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Case Reports

Postoperative Rehabilitation Following Subscapularis Repair and Biceps Tenodesis in an Adolescent Overhead Athlete: A Resident's Case Report

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Background

The incidence of rotator cuff pathology in adolescent athletes is incredibly rare, consisting of only 1% of upper extremity injuries in those under the age of 20. Most rotator cuff injuries in this population are of the supraspinatus with few being of the subscapularis. The subscapularis aids with internal rotation and stabilization of the glenohumeral joint. Surgical management of these injuries in an adolescent athlete presents unique challenges due to periods of rapid growth in adolescence. Additional challenges exist in guiding post-operative physical therapy due to limited information on this injury. The purpose of this case report is to describe the surgical management and postoperative physical therapy of an adolescent, overhead athlete with a full thickness subscapularis tendon tear with concomitant long head of biceps tendon tear.

Case Description

A 13-year-old, male overhead athlete with a complete subscapularis tendon tear and partial-thickness tendon tear of the long head of the biceps was treated surgically with open subscapularis tendon repair and bicep tenodesis. The subject completed 22 physical therapy sessions over 30 weeks including completion of a return-to-throwing program.

Outcomes

By the end of the course of treatment, the subject was able to return to sport and displayed clinically meaningful improvements in in range of motion and strength as well as patient reported outcome measures including the Pennsylvania Shoulder Score (PSS) and the QuickDASH.

Discussion

This case report emphasizes the uniqueness of an injury to the subscapularis tendon and long head of the biceps tendon tear in an adolescent overhead athlete along with the rarity of surgical intervention in this population. This case further outlines the success of surgical management following the use of a multi-phased rehabilitation program, allowing the athlete to safely return to sport.

Level of Evidence

Level 5

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INTRODUCTION

Only one percent of upper extremity injuries in adolescents consist of rotator cuff tears.[1] For isolated subscapularis tears in adolescents, the main injury mechanism is a traumatic event with the arm forced into external rotation or a fall on an outstretched arm.[2] Considering anatomical proximity and the high energy involved in upper arm traumatic events, biceps tendon injuries can occur concomitantly with subscapularis tears.[3]

The subscapularis and long head of the biceps are critical muscles for throwing. The subscapularis aids in stabilizing the shoulder joint when the arm is abducted and externally rotated in the cocking phase of throwing.[3] The biceps tendon plays a role eccentrically during the deceleration phase of throwing.[3,4] Thus, a tear of the subscapularis with concomitant injury to the biceps tendon can limit throwing and other overhead activities.

Few case reports exist that describe the surgical repair of a subscapularis tear in adolescent athletes. Outcomes indicate variable return to sport timelines ranging from four months to one year before athletes are able to return to sport, with some studies indicating the inability to return to sport at all.[5-8] Previous studies provide no information on the postoperative rehabilitation for these injuries, making it hard to guide treatment. Therefore, the purpose of this case report is to describe the surgical management and postoperative physical therapy of an adolescent, overhead athlete with a full thickness subscapularis tendon tear with concomitant long head of biceps tendon tear.

CASE DESCRIPTION

A 13-year-old male, overhead athlete presented to a sports medicine clinic one month after a fall on his outstretched dominant shoulder while playing football. At the time of injury, he participated in both football (quarterback) and baseball (pitcher). The subject's chief complaint was anterior shoulder pain during the late cocking phase of overhead throwing with associated decreased control and velocity of this movement.

Initial examination by the orthopedic surgeon revealed tenderness to palpation of the biceps tendon, a positive empty can test, and weakness and pain with belly press test. The remainder of the shoulder exam, including strength and range of motion, was normal. Radiographs were negative for acute fracture or dislocation; however, a small density along the lesser tuberosity, only noted when in an internally rotated position, was observed. Magnetic resonance imaging (MRI) revealed a full-thickness tear of the subscapularis tendon with few fibers intact superiorly, a small nondisplaced tear of the anteroinferior glenoid labrum, and a partial-thickness tear and medial subluxation of the biceps tendon. Treatment options were discussed with the subject, his family, and the orthopedic surgeon. Based on the subject's age, severity of the injury, and desire to return to overhead throwing, the subject and family elected to proceed with surgical intervention.

SURGICAL INTERVENTION

Arthroscopic examination confirmed the imaging findings, and no other intra-articular pathology was noted. The surgeon opted for an open, deltopectoral surgical approach due to the full-thickness nature of the subscapularis tear. An open approach also afforded better exposure, ensuring avoidance of the open proximal humerus physis. Repair was performed with a double row technique. The biceps was tenodesed using an onlay tenodesis technique with a unicortical, biceps button. Given the subject's age and proximity to physis, a tenodesis helped restore the anatomy as best as possible and the onlay technique avoids multiple large drill holes within the proximal humerus.

OUTCOME MEASURES

A comprehensive set of subject-reported and impairment-based outcomes were used to evaluate the subject over the course of rehabilitation. These outcomes were collected at the beginning of each protocol phase unless prohibited by surgical recommendations.

PATIENT REPORTED OUTCOMES

The Pennsylvania Shoulder Score (PENN) and the Quick Disability of The Arm and Shoulder (QDASH) were used to evaluate shoulder pain and functional limitations. The PENN is a reliable and valid measure (ICC=0.94) for reporting outcomes of subjects with various shoulder disorders with a MCID of 11.4 points.[9] The QDASH demonstrates validity and responsiveness across the whole upper extremity (ICC=0.96) and has an MCID of 9.[10,11]

The 17-item Optimal Screening for Prediction and Referral (OSPRO) was used to screen for psychosocial distress and yellow flags. The OSPRO has good concurrent validity with pain intensity and functional disability across anatomical regions.[12] The PENN and QDASH were collected at initial evaluation, 6 weeks, 12 weeks, and return to throw (16 weeks). The OSPRO was collected at initial evaluation and return to throw (16 weeks).

IMPAIRMENT-BASED OUTCOMES

Shoulder flexion and rotation range of motion in various positions was measured. External rotation range of motion was measured at 0, 45, and 90 degrees of shoulder abduction. Internal rotation range of motion was measured at 90 degrees of shoulder abduction. All these measures were taken with the subject lying supine. A two-tester method was utilized in which one tester stabilizes the scapula and passively moves the shoulder joint to the end of the available glenohumeral range of motion. The second tester aligns the axis of rotation and the goniometer arms to anatomical landmarks.[13]All measures showed good reliability with ICC ranging from 0.85 to 0.97 and a MDC of 7.11° for shoulder flexion, 7.48° for external rotation at 0, 8.03° for external rotation at 90, and 4.93° for internal rotation at 90.[14]

Shoulder strength was measured using a handheld dynamometer (MicroFet 2, Hoggan Scientific LLC, Salt Lake City, UT, USA). Shoulder external and internal rotation were measured at 0 and 90 of shoulder abduction. Handheld dynamometer measurements were recorded in kilograms (kg) and included three trials for each measurement, with the best of three recorded. Rotation at 0 degrees of abduction was tested with the subject lying supine; rotations at 90 degrees of abduction were tested in prone. All measures showed good reliability (ICC > 0.9) and a MDC ranging from 10.0-16.6N for ER at 0, 7.9-11.1N for ER at 90, 9.6-12.6N for IR at 0, and 11.4-14.2N for IR at 90.[14]

EXAMINATION

At initial examination, the subject presented with expected post-surgical pain, joint inflammation, post-surgical range of motion (ROM) and strength limitations. The subject was prescribed a sling to be worn at all times, besides during physical therapy, for the first six post-operative weeks. Table 1 describes the orthopedic surgeon's range of motion and strength restrictions to protect the integrity of the repairs.

POST-SURGICAL REHABILITATION

Discussion between the orthopedic surgeon and rehabilitation team occurred prior to the start of formal post-operative rehabilitation. The University of Florida's Orthopedic and Sports Medicine Institute uses a standard protocol for arthroscopic rotator cuff repairs based on the American Society of Shoulder and Elbow Therapist guidelines.[15] This protocol was adapted for this adolescent overhead athlete indicated by end stage goals including a return to throw and sport program along with delayed initiation of active biceps strengthening due to the concomitant biceps tenodesis. The protocol was modified to minimize stress on the subscapularis and biceps by limiting range of motion passively and actively with elbow flexion, shoulder external rotation, and shoulder internal rotation for the first six weeks along with avoidance of bicep and internal rotation strengthening within that same time frame. Rehabilitation consisted of four phases: protective (Phase 1), intermediate (Phase 2), advanced strengthening (Phase 3) and return to activity (Phase 4) which are outlined in the protocol, found in Appendix 1.

The subject participated in physical therapy 2x/month in the first month due to restrictions and increased to 3x/month following. Starting from Phase 2, a weekly home exercise program was provided to the subject and high school athletic trainer as transportation to the physical therapy clinic was difficult for the subject.

PHASE 1 - PROTECTIVE PHASE (WEEKS 0-6)

The focus of this phase consisted of protecting the integrity of the subscapularis and biceps repair, implementing passive and active assisted range of motion, and initiating shoulder strengthening. Passive and active assisted range of motion exercises were performed with a two-week progression schedule. Strengthening exercises started with isometrics, with the exception of internal rotation, and progressed to isotonic strengthening which included prone rows to a neutral arm position, prone horizontal abduction, low rows, front raises, and wrist and forearm strengthening. Isolated bicep strengthening and active elbow flexion range of motion was restricted during this phase due to the concomitant biceps tenodesis, but passive and active assisted range of motion for the biceps was allowed in full range of motion. The subject began use of the upper extremity ergometer along with rhythmic stabilization drills at the end of this phase.

PHASE 2 – INTERMEDIATE PHASE (WEEKS 7-12)

The subject was discharged from the sling during this phase and began working towards full active range of motion. Phase 2 goals consisted of progressive strengthening of the rotator cuff musculature in various positions along with introduction of internal rotation isometric strengthening. Due to the biceps tenodesis, the subject started elbow flexion active range of motion at week seven along with isotonic biceps strengthening, starting with a bicep curl with a one-pound dumbbell, at week nine. The subject was introduced to internal rotation strengthening in this phase, starting with isometrics, and progressing to isotonics with use of resistance bands. By the end of this phase, the subject progressed from rhythmic stabilization drills to closed kinetic chain stabilization exercises, such as tall planks on an elevated height.

PHASE 3 - ADVANCED STRENGTHENING PHASE (WEEKS 13-20)

Phase 3 consisted of advanced strengthening exercises with the goal of building strength and power of the shoulder complex. Compound strengthening exercises such as latissimus dorsi pull downs, chest press, military press, and machine row were initiated in this phase. In the second half of this phase, upper extremity plyometric activities such as ball slams, overhead ball tosses for eccentric loading, and progression of closed kinetic chain stabilization exercises occurred. Plyometrics exercises progressed from two- to one-hand patterns based on tolerance.

PHASE 4 - RETURN TO ACTIVITY (WEEKS 21-28)

Phase 4 consisted of completion of a return to throwing program with continuation of other rehabilitation exercises to build upon strength and power. The subject returned to football first; thus, a return to football throwing program was implemented (Appendix 2). The program was based on when the subject needed to return to sport along with the feasibility of performing the program outside of the clinic. Due to difficulty attending physical therapy sessions, implementation of the return to throwing and home exercise programs was coordinated with the school athletic trainer. Weekly remote follow-ups were implemented to discuss progressions and adjust accordingly.

Table 1. Surgeon prescribed restrictions to protect the integrity of the surgical repair.

Outcome		Phase 1			Phase 2	
		0-2 weeks	3-4 weeks	5-6 weeks	7-8 weeks	9-10 weeks
Range of Motion						
Shoulder	Flexion	To 90° AAROM	To 145° AAROM (To 90° active)	Progress as tolerated AAROM (To 90° active)	Progress to active as tolerated	...
	IR, scapular plane	To 45° AAROM	Progress as tolerated AAROM	...	Progress to active as tolerated	...
	IR, 90° abduction	Not allowed	To 45° AAROM	Progress as tolerated AAROM	Progress to active as tolerated	...
	ER, scapular plane	To 45° AAROM	To 45° AAROM	Progress as tolerated AAROM	Progress to active as tolerated	...
	ER, 90° abduction	Not allowed	Not allowed	Progress as tolerated AAROM	Progress to active as tolerated	...
Elbow	Flexion	Full AAROM	Full AAROM	Full AAROM	Progress to active as tolerated	...
	Extension	Full AAROM	Full AAROM	Full AAROM	Progress to active as tolerated	...
	Forearm Pronation/ Supination	Full AAROM	Full AAROM	Full AAROM	Progress to active as tolerated	...
Strength						
Shoulder	Shoulder ER	Isometric	Isotonics	Isotonics	Progress as tolerated	...
	Shoulder IR	Not allowed	Not allowed	Not allowed	Isometric	Isotonic
	Shoulder Flexion	Isometric	Isotonics	Isotonics	Progress as tolerated	...
	Shoulder Extension	Isometric	Isotonics	Isotonics	Progress as tolerated	...
Elbow	Elbow Flexion	Not allowed	No allowed	Not allowed	Isometric & Isotonic	Progress as tolerated
	Elbow Extension	Isometric	Isometric	Isotonics	Progress as tolerated	...
	Forearm Pronation/ Supination	Isometric	Isotonics	Progress as tolerated	...	

AAROM = assistive active range of motion, ER=external rotation, IR= internal rotation

RESULTS

The subject participated in 22 sessions of physical therapy over 30 weeks. During the first month, the subject participated in two physical therapy sessions, including the evaluation. Due to limitations in range of motion and strength based on surgical protocol, frequency of physical therapy was reduced at this time. Following the first month, the subject participated in physical therapy approximately three times per month for six and a half months completing his last physical therapy appointment seven and a half months following his evaluation. The subject had difficulty obtaining transportation to physical therapy appointments which limited the frequency of visits throughout the plan of care. Due to this challenge, the physical therapist would supply the school athletic trainer with an updated home exercise and return to throwing program.

The subject's functional recovery through rehabilitation is reported in Tables 2, 3, and 4. The tables highlight which outcomes display change greater than clinically important values. At the end of Phase 3, the subject's score on the PSS and QDASH improved 54 points and 84.7%, respectively.

Table 2. Change of subject perception of function between initial evaluation and pre-throwing utilizing PSS, QuickDASH, and OSPRO

Outcome	Initial evaluation	6 weeks	12 weeks	Pre-Throwing	Change from initial evaluation to pre-throwing	
					Absolute value	Percentage
Penn Shoulder Score (PSS), total points	43	54	79	97	54	125.6
PSS Pain, points	27	22	27	30	3	11.1
PSS Satisfaction, points	7	10	10	8	1	14.3
PSS Function, points	9	22	42	59	50	555.6
Quick-DASH, %	87	52.3	2.3	2.3	84.7	-97.4
OSPRO						
TSK-11	22.35	NT	NT	14.77	7.58	-33.9
PCS	4.29	NT	NT	1.59	2.7	-62.9
FABQ-PA	23.55	NT	NT	3.55	20	-84.9
FABQ-W	33.5	NT	NT	3.8	29.7	-88.7
PASS-20	21.63	NT	NT	1.7	19.93	-92.1
PHQ-9	2.23	NT	NT	0.67	1.56	-70.0
STAI	26.78	NT	NT	23.33	3.45	-12.9
STAXI	11.12	NT	NT	10.9	0.22	-2.0
CPAQ	72.55	NT	NT	76.52	3.97	5.5
PSEQ	40.87	NT	NT	26.67	14.2	-34.7
SER	112.5	NT	NT	105.91	6.59	-5.9

Shaded results indicate met MCD.

MCD=Minimal clinically detectable change, PSS=Pennsylvania Shoulder Score, Quick-DASH=Quick Disabilities of the Hand, Shoulder, and Arm Questionnaire, FABQ-W=Fear Avoidance Belief Questionnaire-Work Scale, FABQ-PA=Fear Avoidance Belief Questionnaire-Physical Activity Scale, TSK-11=Tampa Scale of Kinesiophobia-11, PCS=Pain Catastrophizing Scale, PHQ-9=Subject Health Questionnaire, PASS-20=Pain Anxiety Symptom Scale, PSEQ=Pain Self Efficacy Questionnaire, SER=Self Efficacy for Rehabilitation, CPAQ=Chronic Pain Acceptance Questionnaire, STAXI=State Trait Anger

Shoulder ROM increased 25° in flexion, 40° in ER at 0° of abduction, 5° in ER at 45° of abduction, and 10° in IR at 90° of abduction. Shoulder flexion and ER at 0° of abduction ROM were similar to the contralateral arm, but shoulder IR showed a 10° deficit. Shoulder ER strength at 0° and 90° of abduction improved 4.9 and 4.5Kg, respectively. Shoulder IR strength at 0° and 90° of abduction improved 6.3 and 3.6Kg, respectively. Shoulder IR strength at 90° of abduction were symmetrical at pre-throwing while other strength measures showed deficits ranging between 1.4 and 3.2Kg.

DISCUSSION

This case report describes the unique presentation, surgical treatment, post operative rehabilitation, and return to sport progression following surgical repair of the subscapularis and long head tendon of the biceps in an adolescent, overhead athlete. Unique challenges experienced in the rehabilitation of this subject include post-operative restrictions for range of motion and strength and limited subject availability to attend in-person physical therapy visits. The use of a multidisciplinary treatment approach including the orthopedic surgeon, physical therapist, and school athletic trainer helped with overcoming these barriers as each provider assisted in the weekly rehabilitation progressions.

Isolated subscapularis tendon tears are uncommon at any age, and even more so, in an adolescent population.[6,16,17] Diagnosing these injuries is challenging in the acute setting and may overlap with an instability injury, muscle strain, or a physeal injury when in the adolescent population.[6] Additionally, correct diagnosis is often delayed as subjects can regain function with daily activities but remain unable to throw or perform at prior velocity of throwing.[6-8] A systematic review of skeletally immature patients indicated the median time to diagnosis is two months while some studies indicate delayed diagnosis up to one year.[2] It is important that physical therapists be mindful of this injury when considering their differential diagnosis, and advocate for obtaining an MRI if deemed necessary, as non-operative treatment of this injury is often unsuccessful.[8]

Through the course of rehabilitation, the subject displayed improvements on the PSS and QDASH. The absolute change from baseline to pre-throwing surpassed the minimal clinical importance difference for both measures. It should be noted that the PROs utilized in this case report focus on activities of daily living (ADLs). Previous case reports display athletes' ability to perform ADLs returns fairly quickly while higher functioning sport-related activities do not.[5-8] Use of these PROs may overestimate a subject's functional ability and because of this, these measures should not be used in isolation.

Table 3. Subject psychosocial status at baseline and pre-throwing. Score and presence of yellow flags were estimated using the Optimal Screening for Prediction of Referral and Outcome tool.

	Baseline		Pre-throwing	
Domain	Outcome	Score	Score	Yellow flag (Y/N)
Fear avoidance	TSK-11	22.35	14.77	N
	PCS	4.29	1.59	N
	FABQ-PA	23.55	3.55	N
	FABQ-W	33.5	3.8	N
	PASS-20	21.63	1.7	N
Negative mood	PHQ-9	2.23	0.67	N
	STAI	26.78	23.33	N
	STAXI	11.12	10.9	N
Positive coping	CPAQ	72.55	76.52	N
	PSEQ	40.87	26.67	N
	SER	112.5	105.91	N

FABQ-W=Fear Avoidance Belief Questionnaire-Work Scale, FABQ-PA=Fear Avoidance Belief Questionnaire-Physical Activity Scale, TSK-11=Tampa Scale of Kinesiophobia-11, PCS=Pain Catastrophizing Scale, PHQ-9=Subject Health Questionnaire, PASS-20=Pain Anxiety Symptom Scale, PSEQ=Pain Self Efficacy Questionnaire, SER=Self Efficacy for Rehabilitation, CPAQ=Chronic Pain Acceptance Questionnaire, STAXI=State Trait Anger

When compared to the uninjured arm at the return to throwing time frame, shoulder ROM was symmetrical outside of internal and external rotation. The athlete exhibited an internal rotation deficit of 10° relative to the uninvolved arm. This observation is common in overhead athletes with studies displaying increased ER and decreased IR as a result of humeral retroversion that occurs as an adaptive change in the proximal humeral anatomy in throwers.[18] However, this subject also displayed a 10° deficit in external rotation ROM with the arm abducted to 90°. This finding is less common in overhead athletes but may be explained by current uncertainty as to what age asymmetry develops in youth athletes as a result of humeral retroversion.[19] This may be explained due to the subject's limited exposure to repetitive throwing before achieving skeletal maturity. Additionally, the final follow-up data point was collected at the start of return to throwing in which the subject had not been exposed to a large volume of repetitive motions for a long period of time.[18-20] It is possible that after the subject completed the return to throwing program, the exposure to the repetitive overhead motion would have induced changes in the ROM of the surgical shoulder.

The subject met MDC values for all strength measurements when comparing six weeks to pre-throwing but continued to show strength deficits relative to the non-surgical side. Similar to the lack of consensus on return to sport testing for overhead athletes, there is no specific criteria for return to practice or throwing in this population.[21,22] The subject displayed a limb symmetry index greater than 70% for all strength metrics; therefore, it was decided the subject was able to begin a throwing program while continuing to address strength with a home exercise program and rehabilitation session with the school athletic trainer.[20]

Limitations of this case report include those typical of a case report, and cause and effect cannot be presumed. An additional challenge was the limitation in follow-up visits due to difficulty in transporting the subject to physical therapy. This resulted in an inability to collect data at the time of return to sport although the subject received clearance from the physician. Future studies should outline decision making processes for surgical versus conservative management of rotator cuff tears in an adolescent population, further explore the protocol used with this subject, and investigate return to sport testing batteries in overhead, adolescent athletes who undergo surgical procedures such as this subject did.

CONCLUSION

This case report presents a unique case involving combined subscapularis and long head of biceps tendon repair in a skeletally immature, overhead athlete. The results of this case report provide evidence for positive outcomes, including return to sport for this youth athlete.

CONFLICT OF INTEREST

The authors report no conflicts of interest.

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Table 4. Change of clinical outcomes of range of motion and strength throughout plan of care

Outcome	Injured Arm			Uninjured Arm	Change from 6 or 12 weeks to pre throwing		Between arm difference at pre-throwing	
	6 Weeks	12 Weeks	Pre-throwing	Pre-Throwing	Absolute value	Percentage	Absolute value	Percentage
Range of motion								
Shoulder flexion, °	140	155	160	165	20	14.3	5.0	-3.1
Shoulder ER (0° of abduction), °	30	65	70	70	40	133.3	0.0	0.0
Shoulder ER (45° of abduction),°	NT	80	80	85	0	0.0	5.0	-6.1
Shoulder ER (90° of abduction).°	NT	100	95	95	5	-5.0	0.0	0.0
Shoulder IR (90° of abduction), °	NT	30	30	40	0	0.0	10.0	-28.6
Strength								
Shoulder ER (0° of abduction), Kg	2.3	2.7	7.3	8.6	5.0	219.8	1.4	-17.0
Shoulder ER (90° of abduction).Kg	NT	3.6	6.4	8.2	2.7	75.4	1.8	-24.9
Shoulder IR (0° of abduction), Kg	2.3	4.1	8.6	11.8	6.3	279.3	3.2	-31.2
Shoulder IR (90° of abduction), Kg	NT	4.5	8.2	8.2	3.6	80.1	0.0	0.0

Shaded results indicate met MDC.
MDC= minimal detectable change, ER=external rotation, IR=internal rotation

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SUPPLEMENTARY MATERIALS

Appendix 1

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Appendix 2

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