Emergency Management of Diverticulitis

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ABSTRACT

The most common indications for emergency operative intervention in the treatment of sigmoid diverticulitis are peritonitis and failure of medical therapy. Primary resection and diversion (Hartmann's procedure) followed by delayed colostomy closure is the current standard of emergency surgical care. Guidelines for best operative strategy, however, remain controversial and continue to evolve based on recent comparative reviews of surgical outcomes. Primary resection and anastomosis with or without proximal diversion and laparoscopic lavage are alternatives to Hartmann's procedure that may provide an improved outcome in properly selected patients. Ongoing changes in the historical paradigm of the surgical approach to this disease mandate the need for large multicentered prospective randomized trials to determine the best surgical strategy under emergent conditions for the treatment of diverticulitis. The current literature is reviewed with suggestions for a management algorithm.

KEYWORDS: Diverticular peritonitis, diverticulitis, peritonitis, Hartmann's procedure, primary resection, anastomosis, laparoscopic lavage

Objectives: Upon completion of this article, the reader should be able to summarize approaches in the emergency management of diverticulitis.

The impact of diverticular disease on Western society is substantial, affecting 50% of those older than 60 years, and up to 80% of those age 80 years and older.¹⁻³ Of those with diverticular disease, 20% will develop diverticulitis. Recent epidemiologic studies suggest its incidence may be dramatically on the rise, in part due to the growing burden of disease as the baby boomer population ages, as well as the increased use of computed tomography (CT) for diagnosis.⁴ Up to 25% of these patients will undergo emergency surgery.^{5,6} The cost of treating acute diverticulitis is more than 2.6 billion dollars per year, the largest portion of which is spent on operative expense and management of postoperative complications.^{7,8}

The current standard of care in emergency surgery for acute diverticulitis is Hartmann's procedure (HP), as recommended in the most recent 2006 report by the Standards Committee of the American Society of Colon and Rectal Surgeons.⁹ This recommendation is under scrutiny, however, due to a paucity of high level evidence to support it as the best operative approach for all patients with diverticular peritonitis. The complexity of the disease, patient comorbidities, surgeon's experience, and hospital conditions are all variables that play a role in the outcome of operative strategy selected, the extent of which remains to be determined.

Recent comparative outcome reviews evaluating resection with primary anastomosis with or without

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temporary diverting ileostomy suggest these alternative strategies may have a comparable or improved outcome in selected patients and an overall decreased cost of care by avoiding a second operation for colostomy take-down.^{8,10,11} The 2006 Standards Committee's report recognizes these procedures as alternatives to HP; however, criteria for indications and patient selection remain unsettled.⁹

Adding to the debate of best operative intervention is a recent study reporting the use laparoscopic lavage for the treatment of purulent peritonitis without subsequent resection, or as a bridge to percutaneous drainage or HP, calling to question the need for resection and, possibly, our understanding of the natural history of complicated diverticulitis.¹²

The best operative strategy in the emergency management of diverticulitis has yet to be determined, but a paradigm shift is underway. Study selection bias, number limitations to power, and the lack of prospective randomized trials serve as major impediments to the generalized acceptance of alternative operative strategies, and beg for the development of a large multicentered prospective randomized trial. This article aims to provide a current review of reported outcomes in emergency operative strategies used to treat patients who have diverticular peritonitis, and to provide suggestions for a treatment algorithm.

COMPLEXITY OF DISEASE

Acquired colonic diverticula are a Western disease, thought to be brought about by industrialized processing of grain and subsequent loss of dietary fiber.¹³ Although not proven, the etiology proposed begins with a decrease in stool bulk, which promotes higher intraluminal pressure during contractile efforts to evacuate the bowel. Mucosal herniation occurs at points where the vasa recta penetrate the bowel at the antimesenteric tenia coli.¹⁴ Torsion or inspissation of the diverticula result in inflammation, called diverticulitis, which occurs in 10 to 20% of people with diverticular disease, and is largely isolated to the sigmoid colon. Perforation occurs when intraluminal pressure exceeds wall tension, and is uncommon with an overall reported prevalence of 3.8 cases per 100,000.¹⁵ Perforation may not correlate with severity of disease, however, and should not be used as the sole indicator for determination of operative management.

The grade and stage of diverticulitis are determined by clinical severity and Hinchey classification of disease, and used to identify patients likely to fail medical management or require surgery. The clinical classification developed by The European Association for Endoscopic Surgeons divides the disease into symptomatic uncomplicated, recurrent symptomatic, and complicated disease (Table 1).¹⁶ Complicated diverticulitis is determined by presence of perforation, abscess, phlegmon,

Table 1 Clinical Classification of Diverticulitis

Grade	Clinical Description	Symptoms
I	Symptomatic uncomplicated	Fever abdominal pain Computed tomography (CT) evidence
II	Recurrent symptomatic	Recurrence of above
III	Complicated	Phlegmon, abscess, perforation, purulent and fecal peritonitis, fistula, obstruction, hemorrhage

stricture, obstruction, fistula, or hemorrhage, and is an indication for operative management, but not always on an emergency basis. Hinchey's classification provides a means of consistent classification of severity of disease for clinical description, decisionmaking, and research.¹⁷ Perforation with operative findings of purulent peritonitis corresponds to Hinchey stage III, and feculent peritonitis to Hinchey stage IV. The most common cause for an emergency operation is advanced stage III or IV disease. Patients with stage I to II disease who fail medical management or who present with diverticular hemorrhage or obstruction may also require emergency operation illustrating the complexity of disease, and varying degrees of severity that can require emergency operation.

CLINICAL EVALUATION

The clinical evaluation of the patient with acute diverticulitis is the best indicator of who requires an emergency operation. The initial evaluation should focus on obtaining adequate history, physical exam, initiating immediate resuscitative measures and appropriate antibiotics, and preparing the patient for the operating room. The clinical severity of disease is reflected in the presence of left lower quadrant pain, leukocytosis, and fever, which are the three most common findings in decreasing order.¹⁵ Patients with indication for emergent laparotomy may also have tachycardia and hypotension due to intravascular volume depletion and sepsis. These patients require immediate placement of two large peripheral intravenous (IV) catheters, administration of IV fluids, Foley catheter and nasogastric tube placement, and timely initiation of broad-spectrum antibiotics directed against enteric pathogens. Central venous line

Table 2 Hinchey Classification Complicated Diverticulitis

Stage	Description
I	Pericolic or mesenteric abscess
II	Walled off pelvic abscess
III	Generalized purulent peritonitis
IV	Generalized fecal peritonitis

placement should be considered in patients with multiple comorbidities for hemodynamic monitoring. Laboratory tests include complete blood count with differential, electrolytes, liver function enzymes, prothrombin time and partial thromboplastin time, and urinalysis, and 12-lead electrocardiogram for those with risk factors for coronary artery disease. Additionally, carcinoembryonic antigen (CEA) level should be drawn when the diagnosis of colon cancer is in question.

In the acute situation, diagnostic radiographic studies may be limited to a plain abdominal film, which can confirm pneumoperitoneum or colonic obstruction in a patient requiring an imminent laparotomy. However, a CT scan of the abdomen and pelvis with oral and IV contrast is the best diagnostic study with very high sensitivity and specificity, and a low false-positive rate.¹⁸ In the majority of clinical settings, it is the most appropriate imaging modality for the assessment of severity of disease, and allows for the selection of patients most likely to respond to medical therapy or percutaneous drainage of intraabdominal abscess.⁹ Increased use of this imaging modality has allowed for a comparative evaluation between surgeons and institutions on indications for operative intervention, and, subsequently, a better understanding of the relationship between the choice of operative and outcome relative to the complexity of the disease.

EMERGENCY OPERATIVE STRATEGIES

Hartmann's Procedure

The operative strategy selected in the treatment of acute diverticular disease depends on the degree of inflammation encountered during surgery, patient comorbidities, and experience of the surgeon. Most patients undergoing an emergent operation will have an advanced Hinchey stage of purulent or fecal peritonitis, and undergo HP, which is the current gold standard of care. This procedure, originally described by Henri Hartmann in 1923 for the treatment of obstructing colorectal cancer,¹⁹ involves resection of the perforated segment of sigmoid colon, creation of an end colostomy, and oversewing the distal stump.¹⁹ The proximal and distal extent of resection should extend to healthy, normal colon and rectum. Delayed closure of the colostomy is planned after resolution of pelvic sepsis and tissue inflammation, usually within 6 months after the initial procedure, to minimize complications such as anastomotic leak.

Widespread use of the HP has replaced delayed sigmoid resection, known as the three-staged technique, which was commonly practiced prior to the 1980s, and involved proximal diversion, subsequent resection and primary anastomosis with maintenance of stoma, and finally colostomy closure.²⁰ This adaptation developed from evidence reported in a large multicenter

randomized trial comparing outcomes of both procedures in the treatment of generalized diverticular peritonitis. Patients who maintained the perforated diseased segment of colon after proximal diversion had a significant increase in postoperative morbidity due to ongoing smoldering diverticulitis, reoperation, and prolonged hospital stay when compared with primary-resection HP.²¹

Recent collective reviews reporting outcomes in patients undergoing HP indicate, however, significant associated complications reported with this procedure, including rates of wound infection up to 29.1%, stoma complications of 7 to 12%, anastomotic leak rate as high as 30% with stoma reversal, and overall mortality of 15 to 30%.^{5,11,16,22} Furthermore, ~30 to 50% of patients with colostomy will never have reversal, thus calling to question alternative methods for minimizing morbidity and impact to patient quality of life.^{23,24}

Primary Resection and Anastomosis

A single-staged technique of sigmoid resection with primary anastomosis is becoming a recognized alternative to HP for the treatment of acute diverticulitis. Initially it was reported by Belding in 1957, who used it to treat three patients with diverticular peritonitis with no report of subsequent anastomotic leak.²⁵ Primary resection and anastomosis (PRA) has gained popularity after its successful application in the repair of penetrating traumatic colon injuries.^{26,27} A subsequent case series using PRA with or without protective stoma and intraoperative lavage has now been reported in the treatment of acute diverticulitis, and several advantages of this approach have been recognized. Creation of anastomosis during the initial resection avoids the technical difficulty of colostomy reversal, the additional cost and length of hospital stay, and improves the likelihood for maintaining intestinal continuity.^{8,10}

This approach is an acceptable alternative to treating patients with low-grade Hinchey I and II disease who undergo laparotomy for diverticular peritonitis; it is supported by the European Association of Endoscopic Surgeons as a treatment option to HP in perforation with purulent peritonitis (Hinchey III) when used with protective stoma.²⁸ Recent comparative reviews of the literature reflect favorably on the use of PRA compared with HP in advanced staged diverticulitis, but must be interpreted with caution due to considerable selection bias, lack of prospective randomized trials, and heterogeneity of patient disease.

Three large comparative reviews have been published in the past 5 years evaluating outcome differences in HP and PRA in the emergency setting (Table 3). Two studies performed a systematic review of the literature reporting aggregated outcomes of PRA versus HP. In Salem and Flum's review of 54 studies of patients with diverticular peritonitis (Hinchey III and IV), the

Table 3 Outcome Reviews of Three Large Comparative Studies Evaluating Hartmann's Procedure (HP) and Primary Resection Anastomosis (PRA) with and without Diverting Stoma

		N = no. of patients	Mortality	Stoma Complication	Abdominal Abscess	Anastomotic Leak	Wound Infection	Limitations of Study
Abbas et al, 2007	HP	526	19%	7–12%	8%		22.6%	Variable criteria of severity
	18 studies ⁵							
	HP reversal					8%		Retrospective
	PRA	358	9%		4%	5.5%	14%	Selection bias
Salem et al, 2004	HP	1051	18%	10.3%			24.2%	Statistical comparisons not possible due to design heterogeneity
	54 studies ¹¹							
	HP reversal	787	0.8%			4.3%	4.9%	Selection bias
	PRA	569	9.9%				9.6%	
Constantinides et al, 2006	HP	416	15.1% (OR = 0.41)		8.7%		22.3% (OR 0.42)	Random effects model sensitivity analysis
	15 studies ²²							
	HP reversal			3.9% *				
	PRA	547	4.9%		3.9%		9.6%	
	PRA and stoma			8.3% *				

*No difference in incidence of stoma complications: 95% CI = 0.2–1.36.

mortality of patients undergoing PRA was 9.9% compared with overall mortality of 18.8% in those undergoing HP with stoma reversal. The wound infection rate for patients undergoing PRA was 9.6% compared with 24.2% for HP and 4.9% for HP reversal.¹¹ Abbas reported similar results after review of 18 studies of patients with acute complicated diverticulitis, revealing 9% mortality in patients undergoing PRA compared with 19% in HP, and 14% wound infection rate in PRA compared with 22.6% in HP.⁵ The authors conclude that in the absence of higher reported morbidity and mortality rates of patients undergoing PRA compared with HP, that PRA is a safe alternative in the treatment of certain patients with advanced staged diverticular peritonitis.

The similarities in reported outcomes between the two reviews are due to an overlap in the studies reported. There were also different inclusion criteria for an operative indication based on the definition of severity of disease.^{29–35} One review included patients with diverticular peritonitis Hinchey grade >2; the other used more generalized definition of acute complicated diverticulitis. Design heterogeneity, variations in criteria relating to severity of peritonitis, lack of randomization of patient to treatment arm, and severe selection bias in potential assignment of HP to the most clinically severe and advanced stage of diverticular perforation precludes statistical comparison between the two procedures.

A review of 15 more recently published comparative studies between 1984 and 2004 utilizes a random effects model and sensitivity analysis to control for heterogeneity of confounding variables, such as the presence and severity of peritonitis, mode of operation, and type of PRA. Outcomes are reported in terms of the odd ratio which is the odds of an adverse event occurring in the treatment group (PRA) versus the reference group (HP), with an odds ratio of <1 favoring the treatment group. Results report overall statistically significant reduced post-operative mortality of 4.9% in primary resection and anastomosis compared with 15.1% with HP (odds ratio [OR] = 0.41). In subgroup analysis, patients undergoing an emergency operation showed decreased mortality with primary resection and anastomosis compared with HP (7.4% versus 15.6%; OR = 0.44). Patients undergoing an emergency operation who were matched for severity of peritonitis (Hinchey grade >2) had no difference in mortality between PRA and HP (14.1% versus 14.4%; OR = 0.85). Evaluation of primary anastomosis with diverting stoma and primary anastomosis intraoperative lavage were not possible due to a lack of reported outcomes in studies using these variations of PRA.²² The authors conclude that primary resection and anastomosis has lower mortality than HP in the emergency setting, and comparable mortality under conditions of advanced peritonitis (Hinchey grade >2), but caution against

clinical extrapolation of results due to patient selection bias and a lack of large prospective randomized trials.

In the only publication of its kind to date, a recent study to determine the best operative strategy in purulent and feculent diverticulitis used a decision-analysis model to compare the competing management strategies of PRA and primary anastomosis with defunctioning stoma (PADS) to HP in the treatment of a hypothetical 65-year-old patient with peritonitis secondary to Hinchey stage III or IV perforated diverticulitis. Probability estimates of outcome in terms of morbidity and complications are obtained from a database of 6879 patients with Hinchey stage III and IV diverticulitis who undergo PRA ($n = 135$), PADS ($n = 125$), and HP with or without reversal ($n = 6619$). Probability of outcome is compared with quality-adjusted life expectancy (QALYs) for each strategy. Sensitivity analysis reveals the optimal strategy to be PADS with 9.98 QALYs (or 6.5 additional months of acceptable quality of life) when long-term outcomes are considered, compared with 9.44 QALYs after HP, and 9.02 QALYs after PRA. PRA had the highest probability of complications at 55%, thus explaining the lowest QALY score, followed by 40% for PADS, and 35% for HP. A shift from optimal operative strategy from HP to PADS was due to the increased risk of permanent stoma after HP (27.4%) compared with PADS (8%), as well as increased risk of complication after HP reversal (9.3%) compared with PADS reversal (5.2%). The authors conclude that PADS should be considered the operation of choice if the risk of postoperative complications from this procedure is below 44%. When the predicted complication rate is estimated above this level, the short-term benefit of HP may outweigh the risk of PADS, provided that the risk of complicated reversal of HP or permanent stoma are not high.¹⁰ However, the limitations of this study include a high degree of variation in study quality and expert opinion used to derive probability for postoperative outcome, and the small number of patients reported undergoing PRA and PADS.

In the absence of high-volume multiinstitutional prospective randomized trial, the operative decision to use PRA, PADS, or HP still remains subjective based on the surgeon's judgment in evaluating operative risk. Development of validated risk assessment model for colorectal surgery is underway, and may provide a future method for standardizing preoperative estimation of risk of morbidity and mortality and subsequent choice of operation.³⁶

Laparoscopic Lavage

An increasing number of studies report favorable outcomes with the use of laparoscopic lavage in the treatment of acute diverticulitis (Table 4). This technique was first described over 12 years ago; there are now over

Table 4 Laparoscopic Lavage in Diverticular Peritonitis

Study	Year	Number
O'Sullivan et al ⁴¹	1996	8
Rizk et al ⁴²	1998	10
Faranda et al ³⁷	2000	18
Taylor et al ⁴³	2006	14
Myers et al ¹²	2008	100
Franklin et al ³⁸	2008	40
Lam et al ⁴⁰	2009	11
Karoui et al ³⁹	2009	35
Total		236

10 series reported in the literature.^{12,37-43} The largest prospective study to date reports 92 patients with Hinchey grade II pelvic abscess ($n = 25$) or Hinchey grade III purulent peritonitis ($n = 67$) who underwent laparoscopic peritoneal lavage as the primary treatment for this disease. Lavage was performed using 4 L of warm saline followed by placement of two nonsuction Penrose drains. Eighty-seven patients had resolution of disease, with a reported morbidity of 4% to include lower respiratory tract infection, myocardial infarction, and pulmonary embolus. Two patients had recurring pelvic abscesses, one who successfully underwent percutaneous drainage, and the other who underwent HP. The postoperative mortality rate was 3% (3 of 92 patients) 2 of whom died of multiorgan failure and one from a pulmonary embolus. Two of these patients were immunocompromised renal transplant recipients at the time of presentation of illness, suggesting possible contraindication in the use of this approach in this population.¹² Patients were followed yearly up to 3 years, and no patient required operative reintervention subsequent to the complication of recurrence of disease.

Identification of the optimal patient who may benefit from this minimalist approach remains to be determined, but calls for larger prospective randomized trials with control for severity of presentation of disease and comorbidity of the patient. Application of this strategy may be optimal in relatively healthy and clinically stable patients. It may serve as a useful intervention for downgrading severity of disease, or providing a bridge to operative intervention. Furthermore, none of the patients who recovered from this intervention had recurrent operative disease after 3 years, calling to question the current indication for resection after presentation of complicated disease. These findings warrant additional evaluation of long-term outcome.

DISCUSSION

The choices of operative strategies in the treatment of acute diverticulitis continue to grow based on individual and economic need for improved quality outcome. A

**Algorithm:
Determining Optimal Operative Strategy in Acute Diverticular Peritonitis**

**Likelihood of performing HP based on accumulation of RF*

Figure 1 This proposed algorithm depicts a nominal scale of categories of risk factors to consider in determining the risk of surgical outcome. The categories consist of Severity of Disease, Patient Presenting Physiology, Patient Comorbidities, Hospital/Situational Factors, and Surgeon Factors. Assignment of a value to each variable within a category is not possible due to the lack of a validated scoring system. However, variables are stratified from low risk for morbidity and mortality to high risk, and should be considered as a guide in the process of deciding operative strategy, with the caution that additional unidentified variables certainly exist, and may play a significant role in outcome. The likelihood of performing Hartmann's procedure is based on accumulation of risk factors and application of surgeon's judgment based on the clinical scenario.

better understanding of the complexity of disease and the effect of individual variables on predicted outcomes of intervention is the basis upon which surgical practice evolves. Risk assessment of morbidity and mortality of surgical intervention has largely been an "art" reflective of the surgeon's ability to judge severity of disease, presentation, comorbidities of the patient, personal skill and operative experience, and the hospital setting in which the patient presents. A growing body of literature using sophisticated analytical technique continues to contribute to the evolution of this art into a "science" by which preoperative risk of complication may be more accurately predicted and applied in the decision algorithm for choice of best strategy. In the absence of high-level evidence-based prospective randomized studies, the development and validation of a dedicated colorectal physiologic and operative severity score such as the colorectal POSSUM (Physiology and Operative Severity Score for Enumeration of Mortality and Morbidity), may facilitate the selection of the best operation.³⁶ Until this tool is developed and implemented, the current decision for best operative management is based on the best available knowledge.

An algorithm for treatment options is provided; however, it does not recommend the superiority of one procedure over another in the clinical setting of diverticular peritonitis (Fig. 1). Factors to consider include accurate assessment of severity of disease by clinical presentation and Hinchey grade, and preoperative assessment of patient comorbidities, and realistic evaluation of hospital setting of presentation. A young patient presenting with Hinchey I or II diverticular peritonitis may do well with primary resection anastomosis with or without diverting stoma. An elderly hypotensive patient with purulent peritonitis and history of coronary disease on steroids may have better outcome with HP. Similarly, HP may be best applied in the relatively healthy patient who requires operative intervention in the middle of the night in a community hospital with limited support staff or surgical assistance.

Development of a large multicentered prospective randomized trial is needed to establish high-level evidence-based recommendations concerning best operative approach. The challenges of this have already been recognized by Constantinides et al,²² who determine that the power needed to significantly determine the primary outcome of interest in a traditional randomized controlled trial would require 906 patients in each arm. Accrual of such a high number of patients per treatment arm, and controlling for other variables such as individual surgeon technique and institutional variation in practice pose great difficulty in the development of a study like this. Nonetheless, the paradigm of operative strategy in acute diverticulitis continues to change, and will be the topic of ongoing debate, with perhaps changes in standards of practice among surgeons in the years to come.

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