP repair in collegiate or professional overhead athletes. Other previous series professional baseball pitchers have described the need for concomitant rotator cuff repair as a negative prognostic factor for RTP, although within 17 players included here there was no difference.³⁰ The difference in rates of RTP between pitchers and position players has not been previously described but again may relate to individual factors with these specific players, given the overall small number of players involved in the study.

Limitations

Our study has several limitations. Although the study examined all professional players entered into the MLB injury database who underwent BT between 2010 and 2013, the small number of patients included in the study may lead to statistical comparisons that are underpowered and a potential for type II error. The lack of a control group limits our ability to draw comparisons between BT and other procedures. Given that the indications for BT among the 17 players included are unknown and likely heterogeneous, the authors did not feel that an appropriate control group could be selected. The use of a database design also has limitations because data such as surgical indications, surgical

technique, standardized outcome measures, range of motion, and quality of life are not available. Similarly, errors in entering the data would result in errors in our analysis, which could create a recording bias. The patients are heterogeneous with respect to surgical indications, primary or revision surgery, concomitant pathology, operative technique, postoperative rehabilitation protocol, and numerous other aspects of the perioperative care. These factors as well as the study design contribute to a likely substantial selection bias. We have used a retrospective design. It remains unclear whether these results can be generalized to nonprofessional players, to other overhead athletes, or to the general public. In addition, many of these players underwent concomitant procedures and previous procedures, which can also influence outcome. Also, our study is limited in that performance data were only available for pitchers.

Conclusions

Professional baseball players who undergo BT have a 35% rate of return to their prior level of play. Whereas pitchers have only a 17% rate of RTP, position players have an 80% rate of RTP. Of those who returned, all returned to their prior level of play. The pitchers who returned had no significant change in performance statistics.

References

1. Werner SL, Gill TJ, Murray TA, Cook TD, Hawkins RJ. Relationships between throwing mechanics and shoulder distraction in professional baseball pitchers. *Am J Sports Med* 2001;29:354-358.
2. Fleisig GS, Barrentine SW, Escamilla RF, Andrews JR. Biomechanics of overhand throwing with implications for injuries. *Sports Med* 1996;21:421-437.
3. Fleisig GS, Andrews JR, Dillman CJ, Escamilla RF. Kinetics of baseball pitching with implications about injury mechanisms. *Am J Sports Med* 1995;23:233-239.
4. Chalmers PN, Sgroi T, Riff AJ, et al. Correlates with history of injury in youth and adolescent pitchers. *Arthroscopy* 2015;31:1349-1357.
5. Burkhart S, Morgan C. SLAP lesions in the overhead athlete. *Orthop Clin North Am* 2001;32:431-441.
6. Burkhart SS, Morgan CD, Kibler WB. Shoulder injuries in overhead athletes. The "dead arm" revisited. *Clin Sports Med* 2000;19:125-158.
7. Burkhart SS, Morgan CD. The peel-back mechanism: Its role in producing and extending posterior type II SLAP lesions and its effect on SLAP repair rehabilitation. *Arthroscopy* 1998;14:637-640.
8. Burkhart SS, Morgan CD, Kibler WB. The disabled throwing shoulder: Spectrum of pathology. Part I: Pathoanatomy and biomechanics. *Arthroscopy* 2003;19:404-420.
9. Lesniak BP, Baraga MG, Jose J, Smith MK, Cunningham S, Kaplan LD. Glenohumeral findings on magnetic resonance imaging correlate with innings

- pitched in asymptomatic pitchers. *Am J Sports Med* 2013;41:2022-2027.
10. Sheridan K, Kreulen C, Kim S, Mak W, Lewis K, Marder R. Accuracy of magnetic resonance imaging to diagnose superior labrum anterior-posterior tears. *Knee Surg Sports Traumatol Arthrosc* 2015;23:2645-2650.
 11. Keener JD, Brophy RH. Superior labral tears of the shoulder: Pathogenesis, evaluation, and treatment. *J Am Acad Orthop Surg* 2009;17:627-637.
 12. Boileau P, Parratte S, Chuinard C, Roussanne Y, Shia D, Bicknell R. Arthroscopic treatment of isolated type II SLAP lesions: Biceps tenodesis as an alternative to reinsertion. *Am J Sports Med* 2009;37:929-936.
 13. Frank RM, Nho SJ, McGill KC, et al. Retrospective analysis of arthroscopic superior labrum anterior to posterior repair: Prognostic factors associated with failure. *Adv Orthop* 2013;2013:1-7.
 14. Kim S-H, Ha K-I, Kim S-H, Choi H-J. Results of arthroscopic treatment of superior labral lesions. *J Bone Joint Surg Am* 2002;84:981-985.
 15. Enad JG, Gaines RJ, White SM, Kurtz CA. Arthroscopic superior labrum anterior-posterior repair in military patients. *J Shoulder Elbow Surg* 2007;16:300-305.
 16. Ide J. Sports activity after arthroscopic superior labral repair using suture anchors in overhead-throwing athletes. *Am J Sports Med* 2005;33:507-514.
 17. Cohen DB, Coleman S, Drakos MC, et al. Outcomes of isolated type II SLAP lesions treated with arthroscopic fixation using a bioabsorbable tack. *Arthroscopy* 2006;22:136-142.
 18. Chalmers PN, Trombley R, Cip J, et al. Postoperative restoration of upper extremity motion and neuromuscular control during the overhand pitch: Evaluation of tenodesis and repair for superior labral anterior-posterior tears. *Am J Sports Med* 2014;42:2825-2836.
 19. Provencher MT, LeClere LE, Romeo AA. Subpectoral biceps tenodesis. *Sports Med Arthrosc* 2008;16:170-176.
 20. Kumar VP, Satku K, Balasubramaniam P. The role of the long head of biceps brachii in the stabilization of the head of the humerus. *Clin Orthop Relat Res* 1989;244:172-175.
 21. Strauss EJ, Salata MJ, Sershon RA, et al. Role of the superior labrum after biceps tenodesis in glenohumeral stability. *J Shoulder Elbow Surg* 2014;23:485-491.
 22. Patzer T, Habermeyer P, Hurschler C, et al. The influence of superior labrum anterior to posterior (SLAP) repair on restoring baseline glenohumeral translation and increased biceps loading after simulated SLAP tear and the effectiveness of SLAP repair after long head of biceps tenotomy. *J Shoulder Elbow Surg* 2012;21:1580-1587.
 23. Laughlin WA, Fleisig GS, Scillia AJ, Aune KT, Cain EL, Dugas JR. Deficiencies in pitching biomechanics in baseball players with a history of superior labrum anterior-posterior repair. *Am J Sports Med* 2014;42:2837-2841.
 24. Denard PJ, Lädermann A, Parsley BK, Burkhart SS. Arthroscopic biceps tenodesis compared with repair of isolated type II SLAP lesions in patients older than 35 years. *Orthopedics* 2014;37:e292-e297.
 25. Werner BC, Pehlivan HC, Hart JM, et al. Biceps tenodesis is a viable option for salvage of failed SLAP repair. *J Shoulder Elbow Surg* 2014;23:e179-e184.
 26. Gupta AK, Chalmers PN, Klosterman EL, et al. Subpectoral biceps tenodesis for bicipital tendonitis with SLAP tear. *Orthopedics* 2015;38:e48-e53.
 27. Ek ETH, Shi LL, Tompson JD, Freehill MT, Warner JJP. Surgical treatment of isolated type II superior labrum anterior-posterior (SLAP) lesions: Repair versus biceps tenodesis. *J Shoulder Elbow Surg* 2014;23:1059-1065.
 28. Fedoriw WW, Ramkumar P, McCulloch PC, Lintner DM. Return to play after treatment of superior labral tears in professional baseball players. *Am J Sports Med* 2014;42:1155-1160.
 29. Neri BR, ElAttrache NS, Owsley KC, Mohr K, Yocum LA. Outcome of type II superior labral anterior posterior repairs in elite overhead athletes: Effect of concomitant partial-thickness rotator cuff tears. *Am J Sports Med* 2011;39:114-120.
 30. Neuman BJ, Boisvert CB, Reiter B, Lawson K, Ciccotti MG, Cohen SB. Results of arthroscopic repair of type II superior labral anterior posterior lesions in overhead athletes: Assessment of return to preinjury playing level and satisfaction. *Am J Sports Med* 2011;39:1883-1888.