Original Article

Depressive and Anxiety Disorders Increase Risk for Recurrent Anterior Shoulder Pain Following Arthroscopic Suprapectoral Biceps Tenodesis

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Purpose: To evaluate factors associated with postoperative anterior shoulder pain following arthroscopic suprapectoral biceps tenodesis (ABT) and to determine the clinical impact of postoperative anterior shoulder pain. **Methods:** A retrospective study of patients that underwent ABT between 2016 and 2020 was conducted. Groups were categorized by the presence (ASP+) or absence (ASP−) of postoperative anterior shoulder pain. Patient-reported outcomes (American Shoulder and Elbow score [ASES], visual analog scale [VAS] for pain, subjective shoulder value [SSV]), strength, range of motion, and complication rates were analyzed. Differences between continuous and categorical variables were tested with two-sample *t*-tests and chi-squared or Fisher's exact tests, respectively. Variables collected at different postoperative timepoints were analyzed using mixed models with post hoc comparisons when significant interactions were detected. **Results:** A total of 461 (47 ASP+, 414 ASP−) patients were included. A statistically significant lower mean age was observed in the ASP+ group ($P < .001$). A statistically significant higher prevalence of major depressive disorder (MDD) ($P = .03$) or any anxiety disorder ($P = .002$) was observed in the ASP+ group. Prescription medication with psychotropic medications ($P = .01$) was significantly more prevalent in the ASP+ group. No significant differences were observed in the proportion of individuals reaching the minimal clinical important difference (MCID) for ASES, VAS, or SSV between groups. **Conclusions:** A pre-existing diagnosis of major depressive disorder or any anxiety disorder, as well as the use of psychotropic medications was associated with postoperative anterior shoulder pain following ABT. Other factors associated with anterior shoulder pain included younger age, participation in physical therapy before surgery, and lower rate of concomitant rotator cuff repair or subacromial decompression. Although the proportion of individuals reaching MCID did not differ between groups, the presence of anterior shoulder pain after ABT resulted in prolonged recovery, inferior PROs, and a higher incidence of repeat surgical procedures. The decision to perform ABT in patients diagnosed with MDD or anxiety should be carefully considered, given the correlation to postoperative anterior shoulder pain and inferior outcomes. **Level of Evidence:** Level III, retrospective case-control study.

Introduction

The long head of the biceps brachii tendon (LHBT) is a well-established source of shoulder pain.[1-3] Pathology of the LHBT is variable and includes tearing, subluxation, dislocation, tenosynovitis, and superior labrum anterior to posterior (SLAP) tears. Frequently, biceps pathology is secondary to or concomitant with rotator cuff disorders, particularly tears of the subscapularis tendon.[4-7] Nonoperative management for LHBT pathology, including activity modification, physical therapy, anti-inflammatory medications, or corticosteroid injection can provide benefit.[8] However, if

these measures fail to improve shoulder pain or if concomitant rotator cuff pathology prevents shoulder functionality, operative management may be indicated.[8,9]

Controversy exists regarding operative management of LHBT pathology with biceps tenodesis or tenotomy. Generally, tenotomy is preferred for older or sedentary individuals, while tenodesis is preferred for younger individuals involved in high-demand activities or individuals who want to avoid cosmetic deformity.[1,3,9,10] Benefits of biceps tenotomy include a simpler, quicker, and less costly surgical technique compared to biceps tenodesis.[11,12] However, tenotomy can result in cosmetic deformity and decreased biceps strength relative to tenodesis.[3,10,13,14] Clinical comparisons between biceps tenotomy and tenodesis have demonstrated similar outcomes.[2,3,13,15] Despite similar outcomes, there has been an increased incidence of biceps tenodesis over the past 15 years,[16,17] and recent literature has demonstrated an increased preference among surgeons for tenodesis.[18,19] Operative techniques for tenodesis include, but are not limited to, open subpectoral biceps tenodesis (OBT) and arthroscopic suprapectoral biceps tenodesis (ABT). Studies investigating differences between OBT with tenodesis performed distal in the bicipital groove and ABT with tenodesis performed at the proximal aspect of the bicipital groove have predominantly revealed similar clinical outcomes, including the presence of postoperative anterior shoulder pain.[20−22]

Demographic and intraoperative factors associated with postoperative anterior shoulder pain following ABT have been reported, but with conflicting results.[23−27] Notably, there is a paucity of literature directly comparing individuals with or without postoperative anterior shoulder pain following ABT. The purposes of this study were to evaluate factors associated with postoperative anterior shoulder pain following ABT and to determine the clinical impact of postoperative anterior shoulder pain. We hypothesized that pre-existing diagnoses of chronic pain syndromes would be associated with recurrent postoperative anterior shoulder pain following ABT.

Methods

Study Design

A retrospective case-control study comprising patients undergoing ABT within a multicenter regional healthcare system was completed. This study was approved by the local ethical committee. Institutional review board approval was obtained (STUDY20030061), and data were collected from the electronic medical record (EMR) and entered into an institutional REDCap database (UL1-TR-001857). Inclusion criteria consisted of any patient undergoing ABT by two senior authors

(A.L. and B.P.L.) between 2016 and 2020. Exclusion criteria consisted of concomitant superior capsular reconstruction, concomitant shoulder labrum repair, revision biceps tenodesis, open biceps tenodesis, biceps tenotomy, and those with insufficient follow-up. Insufficient follow-up was defined as less than 4 months from surgery, with the exception of those undergoing isolated ABT and advised to follow up as needed by their surgeon once functionally optimized. Documented clinical examination findings considered for the definition of anterior shoulder pain included bicipital groove tenderness to palpation, positive Speed's test, positive Yergason's test, and patient-endorsed anterior shoulder pain in the absence of posterior shoulder, neck, or periscapular pain. Postoperative anterior shoulder pain was defined when a minimum of 2 clinical examination findings were present during at least 2 postoperative clinical visits. Comparisons were made between those with postoperative anterior shoulder pain (ASP+) and those without postoperative anterior shoulder pain (ASP−).

Data Sources and Outcome Measures

Variables extracted from the EMR included demographic characteristics, comorbidities, and current prescription medications. Preoperative medication reconciliation and medical history were performed, and the corresponding note within the EMR was used to identify prescription medications and comorbidities. To ensure diagnoses were made preoperatively and that medications were actively taken by patients, comorbidities and medications were further verified by review and confirmation of prescription dates and dates of diagnoses. Psychotropic medications were further categorized as either typical antidepressants, including selective norepinephrine reuptake inhibitors (SNRIs) and selective serotonin reuptake inhibitors (SSRIs), or atypical antidepressants, including tricyclic antidepressants and monoamine oxidase inhibitors. Concomitant procedures and repair characteristics were extracted from operative notes. Strength, range of motion (ROM), complication rates, and the following patient-reported outcomes (PROs): subjective shoulder value (SSV), American Shoulder and Elbow Surgeons score (ASES), and visual analog scale for pain (VAS), were analyzed at various timepoints throughout the clinical course. These PROs were prospectively recorded and documented within the EMR via an electronic system at each clinical visit and subsequently extracted from the EMR retrospectively. Subsequently, the minimal clinical important difference (MCID) for ASES, VAS, and SSV, as well as the patient-acceptable symptomatic state (PASS) for ASES and VAS were calculated for each group. Strength assessments were performed by the surgeon and quantified on a scale of 0 to 4, as previously published.[28,29] Range of Motion assessments
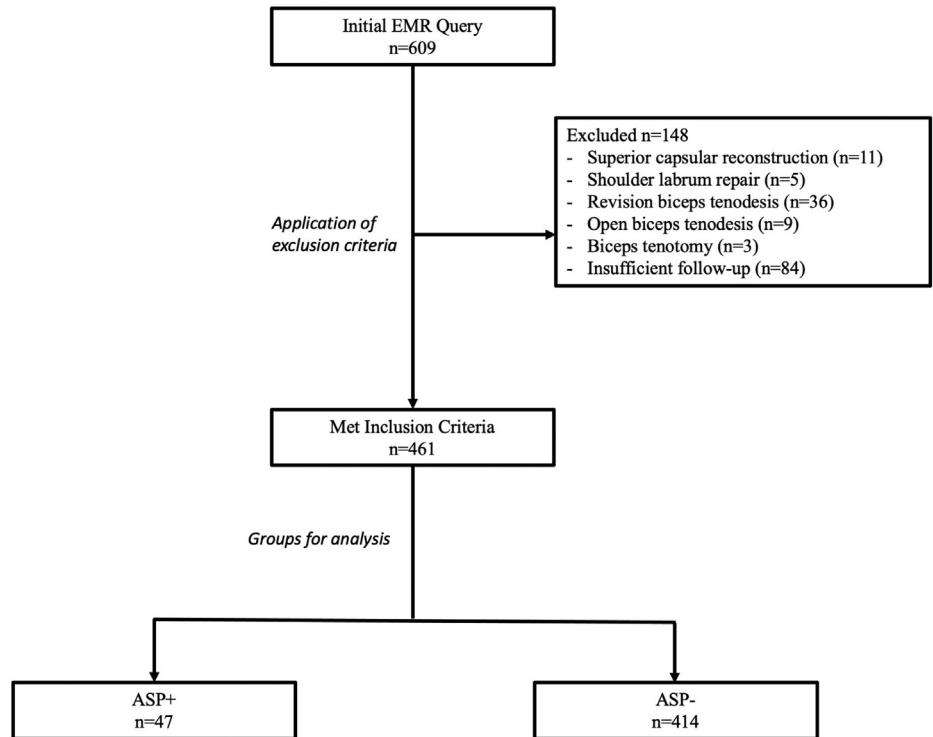
Fig 1. Patient selection and exclusion criteria.

were also performed by the surgeon and included forward flexion (FF), external rotation (ER), and internal rotation. External rotation was measured with the elbow at the side of the body, and internal rotation was measured using a standard clinical evaluation of vertebral level and quantified according to existing literature.[30,31] Specifically, the least amount of internal rotation (ability to reach the greater trochanter) was assigned a number of 0, followed by internal rotation to the ilium/gluteus assigned a number of 1, internal rotation to the iliac crest assigned 2, internal rotation to the sacrum assigned 3, and vertebral levels from L5 to T5 assigned numbers 4 through 16. Complications recorded included those noted by the surgeon or found in an associated revision operative note. Cases of rotator cuff or LHBT retear were confirmed with magnetic resonance imaging (MRI). Return to full activity was defined when the surgeons' notes indicated return to work, sports, or daily activities to the same level as prior to injury. The postoperative rehabilitation protocol consisted of passive range of motion (PROM) exercises between postoperative weeks 2 and 6. This was followed with PROM beginning at postoperative week 6 and strengthening exercises beginning at postoperative week 12. Variables were collected preoperatively, as well as at 6 weeks, 3 months, 6 months, and at a final follow-up timepoint, postoperatively. The final follow-up timepoint was defined as the most recently dated clinical encounter for an individual datapoint.

Surgical Technique

Indications for ABT included preoperative examination consistent with symptomatic SLAP tear or biceps tendonitis with or without rotator cuff tear. Tenodesis was only completed when these diagnoses were confirmed by arthroscopic evaluation of the labrum and LHBT. Operations were performed in the beach chair position using a previously described technique for ABT.[32,33] The LHBT was secured with suture by first looping suture around the LHBT and subsequently piercing the tendon with an arthroscopic suture-passing device. After proper suturing was completed, the LHBT was cut sharply from the superior labrum proximal to the suture placement. Once the LHBT was transected, preparation of the biceps tenodesis site was carried out with a curette or arthroscopic shaver to expose a bleeding subchondral bone bed at the proximal end of the bicipital groove. The tenodesis suture was then placed through a suture anchor, which was then inserted at the proximal aspect of the bicipital groove. In cases where subacromial decompression (SAD) was performed, this began with subacromial and subdeltoid bursectomies, as well as examination of the bursal surface of the rotator cuff. If a subacromial spur was observed, the coracoacromial ligament was taken down, and acromioplasty was performed to remove the subacromial spur to a flat surface.

Table 1. Baseline Characteristics

	Postoperative Pain (*n* = 47)	No Postoperative Pain (*n* = 414)	*P* Value
Demographics			
Age at operation, years (mean) (SD)][†]	51 (14)	61 (10)	<.01*
Gender: female (*n* [%])[††]	28 (60%)	208 (50%)	.23
BMI, kg/m² [mean (SD)][†]	31 (7)	30 (6)	.34
Dominant arm injured (*n* [%])[††]	23 (49%)	248 (60%)	.15
Workers' compensation [*n* (%)][††]	8 (17%)	65 (16%)	.78
Traumatic injury etiology [*n* (%)][††]	21 (45%)	174 (42%)	.73
Injury to surgery time (mean)[†] (SD)	396 (503)	405 (600)	.92
Physical therapy before surgery[††] [*n*][†† †† ††] (%)]	26 (55%)	144 (35%)	.01*
Comorbidities (*n* [%])[††]			
Obesity (BMI > 30)	21 (45%)	178 (43%)	.83
Morbid obesity (BMI > 40)	13 (28%)	75 (18%)	.11
Current smoker	5 (11%)	41 (10%)	.8
Diabetes	7 (15%)	52 (13%)	.65
Peripheral vascular disease	2 (4%)	11 (3%)	.63
Cancer within five years	6 (13%)	37 (9%)	.42
Inflammatory arthritis	3 (6%)	12 (3%)	.19
Major depressive disorder	15 (32%)	77 (19%)	.03*
Pre-existing anxiety diagnosis	19 (40%)	72 (17%)	<.01*
Chronic pain syndromes**	8 (17%)	45 (11%)	.21
Chronic migraines	7 (15%)	34 (8%)	.17
Osteoporosis	2 (4%)	12 (3%)	.64
None	5 (11%)	63 (15%)	.4
Medications at diagnosis [*n* (%)][††]			
CSI within 3 months	2 (4%)	23 (6%)	1
Chronic NSAIDs	18 (38%)	123 (30%)	.23
Opioids [*n* (%)]	7 (15%)	49 (12%)	.54
Muscle relaxants [*n* (%)]	11 (23%)	30 (7%)	<.01*
SSRI/SNRIs [*n* (%)]	16 (34%)	69 (17%)	<.01*
Atypical antidepressants [*n* (%)]	11 (23%)	43 (10%)	.01*
Benzodiazepines [*n* (%)]	3 (6%)	6 (1%)	.05
Sedative/hypnotics [*n* (%)]	6 (13%)	42 (10%)	.61

BMI, body mass index; CSI, corticosteroid injection. (intra-articular); SD, standard deviation; SNRI, selective norepinephrine reuptake inhibitors; SSRI, selective serotonin reuptake inhibitors.

*Statistically significant.

**Chronic pain syndromes included fibromyalgia, chronic regional pain syndrome, and chronic back pain currently under treatment with medications or injections.

[†]Continuous variable; tested with two-sample *t*-test.

[††]Categorical or nominal variable; tested with the chi-squared or Fisher's exact test.

Statistical Analysis

Comparisons of continuous demographic and clinical variables between groups were tested with two-sample *t*-tests, and differences between categorical or nominal variables between groups were tested with the chi-squared or Fisher's exact test. Linear mixed models with fixed effects for time (preoperative, 3 months postoperative, 6 months postoperative, and final postoperative follow up), cohort (postoperative anterior shoulder pain or no postoperative anterior shoulder pain), the time-cohort interaction, and a random patient effect to account for repeated measures within a patient were used to determine whether PROs and ROM differed between groups over time. Mixed logistic regression with the same fixed and random effects were used to determine if strength (full strength or not full strength) differed between groups over time. Post hoc comparisons were controlled for multiple testing with

the Benjamini-Hochberg procedure. The alpha level was 0.05 for all tests, and all tests were two-sided. The proportion of individuals within each group meeting or exceeding MCID or PASS was calculated using reference values derived from existing literature[34-36] and subsequently compared between groups. A post hoc power analysis was performed using PASS version 21.0.3 and revealed sample sizes of 47 in the ASP+ group and 414 in the ASP− group provided 80% power to detect a 0.43 standard deviation difference between the two group means for the PROs and ROM (alpha = 0.05).

Results

Baseline Characteristics

Out of a total of 609 patients undergoing ABT between 2016 and 2020, 461 (47 ASP+, 414 ASP−), patients met

Table 2. Intraoperative Details

	Postoperative Pain [n = 47]	No Postoperative Pain [n = 414]	P Value
Concomitant procedures (n [%])[††]			
Rotator cuff repair	36 (77%)	372 (90%)	.01*
Extensive debridement with bursectomy	42 (89%)	398 (96%)	.05
Subacromial decompression	43 (91%)	410 (99%)	<.01*
Capsular release & MUA	0 (0%)	23 (6%)	.15
Acromioclavicular joint resection	1 (2%)	19 (5%)	.71
Calcific debridement	0 (0%)	5 (1%)	1
Supraspinatus repair details (n [%])[††]			
Double-row repair	32 (89%)	308 (90%)	.78
Single-row repair	4 (11%)	22 (6%)	.29
Intratendinous repair	0 (0%)	10 (3%)	.61
Full-thickness tear	12 (33%)	159 (47%)	.13
Partial-thickness tear	24 (67%)	182 (53%)	
Tear size [mean (SD)] [†]	12.1 (7.7) [n = 32]	14.3 (9) [n = 311]	.19

MUA, manipulation under anesthesia.
*Statistically significant
[†]Continuous variable; tested with two-sample *t*-test.
[††]Categorical or nominal variable; tested with the chi-squared or Fisher's exact test.

criteria for analysis (Fig 1), representing a rate of postoperative anterior shoulder pain of 10.2%. Baseline characteristics associated with postoperative anterior shoulder pain are displayed in Table 1. The ASP+ group had a lower mean age at operation than the ASP− group (51 ± 14 years and 61 ± 10 years; $P < .01$). Diagnoses of major depressive disorder (32% and 19%; $P = .03$) and any anxiety disorder (40% and 17%; $P < .01$) were more prevalent in the ASP+ group compared to the ASP− group. Prescribed medication with either SNRIs or SSRIs (34% and 17%; $P < .01$) and atypical antidepressants (23% and 10%; $P = .01$) were more prevalent in the ASP+ group compared to the ASP− group.

Intraoperative Details

Comparisons between groups with respect to intraoperative details are displayed in Table 2. The ASP+ group underwent concomitant rotator cuff repair (RCR) less frequently than the ASP− group (77% and 90%, respectively; $P = .01$). The ASP+ group underwent SAD less frequently than the ASP− group (91% and 99%, respectively; $P < .01$).

Table 3. Patient-Reported Outcomes at Various Postoperative Timepoints

	Postoperative Pain [n = 47]	No Postoperative Pain [n = 414]	P Value for Interaction Term	Adjusted, Post Hoc P Value
SSV [mean (SD)]				
Preoperative	51.9 (21.8) [n = 34]	54.2 (22.2) [n = 360]	.01*	.32
3 months follow-up	57.4 (27.7) [n = 13]	69.1 (19.3) [n = 125]		.07
6 months follow-up	68.2 (21.1) [n = 31]	83.5 (12.9) [n = 338]		<.01*
Final follow-up	72.4 (19.8) [n = 32]	85.2 (13.5) [n = 358]		<.01*
ASES [mean (SD)]				
Preoperative	43.2 (19.3) [n = 32]	51.8 (19) [n = 285]	.02*	.02*
6 weeks follow-up	38.9 (19.9) [n = 32]	50.6 (17.4) [n = 247]		<.01*
3 months follow-up	50.6 (20.2) [n = 24]	66.7 (16.9) [n = 243]		<.01*
6 months follow-up	63.5 (19.6) [n = 28]	80.5 (16.1) [n = 283]		<.01*
Final follow-up	63.7 (18.6) [n = 27]	81.5 (16.1) [n = 307]		<.01*
VAS [mean (SD)]				
Preoperative	7 (2.2) [n= 42]	6 (23) [n = 397]	.12	n/a
6 weeks follow-up	5.3 (3) [n = 36]	3.6 (2.5) [n = 300]		n/a
3 months follow-up	4.2 (2.6) [n = 35]	2.7 (2.3) [n = 336]		n/a
6 months follow-up	3.7 (2.3) [n = 38]	1.6 (1.9) [n = 364]		n/a
Final follow-up	3.7 (2.5) [n = 39]	1.6 (1.9) [n = 393]		n/a

Comparisons between groups were tested with two-sample *t*-tests. Linear mixed models with fixed effects for time, cohort, the time-cohort interaction, and a random patient effect were then used to determine whether patient-reported outcomes differed between groups over time.
ASES, American Shoulder and Elbow score; SSV, subjective shoulder value; VAS, visual analog scale for pain.
*Statistically significant.

Table 4. Range of Motion at Various Postoperative Timepoints

	Postoperative Pain [n = 47]	No Postoperative Pain [n = 414]	P Value for Interaction Term	Adjusted, Post Hoc P Value
Forward Flexion (mean) (SD)]				
Preoperative	153 (25) [n = 47]	144 (36) [n = 411]	.13	n/a
3 months follow-up	142 (26) [n = 41]	142 (28) [n = 383]		n/a
6 months follow-up	157 (17) [n = 43]	157 (19) [n = 382]		n/a
Final follow-up	159 (17) [n = 47]	160 (15) [n = 411]		
External Rotation (mean) (SD)]				
Preoperative	52 (12) [n = 47]	47 (12) [n = 407]	.01*	.04*
3 months follow-up	41 (13) [n = 40]	42 (13) [n = 368]		.67
6 months follow-up	47 (12) [n = 43]	49 (12) [n = 382]		.67
Final follow-up	48 (12) [n = 47]	50 (12) [n = 411]		.67
Internal Rotation (mean) (SD)]				
Preoperative	8 (4) [n = 47]	8 (3) [n = 397]	.24	n/a
3 months follow-up	6 (3) [n = 30]	6 (3) [n = 299]		n/a
6 months follow-up	8 (3) [n = 37]	8 (3) [n = 366]		n/a
Final follow-up	8 (3) [n = 46]	9 (3) [n = 398]		n/a

Comparisons between groups were tested with two-sample t-tests. Linear mixed models with fixed effects for time, cohort, the time-cohort interaction, and a random patient effect were then used to determine whether range of motion differed between groups over time. Abbreviations: SD, standard deviation

*Statistically significant

Clinical Outcomes

Analysis of the postoperative clinical course revealed a longer mean duration of postoperative physical therapy in the ASP+ group compared to the ASP- group (159.4 ± 86.8 days and 129.9 ± 56.9 days; p = .04). A lower frequency of return to full activity level (64% and 89%; p<0.01) and a observed as well as longer mean time to return to full activity (7.5 ± 4.0 months and 5.7 ± 1.9 months; p = .02) was observed in the ASP+ group compared to the ASP- group. The mean follow-up length was longer in the ASP+ group compared to the ASP- group (7.8 ± 5.6 months and 5.3 ± 3.1 months; p < .01).

The MCID for ASES[34] was achieved by 25 (78.1%) and 172 (76.4%) individuals within the ASP+ and ASP- groups, respectively (p=0.74). The MCID for for VAS[36] was achieved by 35 (79.6%) and 321 (85.4%) individuals within the ASP+ and ASP- groups, respectively (p=0.35). The MCID for SSV[34] was achieved by 26 (66.7%) and 243 (77.9%) individuals within the ASP+ and ASP- groups, respectively (p=0.08). The PASS for ASES for achieved by 33 (84.6%) and 249 (84.7%) of individuals within the ASP+ and ASP- groups, respectively (p=0.85). The PASS for VAS was achieved by 21 (46.7%) and 227 (58.7%) of individuals within the ASP+ and ASP- groups, respectively

Table 5. Strength at Various Postoperative Timepoints

	Postoperative Pain [n = 47]	No Postoperative Pain [n = 414]	P Value for Interaction Term	Adjusted, Post Hoc P Value
Forward Flexion (full strength) [n (%)]				
Preoperative	20 (43%) [n = 47]	110 (27%) [n = 404]	.05	n/a
3 months follow-up	6 (60%) [n = 10]	52 (54%) [n = 96]		n/a
6 months follow-up	27 (73%) [n = 37]	283 (81%) [n = 348]		n/a
Final follow-up	33 (79%) [n = 42]	333 (86%) [n = 388]		n/a
External Rotation (full strength) [n (%)]				
Preoperative	36 (77%) [n = 47]	219 (54%) [n = 404]	.08	n/a
3 months follow-up	7 (70%) [n = 10]	59 (63%) [n = 94]		n/a
6 months follow-up	31 (84%) [n = 37]	301 (86%) [n = 348]		n/a
Final follow-up	37 (88%) [n = 42]	347 (89%) [n = 388]		n/a
Internal Rotation (full strength) [n (%)]				
Preoperative	30 (88%) [n = 34]	211 (71%) [n = 296]	<.01*	.06
3 months follow-up	6 (67%) [n = 9]	59 (72%) [n = 82]		.84
6 months follow-up	26 (81%) [n = 32]	300 (94%) [n = 318]		.04*
Final follow-up	30 (83%) [n = 36]	346 (95%) [n = 363]		.04*

Comparisons between groups were tested with chi-squared or Fisher's exact tests. Linear mixed models with fixed effects for time, cohort, the time-cohort interaction, and a random patient effect were then used to determine whether strength differed between groups over time. Note: Full strength was defined as 5/5 strength with manual muscle testing performed by the surgeon.

*Statistically significant

Table 6. Complications

Complication [n (%)]	Postoperative Pain [n = 47]	No Postoperative Pain [n = 414]	P Value
Generalized shoulder pain	0 (0%)	24 (6%)	.16
Prolonged weakness	1 (2%)	18 (4%)	.71
Nerve palsy	0 (0%)	7 (2%)	1
Adhesive capsulitis	1 (2%)	12 (3%)	1
Postoperative CSI for persistent pain	15 (32%)	27 (7%)	<.01*
Retear[†]	5 (11%)	9 (2%)	.01*
Reoperation	4 (9%)	8 (2%)	.03*

CSI, corticosteroid injection.

*Statistically significant.

[†]All retears were of the rotator cuff with one exception of an isolated biceps tenodesis repair failure (ASP+ group)

(p=0.09). The ASP+ group had a lower mean SSV (72.4 and 85.2; p<0.01) compared to the ASP- group at final follow-up. Lower ASES scores were observed in the ASP+ group across all timepoints (Table 3). There were no differences between groups with regard to postoperative ROM (Table 4). The proportion of individuals with full internal rotation (IR) strength was lower in the ASP+ group compared to the ASP- group at the six-months postoperative timepoint (81% and 96%; p=0.04) and at final follow-up (83% and 95%; p=0.04) as seen in Table 5. Comparisons of complications revealed a larger proportion requiring intra-articular corticosteroid injections (CSI) for pain alleviation in the ASP+ group compared to the ASP- group (32% and 7%; p<0.01). A higher rotator cuff retear rate (11% and 2%; p=0.01) and reoperation rate (9% and 2%; p=0.03) was observed in the ASP+ group compared to the ASP- group (Table 6). Reoperation procedures consisted of biceps tenotomy, conversion to OBT, revision RCR, and lysis of adhesions. The four individuals within the ASP+ group requiring reoperation experienced resolution of symptoms meeting criteria for postoperative anterior shoulder pain.

Discussion

The most important finding of this study was that younger age, diagnoses of MDD or any anxiety disorder, and use of psychotropic medications were independent risk factors for recurrent anterior shoulder pain following arthroscopic suprapectoral biceps tenodesis. Additionally, patients with postoperative anterior shoulder pain were less likely to have undergone concomitant SAD or RCR, and more likely to have participated in preoperative physical therapy, as compared to those without postoperative anterior shoulder pain. Although the proportion of individuals reaching MCID did not differ between groups, the presence of anterior shoulder pain after ABT resulted in prolonged recovery, inferior PROs, and a higher incidence of repeat surgical procedures.

In this study, we found an association between younger age and postoperative anterior shoulder pain.

Although some studies have revealed higher satisfaction after RCR in older patients, others have shown older age to be predictive of increased stiffness and movement-evoked shoulder pain following shoulder arthroscopy.[10,26,37,38] Despite conflicting evidence for the role of age on outcomes following shoulder surgery, no study has specifically defined postoperative anterior shoulder pain in the setting of ABT and found an association with younger age. The role of preoperative expectations merits discussion, as it is reasonable to think that younger, more active, individuals have higher expectations and higher physical demands after undergoing RCR than their older counterparts. It has been demonstrated that higher preoperative expectations correlate with higher postoperative PROs and greater improvement from baseline scores.[39] However, the ASP+ group did not demonstrate higher postoperative PROs nor a larger increase from baseline, suggesting no differences in preoperative expectations. It should be noted that the current study is not geared toward elucidating preoperative expectations. Relatedly, younger patients more often present with traumatic injury etiologies, while older patients more often present with LHBT pathology secondary to degenerative rotator cuff tears.[1,40] Because we did not observe differences between groups regarding traumatic versus atraumatic injuries, the mechanism of injury unlikely confounds our age-related findings. Concomitant RCR was significantly higher in the ASP− group, which is consistent with the association between rotator cuff tears and older age.[41] It may be the case that the ASP− group comprised a larger proportion of older individuals with atraumatic, degenerative rotator cuff tears, which were successfully repaired and resulted in resolution of pain-related symptoms. Nevertheless, the current study provides information on the association between younger age and specifically, postoperative anterior shoulder pain following ABT.

A diagnosis of MDD or anxiety disorders, as well as prescription medication with SNRI, SSRI, or atypical antidepressants was associated with postoperative anterior shoulder pain following ABT. Inferior clinical

outcomes have been demonstrated with a diagnosis of psychiatric illness in shoulder surgery, including RCR, labrum repair, and shoulder arthroplasty.[24,42−45] Our findings corroborate established literature demonstrating inferior outcomes after shoulder surgery in individuals with mental illness, but specifically pertain to postoperative anterior shoulder pain. Consequently, patients diagnosed with MDD or anxiety disorders, as well as those taking psychotropic medications should receive appropriate counsel about the increased risk of recurrent anterior shoulder pain following ABT.

Arthroscopic SAD was more frequently performed in the ASP− group compared to the ASP+ group. The role of arthroscopic SAD is controversial in the setting of rotator cuff tears and impingement syndrome. Randomized controlled trials have failed to show benefits of performing SAD in the setting of RCR or isolated impingement syndrome.[46−50] Although our results differ from established literature on rotator cuff impingement or tears, those investigations focused on rotator cuff pathology and either excluded operative management of LHBT pathology or did not control for LHBT treatment. Thus, it is possible that SAD decreases the odds of developing postoperative anterior shoulder pain specifically in the setting of ABT. However, 99% of patients without anterior shoulder pain with concomitant SAD versus 91% of patients with anterior shoulder pain is statistically, but unlikely clinically, significant. Separately, those who developed postoperative anterior shoulder pain attended preoperative physical therapy more frequently than those without postoperative anterior shoulder pain. It has been shown that preoperative PT does not affect postoperative pain in the context of shoulder arthroscopy for rotator cuff tear, labral tears, or adhesive capsulitis.[51] This finding may indicate that the patients with recurrent anterior shoulder pain postoperatively had a longer duration of symptoms prior to ABT. Alternatively, this finding may indicate that those who developed postoperative anterior shoulder pain were inadequately optimized at initial presentation, prompting recommendations to participate in PT prior to surgery. Such optimization through PT may also explain the observation of greater preoperative external rotation ROM in the ASP+ group. However, a lower preoperative ASES score was observed in the ASP+ group. Taken together, the finding of increased preoperative PT use within the ASP+ group may reflect a need to optimize patients preoperatively but does not provide evidence of inferior optimization within the ASP+ group. The absence of differences between groups in all other preoperative PROs, ROM, and strength measures implies similar optimization prior to surgery throughout the study population.

Significant findings illustrating the inferior clinical course in the ASP+ group included a longer mean duration of PT, lower rates of return to full activity, longer time to return to full activity, lower SSV at the 6-month postoperative timepoint and final follow-up, lower ASES scores at all postoperative timepoints, a lower proportion of full IR strength at the 6-month postoperative timepoint and final follow-up, higher complication rates, including retear, reoperation, and the need for intra-articular CSI for pain alleviation. It is important to emphasize that the comparison group (ASP−) was not free of complications, as a total of 105 (25%) patients experienced complications unrelated to anterior shoulder pain. The observation of a higher proportion of complications unrelated to anterior shoulder pain within the ASP+ group brings into question whether pain and related complications originate from the LHBT or surrounding tissues. The higher rates of CSI for pain control, as well as higher retear and reoperation rates related to the rotator cuff observed in the ASP+ group may suggest that the rotator cuff contributes to pain. The subscapularis and supraspinatus have been implicated as myotendinous structures contributing to anterior shoulder pain in the setting of LHBT pathology.[4,52] However, the rate of concomitant RCR was significantly lower in the ASP+ group, decreasing the plausibility that rotator cuff pathology underlies the differences in postoperative pain. A multifactorial etiology to postoperative anterior shoulder pain is also suggested by the resolution of symptoms meeting criteria for anterior shoulder pain following reoperation for either the LHBT (tenotomy, conversion to OBT) or the rotator cuff (revision RCR) in the 4 individuals within the ASP+ group. Because no verified clinical definition for postoperative anterior shoulder pain exists, we applied a specific definition based on patient symptoms and physical examination findings. According to our definition, postoperative anterior shoulder pain results in a substantial negative impact on clinical outcomes following ABT. These findings stress the importance of closely monitoring anterior shoulder or biceps-related symptoms during the postoperative course following ABT.

Limitations

There are limitations to the present study. Inherent limitations related to the retrospective nature of data collection include a lack of randomization between cohorts and incomplete data for several outcome measures. The current study did not have preoperative and postoperative MRI available for analysis, precluding confirmation of specific LHBT pathologies with MRI. Range of motion assessments were not done by a single observer nor with the use of a goniometer, likely increasing variability and decreasing accuracy, respectively. The final follow-up time period varied between individuals within the study, creating cohort-based comparisons, from which conclusions should not be

made at the final follow-up timepoint. Nevertheless, comparisons made at the 6 weeks, 3 months, and 6 months postoperative timepoints were consistent between cohorts. Additionally, the mean follow-up lengths of 9.3 months and 6.8 months in the ASP+ and ASP− groups, respectively, was limited by the retrospective nature of this study. However, a systematic review aimed at determining the optimal time frame for outcome collection with rotator cuff tears revealed no clinically meaningful improvements after 6 months.[53] Lastly, the sample size of the ASP+ group was limited by the incidence of postoperative anterior shoulder pain within our study population.

Conclusion

A pre-existing diagnosis of major depressive disorder or any anxiety disorder, as well as the use of psychotropic medications was associated with postoperative anterior shoulder pain following ABT. Other factors associated with anterior shoulder pain included younger age, participation in physical therapy before surgery, and lower rate of concomitant rotator cuff repair or SAD. Although the proportion of individuals reaching MCID did not differ between groups, the presence of anterior shoulder pain after ABT resulted in prolonged recovery, inferior PROs, and a higher incidence of repeat surgical procedures. The decision to perform ABT in patients diagnosed with MDD or anxiety should be carefully considered given the correlation to postoperative anterior shoulder pain and inferior outcomes.

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