Update on Performance and Return to Sport After Biceps Tenodesis in Professional Baseball Players

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Background: Bicipital disorders are common among overhead athletes, especially professional baseball players. The ideal treatment for bicipital problems in professional baseball players is unknown.

Purpose/Hypothesis: The purpose was to determine the return-to-sport (RTS) rate and performance after RTS in professional baseball players who underwent biceps tenodesis. It was hypothesized that there will be a high RTS rate in this population, with no difference between the biceps tenodesis and control groups in the RTS rate or performance.

Study Design: Case series; Level of evidence, 4.

Methods: All professional Major League Baseball players who underwent biceps tenodesis between 2014 and 2017 were included. Players with concomitant rotator cuff repair were excluded. Demographic and performance data (preoperative and postoperative) were recorded for each player. Performance metrics were then compared between players with biceps tenodesis and matched controls (no history of biceps tenodesis).

Results: Included were 14 players (mean age, 27 ± 4 years; 12 pitchers, 2 position outfielders). Most surgeries (79%) were open subpectoral tenodeses, 2 were arthroscopic biceps transfers, and 1 was an arthroscopic suprapectoral tenodesis. Fixation methods included cortical button (42%), interference screw (25%), suture anchor (25%), and drill holes (8%). Most players (79%) underwent concomitant procedures (43% underwent superior labral anterior-posterior repairs). While 86% (12/14) were able to RTS, 50% (7/14) returned at the same or a higher level, and 50% of the whole study were either unable to return or returned to a lower level. Among pitchers, 100% (12/12) were able to RTS, but only 50% (6/12) were able to return to the same or a higher level. For those players who did RTS, it took 245 ± 84 days, and their performance after RTS was unchanged and did not differ from that of matched controls.

Conclusion: Open subpectoral tenodesis was the most common tenodesis technique performed on professional baseball players. While 86% of players returned to sport after biceps tenodesis, only 50% returned to the same or higher level. No decline in performance was noted in players who returned successfully.

Keywords: baseball; biceps; biceps tenodesis; labrum; return to sport (RTS); shoulder

The biceps tendon has been shown to be a source of shoulder pain.[26,27] This pain can occur from degeneration within the tendon, instability secondary to a superior labral anterior-posterior (SLAP) tear, disruption of the biceps anchor as well as other pathologies.[10,27] Overhead athletes, specifically baseball pitchers, are particularly susceptible to problems involving the biceps given the amount of stress they place on their shoulder with each pitch.[8,9,16] While nonoperative management remains the mainstay of treatment for biceps issues in baseball players, when a player fails nonoperative management and wants to continue to play at a high level, surgical intervention is often offered. This intervention is typically a SLAP repair, biceps tenodesis, biceps transfer, or a combination SLAP repair and biceps tenodesis.[5,12] Since 2004 within the general population, the number of SLAP repairs has decreased while the number of biceps tenodeses has increased, contrary to trends in the past years.[1,12-14,20]

Despite the attention the biceps tendon receives, its role in the overhead athlete remains a topic of debate.[18,23,25] There are some who believe the long head of the biceps tendon plays an active role as a humeral head depressor.[19] Prior cadaveric work[18] has demonstrated an increase in superior humeral head migration following release of the long head of the biceps. Others believe the biceps plays a role as a static stabilizer of the glenohumeral joint as several cadaveric studies[23,25] have demonstrated a decrease in glenohumeral stability following release of the long head of

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the biceps tendon. In a controlled laboratory study[7] using surface electromyographic measurements and markerless motion analysis, others have shown no significant difference in glenohumeral kinematics during the overhead pitch when the biceps tendon has been tenodesed compared with the intact state. While the cadaveric and laboratory studies provide a foundation for treatment of biceps issues in throwers, the ideal management of biceps issues in the overhead athlete remains elusive.

There have been limited studies on the success and/or failure of biceps tenodesis in the baseball pitcher. In a previously published study,[5] we evaluated 17 professional baseball players (71% pitchers) who underwent biceps tenodesis between 2010 and 2013 and found a return-to-sport (RTS) rate of 35% for isolated biceps tenodesis. When broken down by position, we found that 80% of position players were able to RTS, while only 17% of pitchers were able to do so. The primary purpose of the current study was to build on our previous work in determining the RTS rate and performance in professional baseball players who underwent biceps tenodesis. A secondary purpose was to compare the postoperative performance of the group of players who underwent biceps tenodesis with a group of matched controls with no history of biceps tenodesis. We hypothesized there would be a high rate of RTS in professional baseball players after biceps tenodesis, with no significant difference between the biceps tenodesis and control groups in the rate of RTS or performance upon RTS.

METHODS

This study was performed with the approval of the Major League Baseball (MLB) Research Committee; institutional review board approval was waived because only deidentified data were used. All professional baseball players who underwent open or arthroscopic biceps tenodesis between 2014 and 2019 were eligible for study inclusion. Study data were analyzed from the MLB Health and Injury Tracking System (HITS) database. HITS is a centralized database that contains deidentified major and minor league player information, and was developed as a league-wide injury surveillance system in 2010 to record player injuries and injury time. Deidentified operative reports were reviewed retrospectively to determine the type of tenodesis (open vs arthroscopic vs transfer to the coracoid), method of fixation for the tenodesis (tenodesis screw, unicortical button, etc), location of the tenodesis (in the groove, suprapectoral, subpectoral), concomitant procedures (labral repair, rotator cuff repair, etc), and patient position during surgery (beach chair vs lateral decubitus). Preoperative and postoperative level of play and performance metrics were recorded.

A player was deemed to have RTS if he played in any professional game after biceps tenodesis. Players who underwent biceps tenodesis with a minimum 2-year follow-up were included in the study. Subject inclusion criteria were any male, professional baseball pitcher who underwent biceps tenodesis after being drafted, and who played in at least 1 professional baseball game prior to surgery. Players were excluded if the procedure was performed less than 2 years prior to the time of data collection or if they underwent concomitant rotator cuff repair. Players who returned to professional baseball and played in at least 1 game postoperatively were included in the preinjury and postinjury ingame performance statistical analysis. Players who RTS at the same or higher level of MLB were deemed to have RTS at the same or higher level. Players who RTS but did not return to their same level of play as before surgery were deemed to have RTS but at a lower level. A group of control players with no history of a biceps tenodesis or superior labral repair was matched to cases based on sex, age, years of experience in professional baseball, level of play and performance metrics. An "index year" was designated for controls, analogous to the biceps tenodesis year in cases. In other words, the controls played the same number of years before the index year as the cases played before the injury. The same demographic and ingame performance data were collected and analyzed as a total before and after the index year.

Statistical Analysis

All analyses were performed in Excel X (Microsoft) and SPSS 25 (IBM). As this is a retrospective study of an uncommon procedure in a specific population subgroup, no a priori power analysis was conducted and all patients who met the aforementioned criteria were included. Descriptive statistics were calculated. Data were analyzed for normality using the Kolmogorov-Smirnov test, and parametric and nonparametric tests were used as appropriate. Performance outcomes were averaged before the injury and postoperatively. To do so, performance data were

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TABLE 1
Demographic Characteristics of the Included Players (N = 14)

Variable	Percentage (n/N) or Mean ± SD
Laterality	
Right	86% (12/14)
Left	14% (2/14)
Dominant side affected	
Yes	93% (13/14)
No	7% (1/14)
Age, y	27 ± 4
Mean height ± SD	188 ± 5 cm
Mean weight ± SD	93 ± 5 kg
Position	
Pitcher	86% (12/14)
Starter	50% (7/14)
Reliever	36% (5/14)
Position player	14% (2/14)
Centerfielder	7% (1/14)
Outfielder	7% (1/14)

categorized as either ≥1 year before injury or ≥1 year postoperative. Performance data within a year of surgery were discarded due to potential variations in injury chronicity and rehabilitation variations.

Baseball performance data are reported as both counts and percentages. For the former, count per year was calculated and, for the latter, averages weighted by number of games played per year were calculated. Pre- and postoperative data were then compared using paired Student *t* tests and related-samples Wilcoxon signed-rank tests as appropriate based upon data normality. For each player, maximum preoperative and postoperative level of play was determined, and each player was then determined to have either returned to the same or a higher level of play, returned but to a lower level, or having not returned. Preoperative and postoperative performance data were also compared between patients and controls.

RESULTS

Overall, 24 professional baseball players were identified as having undergone biceps tenodesis since the previous study.[5] Of these, 7 had procedures performed less than 2 years prior to data collection and these were excluded. An additional 3 players were excluded, as they underwent concomitant rotator cuff repair, leaving 14 players available for our study: 4 major league players and 10 minor league players (Table 1).

Most tenodeses were open subpectoral tenodeses with a variety of fixation methods (Table 2). Anchor and interference screw sizes varied from 6 to 8 mm. Of the 3 arthroscopic tenodeses, 2 were soft tissue tenodeses to the conjoint tendon (biceps transfer) and another was a suprapectoral tenodesis in the groove using a 5.5-mm anchor. Surgical positioning for the arthroscopic portion of the case was lateral decubitus in 9 (64%) and beach chair in 5 (36%).

TABLE 2
Surgical Characteristics of the Included Players

Variable	Percentage (n/N)
Approach	
Arthroscopic	21% (3/14)
Open	79% (11/14)
Subpectoral tenodesis fixation	
Cortical button	42% (5/12)
Interference screw	25% (3/12)
Suture anchor	25% (3/12)
Drill holes	8% (1/12)
Concomitant procedures	
Cuff debridement	43% (6/14)
Labral repair	57% (8/14)
Labral debridement	79% (11/14)
Posterior capsular release	7% (1/14)

Most players (79%, 11/14) underwent concomitant procedures such as labral repairs (Table 2). Of the labral repairs, 1 used 4 anchors, 3 used 3 anchors, 3 used 2 anchors, 1 used 1 anchor, and all but 1 were knotless repairs. Of the 8 players who underwent concomitant labral repair, 6 (75%) were SLAP repairs. Of the 6 players who did not undergo concomitant labral repair, 3 underwent labral debridement, and 1 underwent cuff debridement, such that only 2 players underwent biceps tenodesis as an isolated procedure.

Injuries were classified by trainers at the time of injury as acute in 57% (8/14) of cases and overuse in 43% (6/14). Almost all (93%, 13/14) were recorded as associated with pitching or throwing, with the remaining injury recorded as a batting-related injury. Most injuries were documented as associated with a game, with 36% (5/14) occurring ingame, 1 occurring postgame, and 29% (4/14) occurring pregame, with the remaining 29% (4/14) occurring during practices or workouts.

Among the 14 players included in the study, 2 were unable to RTS, 5 did RTS but to a lower level (all minor league players who returned to lower levels of minor league), and 7 were able to RTS at the same or a higher level. Thus, overall, while 86% (12/14) were able to RTS, 50% (7/14) were able to return to the same or a higher level, and 50% were either unable to return or returned to a lower level. Among pitchers specifically, 100% (12/12) were able to return to play, but only 50% (6/12) were able to return to the same or a higher level. Those who did return did so after a mean period of 245 ± 84 days. For those players who were able to return to play, performance was unchanged and did not differ from matched controls, although there were some preinjury differences (Table 3). Of note, for the players who were able to RTS at the same level, 3 had a concomitant labral repair with their biceps tenodesis and 4 did not have a concomitant labral repair. For the players that were not able to RTS at the same level, 5 had a concomitant labral repair with their biceps tenodesis and 2 did not have a concomitant labral repair.

TABLE 3
Performance Statistics for Pitchers and Position Players[a]

	Patients			Controls			*P* (between groups)	
	Pre	Post	*P*	Pre	Post	*P*	Pre	Post
Pitchers								
GP	23 ± 19	25 ± 9	.705	25 ± 7	25 ± 12	.976	.744	.923
GS	4 ± 2	12 ± 10	.087	12 ± 11	13 ± 10	.307	.066	.814
GR	19 ± 20	13 ± 13	.199	13 ± 13	12 ± 14	.527	.529	.938
IP	33 ± 21	81 ± 51	.102	81 ± 46	80 ± 50	.432	**.032**	.988
Wins	2 ± 3	5 ± 4	.233	5 ± 4	5 ± 4	.489	.271	.909
Strikeouts	29 ± 18	72 ± 43	.062	65 ± 40	71 ± 45	.526	.121	.931
Walks	16 ± 10	31 ± 21	.371	33 ± 12	32 ± 18	.932	**.033**	.893
ER	16 ± 11	36 ± 19	.119	45 ± 27	36 ± 20	.718	.063	.954
ERA	4.6 ± 1.1	4.3 ± 1	.244	5.3 ± 1.2	4.4 ± 1.1	**.029**	.383	.809
WHIP	1.2 ± 0.6	1.4 ± 0.2	.961	1.6 ± 0.4	1.4 ± 0.2	.091	.221	.781
Position players								
Singles	22 ± 15	54 ± 34	.087	56 ± 33	50 ± 31	.450	.082	.795
Doubles	6 ± 4	15 ± 9	.130	18 ± 14	15 ± 9	.356	.122	.992
Triples	1 ± 1	2 ± 1	.092	2 ± 1	2 ± 2	.396	.05	.757
Home runs	4 ± 4	6 ± 5	.214	11 ± 7	7 ± 5	.908	.12	.791

[a]Bolded *P* values indicate statistically significant differences between comparisons ($P < .05$). ER, earned runs; ERA, earned run average; GP, games played; GR, games relieved; GS, games started; HR, home runs; IP, innings pitched; Post, postoperative; Pre, preoperative; WHIP, walks and hits per innings pitched.

DISCUSSION

Biceps tendon issues in the overhead athlete, specifically baseball pitchers, present a unique and difficult challenge for orthopaedic surgeons. The authors' hypotheses were partly confirmed as there was a high rate of RTS in professional baseball players following biceps tenodesis without a significant change in performance when compared with preoperative performance or with a group of matched controls. However, while the overall RTS rate was high, the rate of return to the same level of sport was not.

The biceps tendon remains a source of controversy within the overhead athlete's shoulder. Pathology can range from tendonitis/inflammation to instability to partial tearing, and the optimal treatment remains unclear, with recommended treatment options including everything from injections to operative intervention. The throwing motion places extreme forces and torques upon the shoulder, which serves a critical role in translating force generated in the trunk and legs into the arm to accelerate the ball. Thus, all aspects of the shoulder must be working in concert for the athlete to throw effectively. As a result, nonanatomic procedures such as biceps tenodesis have been viewed with caution in these types of athletes. Furthermore, the exact role of the long head of the biceps tendon in the athlete's glenohumeral joint has been debated. Cadaveric studies[18,25] have found that the biceps tendon may have a minor role in stabilizing the glenohumeral joint. When a simulated biceps contraction was performed in the cadaver shoulders, the amount of humeral translation decreased, indicating the biceps may play a role in stabilizing the glenohumeral joint.[21,22] This function may be important for a baseball player as even a minor loss of stability may prevent the athlete from a full return and may increase the risk for impingement.[2,15,17,24] Despite this cadaveric evidence, in vivo evidence has been mixed. Chalmers et al[7] evaluated 18 pitchers in a laboratory setting (7 uninjured controls, 6 players pitching after SLAP repair, and 5 players pitching after subpectoral biceps tenodesis) to determine the muscle activation patterns of the upper extremity during the throwing motion, and found that pitchers with a prior SLAP repair exhibited altered patterns of thoracic rotation compared with controls and pitchers with a prior biceps tenodesis.

The current study was an update to our 2018 case series.[5] Similar to the current study, we found that players who were able to successfully RTS did not see a decline in their performance upon RTS. There are some interesting similarities and differences between the prior study[5] and the present study. Both studies evaluated the same number of years (2010-2013 vs 2014-2017) and noted a similar number of surgeries over the same time period, indicating that the number of biceps tenodeses in professional players has remained constant. This is in contrast to the trend in the number of biceps tenodeses performed in the general population, which has been increasing significantly each year, as well as rates of other surgeries performed on professional baseball players, such as ulnar collateral ligament reconstructions, which are increasing significantly each year.[3,4,11,14]

The overall RTS rate significantly improved in the current study, as 86% of players were able to RTS compared with 35% from the prior study.[5] Despite the increase in the RTS rate, the rate of RTS at the same or higher level was only 50% in the current study. Interestingly, the RTS in pitchers in the current study was much higher than in the previous study (100% vs 17%). This increase may be secondary to an improved understanding and selection of

players who would benefit from a tenodesis and who would not. In particular, the current study included more patients undergoing concomitant labral repair and fewer patients undergoing tenodesis as a revision procedure after a prior failed labral repair, which may affect our results. Performance upon RTS was similar in both studies as no significant decline in performance was noted after biceps tenodesis if players successfully RTS.

One novel finding from this study is the number of baseball players who had an open biceps tenodesis with concomitant labral repair. Of the 14 patients who underwent biceps tenodesis in this study, 57% had a concomitant labral repair. Of the labral repairs, 6 (75%) were SLAP repairs. The issue of how to address the labrum in the setting of a SLAP tear treated with a biceps tenodesis is a matter of debate. In a survey of MLB team physicians on the treatment of SLAP tears, no surgeon said they would treat a SLAP tear in a professional baseball pitcher with a biceps tenodesis and concomitant labral repair.[12] Chalmers et al[6] reported the only series in the literature where 18 patients with SLAP tears were treated with concomitant SLAP repair and biceps tenodesis. They found worse outcomes in patients who had combined SLAP repair and biceps tenodesis compared with those who underwent isolated SLAP repair or isolated biceps tenodesis. The results of the current study were more positive, as 3 of the 7 players who RTS at the same level had concomitant labral repair. However, 5 of the 7 players who did not RTS at the same level had a concomitant labral repair. Hence, it seems a concomitant labral repair is a potential option, although its impact on outcome has yet to be thoroughly defined. These concomitant labral repairs may have contributed to the long time to RTS in these patients (an average of 245 ± 84 days). While many surgeons will move patients faster following an isolated biceps tenodesis, when a concomitant labral repair is performed the rehabilitation protocol often changes to protect the repair. This may have contributed to the length time to RTS.

Further work on the exact function of the long head of the biceps tendon in the overhead athlete, specifically baseball pitchers, is needed to determine the best method of treatment for biceps pathology in these athletes. This study suggests that biceps tenodesis may be a more viable surgical option than suggested by previous research but is still unreliable for return to the same or higher level of play. More research is needed in order to completely define the role of biceps tenodesis in the overhead throwing athlete.

Limitations

This study utilized the MLB HITS database and is therefore subject to data entry errors. While club athletic trainers do an outstanding job of entering information on all of these athletes, it is possible that some of the dates for certain landmarks were entered incorrectly. While acute versus chronic injury status was known, cause of injury to the biceps/labrum was not recorded in every case and therefore could not be commented on reliably. Players who underwent concomitant rotator cuff repair were excluded and, as such, these results are not generalizable to patients who undergo biceps tenodesis with concomitant rotator cuff repair. Furthermore, there was not perfect matching for performance metrics, the number of other procedures may have affected the results (positively or negatively) and these numbers are likely too small to identify any differences between techniques. Finally, this study involves professional baseball players and therefore may not be generalizable to high school and college baseball players.

CONCLUSION

While 86% of professional baseball players returned to sport following biceps tenodesis, only 50% returned to the same or higher level. No decline in performance was noted in players who returned successfully to sport. Open subpectoral tenodesis is the most common tenodesis technique performed on professional baseball players.

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