ORIGINAL ARTICLE

Use of Laparoscopic vs Open Repair for Perforated Peptic Ulcers is Determined by Surgeon Experience

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Abstract

Introduction: The incidence of perforated peptic ulcers (PPU) has decreased with effective medical treatment such that surgical repair has become a relatively infrequent procedure. We hypothesized that the surgeon's experience and the patient's clinical presentation are the most influential factors that determined the surgical approach.

Methods: A retrospective chart review of PPU repairs in the last 10 years was performed to collect surgeon demographics, patient clinical condition, comorbidities, and whether surgeries were done at a regional or tertiary site. Outcome variables included length of stay, complications, and readmissions. A multivariate analysis was used to establish statistically significant correlations.

Results: Of 219 operations for PPU, 49 were started laparoscopic (23.2%), 12 were converted to open (5.7%), and 162 were performed open (76.5%). The open and laparoscopic cohorts were similar without statistical difference between the groups in terms of age, sex, comorbidities, previous steroid use, NSAID, and anticoagulation use. Surgeons who attempted laparoscopy were more likely to have completed MIS fellowship (60.2%, $p < 0.001$). The patients who had laparoscopic repair had a significantly shorter length of stay (8.5 vs 12.6 days; $p < 0.01$). The patients who had an open repair had slightly more complications (18.4 vs 5.4%), readmissions (5.2 vs 2.7%), and hospital mortality (12.1 vs 5.4%) than their laparoscopically treated counterparts, although none was statistically significant.

Conclusion: Surgeons who completed a minimally invasive fellowship were more likely to perform a laparoscopic repair of perforated peptic ulcer, regardless of the patient's clinical presentation, comorbid conditions, and demographics. Patients who underwent laparoscopic repair had a significantly shorter LOS. Educational efforts directed toward community surgeons who do not have prior MIS training are likely to benefit patients with PUD by increasing access to laparoscopic surgery for PPU.

Keywords: Laparoscopic, Minimally invasive surgery, Perforated peptic ulcer.

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Introduction

The incidence of perforated peptic ulcer disease (PPU) has decreased over the years such that surgical repair has become a relatively infrequent operation.[1,2] This is due to the effective medical management of peptic ulcers, mainly proton pump inhibitor (PPI) therapy.[3] Additionally, endoscopy has led to earlier diagnosis of peptic ulcer disease (PUD) before complications such as perforation can occur, as well as recognition and treatment of *Helicobacter pylori*.[4] Nonetheless, PPU remains a surgical emergency that every general surgeon will encounter.

Several studies have demonstrated the viability and advantages of a laparoscopic repair when compared directly to the open approach for PPU.[5–11] Despite laparoscopic surgery being a core skill in current surgical training, the majority of PPU are repaired using an open approach. Our study aimed to address the reasons for this discrepancy. We hypothesized that the decision to repair a PPU laparoscopically over the open approach was based on the surgeon's experience (i.e., surgeon's training). The clinical presentation of the patient, and other circumstantial reasons not related to patient or surgeon factors (i.e., time of day, preoperative diagnosis, or localization of perforation, etc.).

The primary objective of our study was to establish specific characteristics of patients and surgeons that contribute to a surgeon choosing laparoscopic PPU repair over open repair. The secondary objective of this study was to analyze the outcomes of laparoscopic PPU repair vs open PPU repair, including mortality, complications, readmission, and length of stay (LOS).

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Methods

Our study was a retrospective chart review of patients admitted for perforated peptic ulcers (PPU) from 2007 to 2017. We used ICD-10 codes for primary perforated gastric or duodenal ulcers to select patients from the database. Surgeries were performed in both tertiary care centers and community hospitals within the hospital network. IRB approval was obtained before proceeding with the study.

Adult patients who presented with PPU and underwent surgery were divided into two groups—laparoscopic or open repair. Patients who underwent laparoscopic converted to open repair were considered laparoscopic on an intention-to-treat basis, but were included in the open group for outcome analysis. Patients with iatrogenic bowel injury or those who developed a perforated peptic ulcer during an unrelated hospital admission were excluded.

We assessed several surgeon specific factors that could influence the surgical approach chosen. This included the surgeon's level of training (residency only vs fellowship training), surgeon's graduation year, and hospital level of care (i.e., tertiary referral center vs community hospital). The level of training was determined based on the information provided in the hospital credentialing information system. MIS fellowship trained surgeons were analyzed as a subgroup of the fellowship training category.

Circumstantial factors evaluated include the time of presentation, ability to localize the perforation on imaging, and time of diagnosis. Patient factors included vital signs in the emergency department, medical comorbidities, and preoperative labs. Patients who met the criteria for sepsis or systemic inflammatory response syndrome on presentation were categorized as being septic in the statistical analysis. Outcome variables analyzed included LOS, complications, readmissions, and discharge disposition.

Laparoscopic and open surgical approaches were compared based on demographics, clinical characteristics, and lab variables by using Chi-square, Fisher's exact, and Wilcoxon rank-sum tests. Multiple logistic regressions were used to establish relevant associations and to calculate adjusted odds ratios, expressed as odds ratios, and 95% confidence intervals. The patient presentation and surgeon specific variables were analyzed on an intention to treat basis. With regard to the outcome variables, the laparoscopic surgeries that were converted to open were analyzed within the open repair group. An additional analysis was performed that excluded patients with missing laboratory values ($n = 49$). Variables included in this regression model were selected by forward stepwise regression. All tests were two-tailed and statistical significance was defined as $p < 0.05$. Statistical analysis was performed with the use of R software version 4.0.0 (Vienna, Austria).

Results

A total of 219 observations were included (52 laparoscopic, 167 open) that underwent surgical management of ulcer disease. There were a total of 77 unique surgeons in the data set. Of these, 25 surgeons were responsible for the 52 laparoscopic repairs performed. The maximum number of PPU repairs performed by a single surgeon was 11 and the average was 2.84. The maximum number of laparoscopic repairs of PPU by a single surgeon was 5 with an average of 2.08 laparoscopic repairs.

Intention to Treat Data Analysis

Surgeries that started laparoscopic but converted open were analyzed on an intention to treat basis with respect to the patient demographic and presentation data. Overall, the groups were comparable in terms of their presentation and demographics with no statistically significant factors distinguishing the laparoscopic and open repair groups. The median age of the patients undergoing laparoscopic vs open surgery was (59.9 vs 63; $p = 0.394$), NSAID use (30.8 vs 28.7%; $p = 0.916$), PPI use (21.2 vs 12.6%; $p = 0.192$), previous surgery (44.9 vs 33.7%; $p = 0.210$). Patient comorbidities such as COPD (13.5 vs 12.6%; $p = 1.000$), CHF (5.77 vs 8.38%; $p = 0.768$), CKD (3.85 vs 11%; $p = 0.738$) were also not significant in determining the surgical approach (Reference Table 1 for complete patient demographic data). In terms of the clinical presentation of the patient (Table 2), 36.1% of patients ($n = 79$) were deemed septic upon presentation based on SIRS criteria; however, this was not a statistically significant factor in determining the operative approach (28.8% laparoscopic vs 38.3% open; $p = 0.281$). Very few patients ($n = 9$) presented with hypotension and only 16 patients presented with an abnormal INR above 2—factors not found influential in choosing the type of repair (5.7 vs 10.2% open; $p = 0.531$).

A subset of factors in Table 2 were circumstantial factors relating to the case that may have an influence on the surgeon's operative choice. These factors did not relate specifically to the characteristics of the patient or surgeon and included the time of day, location of the ulcer, and preoperative imaging localization. Intraoperative ulcer sites were found 42.9% of the time in the stomach (28.8% laparoscopic, 47.3% open) and 57.1% in the duodenum (71.2% laparoscopic, 52.7% open). Of the 52 laparoscopic repairs of PPU, 37 were found to be in the duodenum which was statistically significant (71.2% laparoscopic; $p = 0.029$). PPU was localized on preoperative imaging (duodenal vs stomach) in 59.4% of total cases (61.5% laparoscopic, 58.7% open); however, its relation to operative planning was not found statistically significant. The time of diagnosis was 55.3% in the daytime defined as 7 am–7 pm (61.5% laparoscopic, 53.3% open; $p = 0.838$), but this association was not statistically significant in determining the surgical approach.

Surgeon specific characteristics were also analyzed in the laparoscopic and open groups on an intention to treat basis (Table 3). A total of 56 surgeries (25.6%) were performed by surgeons with MIS fellowship training and these surgeons were found to perform laparoscopic repair of PPU more frequently (46.2% open vs 63.8% laparoscopic; $p \leq 0.0001$). The median year of residency graduation was 2006; however, the length of time the surgeon has been practicing was not found to be significantly correlated with the surgical approach. The majority of surgeries performed were by surgeons who trained at tertiary care centers rather than community hospital residencies (64.8 vs 35.2%; $p = 0.054$), but training at a tertiary center alone was not correlated with surgical approach. The hospital level of care (community hospital vs tertiary care center) was relatively evenly split, with 53% of surgeries being performed at community hospitals and 47% at tertiary care centers; however, the level of care was not significant in the choice of a laparoscopic approach (33 laparoscopic repairs in community hospitals vs 20 in tertiary centers).

As there were not many factors specific to the demographics or patient presentation that were clinically significant in choosing a laparoscopic over open repair, an additional analysis was conducted that excluded patients with missing variables, namely, INR ($n = 49$) and hypotension ($n = 9$) (Table 4). Since most patients presumably had their coagulopathy or hypotension corrected before proceeding to the operating room, these factors were deemed clinically irrelevant. A new forward stepwise regression analysis was then conducted excluding the variables INR and hypotension. The final model contained five relevant factors: BMI, comorbidities, residency type—tertiary vs community, fellowship, MIS fellowship.

Table 1: Patient demographics

	All	*Laparoscopic*	*Open*	
	N = 219	*N = 52*	*N = 167*	*p overall*
Sex, *N* (%)				
Female	108 (49.3%)	28 (53.8%)	80 (47.9%)	
Male	111 (50.7%)	24 (46.2%)	87 (52.1%)	
Age, median (25th; 75th)	62.6 (53.6; 74.6)	59.9 (53.3; 73.0)	63.0 (54.4; 74.7)	0.394
BMI, median (25th; 75th)	26.3 (22.6; 31.2)	26.4 (22.9; 30.7)	26.2 (22.5; 31.3)	0.614
Medication use: *N* (%)				
PPI	32 (14.6%)	11 (21.2%)	21 (12.6%)	0.192
NSAIDs	64 (29.2%)	16 (30.8%)	48 (28.7%)	0.916
Immunosuppressant	32 (14.6%)	7 (13.5%)	25 (15.0%)	0.965
Anticoagulation	18 (8.22%)	3 (5.77%)	15 (8.98%)	0.574
Comorbidities: *N* (%)				
COPD	28 (12.8%)	7 (13.5%)	21 (12.6%)	1.000
DM	35 (16.0%)	7 (13.5%)	28 (16.8%)	0.725
HTN	119 (54.3%)	27 (51.9%)	92 (55.1%)	0.810
CHF	17 (7.76%)	3 (5.77%)	14 (8.38%)	0.768
CKD	13 (5.94%)	2 (3.85%)	11 (6.59%)	0.738
Cirrhosis	8 (3.65%)	0 (0.00%)	8 (4.79%)	0.203
Previous *H. pylori*	6 (2.74%)	0 (0.00%)	6 (3.59%)	0.340
Previous surgery, *N* (%)	77 (36.3%)	22 (44.9%)	55 (33.7%)	0.210

PPI, proton pump inhibitor; NSAIDs, nonsteroidal anti-inflammatory drugs; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus; HTN, hypertension; CHF, congestive heart failure; CKD, chronic kidney disease

Table 2: Clinical presentation data

	All	*Laparoscopic*	*Open*	
	N = 219	*N = 52*	*N = 167*	*p overall*
Hospital setting *N* (%)				
Community	116 (53.0%)	33 (63.5%)	83 (49.7%)	0.115
Tertiary	104 (47.5%)	20 (38.5%)	84 (50.3%)	0.182
Vitals Median (25th; 75th)				
Heart rate	85.0 (74.0; 95.5)	79.0 (70.0; 93.2)	86.0 (75.5; 97.0)	0.050
Respiratory rate	18.0 (18.0; 20.0)	18.0 (16.0; 18.0)	18.0 (18.0; 20.0)	0.068
Temperature (F)	98.1 (97.7; 98.6)	98.0 (97.7; 98.4)	98.1 (97.7; 98.6)	0.629
SBP (mm Hg)	127 (112; 140)	127 (115; 139)	127 (112; 140)	0.803
DBP (mm Hg)	70.0 (60.0; 79.0)	68.0 (59.0; 76.2)	71.0 (60.0; 80.5)	0.299
Lab values Median (25th; 75th)				
WBC	13.2 (8.85; 20.6)	13.9 (9.19; 25.8)	13.1 (8.71; 20.1)	0.842
Hgb	12.5 (10.2; 14.3)	12.9 (10.1; 14.3)	12.3 (10.4; 14.2)	0.946
Plt	271 (200; 368)	282 (227; 375)	268 (194; 366)	0.288

[1]Abnormal Hgb, *N* (%)	48 (21.9%)	12 (23.1%)	36 (21.6%)	
[2]Hypotension, *N* (%)	9 (4.11%)	0 (0.00%)	9 (5.39%)	
[3]Normal INR, *N* (%)	156 (90.7%)	33 (94.3%)	123 (89.8%)	
Sepsis, *N* (%)	79 (36.1%)	15 (28.8%)	64 (38.3%)	0.281
Ulcer location, *N* (%)				0.029
Stomach	94 (42.9%)	15 (28.8%)	79 (47.3%)	
Duodenum	125 (57.1%)	37 (71.2%)	88 (52.7%)	
Preoperative CT scan, *N* (%)	193 (88.1%)	46 (88.5%)	147 (88.0%)	1.000
Image localized perforation, *N* (%)	130 (59.4%)	32 (61.5%)	98 (58.7%)	0.838
Time of diagnosis, *N* (%)				0.376
[4]Daytime	121 (55.3%)	32 (61.5%)	89 (53.3%)	
[5]Nighttime	98 (44.7%)	20 (38.5%)	78 (46.7%)	

SBP, systolic blood pressure; DBP, diastolic blood pressure; WBC, white blood cell ($\times 10^3/\mu L$); Hgb, hemoglobin (g/dL); Plt, platelets ($\times 10^3/\mu L$); INR, international normalized ratio; 1, any deviation from normal range for age and sex; 2, SBP <90 mm Hg; 3, INR >2; 4, between 7 am and 7 pm; 5, 7 pm 7 am

Table 3: Surgeon demographics

	All	*Laparoscopic*	*Open*	
	N = 219 (%)	*N = 52 (%)*	*N = 167 (%)*	*p overall*
Residency graduation after 2006	122 (55.7%)	32 (61.5%)	90 (53.9%)	
Residency hospital type				
Community	77 (35.2%)	12 (23.1%)	65 (38.9%)	
Tertiary	142 (64.8%)	40 (76.9%)	102 (61.1%)	
Fellowship	133 (60.7%)	33 (63.5%)	100 (59.9%)	0.765
MIS fellowship	56 (25.6%)	24 (46.2%)	32 (19.2%)	<0.001

MIS, minimally invasive surgery

Table 4: Final stepwise regression analysis

	Group = "Laparoscopic"			*Group = "Laparoscopic"*		
Predictors	*Odds ratios*	*CI*	*p*	*Odds ratios*	*CI*	*p*
(Intercept)	0.14	0.00–6.96	0.328	0.07	0.02–0.31	**<0.001**
Age	0.99	0.97–1.02	0.481			
Sex: Male vs Female	0.79	0.37–1.70	0.545			
BMI	1.05	1.00–1.11	**0.050**	1.05	1.01–1.10	**0.027**
PPI: Yes vs No	1.68	0.64–4.39	0.292			
NSAID: Yes vs No	0.81	0.37–1.77	0.591			
Immunosuppression: Yes vs No	0.79	0.28–2.29	0.670			
Anticoagulation use: Yes vs No	0.77	0.18–3.28	0.726			
Comorbidity: Yes vs No	0.47	0.20–1.13	0.091	0.50	0.24–1.02	0.056
Previous surgery: Yes vs No	1.53	0.69–3.39	0.300			
Surgeon graduation: 2006 and After vs Before 2006	1.13	0.51–2.54	0.760			
Residency type: Tertiary vs Community	2.31	0.98–5.45	0.057	2.23	0.97–5.11	0.058
Fellowship: Yes vs No	0.32	0.12–0.86	**0.024**	0.35	0.14–0.87	**0.024**
MIS fellow: Yes vs No	5.36	1.99–14.42	**0.001**	6.42	2.63–15.66	**<0.001**
DBP	1.00	0.97–1.03	0.746			
Preoperative CT scan : Yes vs No	1.61	0.47–5.52	0.448			
Imaging localization: Yes vs No	0.78	0.35–1.71	0.528			
Hemoglobin: Normal vs Abnormal	0.93	0.39–2.21	0.876			
Septic: Yes vs No	0.68	0.32–1.45	0.314			
Ulcer location: Duodenum vs Stomach	1.45	0.65–3.26	0.368			

(Contd...)

Table 4: *(Contd...)*

	Group = "Laparoscopic"			*Group = "Laparoscopic"*		
Predictors	*Odds ratios*	*CI*	*p*	*Odds ratios*	*CI*	*p*
Time visit: Nighttime vs Daytime	0.69	0.33–1.41	0.304			
Observations	219			219		
Tjur's R^2		0.169			0.128	

BMI, body mass index; DBP, diastolic blood; Bold value indicate statistically significant variables

Table 5: Outcomes after conversion to open surgery

	All	*Laparoscopic*	*Open*	
	N = 219 (%)	*N = 40 (%)*	*N = 179 (%)*	*p overall*
Length of stay (days) Median (25th; 75th)	8.00 (6.00; 15.5)	6.00 (5.00; 10.5)	9.00 (6.00; 16.0)	0.002
Mortality	24 (11.0%)	2 (5.00%)	22 (12.3%)	0.264
Readmission	11 (5.02%)	1 (2.50%)	10 (5.59%)	0.694
Complication	36 (16.4%)	3 (7.50%)	33 (18.4%)	0.147
Leak	11 (5.02%)	0 (0.00%)	11 (6.15%)	0.222
Intra-abdominal abscess	9 (4.11%)	1 (2.50%)	8 (4.47%)	1.000
SSI	5 (2.28%)	0 (0.00%)	5 (2.79%)	0.587
DVT/PE	3 (1.37%)	0 (0.00%)	3 (1.68%)	1.000
UTI	12 (5.48%)	2 (5.00%)	10 (5.59%)	1.000
Cardiovascular	6 (2.74%)	1 (2.50%)	5 (2.79%)	1.000
Bleeding	1 (0.46%)	0 (0.00%)	1 (0.56%)	1.000
Return to OR	20 (9.13%)	3 (7.50%)	17 (9.50%)	1.000
Discharge disposition				0.003
Home	123 (56.2%)	32 (80.0%)	91 (50.8%)	
SNF/LTACH	73 (33.3%)	6 (15.0%)	67 (37.4%)	
Death	23 (10.5%)	2 (5.00%)	21 (11.7%)	

SSI, surgical site infection; DVT/PE, deep vein thrombosis/pulmonary embolism; UTI, urinary tract infection; SNF, skilled nursing facility; LTACH, long-term acute care hospital

Of these, MIS training ($p = 0.001$), fellowship training ($p = 0.024$), and BMI ($p = 0.027$) were found to be statistically significant.

Operative Outcome Data

Analysis of postoperative outcomes is shown in Table 5. The 12 patients who underwent laparoscopic converted to open repair were included in the open repair group. Overall, the patients who underwent laparoscopic repair fared better with regard to postoperative outcomes. Patients who underwent open repair had longer lengths of stay (6 vs 9 days; $p = 0.002$) and they were less likely to be discharged home (80 vs 50.8%; $p = 0.003$). Surgeries performed laparoscopic had lower rates of complications compared to open procedures (7.5 vs 18.4%), but the difference did not reach statistical significance ($p = 0.147$).

Discussion

Our study revealed that MIS fellowship trained surgeons more frequently performed a laparoscopic repair of PPU regardless of the patient's clinical presentation, comorbid conditions, and demographics. Additionally, patients who underwent laparoscopic repair had better outcomes with a statistically significant shorter LOS and disposition home rather than a skilled nursing facility (SNF).

The literature overwhelmingly supports the idea that laparoscopic surgery is a safe and effective alternative to open surgery.[6–10,12] Laparoscopic surgery is the preferred approach (avoid standard of care without a citation) for many surgical emergencies such as acute appendicitis and cholecystitis.[13,14] Our study found that laparoscopic repair of PUD is safe and effective as the laparoscopic group was shown to have better outcomes without any statistical difference in mortality rates. This is not a finding that is unique to our study as there have been numerous other studies that support our finding with regard to laparoscopic outcomes.[6,7,9,10] In the study by Guadagni et al.,[8] there was no significant difference in morbidity or mortality of the patients who underwent laparoscopic repair of perforated PUD compared to the group that underwent open repair. Furthermore, Cirocchi et al., conducted a meta-analysis that concluded there was no clinically significant difference in outcomes between laparoscopic and open repair of PPU.[12] Although it was not statistically significant, our study found that the laparoscopic group had less complications than the open group. There were no complications related to surgical site infections and this likely contributed to the decreased LOS (6 vs 9 days; $p = 0.002$) found in the laparoscopic group over the open group. This finding was supported in Cirocchi et al. study as patients who underwent laparoscopic repair of PPU also were found to have less wound infections compared to the open repair group. Our study also revealed that the laparoscopic group was more likely to be discharged home, rather than to a SNF (80 vs 56.2%, respectively, $p = 0.003$) which is likely related to the decreased complication rate.

The goal of our study was to distinguish which factors were most influential in surgical decision making to repair a PPU laparoscopically. These factors were broken down into three main groups; the clinical status of the patient, the surgeon's experience, and circumstantial factors relating to the case. Of the many patient factors analyzed, only BMI and ulcer location (duodenum) were found to be statistically significant for choosing laparoscopic over open repair. Laparoscopic surgery in obese patients has decreased rates of wound infection and incisional hernias.[13] Open repair in very obese patient can be more difficult to perform, and this would lead a surgeon to opt for a laparoscopic approach.

Based on our data, the ulcer location being found in the duodenum is difficult to explain as it is an intraoperative finding that could not definitively be confirmed in preoperative planning. Additionally, the preoperative imaging localization on the CT scan was not found to be a significant factor for the surgeon choosing laparoscopic repair or open. For this reason, we do not feel it is a relevant factor in determining the operative approach. Given the BMI was the only significant patient related factor, we can infer that the decision for a surgeon to repair a PPU laparoscopically was otherwise only influenced by the surgeon's experience. MIS fellowship training (46.2% laparoscopic if MIS fellowship vs 19.2% laparoscopic if no MIS fellowship $p \leq 0.001$) proved to be the most important factor in determining the operative approach. Patient characteristics that typically indicate a patient to be a poor laparoscopic candidate were not found to be significant. These factors included prior abdominal surgeries, septic presentation, medical comorbidities, and anticoagulation. This finding suggests that a MIS trained surgeon was more willing to resuscitate the patient, reverse anticoagulation, provide supportive measures for their patients' comorbidities, and still proceed with laparoscopic surgery rather than choosing to proceed with the open procedure due to the known benefits of laparoscopic surgery.

Our study was limited by the fact that it was a retrospective chart review and this inherently makes the study prone to selection bias. Our data may have been a reflection of surgeons at our specific hospital network rather than the surgical community as a whole as only 25 or the 77 surgeons in the study accounted for the laparoscopic group. Further randomized control trials need to be performed to combat this type of bias.

One particular obstacle to address regarding the adoption of laparoscopic repair of PPU is the surgeon's comfort with intracorporeal suturing. Lim et al. study cited this particular issue as a "barrier to the greater adoption" of MIS.[15] Laparoscopic knot tying was inferior to open knot tying across all levels of surgical training.[16] Surgeons who are performing laparoscopic PPU repair are likely more technically proficient laparoscopic surgeons due to their training (i.e., MIS fellowship). The improved outcomes found in our laparoscopic group may not be reflective of surgeons who do not have the same level of laparoscopic training.

Although the data did not ultimately reveal a clear and specific subgroup of patients or "indications" to perform laparoscopic surgery, the question must be asked; should we be performing more PPU repairs laparoscopically? Based on our findings, laparoscopic PPU disease repair is safe, decreases LOS, and improves overall patient outcomes when compared to open repair. Many surgeries that were done as open procedures are now done laparoscopically.[14,17] And thus, we believe the management of PPU disease should also evolve. Surgeon experience is a modifiable factor, and with better surgical education and laparoscopic training, we feel more surgeons would be capable of performing a laparoscopic repair of PPU disease. Specifically, educational efforts should be directed to community surgeons without MIS training, as it will benefit their patient population.

Conclusion

Our study further validates the use of laparoscopic repair for PPU disease as an option with better outcomes. The majority of surgeons do not perform laparoscopic repair of PPU because the choice to perform laparoscopic PPU repair is based largely on the experience and technical ability of the surgeon. Surgeons may benefit from education and training to laparoscopically address PPU, particularly community surgeons without MIS fellowship training. This additional investment in training would benefit both the patient and reduce hospital costs by decreasing LOS and the need for SNF discharges.

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