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Correlation between the optimal screening for prediction of referral and outcome yellow flag tool and patient-reported legacy outcome measures in patients undergoing shoulder surgery

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Background: The Optimal Screening for Prediction of Referral and Outcome Yellow Flag (OSPRO-YF) Tool is a 10-item multidimensional screening tool utilized to evaluate pain-related psychological traits in individuals with musculoskeletal pain conditions. The validity of postoperatively collected OSPRO-YF is unclear. This study sought to assess validity of the OSPRO-YF by comparing it to patient-reported outcome scores in both preoperative and postoperative settings.

Hypothesis: The authors hypothesized that OSPRO-YF overall score would correlate with shoulder and global function PROs at preoperative and postoperative timepoints.

Methods: A review of 101 patients undergoing shoulder surgery by one sports medicine orthopedic surgeon at a large academic institution was conducted. 90 and 54 patients had complete preoperative and postoperative patient-reported outcome responses. OSPRO-YF, American Shoulder and Elbow Surgeons (ASES) Evaluation Form, and Patient-Reported Outcomes Measurement Information System Computer Adaptive Test (PROMIS-CAT) were routinely administered before and after surgery at the senior author's clinic visits. Concurrent validity of OSPRO-YF at either timepoint was assessed by comparing scores with PROs cross-sectionally using Pearson correlations and multiple comparison corrections.

Results: Preoperatively, higher OSPRO-YF total score was associated with greater concurrent PROMIS-CAT Pain Interference ($r = 0.43$; $P < .01$) and Depression ($r = 0.36$; $P = .05$) and lower ASES ($r = -0.34$; $P < .01$). Higher postoperative OSPRO-YF was also associated with greater concurrent PROMIS-CAT Pain Interference ($r = 0.43$; $P < .01$) and Depression ($r = 0.36$; $P < .01$) and lower ASES ($r = -0.34$; $P = .01$). ASES had strong correlation with Single Assessment Numeric Evaluation and Pain scores at both preoperative and postoperative timepoints. Single Assessment Numeric Evaluation was not significantly associated with OSPRO-YF total score or number of yellow flags at either timepoints.

Conclusion: The study findings support the clinical validity of the 10-item OSPRO-YF tool when administered before or after shoulder surgery. For patients exhibiting suboptimal recovery or those identified as high risk at initial screening, assessment of pain-related psychological distress post-operatively may be particularly beneficial in guiding rehabilitation.

Psychological distress, even at low to moderate levels, is linked to adverse outcomes in patients with various diseases.[22] Recently, psychological distress has become increasingly recognized as a negative predictor of recovery and function following orthopedic surgery.[10,24,32] However, there are limited screening tools available that thoroughly assess all relevant psychological constructs while being concise enough to be clinically feasible in an orthopedic clinic. The 10-item Optimal Screening for Prediction of Referral and Outcome Yellow Flag (OSPRO-YF) assessment tool is a patient-reported measure developed for multidimensional psychological screening.[4,19] It accurately identifies patients with high psychological distress and has been validated across patients with various orthopedic injuries.[4,19] In comparison, several shoulder (i.e, American Shoulder and Elbow Surgeons [ASES] Evaluation Form and Oxford Shoulder Score) and shoulder pathology-specific patient-reported outcome (PRO) measures (i.e., Western Ontario Shoulder

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Indices for instability and Western Ontario rotator cuff pathology), have been well-studied over the last two decades, and are typically collected preoperatively and at continuous postoperative visits.[8,15,16,23]

Two prior studies of patients with shoulder pathology have found significant associations between preoperative OSPRO-YF and concurrently collected shoulder-specific and global function PROs.[20,24] However, the relationship between these measures when collected in the postoperative setting as part of patient monitoring, has not been studied. It is unclear whether a psychological distress assessment should be performed both before and after surgery, and whether the psychological distress profile changes postoperatively. While increasing frequency of survey administration could ideally offer a more nuanced understanding of outcomes and adverse events, excessive administration increases the survey burden on patients, which can lead to questionnaire fatigue and result in lower response rates and reduced accuracy.[13,14,18] The heterogeneity of psychological distress measures, often involving unidimensional tools (i.e., insomnia only) or tools validated in only one orthopedic condition (i.e., low back pain), have yielded mixed results on the responsiveness of psychological distress with surgery.[6,17]

Therefore, the primary aim of this study was to assess the relationship between OSPRO-YF and standard PROs collected at preoperative and postoperative timepoints. The authors hypothesized that the OSPRO-YF overall score and number of yellow flags (YFs) would correlate with shoulder and global function PROs at both preoperative and postoperative timepoints.

Materials and methods

Study setting

This was a retrospective study performed at a single, large academic center. After receiving Institutional Review Board Approval, the institutional electronic health record database was queried for all patients who underwent surgical treatment by a fellowship-trained sports medicine surgeon between February 2020 and August 2022. The study period start date is reflective of the beginning of routine collection of OSPRO-YF questionnaires in the senior author's clinic and the end date allowed for a minimum of 6 months of follow-up for collection of postoperative PROs at the outset of the study. During this period, a total of 272 patients underwent 304 shoulder-related surgeries. Procedures such as irrigation and débridement (n = 2) and arthroscopic lysis of adhesions for stiffness (n = 5) were excluded. Rotator cuff repairs (n = 81, 56.3%) and labral and/or capsule repair or reconstruction (n = 33, 22.9%) were the most common procedures performed in this cohort (Table 1). Data on patient demographics and characteristics such as age, race, body mass index, current smoking status, American Society of Anesthesiologists classification were obtained from the electronic health record.

Survey information

All patients presenting to the surgeon's clinic were invited to complete PRO questionnaires tailored to the anatomical location of injury as well as overall patient health and function at their initial clinic visit and every follow-up visit thereafter. Patients completed questionnaires on a voluntary basis either prior to arriving at their clinic visit (via the institutional online portal, MyChart) or during their visit (via a tablet device).

The 10-item OSPRO-YF tool generates estimates for 11 full-length psychological questionnaires spanning multiple pain-related distress domains (i.e., negative mood, poor coping, positive affect) (Adapted examples in Fig. 1).[4,19,24,28] The "OSPRO-YF total score" is the unweighted summation across the 10-items and has been validated across multiple anatomical regions as predictive of patient-reported clinical outcomes for pain and disability. Thus, the OSPRO-YF total score was used as a single measure of overall pain-related psychological distress in this study. A higher score indicated greater psychological distress on a scale of 3-57. YFs are also used to flag specific psychological domains when a patient's score estimate falls within the top or bottom quartile for negative or positive psychological questionnaires, respectively. The total number of YF's are counted. Legacy PROs collected for patients presenting with shoulder symptoms to the senior author's clinic included the ASES Shoulder Score, the Single Assessment Numeric Evaluation (SANE), and the Pain Numerical Rating Scale for both affected and unaffected sides.[23] Additionally, to measure overall patient wellbeing and function, all patients were administered Patient-Reported Outcomes Measurement Information System Computer Adaptive Test questionnaires including the Pain Interference, Physical Function, and Depression categories.[3,30]

Table I
Patient characteristics of the preoperative and postoperative score cohorts.

	Preoperative cohort (n = 90)	Postoperative cohort (n = 54)	*P* value
Age, mean (sd)	51.33 (17.48)	52.74 (17.01)	.637
Male Sex, n (%)	59 (65.6)	36 (66.7)	1.000
Race (%)			.881
White	69 (76.7)	42 (77.8)	
Black/AA	16 (17.8)	10 (18.5)	
Mixed/other/not reported	5 (5.6)	2 (3.7)	
BMI (kg/m^2), mean (sd)	30.10 (6.95)	29.25 (6.04)	.460
Current smoker, n (%)	4 (4.4)	1 (1.9)	.414
ASA, mean (sd)	2.23 (0.62)	2.24 (0.67)	.946
Laterality = right, n (%)	53 (58.9)	27 (50.0)	.386
Procedure type, n (%)			.541
AC/clavicle resection	5 (5.6)	4 (7.4)	
ORIF	2 (2.2)	4 (7.4)	
Rotator cuff repair	53 (58.9)	28 (51.9)	
Shoulder labral/capsule repair	22 (24.4)	11 (20.4)	
Subacromial decompression/biceps tenodesis	5 (5.6)	3 (5.6)	
Other tenodesis/tenotomy	3 (3.3)	4 (7.4)	

sd, standard deviation; *AA*, African American; *BMI*, Body Mass Index; *ASA*, American Society of Anesthesiologists Classification score; *AC*, acromioclavicular joint; *ORIF*, open reduction internal fixation.
Preoperative cohort = patients with completed preoperative OSPRO-YF, and preoperative shoulder legacy surveys; Postoperative cohort = patients with completed postoperative OSPRO-YF, and postoperative shoulder legacy surveys (≥6 months).

Psychological Domain	Example Item (Paraphrased)	Response Range
Negative Mood	"I am hotheaded"	1-4 (Almost never – Almost always)
Poor Coping	"I can't stop thinking about my pain"	0-4 (Not at all – All the time)
	"I refrain from activities that may aggravate my pain"	0-6 (Completely disagree – Completely agree)
Positive affect	"I live a full life despite chronic pain"	0-4 (Never true – Always true)
	"My emotional state does not deter me from performing therapy"	0-10 (I can't do it – I can do it)

Figure 1 Example Items of the 10-item Optimal Screening for Prediction for Referral and Outcome Yellow-Flag (OSPRO-YF) tool. Adapted OSPRO-YF tool from Lentz et al 2016 (https://www.jospt.org/doi/10.2519/jospt.2016.6487).[19]

Cohort selection

Only patients who had completed a preoperative OSPRO-YF questionnaire and/or a postoperative OSPRO-YF questionnaire (>6 months after surgery date) were included in the study (n = 101). Two nonmutually exclusive cohorts (preoperative and postoperative) were established based on availability of questionnaire responses, which were completed on a voluntary basis by patients. The first, preoperative cohort consisted of 90 (29.6%) patients who had completed both a preoperative OSPRO-YF survey and a preoperative ASES and/or SANE survey. The second, postoperative cohort consisted of 54 (17.8%) patients who had completed a postop OSPRO-YF survey and a postoperative ASES and/or SANE survey at a minimum of 6 months after the surgery date. There were 34 (11.8%) patients present in both of the aforementioned cohorts. The mean lengths of time from surgery to postoperative OSPRO-YF and postoperative PRO survey were 14.2 ± 5.4 months and 16.3 ± 6.7 months, respectively.

Statistical analysis and study design

Continuous variables were presented as means and standard deviations, and categorical variables were presented as counts and percentages. Univariable analyses were performed comparing patient baseline demographics, surgical characteristics, and mean PROs between the preoperative and postoperative cohorts. In the preoperative cohort, preoperative OSPRO-YF total score was compared to preoperative shoulder legacy and PROMIS CAT scores via Pearson correlation coefficients. *P* values from correlation tests were adjusted for multiple comparisons using the Benjamini-Hochberg method. In the second postoperative cohort, postoperative OSPRO-YF total score was compared to postoperative shoulder legacy and PROMIS CAT scores in the same manner as described for the preoperative cohort. All statistical analyses were performed using Rv3.6.1 (R Foundation for Statistical Computing, Vienna, Austria). Findings were considered statistically significant if $P < .05$ after multiple comparison corrections where appropriate.

Results

Mean ASES and SANE of the affected shoulder were greater in the postoperative compared to the preoperative cohort (83 vs. 48; $P < .01$ and 81 vs. 39; $P < .01$, respectively) (Table 2). Mean VAS pain score was lower in the postoperative compared to the preoperative cohort (5 vs. 1; $P < .01$). There were no significant differences between preoperative and postoperative mean OSPRO-YF total score or number of YFs ($P > .05$).

Regarding global function measures, mean PROMIS PI was lower (better) in the postoperative compared to the preoperative cohort (63 vs. 54; $P < .01$), and PROMIS PF was greater in the postoperative cohort (47 vs. 38; $P < .01$).

Preoperative OSPRO-YF total score had the highest correlation with preoperative PROMIS PI ($r = 0.43$; $P < .01$) and Depression ($r = 0.36$; $P = .05$) and had the strongest inverse correlation with preoperative ASES ($r = -0.34$; $P < .01$) (Fig. 2). ASES score had the greatest correlation with concurrent SANE score ($r = 0.66$; $P < .01$) and greatest inverse correlation with concurrent Pain ($r = -0.86$; $P < .01$) and PROMIS PI ($r = -0.66$; $P < .01$).

Postoperative OSPRO-YF had the highest correlation with postoperative PROMIS PI ($r = 0.43$ $P < .01$) and Depression ($r = 0.36$; $P < .01$) and the strongest inverse correlation with postoperative ASES ($r = -0.34$; $P = .01$) (Fig. 3). Similar to the preoperative scores, postoperative ASES score was most strongly correlated with postoperative SANE ($r = 0.66$; $P < .01$) and inversely correlated with postoperative Pain ($r = -0.86$; $P < .01$).

Interestingly, SANE was not significantly correlated with OSPRO-YF at either preoperative or postoperative timepoints.

Discussion

Identifying patients at greater risk for psychological distress following surgery is crucial to offer adjunctive interventions and better manage expectations for recovery. We demonstrate significant associations between OSPRO-YF and ASES and PROMIS CAT PI, PF and Depression, but not SANE, for patients undergoing shoulder surgery. Although preoperative OSPRO-YF has previously been evaluated in shoulder surgery, this study is the first to correlate OSPRO-YF with validated shoulder-specific and global function PROs at both preoperative and postoperative timepoints.[24] This has a number of clinical implications. First, it supports the validity of the OSPRO-YF tool as a psychological assessment tool postoperatively, measuring a distinct pathology from ASES and PROMIS, and assessing many more domains of psychological distress than existing tools. For patients exhibiting suboptimal recovery after surgery, there may be utility in collecting a screening OSPRO-YF postoperatively to identify patients newly at risk or for monitoring those who continue to have psychological distress. Second, it demonstrates that distress is not well reflected in SANE, which is anchored on one's own preinjury baseline, and administering an OSPRO-YF in patients with low SANE scores may also be beneficial.

Psychological distress, encompassing a range of emotional states such as anxiety, depression and pain-related characteristics like fear of pain and pain catastrophizing, is a significant factor in how patients respond to tretaments[22] Understanding psychological distress is crucial, as the relation between preoperative psychological distress and functional outcome scores has been shown in prior research. Psychological distress is associated with lower concurrent PRO scores in patients with shoulder pathology,

Table II
Mean preoperative and postoperative patient reported outcomes.

Patient-reported outcome	Preop scores for preop cohort (n = 90)	Postop scores for postop cohort (n = 54)	*P* value
OSPRO total score, mean (sd)	19.46 (7.91)	18.37 (7.45)	.426
OSPRO num of YFs, median [IQR]	5.5 [2.0-8.0]	3.0 [2.0-7.0]	.179
ASES affected side, mean (sd)	48.30 (21.85)	82.70 (19.70)	**<.001**
SANE affected side, mean (sd)	38.70 (26.74)	80.50 (23.94)	**<.001**
Pain affected side, mean (sd)	4.66 (2.72)	1.31 (1.99)	**<.001**
ASES unaffected side, mean (sd)	89.70 (16.91)	89.06 (18.75)	.835
SANE unaffected side, mean (sd)	88.27 (21.11)	89.83 (19.42)	.715
Pain unaffected side, mean (sd)	0.76 (1.68)	0.82 (1.81)	.841
PROMIS CAT - Pain Interference, mean (sd)	62.59 (7.10)	53.76 (9.43)	**<.001**
PROMIS CAT - Physical Function, mean (sd)	37.67 (7.93)	46.81 (10.95)	**<.001**
PROMIS CAT - Depression, mean (sd)	49.68 (8.75)	45.62 (9.15)	.055

OSPRO-YF, Optimal Screening for Prediction for Referral and Outcome Yellow-Flag; *ASES*, American Shoulder and Elbow Surgeons Shoulder score; *SANE*, Single Assessment Numeric Evaluation; *PROMIS*, Patient-Reported Outcomes Measurement Information System; *IQR*, interquartile range; *sd*, standard deviation; *preop*, preoperative; *postop*, postoperative.
Bold values refer to *P*-value less than .05.

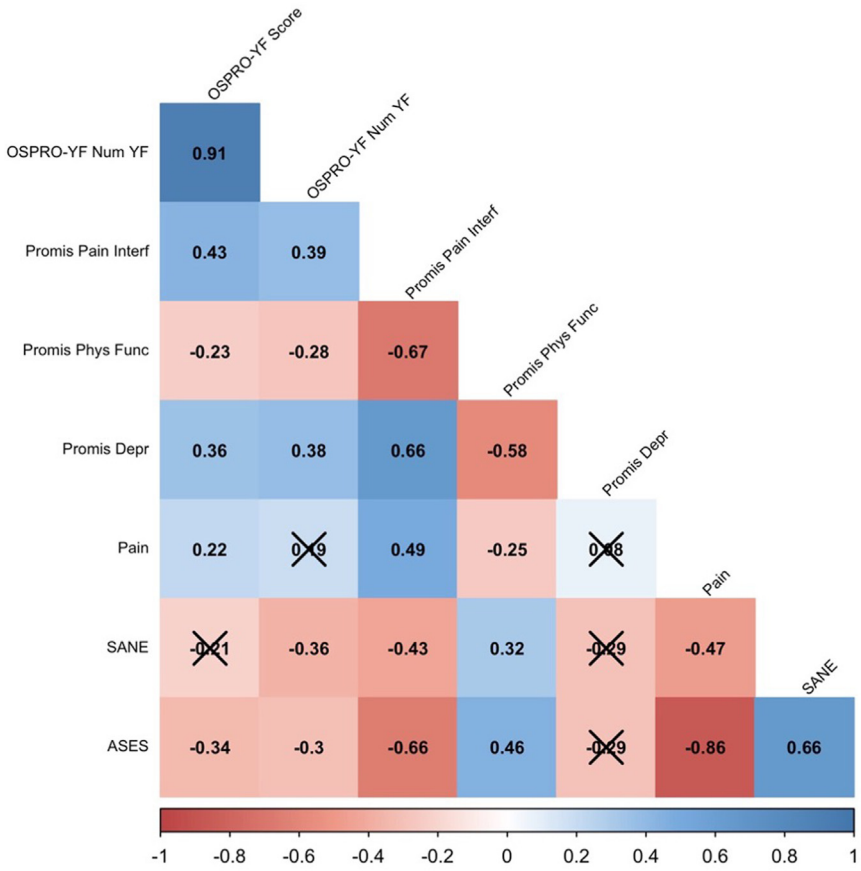

Figure 2 Correlation Matrix Between Preoperative OSPRO and Preoperative Legacy PROs. Pearson Correlation coefficients are reported in each cell and cells are colored according to the direction and magnitude of the correlation indicated by the scale at the Bottom. Cells that are marked with an "X" correspond to Pearson Correlation test *P* values that were >.05 (not significant) after adjusting for multiple comparisons using the BH method. ASES, SANE, and Pain refer to the affected side. *OSPRO-YF Score*, Optimal Screening for Prediction for Referral and Outcome Yellow-Flag; *Promis*, Patient-Reported Outcomes Measurement Information System; *Pain Interf*, Pain Interference; *Phys Func*, Physical Function; *Depr*, Depression; *SANE*, Single Numerical Evaluation; *ASES*, American Shoulder and Elbow Surgeons Shoulder score.

including on the ASES and the Simple Shoulder Test,[25,27,34] This may be mediated by increased rumination or altered perception of shoulder function, despite similar mechanical function.[25] The causative nature of this relationship is unclear, however. Impaired physical function may lead to adverse psychological and mental health outcomes including depression, anxiety, and generalized distress,[2,5,7] potentially mediated by pain and social support.[2,9]

PROs are increasingly important in shoulder surgery for monitoring patient satisfaction and quality of life, and are used in insurance payment models as the US health-care system shifts to value-based compensation.[1,11,21,23] Despite increased PRO collection, consensus on the optimal timing and frequency remains limited, with significant variability based on patient diagnosis, physician preference, and institutional practices[12,33] During the

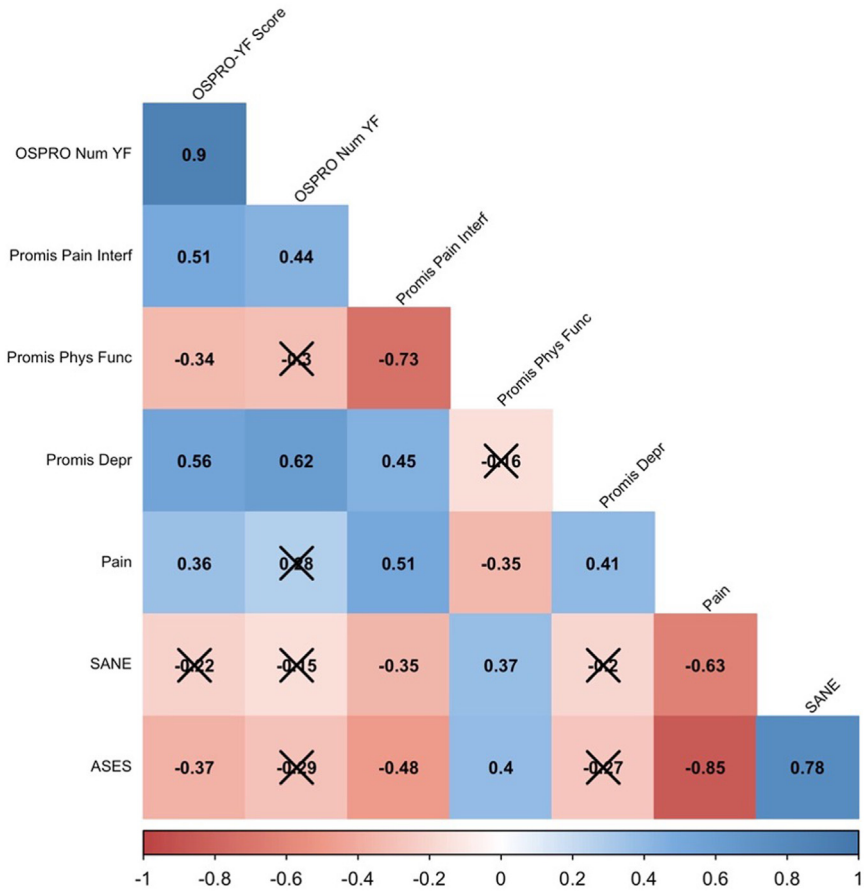

Figure 3 Correlation Between Postoperative OSPRO and Postoperative Legacy PROs. Pearson Correlation coefficients are reported in each cell and cells are colored according to the direction and magnitude of the correlation indicated by the scale at the Bottom. Cells that are marked with an "X" correspond to Pearson Correlation test *P* values that were >.05 (not significant) after adjusting for multiple comparisons using the BH method. ASES, SANE, and Pain refer to the affected side. *OSPRO-YF Score*, Optimal Screening for Prediction for Referral and Outcome Yellow-Flag; *Promis*, Patient-Reported Outcomes Measurement Information System; *Pain Interf*, Pain Interference; *Phys Func*, Physical Function; *Depr*, Depression; *SANE*, Single Numerical Evaluation; *ASES*, American Shoulder and Elbow Surgeons Shoulder score.

postoperative period, physical function is expected to improve for most patients. For patients exhibiting suboptimal recovery, it is reasonable to reassess psychological distress to identify nonphysical sources that may influence recovery and recommend adjunct psychological therapy. Koorevaar et al demonstrated strong associations between specific domains (distress, depression, and somatosensation) of the postoperative Four-Dimensional Symptom Questionnaire and worse perceived improvement in pain and function.[17] Our findings from administering postoperative OSPRO-YF have demonstrated similar patterns. Specifically, postoperative OSPRO-YF score had the strongest inverse correlation with concurrently collected ASES of the affected shoulder.

Psychological distress scores, measured by mean OSPRO-YF total score, were significantly correlated with PROMIS CAT depression measures at both preoperative and postoperative timepoints, demonstrating the sensitivity of OSPRO-YF to one subdomain of the "mood" domain. Furthermore, the OPSRO-YF total scores and PROMIS CAT depression scores were both demonstrated no significant change between preoperative and postoperative mean values, which is reflective of the event between timepoints being an orthopedic intervention aimed at improving physical function, and no formal psychological distress intervention protocol devised and administered during the study period. Overall, the consistency of associations between the OSPRO-YF total score and other PROs at both preoperative and postoperative timepoints supports the clinical validity of OSPRO-YF total score for assessment at either preoperative or postoperative timepoints.

Notably, SANE was not significantly associated with OSPRO-YF total score or PROMIS Depression before or after surgery. While SANE has been shown to be a reliable correlate of shoulder physical function scores, such as ASES and SST, it does not appear to be well reflective of psychological distress.[26,29,31] The reason for this lack of association is unclear.[26] SANE is a one-question tool, making for an efficient but limited self-reported outcome measure. Additionally, SANE is heavily anchored on one's own preinjury baseline. It is plausible that lower SANE scores may be detected in patients exhibiting worsening psychological distress after surgery. Future studies aimed at measuring the effect of changes in OSPRO-YF, particularly those who demonstrated greater distress after surgery, may help identify those at highest risk for poor outcomes. Nevertheless, our study results suggest that SANE is an inadequate marker of psychological distress, and the OSPRO-YF provides a more holistic understanding of a patient's risk for suboptimal postoperative recovery.

The limitations of this study are well-recognized. Our "preoperative" and "postoperative" cohorts had different cohort sizes due to the lack of data availability using a recently implemented psychological distress assessment tool. Ideally, one large cohort with all measurements completed at both preoperative and postoperative timepoints would mitigate potential patient bias as a

result of different cohorts. Additionally, at the current sample sizes, only the total OSPRO-YF score was compared, and relationships between specific OSPRO-YF domains (i.e. mood, coping mechanisms, etc.) and functional outcome scores, which may have provided a more nuanced understanding of the validity and responsiveness of OSPRO-YF, were not evaluated. For the purposes of a screening tool, one total score was felt to be more interpretable and actionable in a clinical setting. Next, this was a single-surgeon, single institution study performed at a large academic institution, and findings should be interpreted in this context. Finally, despite the exclusion of outlier procedures, there was some heterogeneity of shoulder pathology and surgery, which may affect the generalizability of these findings if condition-specific patterns of change in psychological distress exist.

Conclusion

This study supports the concurrent validity of the 10-item OSPRO-YF tool when administered before or after shoulder surgery. Preoperative administration is beneficial to allow for early psychologically informed intervention, if necessary, as a means of optimizing postoperative outcomes. The utility of routine administration of OSPRO-YF after the first instance may be particularly helpful for guiding treatment in patients exhibiting suboptimal recovery or those identified as high risk at initial screening.

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