Resection and primary anastomosis with proximal diversion instead of Hartmann's: Evolving the management of diverticulitis using NSQIP data

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BACKGROUND: The emergency surgical treatment of acute diverticulitis with feculent or purulent peritonitis has traditionally been the Hartmann's procedure (HP). Debate continues over whether primary resection with anastomosis and proximal diversion may be performed in the setting of a high-risk anastomosis in complicated diverticular disease. In contrast to a loop ileostomy takedown, the morbidity of a Hartmann's reversal is preventative for many patients, leaving them with a permanent stoma. Our study compared the surgical outcomes of patients with perforated diverticulitis who underwent a HP to primary anastomosis with proximal diversion (PAPD).

METHODS: The National Surgical Quality Improvement Program (NSQIP) database was queried from 2005 to 2009 to identify all cases of perforated diverticulitis classified as contaminated or dirty/infected. Patients were stratified into HP or PAPD, and logistic regression models were created to control for patient demographics, comorbidities, perioperative risk, and illness severity to determine the impact of surgical procedure on outcome.

RESULTS: There were 2,018 patients meeting the inclusion criteria of which 340 (17%) underwent PAPD and the remainder underwent HP. Significant independent predictors of infectious outcomes were alcohol use, preoperative sepsis, and operative time. There was no significant difference in risk of infectious complications, return to the operating room, prolonged ventilator use, death, or hospital length of stay between the two procedures. When considering only dirty/infected cases, the mortality risk was twofold greater when PAPD was performed.

CONCLUSION: The treatment of acute diverticulitis in the setting of contamination can be safely treated with resection, primary anastomosis, and proximal diversion as opposed to a HP in certain circumstances. Given the decreased morbidity of subsequent loop ileostomy takedown compared with a Hartmann's reversal, this procedure should be given consideration in the management of acute, perforated diverticulitis but may not be warranted in cases of feculent peritonitis. (*J Trauma.* 2012;72: 807–814. Copyright © 2012 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: III, case-control.

KEY WORDS: Diverticulitis; Hartmann's; primary anastomosis; perforated; contaminated; outcomes.

Complicated diverticulitis is a common surgical emergency accounting for reported morbidity and mortality rates of 25% to 50%.[1] Although most patients with diverticulitis never require surgical intervention and expectant treatment of diverticulitis is associated with a lower mortality rate, debate continues over surgical management for complicated diverticulitis.[2] Diverticulitis with feculent peritonitis has been historically treated with the Hartmann's procedure (HP).[3] However, increasing evidence shows that resection and primary anastomosis with or without proximal diversion may be performed safely even in the face of marked contamination.[3–6]

Constantinides et al. showed that morbidity and mortality for a HP was 35% and 20%, respectively, compared with 40% and 25% with primary anastomosis with proximal diversion (PAPD). In the same study, stomas were never reversed in 27% of HP as opposed to 8% of PAPD suggesting that PAPD is the more favorable treatment option.[4]

In contrast to a loop ileostomy takedown, the morbidity of a Hartmann's reversal is preventative for many patients, accounting for only a 40% to 50% reversal rate[7,8] often leaving patients with a permanent stoma.[9] In contrast, a loop ileostomy reversal performed in the context of PAPD is associated with a lower morbidity and considered a less invasive operation. The rate of permanent loop ileostomy in the setting of PAPD has been reported as low as 14% when performed for rectal cancer.[10] Aggregated results of multiple studies were reviewed by Salem and Flum[6] for adverse outcomes comparing HP and PAPD. The combined mortality of the primary procedure and subsequent reversal procedure for patients undergoing PAPD was 9.9% compared with 19.6% for HP.

More recently, laparoscopic lavage has emerged as a potential alternative to resection in a select group of patients with complicated diverticulitis. The LADIES trial (NTR20377) is a multicenter randomized trial in progress comparing laparoscopic peritoneal lavage or resection in patients with purulent peritonitis and HP and PAPD for patient with purulent or fecal peritonitis.[11]

As a result, the optimal emergency surgical strategy in purulent and feculent peritonitis for diverticulitis continues to evolve. To determine whether postoperative outcomes were affected by the surgical procedure performed (HP vs. PAPD) in the setting of contaminated or feculent peritonitis, we compared both procedures using The National Surgical Quality Improvement Program (NSQIP) database.

METHODS

The American College of Surgeons NSQIP is a validated process to obtain data for the purposes of improving quality of care.[12] Data were obtained from a systematic sampling of operations performed by general and vascular surgeons. There were 121 hospitals (community and academic) enrolling patients at the start of 2005, which increased to 211 hospitals by the end of 2008. Preoperative risk factors, intraoperative variables, and 30-day postoperative morbidity and mortality data are collected, validated, and reported back to participating hospitals. Outcomes for each hospital are benchmarked to each other to identify key areas for improvement. In addition, the entire database or parts of it can be made available in a blinded fashion after an application process to answer specific research questions from all participating hospitals.

After obtaining institutional review board approval at the University of Utah and authorization from the American College of Surgeons to use the data for research purposes, the NSQIP was queried from 2005 to 2009 to identify all cases of perforated diverticulitis requiring operative intervention. Patients with CPT codes (562.10–562.13) consistent with the

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diagnosis of diverticulosis or diverticulitis of the large intestine were extracted. To exclude cases in which contamination was the result of unintentional spillage during surgery, those patients with a wound classification of clean/contaminated were excluded. Only cases classified as contaminated or dirty/infected were included and these were stratified by the operative procedure performed. Using the NSQIP variable that defines cases as emergent, only emergent cases were included in the analysis. The CPT code 44141 was used to identify those cases in which the primary procedure was a partial colectomy with primary anastomosis and proximal diversion with loop ileostomy (PAPD). Similarly, the CPT code 44143 was used to identify those cases in which the primary procedure was a partial colectomy with colostomy (HP).

Univariate analysis was performed to identify potential confounders that would be associated with the primary procedure undertaken (PAPD or HP) and the outcomes of interest which included surgical site infection, wound dehiscence, organ space infection, return to the operating room, need for prolonged ventilation (>48 hours), post operative sepsis, and death. Potential confounders were compared by primary procedure using Students *t*-test for continuous variables and χ^2 analysis for categorical variables (Table 1). Multivariate logistic regression analysis was performed to identify independent predictors of the outcomes of interest and to determine whether the outcomes of interest are affected by the primary procedure performed. Those potential confounders with a p value <0.2 were included in the model, and a backward stepwise approach was used to refine the model keeping those variables which affected the odds ratio (OR) of the outcomes of interest by more than 10% within the model. Variables that were thought to be clinically relevant which might affect the choice of procedure were also retained within the model. Univariate and multivariate comparisons were considered statistically significant if alpha was less than 0.05.

To determine whether sicker patients had different outcomes associated with the primary procedure performed, the data were analyzed as described above, limiting the analysis to patients having sepsis/systemic inflammatory response syndrome (SIRS) preoperatively as well as patients classified as having a dirty/infected wound class intraoperatively.

RESULTS

There were 2,018 patients undergoing surgical intervention for perforated diverticulitis in the database coded as either contaminated (15.8%) or dirty/infected (84.2%) cases. The majority of patients were Caucasian with a mean age of 63.1 years with a nearly balanced proportion of men (48.4%) and women (51.6%). There were 340 patients who underwent PAPD (16.9%) and 1,678 (83.2%) patients who underwent HP. Other than race, PAPD and HP patients were similar in terms of patient demographics, comorbidities, body mass index (BMI), American Society of Anesthesiologists (ASA) class, preoperative laboratory values (white blood cells, hematocrit, albumin, and creatinine), preoperative sepsis, operative time, NSQIP calculated probability of complications and death, and proportion of patients with dirty/infected cases (Table 1).

TABLE 1. Patient Characteristics by Surgical Procedure Performed

Characteristic	PAPD (n = 340)	HP (n = 1,678)	*p*
Age*	63.4 ± 15.8	63.0 ± 15.0	NS
Male (%)	48.2	48.5	NS
Race (%)			
White, non-Hispanic	85.3	90.2	<0.05
Hispanic	0.6	2.3	
African American	10.3	6.0	
Asian, American Indian, Pacific Islander	3.8	1.5	
BMI*	28.5 ± 7.9	28.2 ± 8.0	NS
Comorbidities (%)			
Cardiac	2.9	4.1	NS
Chronic obstructive pulmonary disease	9.1	11.4	NS
Peripheral vascular disease	2.3	1.9	NS
Smoker	25.6	26.5	NS
Alcoholism	3.5	6.0	NS
Chronic steroids	14.4	15.6	NS
NIDDM	6.2	9.1	NS
IDDM	5.0	4.4	NS
ASA class			NS
I	0.9	2.0	
II	31.9	31.5	
III	47.8	45.7	
IV	18.3	19.9	
V	1.2	1.0	
Preoperative sepsis (%)			NS
None	38.2	36.3	
Systemic inflammatory response	34.4	33.3	
Sepsis	25.0	24.9	
Severe sepsis	2.4	5.6	
Preoperative laboratory values*			
Albumin	3.2 ± 0.7	3.3 ± 0.8	NS
Creatinine	1.2 ± 0.9	1.2 ± 1.0	NS
Hematocrit	37.1 ± 6.2	37.5 ± 6.1	NS
WBC	13.9 ± 7.3	13.7 ± 6.3	NS
Operative time (min)*	136 ± 64.9	131 ± 56.5	NS
NSQIP probability of death (%)	8.8	9.4	NS
NSQIP probability of complications (%)	41.2	42.0	NS
Wound classification (%)			
Contaminated (n = 318)	17.4	15.4	NS
Dirty/infected (n = 1700)	82.7	84.6	

NS, nonsignificant ($p > 0.05$); NIDDM, noninsulin-dependent diabetes mellitus; IDDM, insulin-dependent diabetes mellitus; ASA, American Society of Anesthesiologists.
* Continuous variables are expressed as means ± SD.

The length of hospital stay and unadjusted rates of wound infection, organ space infection, dehiscence, return to the operating room, prolonged mechanical ventilation, postoperative sepsis, and death were similar for PAPD patients and HP patients (Table 2A). When confining the analysis to

TABLE 2. Unadjusted Rates of Postoperative Outcomes

Outcomes	PAPD, n = 340 (%)	HP, n = 1,678 (%)	p
A. All patients			
Wound infection	11.8	13.5	NS
Organ infection	4.1	5.5	NS
Dehiscence	3.2	3.7	NS
Return to OR	10.3	8.6	NS
Prolonged vent	11.8	13.9	NS
Postop sepsis	14.7	14.2	NS
Death	7.9	6.2	NS
Hospital LOS (d)	13.8	14.1	NS
	PAPD, n = 210 (%)	**HP, n = 1,069 (%)**	
B. Septic patients			
Wound infection	8.6	14.6	0.02
Organ infection	5.7	7.1	NS
Dehiscence	2.9	4.6	NS
Return to OR	10.5	10.7	NS
Prolonged vent	12.4	17.4	NS
Postop sepsis	16.7	15.2	NS
Death	9.0	6.9	NS
Hospital LOS	14.5	14.6	NS
	PAPD, n = 281 (%)	**HP, n = 1,419 (%)**	
C. Dirty/infected patients			
Wound infection	12.5	13.8	NS
Organ infection	5.0	5.7	NS
Dehiscence	3.6	4.2	NS
Return to OR	10.7	9.2	NS
Prolonged vent	12.8	15.2	NS
Postop sepsis	16.0	15.2	NS
Death	8.9	6.3	NS
Hospital LOS	13.9	14.4	NS

NS, nonsignificant ($p > 0.05$); LOS, length of stay; OR, operating room.

septic/SIRS patients (n = 1,279), the length of stay and unadjusted rates of all of the outcomes except for wound infection were not significantly different, but wound infection rate was higher in HP patients (Table 2B). When confining the analysis to patients with a wound class that was dirty/infected (n = 1,700), the length of stay and unadjusted rates of all of the outcomes were the same regardless of the procedure performed (Table 2C).

Variables initially incorporated into the multivariate logistic regression models for the outcomes of interest included age, gender, BMI, preoperative laboratory values (white blood cells, albumin, hematocrit, and creatinine), wound class, preoperative sepsis, diabetes, race, steroid use, smoking status, alcoholism, ASA class, operative time, comorbidities (heart disease, chronic obstructive pulmonary disease, peripheral vascular disease, previous cardiac surgery, renal failure, and stroke), and operative procedure performed. Independent predictors of wound infection included diabetes, ASA class, and operative time. Independent predictors of organ space infection included wound class, preoperative sepsis, alcohol use, and operative time. Independent predictors of wound dehiscence were BMI, steroid use, and ASA class. Independent predictors of returning to the operating room were preoperative sepsis, diabetes, African American race, steroid use, and ASA class. Independent predictors of prolonged mechanical ventilation were preoperative albumin, BMI, wound class, preoperative sepsis, and ASA class. Independent predictors of postoperative sepsis were preoperative albumin, BMI, wound class, preoperative sepsis, ASA class, and operative time. Independent predictors of death were age, preoperative albumin, preoperative sepsis, steroid use, and ASA class (Table 3).

Although controlling for potential confounders, the likelihood of wound infection was the same if PAPD was performed compared with HP (OR 0.90, 95% confidence interval [CI] = 0.59, 1.39). The risk of organ space infection was also the same if PAPD was performed compared with HP (OR 0.69, 95% CI = 0.34, 1.39). The likelihood of dehiscence was the same for PAPD compared with HP (OR 0.60, 95% CI = 0.25, 1.47). The risk of returning to the operating room was 0.98 (0.58, 1.67) if PAPD was performed compared with HP. The risk of requiring mechanical ventilation for more than 48 hours was not greater if PAPD was performed compared with HP (OR 0.72, 95% CI = 0.43, 1.19). The risk of postoperative sepsis was not greater if PAPD was performed compared with HP (OR 1.01, 95% CI = 0.67, 1.53). The risk of death was not increased when PAPD was performed compared with HP (OR 1.51, 95% CI = 0.82, 2.78; Table 4).

Confining the multivariate analyses to patients who were septic/SIRS preoperatively (n = 1,279), the odds of wound infection, organ space infection, dehiscence, return to the operating room, prolonged mechanical ventilation, postoperative sepsis, and death were not greater if PAPD was done compared with HP. Confining the multivariate analyses to patients who were designated as dirty/infected wound class intraoperatively (n = 1,700), the odds of wound infection, organ space infection, dehiscence, return to the operating room, prolonged mechanical ventilation and postoperative sepsis were not greater if PAPD was done compared with HP. However, the odds of death were significantly greater if PAPD was performed compared with HP (OR 2.02, 95% CI = 1.06, 3.85; Table 4).

DISCUSSION

The rationale for using PAPD instead of HP is based upon a growing body of literature that suggests improved outcomes with ileostomies compared with colostomies. In a retrospective study, comparing long-term complication rates of a loop ileostomy, loop colostomy, and an end colostomy, Caricato et al. found that the overall complication rate was 60%. The most common complications were dermatitis, parastomal hernia, leakage, and stenosis. Patients with an end colostomy and younger than 65 years had significantly lower complication rates.[13] This, however, conflicts with the study

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TABLE 3. Independent Predictors of Outcomes in Multivariate Logistic Regression Analyses

Predictor	Wound Infection	Dehiscence	Organ Space Infection	Return to OR	Vent >48 h	Sepsis	Death
Age	0.99 (0.97, 1.00)	0.99 (0.97, 1.02)	0.98 (0.96, 1.01)	1.00 (0.98, 1.02)	**1.01 (1.00, 1.03)**	1.01 (0.99, 1.02)	**1.05 (1.03, 1.07)**
BMI	1.01 (0.99, 1.03)	**1.06 (1.02, 1.09)**	0.98 (0.96, 1.01)	1.02 (0.99, 1.04)	**1.02 (1.00, 1.04)**	**1.02 (1.00, 1.04)**	1.00 (0.97, 1.03)
Albumin	0.87 (0.71, 1.07)	1.14 (0.79, 1.64)	0.85 (0.62, 1.15)	0.91 (0.71, 1.18)	**0.70 (0.56, 0.88)**	**0.71 (0.58, 0.88)**	**0.51 (0.37, 0.71)**
Dirty/infected†	1.33 (0.84, 2.11)	2.96 (0.90, 9.73)	**2.41 (1.00, 5.79)**	1.52 (0.82, 2.82)	**2.04 (1.12, 3.73)**	**1.83 (1.12, 2.99)**	1.14 (0.57, 2.31)
Not septic	ref	ref	ref	ref	ref	ref	ref
SIRS	0.84 (0.57, 1.22)	1.42 (0.68, 2.94)	**2.79 (1.48, 5.29)**	1.33 (0.83, 2.26)	1.37 (0.87, 2.16)	1.27 (0.88,1.83)	0.77 (0.42, 1.43)
Sepsis	1.25 (0.85, 1.84)	1.81 (0.86, 3.79)	**2.67 (1.37, 5.23)**	**1.69 (1.06, 2.97)**	1.54 (0.96, 2.46)	0.74 (0.48, 1.13)	0.86 (0.46, 1.63)
Severe sepsis	0.67 (0.31, 1.47)	1.94 (0.62, 6.07)	**3.46 (1.15,10.36)**	**3.56 (1.80, 7.46)**	**3.66 (1.94, 6.94)**	**0.48 (0.23, 0.99)**	**2.23 (1.03, 4.81)**
Nondiabetic	ref	ref	ref	ref	ref	ref	ref
NIDDM	1.57 (0.97, 2.56)	0.36 (0.11, 1.21)	1.83 (0.87, 3.83)	**0.25 (0.09, 0.65)**	0.96 (0.56, 1.66)	0.60 (0.35, 1.05)	0.71 (0.32, 1.54)
IDDM	**2.19 (1.19, 4.04)**	1.62 (0.61, 4.32)	1.97 (0.72, 5.41)	0.87 (0.38, 1.99)	1.74 (0.90, 3.35)	1.26 (0.68, 2.34)	1.09 (0.45, 2.61)
Steroids	0.72 (0.46, 1.11)	**2.07 (1.11, 3.87)**	0.72 (0.35, 1.48)	**1.98 (1.26, 3.12)**	1.07 (0.70, 1.63)	1.28 (0.88, 1.86)	**2.97 (1.80, 4.91)**
Alcohol	0.79 (0.37, 1.67)	1.74 (0.62, 4.87)	**2.37 (1.09, 5.15)**	**2.92 (1.50, 5.69)**	1.08 (0.46, 2.51)	1.10 (0.53, 2.28)	1.03 (0.22, 4.80)
ASA class I	ref	ref	ref	ref	ref	ref	ref
ASA class II	2.17 (0.28, 16.78)	**4.9e+07 (348669, 6.87e+07)**	0.94 (0.11, 7.83)	**5.8e+06 (921464, 3.64e+07)**	**3.5e+06 (596912, 2.07e+07)**	0.67 (0.08, 5.33)	*
ASA class III	3.53 (0.45, 27.41)	**7.2e+06 (477029, 1.1e+08)**	1.52 (0.18, 12.74)	**5.2e+06 (777600, 3.51e+07)**	**94e+06 (1584294, 5.55e+07)**	2.27 (0.29, 17.65)	**2.0e+06 (161741, 2.50e+07)**
ASA class IV	4.33 (0.54, 34.75)	**1.4e+07 (859929, 2.2e+08)**	1.53 (0.17, 13.74)	**1.1e+07 (1.6e+06, 7.56e+07)**	**4.0+07 (6.6e+06, 2.39e+08)**	5.46 (0.69, 43.44)	**5.4e+06 (423880, 6.86e+07)**
ASA class V	**27.29 (2.71, 274.97)**	*	1.37 (0.07, 28.48)	**7.8e+06 (777387, 7.86e+07)**	**2.8e+08 (3.2e+07, 2.4e+09)**	**16.70 (1.68, 165.89)**	**1.6e+07 (1.0e+06, 2.4e+08)**
OR Time	**1.003 (1.001, 1.006)**	1.00 (0.99, 1.00)	**1.004 (1.001, 1.008)**	1.00 (1.00, 1.00)	**1.002 (1.00, 1.005)**	**1.003 (1.001, 1.006)**	1.00 (0.99, 1.00)

NIDDM, noninsulin-dependent diabetes mellitus; IDDM, insulin-dependent diabetes mellitus; ASA, American Society of Anesthesiologists; OR, operating room.
* No occurrences of the outcome for the predictor.
† Reference category is contaminated cases.
Bold values indicate independent predictors of the surgical outcome.

TABLE 4. Risk of Postoperative Outcomes for All Patients, Septic Patients, and Dirty/Infected Patients

Outcome	All Patients, n = 2,018, OR (95% CI)	Septic Patients, n = 1,279, OR (95% CI)	Dirty/Infected Patients, n = 1,700, OR (95% CI)
Wound infection	0.91 (0.59, 1.39)	0.63 (0.35, 1.13)	0.91 (0.58, 1.48)
Organ infection	0.71 (0.35, 1.42)	0.66 (0.30, 1.46)	0.78 (0.38, 1.59)
Dehiscence	0.60 (0.25, 1.48)	0.65 (0.24, 1.73)	0.64 (0.26, 1.59)
Return to OR	0.99 (0.58, 1.69)	0.86 (0.47, 1.59)	1.11 (0.64, 1.93)
Prolonged vent	0.73 (0.44, 1.21)	**0.54 (0.30, 0.99)**	0.69 (0.40, 1.19)
Postop sepsis	1.02 (0.68, 1.55)	1.10 (0.67, 1.80)	0.99 (0.64, 1.54)
Death	1.51 (0.82, 2.79)	1.22 (0.58, 2.57)	**2.02 (1.06, 3.85)**

OR, operating room.
Bold values indicate significant outcomes.

by Tilney et al.,[14] in which loop ileostomy was found to have a lower hernia and wound infection rate following stoma reversal compared with a loop colostomy. Furthermore, a Cochrane review by Guenaga et al.[15] supports the use of a loop ileostomy compared with a loop colostomy for fecal diversion as a result of a decreased prolapsed rate. More importantly, Salem et al. identified, in a population-based study, that 56.3% of patients who had a colostomy for diverticulitis did not have their stoma reversed. This study also found a higher than expected mortality rate of 2.6% in elderly patients undergoing colostomy reversal.[16] In a review by Constantinides et al.,[4] 27% of patients with HP did not undergo stoma reversal while only 8% of patients with loop ileostomies did not undergo reversal. Salem et al. also performed a systematic review of the surgical management of diverticulitis focusing on HP versus primary anastomosis. Their review did not provide any statistical comparisons because of heterogeneity in the included studies and patient differences; however, they found that the aggregated mortality rate of 54 studies in which HP was performed for diverticulitis was 18.8%. The aggregated mortality rate for those patients undergoing primary anastomosis was only 9.9%.[6] Although their review is open to significant criticism due to selection bias for the choice of procedure and the lack of adjustment for risk factors in the mortality assessment, it has fueled an interest into the possibility that PAPD may be appropriate in some cases of perforated diverticulitis.

Our study demonstrates that the odds of having postoperative surgical site infections, facial dehiscence, prolonged mechanical ventilation, a return to the operating room, or dying are no different if one undergoes PAPD compared with HP in patients with complicated diverticulitis. Although we controlled for the degree of contamination in the multivariate logistic regression analysis in the assessment of the entire patient population, we felt that the degree of contamination could heavily sway a surgeon's decision to perform an anastomosis. Therefore, to ensure that our results were accurate, we performed the subsequent analysis excluding cases that were classified as contaminated and focused on those patients with dirty/infected wound classification. PAPD was not associated with worse outcomes, except for death (two-fold increased risk of mortality) in this subgroup. One might expect a higher mortality when PAPD is performed in this setting, but then the other outcomes we tested, such as postoperative sepsis, prolonged mechanical ventilation, return to the operating room, and organ space infection, should also demonstrate an association with PAPD as these should be in the causal pathway to death. The fact that this was not observed may be the result of an insufficient sample size to detect a significant difference in these secondary outcomes when we excluded those patients who were not classified as dirty/infected. Alternatively, patients may have died before the development of some of these other outcomes; however, this is less likely as we did not observe a significantly lower hospital length of stay in the PAPD subgroup with dirty/infected wound class.

As with all retrospective studies, there are a number of limitations that must be addressed. Differential misclassification of data with respect to the outcomes and the procedure performed is possible; however, given the fact that these data are collected prospectively with specific emphasis on accuracy of data collection and coding with respect to procedure and complications, the likelihood that there is differential misclassification that would lead to a change in the observed results is low. Still, patients construed as having an emergent operation for contaminated peritonitis may be misclassified as is suggested by the fact that almost one-third of patients in our data were described as having SIRS instead of sepsis. Given the fact that only contaminated and dirty/infected cases were included in this analysis, all these patients should have been classified as septic instead of SIRS; however, if no cultures were taken at the time of surgery and no specific reference was made to purulence within the abdomen, then this would necessitate the case being coded as SIRS instead of sepsis. Regardless of whether the case was coded as sepsis or SIRS both categories indicate the presence of physiologic derangement and highlight the fact that the majority of these patients were ill. However, about one-third of patients did not meet sepsis or SIRS criteria within the dataset which raises the question as to whether some cases of an elective nature were included in the analysis. It is for this reason we analyzed the data in aggregate and then again excluding patients without sepsis or SIRS as well as excluding contaminated cases to determine the effects of PAPD on patients who were truly ill with deranged physiology and/or fecal peritonitis.

More importantly, however, is the fact that the data are retrospective and the cases are performed and treated based upon the operative findings and surgical preference. As a result, differences in outcomes may occur as a result of therapeutic maneuvers other than the procedure performed, but that were associated with the procedure performed which lead to the observed difference in outcomes. Suppose, for example, that surgeons who performed PAPD were more likely to keep their patients on a prolonged course of antibiotics while patient who performed HP were less likely to do so. This might yield different results related to postoperative infectious complications, thus providing the impression that the procedure may be producing the observed findings instead of the unknown therapeutic maneuver. We, unfortunately, cannot account for other treatments outside of the variables collected and so it is possible that our findings may not reflect solely the benefits of PAPD over HP or vice versa. Last, this study largely showed that there were no statistically significant differences in mortality and several morbidities in almost all instances. One cannot, however, exclude the possibility of a type II error whereupon we erroneously accept the fact that there is no difference observed in the outcomes, because of a small sample size, when there in fact is a difference.

Based on our study results, PAPD may be used in patients with contaminated diverticulitis without excessive fecal spillage, but we cannot recommend its use in cases of feculent peritonitis given the associated increased risk of mortality observed. Because of the associated benefits of PAPD over HP in terms of stoma reversal and lower combined complication rates taking into account the primary procedure and the stoma reversal procedure, PAPD should be considered in the appropriate patient. This study should provide support for a randomized controlled trial of the two strategies in patients with feculent peritonitis as the data seem to be equivocal in this setting.

AUTHORSHIP

Both authors designed this study, conducted literature searches, collected and interpreted the data. R.N. analyzed the data. Both authors contributed to writing the manuscript and preparing figures.

DISCLOSURE

The authors declare no conflicts of interest.

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DISCUSSION

Dr. David A. Spain (Stanford, California): In his usual manner, Dr. Nirula has presented a very thoughtful analysis of a large validated prospective database to assess the use of primary anastomosis and proximal diversion for a perforated diverticulitis. Ram, I have a couple of quick questions.

Can you clarify your inclusion criteria for me? I wasn't clear. Are you talking about patients that have a post-operative diagnosis of perforated diverticulitis or are we just including cases where the wound was classified as contaminated or dirty?

One-third of your patients had pre-operative SIRS. With this diagnosis they have a documented source of infection so shouldn't these patients be classified as septic patients?

Were there any elective cases included in this database? I suspect there are because one-third of your patients actually had no SIRS pre-operatively.

Also, using your inclusion criteria were there any patients that had a proximal or a primary anastomosis without proximal diversion but were classified as contaminated cases which may suggest they were classified as contamination not on the basis of peritonitis but on the basis of intraoperative spillage which I think is a different animal?

And then, finally, based on the data in your manuscript, looking at the predictive mortality in these two groups, if I just, you know, do a back-of-the-napkin calculation, the O to E ratio for a Hartmann's procedure was .66 and the O to E for primary anastomosis and proximal diversion was .9.

And as you pointed out in the feculent cases PAPD had a two-fold increase in mortality. So I know were concerned about the subsequent morbidity of a colostomy closure but first you've got to get there. Thanks.

Dr. Carl J. Hauser (Boston, Massachusetts): Every once in a while, I hear from the colorectal surgeons that we should be doing diverting loop ileostomies on these patients. And they seem to get all the thin young ladies with sort of chronic disease and their feculent contamination consists of about a one cc collection visible someplace with a fleck of air. But I seem to get to do the 250-pound, 60-year-old men with a thick abdominal wall. I'd like some hints on how to do those diverting loop ileostomies on people with feculent peritonitis and thickened or shortened mesenteries and how do we bring these up.

The question is: how does one choose these patients in this data group for diverting loop ileostomy versus Hartmann's procedure? And is there, in fact, a bias based upon body mass in the select body mass index in the selection, the original selection for operation?

Dr. Raminder Nirula (Salt Lake City, Utah): Thanks very much, Dr. Spain, for your questions and Dr. Hauser as well.

The first question relates to the inclusion criteria. These were all cases that were classified as emergent procedures so there were no elective cases included in this. In terms of the classification of sepsis, the way the variable of sepsis is classified in NSQIP is either that you don't meet the criteria for sepsis or they define it as SIRS versus sepsis versus severe sepsis.

And so whether or not the SIRS patients should actually be septic patients is probably a matter of semantics, but when I classified patients as having sepsis I included the definition or those cases that were SIRS patients. In terms of the analysis, SIRS patients were treated the same as septic patients.

The question related to whether or not any of the patients had, that had a primary anastomosis did not have proximal diversion. We excluded any patients that didn't have proximal diversion because we wanted to have a clean analysis here looking at just those two types of operations.

In terms of the O to E ratio of .9 versus .66 and the two-fold increase in mortality, when you look at the unadjusted data for patients who have dirty infected cases, the rate of mortality was about 9% for PAPD patient and the rate of mortality was 6% for patients who had HP so a small difference in the unadjusted rate.

And then when you adjust for confounders that rate does then become significant. So I think that even though there is a small difference in the unadjusted population that then bears out to be statistically significant, it's a small but not trivial amount and so I think that the signal is real.

The problem is trying to figure out what it is about these dirty and infected cases that's leading to the increased mortality and is it just sort of a spectrum of how dirty and infected these cases are.

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Dr. Hauser, your question related to the fact that you get the patients that are heavier and sicker and are more contaminated than your colorectal counterparts, that's a problem at your institution. We don't have that problem at our institution. But the point that you're getting at is how do you figure out what to do with these patients that are heavier, where they have a shortened mesentery, and how do you bring up a loop ileostomy.

In my opinion it's hard to do that and it's hard to do a colostomy in those patients, too. So, you know, I think you have to pick your poison. I don't really have any specific tidbits of information for you on how to do that.

In terms of whether or not there is any selection bias, the proportion of patients that had a loop ileostomy versus a Hartmann's procedure, when I stratify it by BMI that proportion didn't change. So is there a selection bias? It is certainly possible. But I didn't uncover that in our analysis.

Thanks, again, to the AAST for the privilege of presenting.

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