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Influence of mental health on postoperative outcomes in patients following biceps tenodesis

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Purpose: To evaluate the relationship between preoperative mental health measured by the Short-Form 12 health survey mental component score and outcomes after isolated biceps tenodesis.

Methods: The American Shoulder and Elbow Surgeons form (ASES), Single Assessment Numeric Evaluation (SANE), Constant-Murley score (CMS), and visual analog scale (VAS) for pain were administered preoperatively and at 6 and 12 months postoperatively to consecutive patients undergoing isolated biceps tenodesis between 2014 and 2018. Minimal clinically important difference, substantial clinical benefit (SCB), patient-acceptable symptom state (PASS), and rates of achievement were calculated. Patients were stratified by mental health status based on preoperative scores on the Short-Form 12 health survey mental component score. Multivariate logistic regression was performed to evaluate preoperative mental health status on achievement of minimal clinically important difference, SCB, and PASS.

Results: Patients demonstrated significant improvements in all outcome measures ($P < .001$). Patients with depression reported inferior postoperative scores on all patient-reported outcome measures. Low preoperative mental health score significantly predicted reduced likelihood to achieve SCB (odds ratio [OR]: 0.38, 95% confidence interval [CI]: 0.17-0.81, $P = .01$) and PASS (OR: 0.28, 95% CI: 0.12-0.65, $P = .003$) on the ASES form, SANE (OR: 0.24, 95% CI: 0.10-0.61, $P = .003$), CMS (OR: 0.25, 95% CI: 0.08-0.77, $P = .016$), and VAS pain (OR: 0.01, 95% CI: 0.00-0.31, $P = .008$).

Conclusion: Patients with depression reported inferior scores on all postoperative patient-reported outcome measures and demonstrated lower odds of achieving the SCB and PASS on the ASES form and PASS on the SANE, CMS, and VAS pain, compared with nondepressed patients.

Level of evidence: Level III; Retrospective Cohort Design; Treatment Study

Keywords: Biceps tenodesis; mental health; depression; patient-reported outcome measures

Approximately 30% of people experience a mental disorder at some point in their lifetime.[44] These conditions can have a profound effect on baseline patient function and are common causes of physical disability.[28] Concurrent

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psychiatric diagnoses have been linked as a cause of inferior pain, function, and patient-reported outcome measures (PROMs) pre- and postoperatively in several orthopedic procedures.[1,3,6,16,17,27-30,32,35,39-41,46-48,52,57] Furthermore, Werner et al[57] demonstrated that depression was an independent predictor for significantly less improvement in PROMs after total shoulder arthroplasty. However, the effect of preoperative symptoms of depression on postoperative outcomes after common arthroscopic shoulder procedures, such as isolated biceps tenodesis, has yet to be elucidated.

Biceps tenodesis is increasingly performed to treat lesions of the long head of the biceps tendon as well as labral injuries, with satisfactory pain relief and functional improvement.[11,37,50,53-56] Workers' compensation (WC) status, male sex, a higher preoperative Single Assessment Numeric Evaluation (SANE) score, and previous history of ipsilateral shoulder surgery have been shown to be associated with decreased odds of achieving clinically significant outcomes (CSOs) in PROMs.[37] Patients with mental health impairments may also be at significant risk for suboptimal surgical outcomes.[9] Therefore, it is imperative to understand the relationship between mental health disorders and subjective outcomes after isolated biceps tenodesis.

The purpose of this investigation is to assess the effect of concurrent depression as assessed by preoperative threshold scores on the Short-Form 12 (SF-12) mental component score (MCS) among patients undergoing isolated biceps tenodesis at 1-year follow-up. We hypothesize that patients with symptoms of depression will report inferior scores on PROMs and will demonstrate reduced achievement of CSOs.

Methods

Study design and patient demographics

This was a retrospective investigation of a prospective institutional registry. The registry was queried for patients who underwent isolated biceps tenodesis between March 2014 and March 2018 using an electronic data collection service (Outcome Based Electronic Research Database; Universal Research Solutions, Columbia, MO, USA). The inclusion criteria were receipt of a primary arthroscopic suprapectoral or open subpectoral biceps tenodesis, with or without concurrent rotator cuff débridement, for the indication of tenosynovitis, superior labral anterior posterior (SLAP) tear, partial tearing, or biceps instability, as well as completion of preoperative and postoperative PROMs at 1-year follow-up. Exclusion criteria were patients with full-thickness rotator cuff tears, patients receiving concurrent rotator cuff repair or shoulder arthroplasty, and previous history of ipsilateral biceps tenodesis. After preoperative PROM collection, bicep tenodesis was performed by the senior authors (BJC, NV, BF) as previously described.[2,15] Demographics variables were collected including age, sex, body mass index, WC status, and preoperative narcotics use, and stored in the database. Similarly, intraoperative variables including tenodesis approach, fixation device (ie, screw, suture anchor), and long head of the biceps tendon (LHBT) findings on arthroscopy were collected and documented by trained research coordinators at the time of operation. As part of the Outcome Based Electronic Research Database, patients may begin completing PROMs within 3 months before and after the 1-year time-point. Patients who were seen in clinic within a month after the expiry of these PROMs were allowed to complete the questionnaires.

Patient-reported outcomes

A total of 186 patients were included in the analysis after appropriate exclusion. Patients enrolled in the prospective registry completed shoulder-specific functional PROMs, including the American Shoulder and Elbow Surgeons (ASES) form and the SANE, as well as health-related quality of life PROMs, including the Veteran's Rand (VR)-12 and SF-12 physical component scores (PCS) and the VR6D score. In addition, patients completed mental health PROMs including the VR-12 and SF-12 MCS. Patients also completed a visual analog scale (VAS) questionnaire on their level of pain, consisting of the question: "How would you rate your shoulder pain today as a percentage of normal 0 to 100 with 100 being normal?" Patients also completed anchor questions regarding the level of improvement in function and pain of the index shoulder, identical to those outlined in a previous study, which enabled the calculation of CSOs.[12]

The SF-12 MCS is a validated screening measure for symptoms of depression with extensive utilization in the orthopedic literature. Previously established thresholds have been accurately predictive of depression as well as severe depression in several populations.[19,24,51] Patients were stratified based on these methods using preoperative scores on the SF-12 MCS. Cutoff values for symptomatic depression and severe depression were <46.5 and ≤ 36, respectively.[25,42,51]

Statistical analysis

Statistical analysis was performed using RStudio software version 1.0.143 (R Foundation for Statistical Computing, Vienna, Austria). An a priori power analysis was performed to determine the sample size necessary to identify an effect size comparable with changes found in a previous study on the impact of mental health status on outcomes in shoulder surgery. With alpha set at 0.05, a population of 36 patients would sufficiently attain a power of 80% on a 2-sample *t*-test. Continuous variables were presented as means with standard deviations, whereas categorical variables were presented as frequencies and percentages. Paired *t*-tests were used to determine if postoperative patient-reported outcome scores were statistically different from preoperative scores among the entire patient cohort. Independent *t*-tests were used to determine if statistically significant differences existed in continuous variables between the depressed and nondepressed groups. CSO thresholds were calculated through either anchor-based or distribution-based methods. Anchor-based methods used receiver operating curves with an area under the curve (AUC) >0.7 defined as predictive. If anchor-based methods to calculate the minimal clinically important difference (MCID) were inadequately predictive, a distribution-based method, where the MCID was defined as 50%

Table I Demographic and intraoperative findings for patients based on mental health status

	Severe depression (SD)	Depression (D)	No depression (ND)	P value$_{DvsND}$	P value$_{SDvsND}$
Overall, n (%)	15	42	129		
Demographics					
Age (yr)	51.6 ± 10.6	48.5 ± 14.9	51.8 ± 11.8	.1	.9
Male sex	11 (73.3)	20 (47.6)	82 (63.6)	.1	.4
BMI (kg/m^2)	33.1 (4.7)	31.04 (9.9)	28.53 (5.8)	.07	.05
Right-sided	3 (20.0)	24 (57.1)	47 (52.8)	.8	.03
WC	5 (33.3)	21 (50.0)	11 (8.5)	<.001	.3
Intraoperative findings					
Biceps tendon on arthroscopy				.09	.1
Complete tear	0 (0.0)	0 (0.0)	8 (7.2)		
Partial tear	0 (0.0)	3 (8.1)	23 (20.7)		
Tenosynovitis	13 (100.0)	30 (81.1)	71 (64.0)		
No gross pathology	0 (0.0)	4 (10.8)	9 (8.1)		
Fixation device				.1	.6
Suture anchor	10 (76.9)	60 (66.2)	71 (63.9)		
Tenodesis screw	3 (23.1)	27 (33.8)	40 (36.0)		
Tenodesis approach				.5	1
ASPBT	3 (23.1)	17 (32.4)	45 (24.3)		
OBSPBT	10 (76.9)	25 (67.6)	84 (75.7)		

BMI, body mass index; *WC*, workers' compensation; *ASPBT*, arthroscopic suprapectoral biceps tenodesis; *OSPBT*, open suprapectoral biceps tenodesis.

of the sample standard deviation of the score change, was used. Multivariate logistic regression was performed to determine whether there was a significant relationship between achievement of each CSO and mental health while controlling for the demographic and intraoperative variables, as well as preoperative scores. As previously described,[4] an interaction term between mental health state and potential confounders, such as WC, was introduced into the regression to assess for potential confounding of the outcomes. Statistical significance was set at alpha = 0.05.

Results

Of the 186 patients included in the prospectively collected data repository during the study period, 42 patients were preoperatively identified as depressed and 15 patients as severely depressed. Thirteen patients underwent revision procedures by 1-year follow-up. Revision rates were not significantly different between the depressed or severely depressed cohort and the nondepressed cohort (8.7% vs. 6.2%, $P = .4$).

There were 113 male patients (60.8%), the mean age of the cohort was 50.7 ± 12.6 years, the mean body mass index was 28.9 ± 6.7 kg/m^2, and the mean follow-up was 13.2 ± 5.6 months (range, 9-16 months). Demographic information and intraoperative findings for the patient cohorts can be found in Table I. There was a significant difference in the proportion of WC patients between depressed and nondepressed patients (45.6% vs. 8.5%; $P < .001$). All patients experienced significant improvements in PROM scores from baseline at 1-year follow-up (all $P < .001$). Comparison of preoperative PROM (Fig. 1), postoperative PROM (Fig. 2), and change from preoperative to postoperative PROMs (Fig. 3) is provided in Supplementary Appendix S1. Depressed patients demonstrated significantly lower preoperative and postoperative PROM scores other than the SF-12 PCS at baseline and the SANE score and mental health PROMs at follow-up ($P \leq .001$-$.04$) (Supplementary Appendix S1). Similarly, severely depressed patients demonstrated significantly lower preoperative and postoperative scores on all PROMs ($P \leq .001$-$.05$) (Supplementary Appendix S1). However, the change in PROM was not statistically different for the majority of PROMs except for the VR-12 MCS and VAS pain at baseline and follow-up for the depressed and severely depressed groups ($P \leq .001$-$.04$) (Supplementary Appendix S1).

Comparisons of changes in PROM score using pairwise independent *t*-tests between each cohort found the following significant differences: depressed patients experienced significantly reduced change in scores on the VR-12 MCS, the VR6D, and the VAS pain compared with nondepressed patients ($P < .001$-$.02$), whereas severely depressed patients experienced a significantly reduced change in scores on the SF-12 MCS, the VR-12 MCS, and the VAS pain compared with nondepressed patients ($P < .001$-$.037$).

Clinically significant outcomes

Calculations of threshold values for CSOs were performed in the study cohort. MCID was determined by both anchor- and distribution-based methods, whereas substantial clinical benefit (SCB) and patient-acceptable symptom

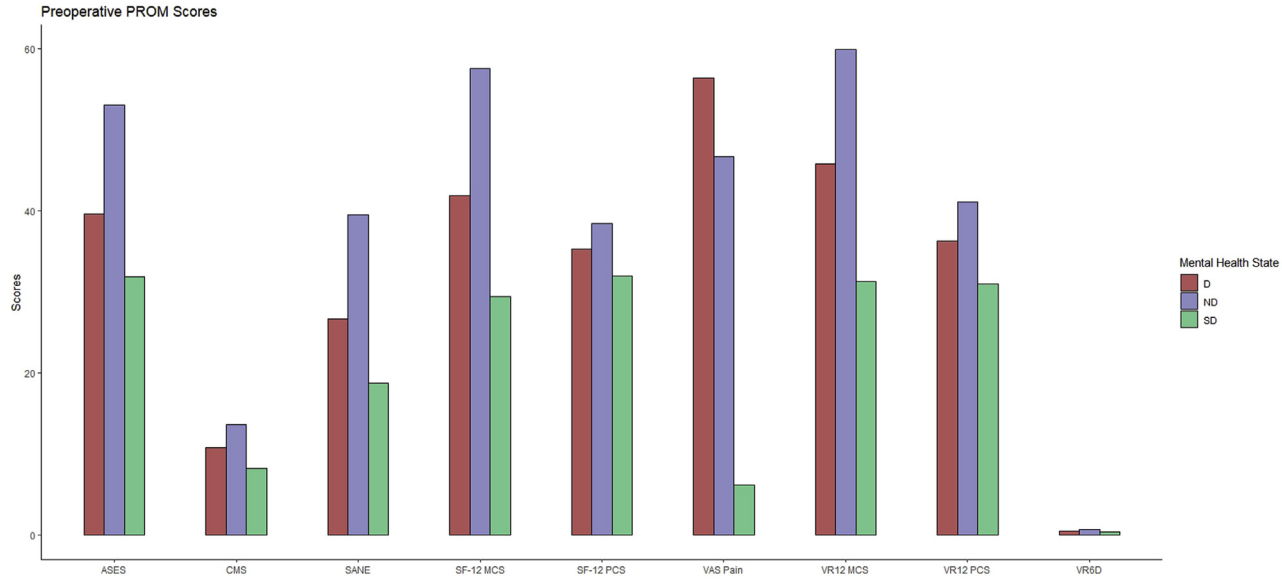

Figure 1 Preoperative PROMs stratified by depression, severe depression, and no depression status. *PROM*, patient-reported outcome measure; *ASES*, American Shoulder and Elbow Surgeons; *CMS*, Constant-Murley score; *SANE*, Single Assessment Numeric Evaluation; *SF-12 MCS*, Short-Form 12 health survey mental component score; *SF-12 PCS*, SF-12 physical component score; *VAS*, visual analog scale; *VR12*, Veteran's Rand 12; *D*, depression; *ND*, no depression; *SD*, severe depression.

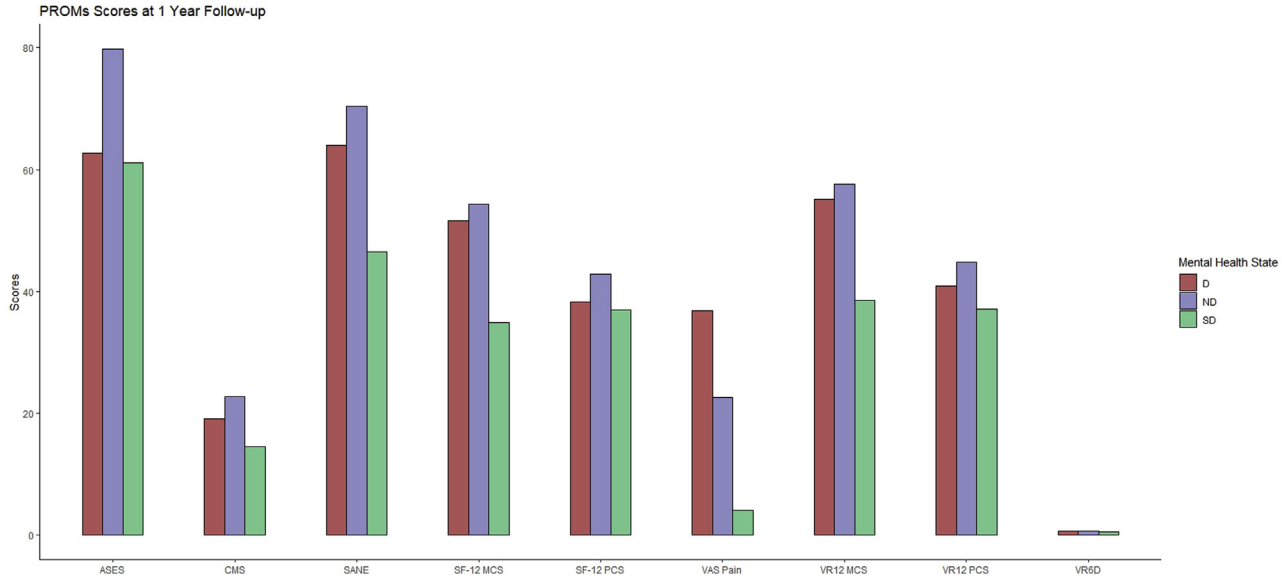

Figure 2 Postoperative PROMs stratified by depression, severe depression, and no depression status. *PROM*, patient-reported outcome measure; *ASES*, American Shoulder and Elbow Surgeons; *CMS*, Constant-Murley score; *SANE*, Single Assessment Numeric Evaluation; *SF-12 MCS*, Short-Form 12 health survey mental component score; *SF-12 PCS*, SF-12 physical component score; *VAS*, visual analog scale; *VR12*, Veteran's Rand 12; *D*, depression; *ND*, no depression; *SD*, severe depression.

state (PASS) were determined using anchor-based methods. The final values calculated for the 3 PROMs in question are given in Table II. Values used to calculate achievement of MCID/SCB/PASS are as follows: net increase of 10.2, net increase of 20.8 (AUC: 0.8), and absolute postoperative score of 78.8 (AUC: 0.9) on the ASES; net increase of 13.5, net increase of 30.2 (AUC: 0.8), and absolute postoperative score of 78.9 (AUC: 0.9) on the SANE; net increase of 4.0, net increase of 11.0 (AUC: 0.8), and absolute postoperative score of 22.5 (AUC: 0.8) on the Constant subjective assessment. CSOs for the VAS pain score were determined in a previous study.[31]

Comparison of achievement rates of each CSO by depressed, severely depressed, and nondepressed patients is provided in Table III. Depressed patients demonstrated significantly reduced rates of achievement of MCID on the SANE and VAS pain forms and PASS on the Constant-Murley score (CMS) and VAS pain forms. Severely

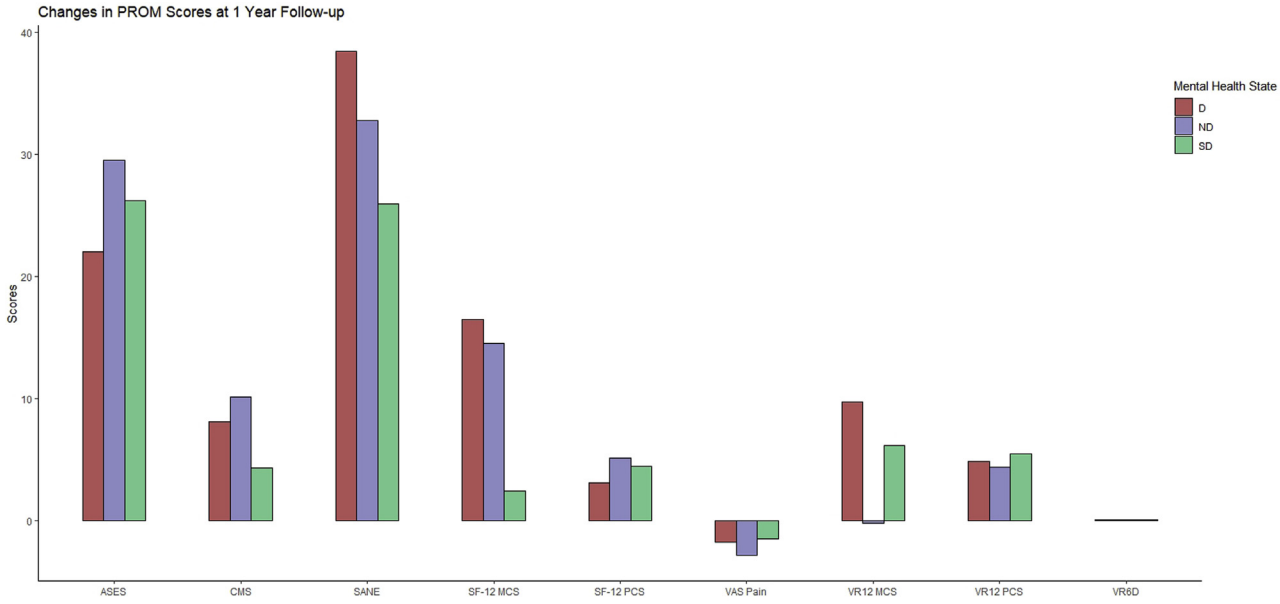

Figure 3 Change in postoperative and preoperative PROMs stratified by depression, severe depression, and no depression status. *PROM*, patient-reported outcome measure; *ASES*, American Shoulder and Elbow Surgeons; *CMS*, Constant-Murley score; *SANE*, Single Assessment Numeric Evaluation; *SF-12 MCS*, Short-Form 12 health survey mental component score; *SF-12 PCS*, SF-12 physical component score; *VAS*, visual analog scale; *VR12*, Veteran's Rand 12; *D*, depression; *ND*, no depression; *SD*, severe depression.

Table II Calculated MCID/SCB/PASS

Anchor	Value	AUC	Distribution
MCID			
ASES	10.2	0.5	10.2
SANE	14.9	0.4	13.5
Constant-Murley	9.0	0.7	4.02
VAS pain	−12.9	0.9	–
SCB			
ASES	20.8	0.8	–
SANE	30.2	0.8	–
Constant-Murley	11.0	0.8	–
VAS pain	−25.1	0.8	–
PASS			
ASES	78.8	0.9	–
SANE	78.9	0.9	–
Constant-Murley	22.5	0.8	–
VAS pain	27.4	0.9	–

MCID, minimal clinically important difference; *SCB*, substantial clinical benefit; *PASS*, patient-acceptable symptom state; *ASES*, American Shoulder and Elbow Surgeons; *SANE*, Single Assessment Numeric Evaluation; *VAS*, visual analog scale; *AUC*, area under the curve.

depressed patients demonstrated significantly reduced rates of achievement of MCID on the ASES form, SCB on the ASES form, and PASS on the SANE, CMS, and VAS pain.

Multivariate logistic regression analysis

Multivariate logistic regression analysis identified depression as a significant predictor of reduced likelihood to achieve MCID on the ASES form (odds ratio [OR]: 2.3, 95% confidence interval [CI]: 1.1-4.9, $P = .02$) (Table IV). Other significant predictors of reduced MCID included preoperative CMS on the SANE form, preoperative SF-12 MCS on the CMS form, and preoperative VAS pain on the VAS pain form (OR: 1.1-1.6). Depression was also a significant predictor of reduced likelihood to achieve PASS on both the ASES form (OR: 0.05, 95% CI: 0.01-0.3, $P \leq .001$) and the VAS pain form (OR: 0.01, 95% CI: 0.00-0.3, $P = .008$) (Table V). Other significant predictors of reduced PASS included preoperative narcotics use on the ASES and VAS pain forms, preoperative VAS pain score on the SANE and VAS pain forms, and preoperative ASES score on the CMS form (OR: 0.05-1.1). Significant predictors of reduced likelihood of achieving SCB included WC status and preoperative ASES on the ASES form, preoperative VAS pain on the SANE form, and preoperative CMS and preoperative VR-12 PCS on the VAS pain form (OR: 0.3-1.0) (Table VI). When assessing the impact of WC status on achievement of SCB on the ASES, an interaction term was introduced. In this instance, WC remained a significant predictor ($P = .044$) and the interaction term did not find a relationship between WC and mental health state ($P = .994$).

Discussion

In this investigation, we demonstrated that patients with preoperative diagnoses of depression or severe depression as assessed through the SF-12 MCS questionnaire

Table III Achievement rates of MCID/SCB/PASS

	Severe depression (SD)	Depression (D)	No depression (ND)	*P* value$_{DvsND}$	*P* value$_{SDvsND}$
MCID					
ASES	86.7	66.7	52.7	.2	.03
SANE	66.7	76.2	53.5	.02	.5
Constant-Murley	26.7	57.1	26.7	.06	.5
VAS pain	73.3	83.3	51.9	.001	.2
SCB					
ASES	86.7	42.9	40.3	.9	.002
SANE	53.3	76.2	41.1	.3	.5
Constant-Murley	28.7	57.1	32.6	.9	.08
VAS pain	53.3	83.3	41.1	.3	.5
PASS					
ASES	20.0	33.3	44.2	.3	.1
SANE	6.7	38.1	54.3	.1	.001
Constant-Murley	0.0	21.4	43.4	.02	.003
VAS pain	20.0	38.1	63.6	.007	.003

MCID, minimal clinically important difference; *SCB*, substantial clinical benefit; *PASS*, patient-acceptable symptom state; *ASES*, American Shoulder and Elbow Surgeons; *SANE*, Single Assessment Numeric Evaluation; *VAS*, visual analog scale.

Table IV Predictors of MCID achievement

	Odds ratio (95% CI)	*P* value
ASES		
Depression	2.3 (1.1-4.9)	.02
SANE		
Preoperative CMS	1.6 (1.1-2.3)	.002
CMS		
Preoperative SF-12 MCS	1.1 (1.02-1.2)	.02
VAS pain		
Preoperative VAS pain	1.4 (1.01-1.9)	.05

MCID, minimal clinically important difference; *ASES*, American Shoulder and Elbow Surgeons; *SANE*, Single Assessment Numeric Evaluation; *CMS*, Constant-Murley score; *SF*, Short-Form; *MCS*, mental component score; *VAS*, visual analog scale; *CI*, confidence interval.

Table V Predictors of SCB achievement

	Odds ratio (95% CI)	*P* value
ASES		
WC	0.3 (0.09-0.7)	.01
Preoperative ASES	1.0 (0.95-1.00)	.05
SANE		
Preoperative VAS pain	0.7 (0.5-1.0)	.04
VAS pain		
Preoperative CMS	0.7 (0.6-1.0)	.02
Preoperative VR-12 PCS	0. 6 (0.4-0.8)	.003

SCB, substantial clinical benefit; *ASES*, American Shoulder and Elbow Surgeons; *WC*, workers' compensation; *SANE*, Single Assessment Numeric Evaluation; *VAS*, visual analog scale; *CMS*, Constant-Murley score; *VR*, Veteran's Rand; *PCS*, physical component score; *CI*, confidence interval.

demonstrated significantly lower preoperative PROMs and more pain than those without a diagnosis of depression at baseline. Patients with depression also demonstrated statistically significant and clinically relevant improvements in PROMs and pain after isolated biceps tenodesis. However, PROM scores were significantly lower, and patients demonstrated higher pain levels than those without depression at 1 year after surgery. Depression is highly prevalent comorbidity amongst patients seeking care for musculoskeletal pain.[7,8,39] Because preoperative patient expectations influence subjective clinical outcomes,[10,36] it is imperative that physicians appropriately counsel patients regarding the influence of depression on postoperative outcomes after isolated biceps tenodesis.

The relationship between mental health and physical outcomes after rotator cuff repair and total shoulder arthroplasty has previously been described.[38,45,57] As with other shoulder pathologies, functional outcomes after biceps tenodesis are affected by preoperative symptoms of mental health. In this investigation, the mean improvement in patient-reported outcomes exceeded the MCID in all groups for the ASES, SANE, and Constant, questionnaires (16.3, 3.5, and 6.8 points, respectively).[37] In addition, the mean improvement in PROs exceeded the SCB in all groups for the ASES and SANE questionnaire (16.8 and 5.8 points, respectively); however, only nondepressed patients exceeded the SCB on the Constant score.[37] Furthermore, patients with depression had a lower rate of achieving CSOs after biceps tenodesis. These results suggest that isolated biceps tenodesis is beneficial to all patients, regardless of symptoms of depression. However, surgeons may counsel patients with depression that they may not perceive their results to be successful in comparison with those without mental health disorders.

Table VI Predictors of PASS achievement

	Odds ratio (95% CI)	*P* value
ASES		
Preoperative narcotics use	0.05 (0.1-0.3)	.002
Depression	0.05 (0.01-0.3)	<.001
SANE		
Preoperative VAS pain	0.7 (0.5-1.0)	.04
CMS		
Preoperative ASES score	1.1 (1.1-1.2)	.003
VAS pain		
Depression	0.01 (0.00-0.3)	.008
Preoperative VAS pain	0.1 (0.01-0.8)	.03
Preoperative narcotics use	0.6 (0.4-1.0)	.04

PASS, patient-acceptable symptom state; *ASES*, American Shoulder and Elbow Surgeons; *SANE*, Single Assessment Numeric Evaluation; *VAS*, visual analog scale; *CMS*, Constant-Murley score; *CI*, confidence interval.

Interestingly, a lower proportion of patients with depression or severe depression were able to achieve the PASS for several outcome measures, such as SANE, CMS, and VAS pain, in comparison with those without depression. Patient satisfaction is a significant factor in clinical practice as hospital systems, insurers, and accreditation and licensing agencies use satisfaction as a variable in determining compensation, reimbursement, and physician performance.[20,43] Based on the results of this investigation, mental health status must be factored into metrics that assess physician performance and compensation.

As health care transitions to value-based model that rewards health care systems for optimal care,[14,21,26] differential risk stratification based on expected health care resource utilization becomes increasingly important. Depression has been identified as an independent risk factor for postoperative delirium, anemia, infection, and discharge to an inpatient health facility after total shoulder arthroplasty.[34] The results of the present investigation and those of Mollon et al[34] demonstrate that patients with depression represent a fundamentally different patient population. Patients with depression are at a higher risk for postoperative complications and lower PROMs after total shoulder arthroplasty.[34,49] After biceps tenodesis, patients with depression may experience worse outcomes and a higher rate of complications. The mechanism connecting depression and poorer outcomes after orthopedic surgery remains unclear; however, psychiatric stressors upregulate inflammatory pathways.[28] Subacute upsurges in systemic inflammation may impede local healing, stimulate autoimmunity, and deregulate nociception.[23,33] Therefore, patients with mental disorders may experience delayed recovery, amplified pain, and functional disability after biceps tenodesis. Furthermore, pain and depression act synergistically, yielding a more severe sense of pain than those experiencing pain individually.[28] Physicians may allocate resources differently and follow patients with depression more closely after isolated biceps tenodesis.

Because of the association between depression and poorer outcomes after orthopedic surgery, surgeons may benefit from recognizing those with mental health disorders to optimize clinical management. Bot et al[5] identified that patient word choice may suggest underlying psychological distress and poor coping mechanism. However, orthopedic surgeons' assessment of psychological distress based on clinical evaluation is significantly less sensitive than standardized questionnaires.[13] Orthopedic surgeons may implement validated questionnaires, such as SF-12, Disabilities of the Arm, Shoulder, and Hand, and Patient Health Questionnaire-9, into clinical practice to better identify patients who may benefit from a more in-depth psychiatric assessment.[18] With appropriate consultation and management, patients may be able to improve coping mechanisms to avoid maladaptive behaviors that may negatively influence patient outcomes. Medicine is a multidisciplinary endeavor that requires contributions from several health care professionals; therefore, orthopedic surgeons may benefit from collaborating with physicians who specialize in mental disorders to improve patient care, outcomes after operative management, and overall patient well-being.

The results of this investigation must be interpreted within the context of its limitations. The retrospective nature of this investigation has inherent limitations, such as an inability to control for baseline demographics, comorbidities, or concomitant diagnoses. Although the use of SF-12 MCS to identify symptoms of depression has been supported in the literature,[19,22,32,42,51] a more comprehensive assessment of mental health by a professional who specializes in this field was unable to be completed. Furthermore, this investigation was unable to determine if shoulder pain and functional limitations were causes or results of depressive symptoms. Although patients were queried for 1-year follow-up, our prospective database begins collecting data within 3 months of this time-point. Thus, if patients completed the survey at 9 months, their function may be reported as lower than what they may experience at 12 months postoperatively. Objective measures, such as range of motion and strength, were not collected. Therefore, it is unknown if patients with depression are performing poorly as assessed through objective measures or if patients perceive their function to be suboptimal. The greater proportion of WC status among patients with depression may be a confounding variable in our analysis. However, the authors attempted to minimize heterogeneity by performing multivariate analysis that controls for potential confounding variables. Furthermore, additional factors, such as duration of symptomology, alcohol or drug abuse, documented diagnosis of depression, concomitant mental disorders, and the level of treatment or control of depression, could not be identified. Future investigations may be needed to assess the impact of

various mental disorders on outcomes after isolated biceps tenodesis.

Conclusion

Following isolated biceps tenodesis, patients with depression demonstrated lower PROM scores and a lower rate of achieving CSOs at 1 year postoperatively. Surgeons may counsel patients with depression that they may not perceive their results to be successful in comparison with those without mental health disorders.

Disclaimer

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Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jse.2020.03.020.

References

1. Ackermann J, Ogura T, Duerr RA, Mestriner AB, Gomoll AH. Mental health has no predictive association with self-assessed knee outcome scores in patients after osteochondral allograft transplantation of the knee. Orthop J Sports Med 2018;6:2325967118812363. https://doi.org/10.1177/2325967118812363
2. Arena C, Dhawan A. Mini-open subpectoral biceps tenodesis using a suture anchor. Arthrosc Tech 2017;6:e1625-31. https://doi.org/10.1016/j.eats.2017.06.019
3. Block AR, Ohnmeiss DD, Guyer RD, Rashbaum RF, Hochschuler SH. The use of presurgical psychological screening to predict the outcome of spine surgery. Spine J 2001;1:274-82.
4. Bohl DD, Fu MC, Golinvaux NS, Basques BA, Gruskay JA, Grauer JN. The "July effect" in primary total hip and knee arthroplasty: analysis of 21,434 cases from the ACS-NSQIP database. J Arthroplasty 2014;29:1332-8. https://doi.org/10.1016/j.arth.2014.02.008
5. Bot AG, Vranceanu AM, Herndon JH, Ring DC. Correspondence of patient word choice with psychologic factors in patients with upper extremity illness. Clin Orthop Relat Res 2012;470:3180-6. https://doi.org/10.1007/s11999-012-2436-y
6. Carragee EJ, Alamin TF, Miller JL, Carragee JM. Discographic, MRI and psychosocial determinants of low back pain disability and remission: a prospective study in subjects with benign persistent back pain. Spine J 2005;5:24-35. https://doi.org/10.1016/j.spinee.2004.05.250
7. Cho CH, Jung SW, Park JY, Song KS, Yu KI. Is shoulder pain for three months or longer correlated with depression, anxiety, and sleep disturbance? J Shoulder Elbow Surg 2013;22:222-8. https://doi.org/10.1016/j.jse.2012.04.001
8. Cho CH, Seo HJ, Bae KC, Lee KJ, Hwang I, Warner JJ. The impact of depression and anxiety on self-assessed pain, disability, and quality of life in patients scheduled for rotator cuff repair. J Shoulder Elbow Surg 2013;22:1160-6. https://doi.org/10.1016/j.jse.2013.02.006
9. Christino MA, Fantry AJ, Vopat BG. Psychological aspects of recovery following anterior cruciate ligament reconstruction. J Am Acad Orthop Surg 2015;23:501-9. https://doi.org/10.5435/jaaos-d-14-00173
10. Cole BJ, Cotter EJ, Wang KC, Davey A. Patient understanding, expectations, and satisfaction regarding rotator cuff injuries and surgical management. Arthroscopy 2017;33:1603-6. https://doi.org/10.1016/j.arthro.2017.03.004
11. Cvetanovich GL, Gowd AK, Agarwalla A, Forsythe B, Romeo AA, Verma NN. Trends in the management of isolated SLAP tears in the United States. Orthop J Sports Med 2019;7:2325967119833997. https://doi.org/10.1177/2325967119833997
12. Cvetanovich GL, Gowd AK, Liu JN, Nwachukwu BU, Cabarcas BC, Cole BJ, et al. Establishing clinically significant outcome after arthroscopic rotator cuff repair. J Shoulder Elbow Surg 2019;28:939-48. https://doi.org/10.1016/j.jse.2018.10.013
13. Daubs MD, Patel AA, Willick SE, Kendall RW, Hansen P, Petron DJ, et al. Clinical impression versus standardized questionnaire: the spinal surgeon's ability to assess psychological distress. J Bone Joint Surg Am 2010;92:2878-83. https://doi.org/10.2106/jbjs.i.01036
14. Epstein AM. Revisiting readmissions—changing the incentives for shared accountability. N Engl J Med 2009;360:1457-9. https://doi.org/10.1056/NEJMe0901006
15. Forsythe B, Agarwalla A, Puzzitiello RN, Mascarenhas R, Werner BC. Rates and risk factors for revision open and arthroscopic proximal biceps tenodesis. Orthop J Sports Med 2019;7:2325967118825473. https://doi.org/10.1177/2325967118825473
16. Gatchel RJ, Polatin PB, Mayer TG. The dominant role of psychosocial risk factors in the development of chronic low back pain disability. Spine 1995;20:2702-9.
17. Giesinger JM, Kuster MS, Behrend H, Giesinger K. Association of psychological status and patient-reported physical outcome measures in joint arthroplasty: a lack of divergent validity. Health Qual Life Outcomes 2013;11:64. https://doi.org/10.1186/1477-7525-11-64
18. Gil JA, Gunaseelan V, DeFroda SF, Brummett CM, Bedi A, Waljee JF. Risk of prolonged opioid use among opioid-naive patients after common shoulder arthroscopy procedures. Am J Sports Med 2019;47:1043-50. https://doi.org/10.1177/0363546518819780
19. Gill SC, Butterworth P, Rodgers B, Mackinnon A. Validity of the mental health component scale of the 12-item Short-Form Health Survey (MCS-12) as measure of common mental disorders in the general population. Psychiatry Res 2007;152:63-71. https://doi.org/10.1016/j.psychres.2006.11.005
20. Graham B, Green A, James M, Katz J, Swiontkowski M. Measuring patient satisfaction in orthopaedic surgery. J Bone Joint Surg Am 2015;97:80-4. https://doi.org/10.2106/jbjs.n.00811
21. Hackett DJ, Rothenberg AC, Chen AF, Gutowski C, Jaekel D, Tomek IM, et al. The economic significance of orthopaedic infections. J Am Acad Orthop Surg 2015;23(Suppl):S1-7. https://doi.org/10.5435/jaaos-d-14-00394
22. Jacobs CA, Burnham JM, Jochimsen KN, Molina DT, Hamilton DA, Duncan ST. Preoperative symptoms in femoroacetabular impingement patients are more related to mental health scores than the severity of labral tear or magnitude of bony deformity. J Arthroplasty 2017;32:3603-6. https://doi.org/10.1016/j.arth.2017.06.053
23. Kiecolt-Glaser JK, Glaser R, Christian LM. Omega-3 fatty acids and stress-induced immune dysregulation: implications for wound healing. Mil Med 2014;179:129-33. https://doi.org/10.7205/milmed-d-14-00167
24. Kiely KM, Butterworth P. Validation of four measures of mental health against depression and generalized anxiety in a community based sample. Psychiatry Res 2015;225:291-8. https://doi.org/10.1016/j.psychres.2014.12.023

25. Kocalevent RD, Hinz A, Brahler E. Standardization of the depression screener patient health questionnaire (PHQ-9) in the general population. Gen Hosp Psychiatry 2013;35:551-5. https://doi.org/10.1016/j.genhosppsych.2013.04.006
26. Kocher RP, Adashi EY. Hospital readmissions and the Affordable Care Act: paying for coordinated quality care. JAMA 2011;306:1794-5. https://doi.org/10.1001/jama.2011.1561
27. LaCaille RA, DeBerard MS, Masters KS, Colledge AL, Bacon W. Presurgical biopsychosocial factors predict multidimensional patient: outcomes of interbody cage lumbar fusion. Spine J 2005;5:71-8. https://doi.org/10.1016/j.spinee.2004.08.004
28. Lansdown DA, Ukwuani G, Kuhns B, Harris JD, Nho SJ. Self-reported mental disorders negatively influence surgical outcomes after arthroscopic treatment of femoroacetabular impingement. Orthop J Sports Med 2018;6:2325967118773312. https://doi.org/10.1177/2325967118773312
29. Lavernia CJ, Alcerro JC, Brooks LG, Rossi MD. Mental health and outcomes in primary total joint arthroplasty. J Arthroplasty 2012;27:1276-82. https://doi.org/10.1016/j.arth.2011.11.015
30. Lozano Calderon SA, Paiva A, Ring D. Patient satisfaction after open carpal tunnel release correlates with depression. J Hand Surg Am 2008;33:303-7. https://doi.org/10.1016/j.jhsa.2007.11.025
31. Lu YBA, Patel BH, Chahla J, Verma NN, Cole BJ, Forsythe B. How can we define clinically important improvement in pain scores after biceps tenodesis? Am J Sports Med 2020. in press.
32. Martin RL, Christoforetti JJ, McGovern R, Kivlan BR, Wolff AB, Nho SJ, et al. The impact of depression on patient outcomes in hip arthroscopic surgery. Orthop J Sports Med 2018;6:2325967118806490. https://doi.org/10.1177/2325967118806490.
33. Meesters A, den Bosch-Meevissen Y, Weijzen CAH, Buurman WA, Losen M, Schepers J, et al. The effect of Mindfulness-Based Stress Reduction on wound healing: a preliminary study. J Behav Med 2018;41:385-97. https://doi.org/10.1007/s10865-017-9901-8
34. Mollon B, Mahure SA, Ding DY, Zuckerman JD, Kwon YW. The influence of a history of clinical depression on peri-operative outcomes in elective total shoulder arthroplasty: a ten-year national analysis. Bone Joint J 2016;98-B:818-24. https://doi.org/10.1302/0301-620x.98b6.37208
35. O'Toole RV, Castillo RC, Pollak AN, MacKenzie EJ, Bosse MJ. Determinants of patient satisfaction after severe lower-extremity injuries. J Bone Joint Surg Am 2008;90:1206-11. https://doi.org/10.2106/jbjs.g.00492
36. Oh JH, Yoon JP, Kim JY, Kim SH. Effect of expectations and concerns in rotator cuff disorders and correlations with preoperative patient characteristics. J Shoulder Elbow Surg 2012;21:715-21. https://doi.org/10.1016/j.jse.2011.10.017
37. Puzzitiello RN, Gowd AK, Liu JN, Agarwalla A, Verma NN, Forsythe B. Establishing minimal clinically important difference, substantial clinical benefit, and patient acceptable symptomatic state after biceps tenodesis. J Shoulder Elbow Surg 2019;28:639-47. https://doi.org/10.1016/j.jse.2018.09.025
38. Ravindra A, Barlow JD, Jones GL, Bishop JY. A prospective evaluation of predictors of pain after arthroscopic rotator cuff repair: psychosocial factors have a stronger association than structural factors. J Shoulder Elbow Surg 2018;27:1824-9. https://doi.org/10.1016/j.jse.2018.06.019
39. Ring D, Kadzielski J, Fabian L, Zurakowski D, Malhotra LR, Jupiter JB. Self-reported upper extremity health status correlates with depression. J Bone Joint Surg Am 2006;88:1983-8. https://doi.org/10.2106/jbjs.e.00932
40. Roh YH, Lee BK, Noh JH, Oh JH, Gong HS, Baek GH. Effect of depressive symptoms on perceived disability in patients with chronic shoulder pain. Arch Orthop Trauma Surg 2012;132:1251-7. https://doi.org/10.1007/s00402-012-1545-0
41. Roh YH, Noh JH, Oh JH, Baek GH, Gong HS. To what degree do shoulder outcome instruments reflect patients' psychologic distress? Clin Orthop Relat Res 2012;470:3470-7. https://doi.org/10.1007/s11999-012-2503-4
42. Shakked R, McDonald E, Sutton R, Lynch MK, Nicholson K, Raikin SM. Influence of depressive symptoms on hallux valgus surgical outcomes. Foot Ankle Int 2018;39:795-800. https://doi.org/10.1177/1071100718762137
43. Shirley ED, Sanders JO. Patient satisfaction: implications and predictors of success. J Bone Joint Surg Am 2013;95:e69. https://doi.org/10.2106/jbjs.l.01048
44. Steel Z, Marnane C, Iranpour C, Chey T, Jackson JW, Patel V, et al. The global prevalence of common mental disorders: a systematic review and meta-analysis 1980-2013. Int J Epidemiol 2014;43:476-93. https://doi.org/10.1093/ije/dyu038
45. Thorpe AM, O'Sullivan PB, Mitchell T, Hurworth M, Spencer J, Booth G, et al. Are psychologic factors associated with shoulder scores after rotator cuff surgery? Clin Orthop Relat Res 2018;476:2062-73. https://doi.org/10.1097/corr.0000000000000389
46. Trief PM, Grant W, Fredrickson B. A prospective study of psychological predictors of lumbar surgery outcome. Spine 2000;25:2616-21.
47. Trief PM, Ploutz-Snyder R, Fredrickson BE. Emotional health predicts pain and function after fusion: a prospective multicenter study. Spine 2006;31:823-30. https://doi.org/10.1097/01.brs.0000206362.03950.5b
48. Tuomainen I, Pakarinen M, Aalto T, Sinikallio S, Kroger H, Viinamaki H, et al. Depression is associated with the long-term outcome of lumbar spinal stenosis surgery: a 10-year follow-up study. Spine J 2018;18:458-63. https://doi.org/10.1016/j.spinee.2017.08.228
49. Vajapey SP, Cvetanovich GL, Bishop JY, Neviaser AS. Psychosocial factors affecting outcomes after shoulder arthroplasty: a systematic review. J Shoulder Elbow Surg 2020;29:e175-84. https://doi.org/10.1016/j.jse.2019.09.043
50. Vellios EE, Nazemi AK, Yeranosian MG, Cohen JR, Wang JC, McAllister DR, et al. Demographic trends in arthroscopic and open biceps tenodesis across the United States. J Shoulder Elbow Surg 2015;24:e279-85. https://doi.org/10.1016/j.jse.2015.04.021
51. Vilagut G, Forero CG, Pinto-Meza A, Haro JM, de Graaf R, Bruffaerts R, et al. The mental component of the short-form 12 health survey (SF-12) as a measure of depressive disorders in the general population: results with three alternative scoring methods. Value Health 2013;16:564-73. https://doi.org/10.1016/j.jval.2013.01.006
52. Vranceanu AM, Jupiter JB, Mudgal CS, Ring D. Predictors of pain intensity and disability after minor hand surgery. J Hand Surg Am 2010;35:956-60. https://doi.org/10.1016/j.jhsa.2010.02.001
53. Werner BC, Brockmeier SF, Gwathmey FW. Trends in long head biceps tenodesis. Am J Sports Med 2015;43:570-8. https://doi.org/10.1177/0363546514560155
54. Werner BC, Burrus MT, Miller MD, Brockmeier SF. Tenodesis of the long head of the biceps: a review of indications, techniques, and outcomes. JBJS Rev 2014;2. https://doi.org/10.2106/jbjs.rvw.n.00020
55. Werner BC, Evans CL, Holzgrefe RE, Tuman JM, Hart JM, Carson EW, et al. Arthroscopic suprapectoral and open subpectoral biceps tenodesis: a comparison of minimum 2-year clinical outcomes. Am J Sports Med 2014;42:2583-90. https://doi.org/10.1177/0363546514547226
56. Werner BC, Holzgrefe RE, Brockmeier SF. Arthroscopic surgical techniques for the management of proximal biceps injuries. Clin Sports Med 2016;35:113-35. https://doi.org/10.1016/j.csm.2015.08.001
57. Werner BC, Wong AC, Chang B, Craig EV, Dines DM, Warren RF, et al. Depression and patient-reported outcomes following total shoulder arthroplasty. J Bone Joint Surg Am 2017;99:688-95. https://doi.org/10.2106/jbjs.16.00541