The American Journal of Surgery 218 (2019) 934–939

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

# Prevalence of posttraumatic stress disorder (PTSD) in patients with an incisional hernia

Hemasat Alkhatib*, Luciano Tastaldi, David M. Krpata, Judith Scheman, Clayton C. Petro, Aldo Fafaj, Steven Rosenblatt, Michael J. Rosen, Ajita S. Prabhu

*Comprehensive Hernia Center, Digestive Disease and Surgery Institute, Cleveland Clinic Foundation, 9500 Euclid Avenue, Cleveland, OH, 44195, USA*

ARTICLE INFO

*Article history:*
Received 2 February 2019
Received in revised form
25 February 2019
Accepted 2 March 2019

**Meeting presentation:** Accepted for oral presentation at the 2019 Americas Hernia Society (AHS) Annual Meeting, Las Vegas, NV, March 2019.

*Keywords:*
Posttraumatic stress disorder
PTSD
Incisional hernia
Mental illness
Quality of life

ABSTRACT

*Background:* We investigate the prevalence of PTSD in patients with an incisional hernia presenting for evaluation at our institution.
*Methods:* Study patients were screened for PTSD using the PCL-5 checklist for DSM-5. Patient-reported quality of life and pain scores were assessed using validated tools (HerQLes and PROMIS Pain Intensity 3a survey).
*Results:* The prevalence of PTSD in 131 patients was 32.1% [95% CI 24%–40%]. Patients screening positive (PTSD+) reported lower quality of life scores on HerQles (17.3 ± 14.3 vs. 47.7 ± 29.6, $P < 0.001$), and higher pain scores on the PROMIS scale (54.2 ± 9.1 vs. 44.2 ± 10, $p < 0.001$). PTSD + patients also reported significantly higher numbers of previous hernia repairs and abdominal operations, as well as a higher rate of a history of an open abdomen.
*Conclusion:* Our study found a significant prevalence of positive screening for PTSD in patients seeking consultation regarding an incisional hernia. We have begun routine preoperative evaluations by a behavioral medicine specialist to address some of these complex issues in high-risk patients. Other high volume hernia programs caring for this challenging patient population should consider such assessments.



## Introduction

Patients presenting to our Comprehensive Hernia Center usually have complex surgical histories, with multiple repairs and complications. Anecdotally, we have noted that many patients display signs of emotional distress and ongoing fear of their disease process throughout the care continuum. In the preoperative phase, this tension can manifest by stress-related behavior such as agitation and tearfulness when discussing their prior operative history and expectations surrounding potential future repair of their incisional hernias. Similarly, during long-term follow up, many patients report dissatisfaction with their outcome and express concerns for ongoing recurrence or further complications—despite an intact repair, a normal anatomy on examination and the absence of chronic pain. Other groups have indirectly reported similar findings in patients who have undergone successful complex abdominal wall reconstruction, noting quicker improvement in functional outcomes compared to mental scores.[1] This led our group to specifically question whether some degree of Posttraumatic Stress Disorder (PTSD) might be present in patients presenting for a consultation at our complex hernia clinic.

PTSD is defined as the development of characteristic symptoms following exposure to a traumatic event, with a projected lifetime risk of 8.7% at age 75 years in the general population.[2,3] The prevalence of PTSD has been studied within a variety of medical settings, most commonly in cardiac, trauma, cancer, transplant and intensive care unit (ICU) patients.[4–10] Younger age, female sex, and a history of psychiatric illness have been identified as risk factors across several of these studies. Zarzaur and colleagues[11] found the prevalence of PTSD to be 22.5% in a population of trauma patients who had undergone delayed abdominal wall reconstruction to manage an open abdomen. Still, to date, there is no existing literature to our knowledge that examines the prevalence of PTSD in patients undergoing elective incisional hernia repair.

In this study, we specifically evaluated for PTSD in those patients

* Corresponding author. Comprehensive Hernia Center, Digestive Disease and Surgery Institute, The Cleveland Clinic Foundation, 9500 Euclid Avenue, A-100, Cleveland, OH, 44195, USA.
*E-mail address:* alkhath2@ccf.org (H. Alkhatib).

https://doi.org/10.1016/j.amjsurg.2019.03.002
0002-9610/

presenting preoperatively for evaluation and treatment of their incisional hernia. We hypothesized that patients with complex surgical histories and multiple repairs would be more likely to screen positive for PTSD.

## Methods

From January to June, 2018, following IRB approval, a cross-sectional survey study was conducted at the Cleveland Clinic Comprehensive Hernia Center (Cleveland, Ohio). The study population included all adult (≥18 years old) patients presenting for evaluation of an incisional hernia at any of the participating surgeons' clinics (DMK, ASP, MJR). Patients were approached at the end of the visit and consent was obtained from those who agreed to participate. Patients with previously diagnosed mental illnesses, including PTSD, were not excluded. The patients were then given the PTSD Checklist (PCL-5), the HerQles questionnaire, and a supplementary questionnaire assessing their surgical and psychiatric history. Patients were counseled that a positive response on the PCL-5 does not necessarily mean a diagnosis of PTSD. If a patient screened positive on the PCL-5 checklist, they were offered a referral to a behavioral medicine specialist (JS). Additionally, a retrospective review of the electronic medical record was conducted to review patient demographics, previously recorded complications or hernia recurrences, and their comorbidities. Study data were collected and managed using REDCap electronic data capture tools hosted at Cleveland Clinic Foundation.[12]

### *The PTSD checklist for DSM-5 (PCL-5)*

The PCL-5 is a 20-item self-reported measure that assesses the 20 symptoms chosen by the Diagnostic and Statistical Manual 5 (DSM-5) for the diagnosis of PTSD. The checklist has been previously evaluated and showed strong reliability and validity.[13–15] The PCL-5 symptom items sheet is validated for both high-risk populations and the public. Each set of questions reflects a symptom criterion according to the DSM-5; items (1–5) for criterion B, intrusive symptoms; items (6–7) for criterion C, avoidance symptoms; items (8–14) for criterion D, negative alterations in cognition; items (15–20) for criterion E, alterations in arousal and reactivity. Patients report the frequency of each symptom on a Likert scale from 0 to 4 (0: Not at all, 1: A little bit, 2: Moderately, 3: Quite a bit, 4: Extremely). A total symptom severity score can be acquired by summing the score for each of the 20 items. A range between 0 and 80 is reported.

This checklist can be used to screen subjects for PTSD as well as provide a provisional diagnosis.[14] Patients were stratified into two groups for statistical analysis: (1) Cases: those who screened positive for PTSD (PTSD+), and (2) Controls: those who screened negative for PTSD (PTSD-). The results of the PCL-5 checklist were interpreted as suggested by the National Center for PTSD[14]: (1) a cut-off score of 33 points was used to screen "positive" for PTSD; any patient scoring above 33 was considered PTSD positive. (2) A provisional diagnosis was made by treating each item with response rated "2: Moderately" or higher as symptoms endorsed, then following the DSM-5 diagnostic rule for the diagnosis of PTSD, which requires 1 item from each of the B and C categories, and, 2 items from each of the D and E categories. If a patient reached either interpretation goal, then they were included in the case group and were asked to which primary stressor they could attribute their symptoms: (1) their previous surgeries and the associated complications, (2) the hernia itself or (3) other stressors, for which they were then asked to elaborate further.

### *Hernia specific patient reported outcomes (PROs)*

Baseline PROs are collected as standard of care at our institution and include a hernia specific quality of life tool, HerQles, and the Patient Reported Outcome Measurement Information System (PROMIS) Pain Intensity 3a survey, a National Institute of Health-developed validated tool, which focuses on PROs of pain characteristics.[16] The HerQLes survey is a 12-question, validated, hernia-specific quality of life instrument with a focus on abdominal wall function and the impact of ventral hernia repair on quality of life.[17] The HerQles score has been found to correlate with changes in core physiology and abdominal wall functionality.[18] Patients report their answers on a Likert scale from 1 to 6 with a raw score calculated by summing each item's score. Raw scores are then converted to summary scores using the following formula:

$$12\ \textit{Question Average} = \frac{\textit{Response to } Q1 + \textit{ Response to } Q2 + \ldots + \textit{Response to } Q12}{12}$$

$$\textbf{\textit{HerQles Summary Score}} = 120 - 20\ \times [12\ \textbf{\textit{Question Average}}]$$

This rescales the raw score so that a 0 value is the worst possible response, and 100 indicates the best possible response. Higher summary scores represent a better quality of life. This is an updated method for interpreting the HerQles score, which is yet to be published. The updated HerQles score is superior to its predecessor in that it provides values where the range of scores are consistently between 0 and 100 across cohorts, untethering the score from the reference population and simplifying the calculation.

### *Other collected variables*

Patients were asked about relevant risk factors: a military and deployment history, a prior history of depression or anxiety diagnosis, and a history of psychiatric medications use. Patients were also asked about their surgical history, including the number of previous hernia repairs and other abdominal surgeries, prior ICU admissions, postoperative wound infections (SSI), wound events requiring procedural intervention (SSOPI), and a history of an open abdomen. An open abdomen is defined as a planned abdominal wall defect created by the surgeon after elective or emergent laparotomy. Wherever possible, medical records were reviewed to assess and reaffirm the patient's history. Patients were also asked if they felt the hernia has distorted the shape of their body. Finally, if an abdominal CT scan was available, hernia width was measured and reported.

### *Data analysis*

To assess for possible risk factors, univariate analyses were used to compare the group of patients who screened positive for PTSD

and those who did not. Data was presented as mean and standard deviation, medians and interquartile ranges, or numbers and percentages as appropriate. ANOVA test was used for comparisons of means, Kruskal-Wallis test was used for comparisons of medians, and Pearson's chi-squared test and Fisher's exact test were used for categorical variables. Analysis was done using SAS 9.4 software (SAS Institute, Cary, NC).

## Results

A total of 131 patients were included in our study. Of this population, 42 patients screened positive for PTSD. The prevalence of PTSD in patients presenting with an incisional hernia at our clinic was 32.1% [95% CI 24.1%–40.1%]. Thirty (71.4%) of the PTSD + patients mentioned that their previous surgeries and the associated complications were the primary stressor causing these symptoms, while five patients (11.9%) reported their primary concern to be the hernia itself. Seven (16.6%) patients cited other stressors, of which three (7.1%) attributed their symptoms to abuse (physical or sexual), one (2.4%) cited a mass shooting incident, one (2.4%) alluded to cancer, and the other two (4.8%) refrained from further elaboration. Of the five patients reporting their hernias as the primary stressor, 4 had CT scans available. Their hernia widths were: 5.4 cm, 14.5 cm, 9.4 cm, and 9 cm. Two of these patients reported three prior hernia repairs, one reported 4 prior hernia repairs, one reported 5 prior hernia repairs, and one had no previous hernia repairs. Only two patients reported being previously diagnosed with PTSD at the time of this study, and both screened positive on the PCL-5 checklist.

Patients who screened positive for PTSD were more likely to be younger (53.8 ± 10.9 vs 59.2 ± 11.2; P = 0.009) and female (69% vs 46.1%; P = 0.014) when compared to the patient population that screened negative. They reported a greater median number of previous hernia repairs (1[IQR 0–4] vs 1[IQR 0–2]; P = 0.022) and previous abdominal surgeries (4[IQR 2–8] vs 3[IQR 2–4]; P = 0.006). Additionally, these patients were more likely to have a history of depression and anxiety (76.2% vs 40.4%, p < 0.001), as well as a prior open abdomen (45.2% vs 27%, p = 0.038). No differences were found between the two groups in terms of history of wound events and ICU admissions, or hernia width.

Patients who screened positive reported worse quality of life on the preoperative HerQLes survey (17.3 ± 14.3 vs 47.7 ± 29.6, P < 0.001), and had worse pain scores on the PROMIS pain score 3a (54.2 ± 9.1 vs 44.2 ± 10, p < 0.001). Table 1 demonstrates patient demographics, characteristics, previous surgical history, and preoperative patient-reported outcomes, comparing those patients who screened positive for PTSD to those who did not.

## Discussion

Our analysis is the first to assess the prevalence of PTSD in patients with an incisional hernia. We found that approximately one-third of incisional hernia patients presenting to our clinic screened positive for PTSD. Overall, these patients were more likely to be young and female, with a complex past surgical history and a prior diagnosis of mental illness. This population also reported a

**Table 1**
Patient demographics, characteristics, previous surgical history, and patient reported outcomes.
Statistics presented as Mean ± SD, Median [Q3 − Q1], or N (%).
P-values: a = ANOVA, b = Kruskal-Wallis test, c = Pearson's chi-square test, d = Fisher's Exact test.

| | PTSD -(N = 89) | PTSD +(N = 42) | Total(N = 131) | P-value |
|---|---|---|---|---|
| Age (Mean ± SD) | 59.2 ± 11.2 | 53.8 ± 10.9 | 57.5 ± 11.4 | ***0.009***[a] |
| Gender | | | | ***0.014***[c] |
| Male | 48 (53.9%) | 13 (31%) | 61 (46.6%) | |
| Female | 41 (46.1%) | 29 (69%) | 70 (53%) | |
| Diabetes | 24 (27%) | 11 (26.2%) | 35 (26.7%) | 0.93[c] |
| BMI, kg/cm$^2$ | | | | 0.10[c] |
| Underweight (<18.5) | 0 (0%) | 1 (2.4%) | 1 (0.76%) | |
| Normal weight (18.5–24.9) | 7 (7.9%) | 5 (11.9%) | 12 (9.2%) | |
| Overweight (25.0–29.9) | 25 (28.1%) | 4 (9.5%) | 29 (22.1%) | |
| Class I obesity (30.0–34.9) | 22 (24.7%) | 10 (23.8%) | 32 (24.4%) | |
| Class II obesity (35.0–39.9) | 22 (24.7%) | 11 (26.2%) | 33 (25.2%) | |
| Class III obesity (Above 40) | 13 (14.6%) | 11 (26.2%) | 24 (18.3%) | |
| COPD[b] | 11 (12.4%) | 6 (14.3%) | 17 (13%) | 0.76[c] |
| Current Smoker | 13 (14.6%) | 4 (9.5%) | 17 (13%) | 0.42[c] |
| History of IBD[b] | 5 (5.6%) | 3 (7.1%) | 8 (6.1%) | 0.73[c] |
| Military | 7 (7.9%) | 3 (7.1%) | 10 (7.6%) | 0.88[c] |
| Deployment | 1 (1.1%) | 2 (4.8%) | 3 (2.3%) | 0.24[d] |
| Hernia Width[a] (Mean ± SD) | 9.9 ± 4.6 | 11.5 ± 6.5 | 10.4 ± 5.3 | 0.12[a] |
| Number of Previous Hernia Repairs (Median [Q1 − Q3]) | 1 [0–2] | 1 [0–4] | 1 [0–2] | ***0.022***[b] |
| Number of Previous Abdominal Surgeries (Median [Q1 − Q3]) | 3 [2–4] | 4 [2–8] | 3 [2–5] | ***0.006***[b] |
| History of SSI | 32 (36%) | 21 (50%) | 53 (40.5%) | 0.13[c] |
| History of SSOPI | 34 (38.2%) | 23 (54.8%) | 57 (43.5%) | 0.074[c] |
| History of Open Abdomen | 24 (27%) | 19 (45.2%) | 43 (32.8%) | ***0.038***[c] |
| History of ICU Admission | 37 (41.6%) | 22 (52.4%) | 59 (45%) | 0.25[c] |
| Primary Indication For Surgery | | | | 0.52[c] |
| 1. Cancer | 17 (19.1%) | 4 (9.5%) | 21 (16%) | |
| 2. Trauma | 3 (3.4%) | 1 (2.4%) | 4 (3.1%) | |
| 3. Perforated Viscous | 13 (14.6%) | 6 (14.6%) | 19 (14.5%) | |
| 4. Unknown | 56 (62.9%) | 31 (73.8%) | 87 (66.4%) | |
| Distorted Shape of Body | 78 (87.6%) | 41 (97.6%) | 119 (90.8%) | 0.065[c] |
| History of Depression or Anxiety | 36 (40.4%) | 32 (76.2%) | 68 (51.9%) | <***0.001***[c] |
| Patient Reported Outcomes | | | | |
| PROMIS pain score 3a | 44.2 ± 10 | 54.2 ± 9.1 | 47.4 ± 10.8 | <***0.001***[a] |
| HerQles Summary Score | 47.7 ± 29.6 | 17.3 ± 14.3 | 37.9 ± 29.3 | <***0.001***[a] |

[a] Data not available for all subjects. Missing values for hernia width = 7.
[b] COPD: Chronic Obstructive Pulmonary Disease, IBD: inflammatory bowel disease.

significantly worse quality of life and abdominal wall function, and higher pain scores than those patients who screened negative for PTSD. The majority (71.4%) of the PTSD population cited their previous operations and the associated complications as the source of their symptoms. The prevalence of PTSD in our patient population is more than four times that of a nationally representative sample,[3] and almost three times higher than the median prevalence found by a systemic review evaluating PTSD within the primary care system for civilian populations.[19] Fig. 1 illustrates the different rates of PTSD across different populations in comparisons to our own.

The prevalence of PTSD in our hernia patient population falls within the range of other life-threatening illnesses, such as cancer and acute coronary syndrome. Posluszney et al.[5] studied a group of patients undergoing gynecological surgery for diagnoses ranging from advanced cancer to benign conditions. The authors found that the prevalence of PTSD increases with the severity of their condition; the actuarial rates of PTSD in advanced cancer patients was 34%, compared to 16% in early cancer, and 15% in benign conditions. Similar ranges of PTSD prevalence (0–65%) were found in systemic reviews of patients with acute coronary syndrome[6] and intensive care unit patients.[7] These studies, in addition to others,[9] have found that patients with PTSD symptoms were more likely to be of younger age, female gender, and have a history of psychiatric illness, which is similar to the findings of our current study. We also found that PTSD-positive patients were more likely to have a been treated for an open abdomen, which correlates with the previously noted findings from Zarzaur et al.[11] where the prevalence of PTSD in patient with a history of an open abdomen was 22.5%.

Additionally, patients screening positive for PTSD in our study tended to report increasing complexity in their past surgical histories, with a higher median number of previous hernia and abdominal operations. Interestingly, hernia width —a marker of hernia severity and the need for extensive surgery— did not differ significantly between the two groups. This finding suggests that the cumulative effects of prior operative interventions and the post-operative clinical course may have imparted greater negative impact on psyche than the actual size and severity of the hernia itself. This is similar to a study evaluating PTSD after abdominal aortic surgery, where the size of the abdominal aorta was not a predictor for PTSD.[9] Likewise, a systemic review of ICU patients found that all seven studies evaluating severity of critical illness report no significant association with PTSD symptoms.[7] Finally, while previous data has linked ICU admission to the development of PTSD, this was not significantly different between our two patient groups.[7]

Other studies evaluating patients after incisional hernia repair have found that those patients who experience a recurrent hernia report a decline in their quality of life.[20,21] These studies, however, only evaluated the impact of a singular recurrence. The influence of multiple recurrences within the same patient population has not previously been appraised. Although both of our patient populations had experienced recurrent hernias, those who screened positive for PTSD reported significantly higher median number of previous hernia repairs, in addition to lower quality of life scores and increased pain scores at baseline. This finding could be affected by other unmeasured confounders, for which we had not adjusted. However, this correlation suggests that the cumulative negative impact of their recurrent hernia experiences and the resulting proportional decline in QoL may predispose these patients to developing acute stress symptoms. Subsequently, evaluations for PTSD and other psychological risk factors along PROs and QoL measures are important tools to assess post-operative recovery in patients at risk.

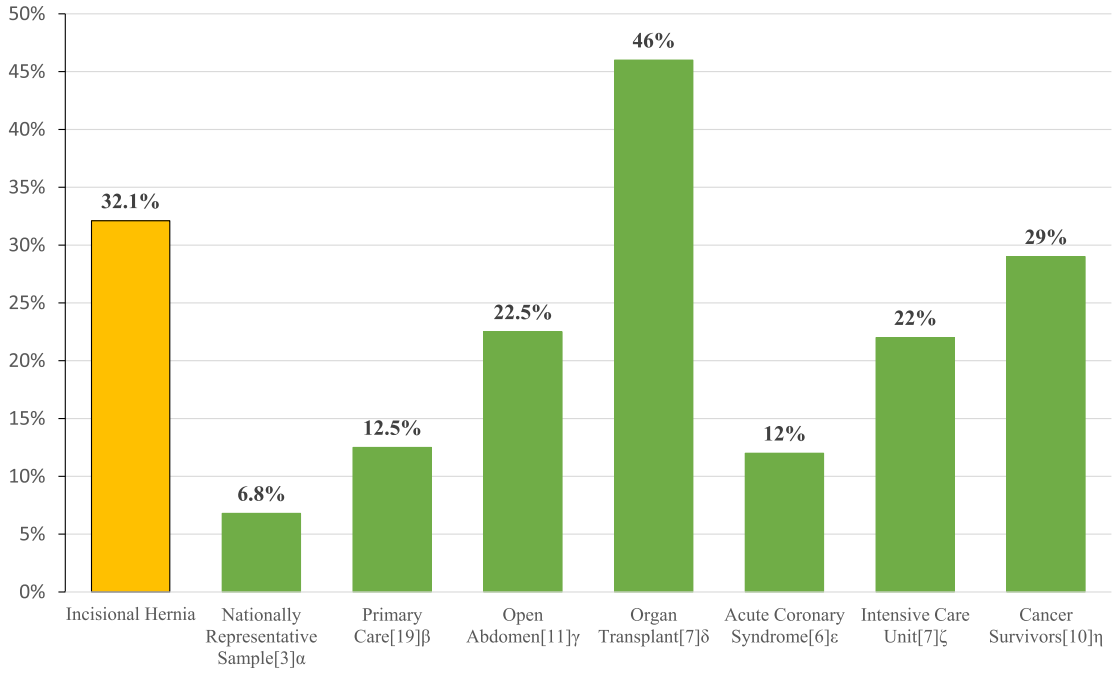


**Fig. 1.** The prevalence of PTSD across different population.
[α] Life time risk prevalence measured using the World Health Organization World Mental Health Survey version of the Composite International Diagnostic Interview.
[β] Median point prevalence of a systemic review measured using a questionnaire based assessment or clinician interview.
[γ] Prevalence measured using the Post-Traumatic Stress Disorder Check List-Civilian (PCL-C).
[δ] Point prevalence of a systemic review measured at mean 1.1 years posttransplant using a questionnaire based assessment.
[ε] Overall aggregate prevalence estimate in a meta-analysis measured using questionnaire based assessment and/or clinician interview.
[ζ] Median point prevalence in a systemic review measured using a questionnaire based assessment.
[η] Prevalence measured using the Posttraumatic Stress Diagnostic Scale (PDS).

Understanding the impact of the psychological status of surgical patients is vital, as both animal and human studies have shown that stress can affect cellular immune functions, thereby delaying wound healing.[22–24] However, studies specifically evaluating the impact of psychological factors on post-operative morbidity report wide variability of evidence, with some finding significant associations while others reporting no difference in post-operative recovery.[25–27] While providing a preoperative evaluation to such vulnerable populations intuitively makes sense, a Cochrane review on the benefit of psychological preparation for post-operative recovery found generally low-level evidence of this benefit.[28] However, it is important to note that this study included patient populations that were not vulnerable mentally prior to surgery. Our study did not look at the impact of PTSD symptoms prior to surgery on postoperative outcomes, nor have we studied the evolution of PTSD after successful hernia repair. Therefore, we cannot comment on the potential benefit of preoperative psychological intervention in such patients. However, based on our results, we believe these two areas of research should be explored in future studies. Currently, our group now involves a behavioral medicine specialist in the care of our high-risk hernia population during preoperative consultation to identify issues and optimize outcomes, which we intend to study.

Our study presents several limitations that deserve mention. First of all, it could be argued that patients in our study did not meet criterion A set by the DSM-5 for the diagnosis of PTSD. This criterion requires that patients reporting PTSD symptoms to have experienced an "exposure to actual or threatened death, serious injury, or sexual violence".[2] In contrast to the literature studying PTSD in medical conditions, hernia repair is a comparatively less life-threatening event, usually performed electively with the goal of improving quality of life, abdominal wall function and cosmesis. However, when stratified according to risk factors, mortality can reach 8.76% and 34.2% in high- and extreme-risk groups.[29] Furthermore, although elective, surgery in of itself is still associated with the potential for morbidity and mortality, as the possible complications, including death, are always mentioned during informed consent. Moreover, hernia repair surgery does not fit into a singular traumatic event, the entire experience can be associated with a series of ongoing wound care and follow-up visits where a subset of patients experience wound morbidity between 0% and 42% or recurrences between 0% and 32%, depending on the operative technique.[30,31] Once hernia patients develop complications, their case complexity for future repairs or wound management increases and subsequent complications are more likely to occur.[32] These complications can be detrimental to the patients' physical and mental health[20,33] and can impose great financial burden.[34,35] We believe that the resulting collective experiences over the course of recovery, relapse, readmission, and reoperation could lead to a "serious injury" significant enough to induce posttraumatic stress disorder in a specific subset of incisional hernia patients. This presumption was evident in our patient population, where 71.4% associated their PTSD symptoms with their previous surgeries and complications. On the other hand, although patients with PTSD in our study reported more complex surgical histories, we cannot conclude that these factors prompted their psychological symptoms but rather that they correlate within the same patient population. Of note, criterion A has previously been shown to have its own challenges and limitations, which are discussed elsewhere.[36–40]

Another limitation to our study is that patient surgical and medical histories were acquired primarily by patient recollection. Whenever medical records were available, they were reviewed to corroborate the patient's claims. However, especially in those patients with extensive surgical histories and complications, not all pertinent medical records were available. Thus, our study is likely affected by recall bias, which was most evident in the history of ICU admission, as more often than not, patients were not able to differentiate between the ICU and the post-operative post-anesthesia care unit. Similarly, for patients who may have developed wound complications, or underwent multiple repairs, not many were able to identify whether a procedure was undertaken for wound management, and many were not able to recall their experiences thoroughly. Moreover, we did not have enough sample size to adjust for confounding factors and draw meaningful conclusions regarding the strength of association for each. Finally, the practice in which this study was conducted presents a highly selective group of patients in a major hernia referral center, with elevated case complexity. Therefore, our prevalence may be overestimated for the more typical hernia patient.

## Conclusion

Our study found a notable and arguably significant prevalence of positive screening for PTSD in patients seeking consultation regarding an incisional hernia, and a significantly worse quality of life measurement in those patients. Future studies should evaluate if this significant decrease in baseline QoL affects these patients' recovery differently than their controls. It is also important to elucidate whether these stress symptoms improve once a successful hernia repair is achieved. Finally, our group has recognized the prevalence of this problem in our complex hernia practice, and we would advocate for including preoperative evaluation by a behavioral medicine specialists especially in high-risk patients.

## Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## References

1. Rosen MJ, Bauer JJ, Harmaty M, et al. Multicenter, prospective, longitudinal study of the recurrence, surgical site infection, and quality of life after contaminated ventral hernia repair using biosynthetic absorbable mesh: the COBRA study. *Ann Surg*. 2017;265(1):205–211. PubMed PMID: 28009747. Epub 2016/12/17.
2. Trauma- and Stressor-Related Disorders. *Diagnostic and Statistical Manual of Mental Disorders*. American Psychiatric Association; 2013.
3. Kessler RC, Berglund P, Demler O, et al. Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the national comorbidity survey replication. *Arch Gen Psychiatr*. 2005 Jun;62(6):593–602. PubMed PMID: 15939837. Epub 2005/06/09. eng.
4. Patel MB, Jackson JC, Morandi A, et al. Incidence and risk factors for intensive care unit-related post-traumatic stress disorder in veterans and civilians. *Am J Respir Crit Care Med*. 2016 Jun 15;193(12):1373–1381. PubMed PMID: 26735627. Pubmed Central PMCID: PMC4910886. Epub 2016/01/07. eng.
5. Posluszny DM, Edwards RP, Dew MA, Baum A. Perceived threat and PTSD symptoms in women undergoing surgery for gynecologic cancer or benign conditions. *Psycho Oncol*. 2011 Jul;20(7):783–787. PubMed PMID: 20878863. Epub 2010/09/30. eng.
6. Edmondson D, Richardson S, Falzon L, et al. Posttraumatic stress disorder prevalence and risk of recurrence in acute coronary syndrome patients: a meta-analytic review. *PLoS One*. 2012;7(6), e38915. PubMed PMID: 22745687. Pubmed Central PMCID: PMC3380054. Epub 2012/06/30. eng.
7. Davydow DS, Gifford JM, Desai SV, et al. Posttraumatic stress disorder in general intensive care unit survivors: a systematic review. *Gen Hosp Psychiatry*. 2008 Sep-Oct;30(5):421–434. PubMed PMID: 18774425. Pubmed Central PMCID: PMC2572638. Epub 2008/09/09. eng.
8. Davydow DS, Lease ED, Reyes JD. Posttraumatic stress disorder in organ transplant recipients: a systematic review. *Gen Hosp Psychiatry*. 2015 Sep-Oct;37(5):387–398. PubMed PMID: 26073159. Pubmed Central PMCID: PMC4558384. Epub 2015/06/16. eng.
9. Liberzon I, Abelson JL, Amdur RL, et al. Increased psychiatric morbidity after abdominal aortic surgery: risk factors for stress-related disorders. *J Vasc Surg*. 2006 May;43(5):929–934. PubMed PMID: 16678685. Epub 2006/05/09. eng.
10. Kwak M, Zebrack BJ, Meeske KA, et al. Prevalence and predictors of post-traumatic stress symptoms in adolescent and young adult cancer survivors: a

1-year follow-up study. *Psycho Oncol*. 2013 Aug;22(8):1798–1806. PubMed PMID: 23135830. Epub 2012/11/09. eng.
11. Zarzaur BL, DiCocco JM, Shahan CP, et al. Quality of life after abdominal wall reconstruction following open abdomen. *J Trauma*. 2011 Feb;70(2):285–291. PubMed PMID: 21307723. Pubmed Central PMCID: PMC3289712. Epub 2011/02/11. eng.
12. Harris PA, Taylor R, Thielke R, et al. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42(2):377–381, 2009/04/01/.
13. Blevins CA, Weathers FW, Davis MT, et al. The posttraumatic stress disorder checklist for DSM-5 (PCL-5): development and initial psychometric evaluation. *J Trauma Stress*. 2015 Dec;28(6):489–498. PubMed PMID: 26606250. Epub 2015/11/26. eng.
14. National Center for PTSD. PTSD Checklist for DSM-5 (PCL-5) [updated 09/24/2018; cited 2018 11/25/2018]; Available from: https://www.ptsd.va.gov/professional/assessment/adult-sr/ptsd-checklist.asp.
15. Bovin MJ, Marx BP, Weathers FW, et al. Psychometric properties of the PTSD checklist for diagnostic and statistical manual of mental disorders-fifth edition (PCL-5) in veterans. *Psychol Assess*. 2016 Nov;28(11):1379–1391. PubMed PMID: 26653052. Epub 2016/11/04. eng.
16. DeWalt DA, Rothrock N, Yount S, Stone AA. Evaluation of item candidates: the PROMIS qualitative item review. *Med Care*. 2007 May;45(5 Suppl 1):S12–S21. PubMed PMID: 17443114. Pubmed Central PMCID: PMC2810630. Epub 2007/04/20. eng.
17. Krpata DM, Schmotzer BJ, Flocke S, et al. Design and initial implementation of HerQLes: a hernia-related quality-of-life survey to assess abdominal wall function. *J Am Coll Surg*. 2012 Nov;215(5):635–642. PubMed PMID: 22867715. Epub 2012/08/08. eng.
18. Criss CN, Petro CC, Krpata DM, et al. Functional abdominal wall reconstruction improves core physiology and quality-of-life. *Surgery*. 2014 Jul;156(1):176–182. PubMed PMID: 24929767. Epub 2014/06/16.
19. Spottswood M, Davydow DS, Huang H. The prevalence of posttraumatic stress disorder in primary care: a systematic review. *Harv Rev Psychiatry*. 2017 Jul/Aug;25(4):159–169. PubMed PMID: 28557811. Pubmed Central PMCID: PMC5498253. Epub 2017/05/31. eng.
20. Snyder CW, Graham LA, Vick CC, et al. Patient satisfaction, chronic pain, and quality of life after elective incisional hernia repair: effects of recurrence and repair technique. *Hernia*. 2011;15(2):123–129, 2011/04/01.
21. Tollens T, Den Hondt M, Devroe K, et al. Retrospective analysis of umbilical, epigastric, and small incisional hernia repair using the Ventralex™ hernia patch. *Hernia*. 2011;15(5):531–540, 2011/10/01.
22. Kiecolt-Glaser JK, Marucha PT, Malarkey WB, et al. Slowing of wound healing by psychological stress. *Lancet*. 1995 Nov 4;346(8984):1194–1196. PubMed PMID: 7475659. Epub 1995/11/04. eng.
23. Kiecolt-Glaser JK, Page GG, Marucha PT, et al. Psychological influences on surgical recovery. Perspectives from psychoneuroimmunology. *Am Psychol*. 1998 Nov;53(11):1209–1218. PubMed PMID: 9830373. Epub 1998/11/27. eng.
24. Segerstrom SC, Miller GE. Psychological stress and the human immune system: a meta-analytic study of 30 years of inquiry. *Psychol Bull*. 2004 Jul;130(4):601–630. PubMed PMID: 15250815. Pubmed Central PMCID: PMC1361287. Epub 2004/07/15. eng.
25. Mavros MN, Athanasiou S, Gkegkes ID, et al. Do psychological variables affect early surgical recovery? *PLoS One*. 2011;6(5), e20306. PubMed PMID: 21633506. Pubmed Central PMCID: PMCC3102096. Epub 2011/06/03. eng.
26. Britteon P, Cullum N, Sutton M. Association between psychological health and wound complications after surgery. *BJS*. 2017 2017/05/01;104(6):769–776.
27. Dao TK, Chu D, Springer J, et al. Clinical depression, posttraumatic stress disorder, and comorbid depression and posttraumatic stress disorder as risk factors for in-hospital mortality after coronary artery bypass grafting surgery. *J Thorac Cardiovasc Surg*. 2010 Sep;140(3):606–610. PubMed PMID: 20074753. Epub 2010/01/16. eng.
28. Powell R, Scott NW, Manyande A, et al. Psychological preparation and postoperative outcomes for adults undergoing surgery under general anaesthesia. *Cochrane Database Syst Rev*. 2016 May 26;(5). Cd008646. PubMed PMID: 27228096. Epub 2016/05/27. eng.
29. Basta MN, Fischer JP, Wink JD, Kovach SJ. Mortality after inpatient open ventral hernia repair: developing a risk stratification tool based on 55,760 operations. *Am J Surg*. 2016 Jun;211(6):1047–1057. PubMed PMID: 26975662. Epub 2016/03/16. eng.
30. Tastaldi L, Alkhatib H. Incisional hernia repair: open retromuscular approaches. *Surg Clin*. 2018 Jun;98(3):511–535. PubMed PMID: 29754620. Epub 2018/05/15. eng.
31. Warren JA, Love M. Incisional hernia repair: minimally invasive approaches. *Surg Clin*. 2018 Jun;98(3):537–559. PubMed PMID: 29754621. Epub 2018/05/15. eng.
32. Holihan JL, Alawadi Z, Martindale RG, et al. Adverse events after ventral hernia repair: the vicious cycle of complications. *J Am Coll Surg*. 2015;221(2):478–485, 2015/08/01/.
33. Pinto A, Faiz O, Davis R, et al. Surgical complications and their impact on patients' psychosocial well-being: a systematic review and meta-analysis. *BMJ open*. 2016;6(2), e007224.
34. Poulose BK, Shelton J, Phillips S, et al. Epidemiology and cost of ventral hernia repair: making the case for hernia research. *Hernia*. 2012 Apr;16(2):179–183. PubMed PMID: 21904861. Epub 2011/09/10. eng.
35. Cox TC, Blair LJ, Huntington CR, et al. The cost of preventable comorbidities on wound complications in open ventral hernia repair. *J Surg Res*. 2016 Nov;206(1):214–222. PubMed PMID: 27916364.
36. Roberts AL, Dohrenwend BP, Aiello AE, et al. The stressor criterion for posttraumatic stress disorder: does it matter? *J Clin Psychiatry*. 2012 Feb;73(2):e264–e270. PubMed PMID: 22401487. Pubmed Central PMCID: PMC3687542. Epub 2012/03/10. eng.
37. Brewin CR, Lanius RA, Novac A, et al. Reformulating PTSD for DSM-V: life after criterion A. *J Trauma Stress*. 2009 Oct;22(5):366–373. PubMed PMID: 19743480. Epub 2009/09/11. eng.
38. Weathers FW, Keane TM. The Criterion A problem revisited: controversies and challenges in defining and measuring psychological trauma. *J Trauma Stress*. 2007 Apr;20(2):107–121. PubMed PMID: 17427913. Epub 2007/04/13. eng.
39. McNally RJ. Can we fix PTSD in DSM-V? *Depress Anxiety*. 2009;26(7):597–600. PubMed PMID: 19569228. Epub 2009/07/02. eng.
40. Maier T Weathers, Keane's. The criterion A problem revisited: controversies and challenges in defining and measuring psychological trauma. *J Trauma Stress*. 2007 Oct;20(5):915–916. discussion 7-9. PubMed PMID: 17955538. Epub 2007/10/24. eng.