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## Sigmoid Diverticulitis with Perforation and Generalized Peritonitis

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Sigmoid diverticulitis with perforation and generalized peritonitis is a grave complication of diverticular disease. To compare accurately the results of two operative approaches—proximal colostomy with drainage and proximal colostomy with resection or exteriorization—the authors assessed the clinical and pathologic features of 121 consecutive patients with perforating sigmoid diverticulitis. There were no differences between treatment groups in age, sex, mean duration of symptoms, clinical presentation, number of coexistent diseases, type of peritonitis or chronic corticosteroid use. Overall mortality for emergency operation was 12 percent. Mortality was significantly greater ( $P < 0.05$ ) among the 31 patients treated by colostomy and drainage (26 percent) than among the 90 patients treated by colostomy and resection or exteriorization (7 percent). Seven of the nine patients who died from persistent sepsis had undergone colostomy and drainage. Four clinical factors were found to be predictive of mortality ( $P < 0.05$ ): persistent postoperative sepsis, fecal peritonitis, preoperative hypotension, and prolonged duration of symptoms. These factors identified a subgroup of patients who, because of an increased risk of death, would be likely to benefit from the more complete eradication of the septic focus that is achieved by colostomy and resection. [Key words: Sigmoid diverticulitis; Perforation; Generalized Peritonitis; Resection; Drainage]

After Smithwick<sup>2</sup> reported his surgical experience in 1942, proximal diverting colostomy and local drainage became accepted widely as the procedure of choice for generalized peritonitis caused by perforated sigmoid diverticulitis. Although this approach continues to be popular,<sup>3-7</sup> others<sup>8-12</sup> have found primary resection or exteriorization of the perforated segment more effective. Unfortunately, most studies fail to assess critically the preoperative status of patients and to define precisely the type and extent of peritonitis present at the time of operation; meaningful comparison of different operative approaches thus is difficult.

The aim of our study was to compare the results of colostomy and drainage to those of colostomy and resection or exteriorization in a consecutive series of 121 patients. The clinicopathologic features of these patients were defined accurately in order to determine comparability of treatment groups and to identify factors predictive of mortality.

GENERALIZED PERITONITIS caused by free colonic perforation or rupture of a pericolic abscess is the most lethal complication of colonic diverticular disease.<sup>1</sup> Although the need for prompt surgical intervention is recognized, debate persists over the efficacy of the various operative approaches.

### Patients and Methods

The authors reviewed the records of 121 consecutive patients with perforating sigmoid diverticulitis and generalized peritonitis managed at the Mayo Clinic between January 1971 and December 1982. Only patients with generalized purulent or fecal peritonitis or with spreading purulent peritonitis from an acutely ruptured peridiverticular abscess were included. Patients with diverticular perforations causing phlegmons, fistulas, or contained intramesenteric or pericolic abscesses were excluded. All patients required emergency operation.

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The sex, age, clinical features, prior diverticular history, associated diseases, results of laboratory and roentgenographic studies, hospital mortality, and operative management were recorded for all patients. Major complications (required reoperation or additional therapy and so prolonged hospital convalescence) and minor complications were noted. Follow-up was continued until intestinal continuity was reestablished or judged to be contraindicated medically. Factors associated with postoperative mortality were determined from these data. Statistical significance was determined by Student's *t* test for unpaired data or  $\chi^2$  analysis with the Yates correction. Differences were considered significant at  $P < 0.05$ .

## Results

### Clinical Findings

**Patient Population:** There were 64 men and 57 women. The mean age was 61 years (range, 27 to 82 years). The mean age of the men (58 years) was not significantly different from that of the women (65 years).

**Signs and Symptoms:** Perforation with generalized peritonitis was the initial manifestation of diverticular disease in 73 percent of the patients. More than 80 percent of the patients presented with acute localized left lower quadrant or hypogastric abdominal pain. In each patient, however, signs and symptoms of generalized peritonitis developed subsequently during hospitalization despite prompt institution of medical treatment. The remaining patients (18 percent) presented with generalized abdominal pain and signs that mandated immediate surgical evaluation. Fever (oral temperature,  $> 100.9^\circ\text{F}$ ) was associated with the acute attack in 84 percent of patients, obstipation in 54 percent, vomiting in 31 percent, diarrhea in 28 percent, rigors in 22 percent, and hematochezia in 8 percent. Hypotension (systolic blood pressure,  $< 90$  mm Hg) occurred preoperatively in 18 patients (15 percent). The mean duration of symptoms from onset of the attack to operation was 5.1 days. Forty-three patients (36 percent) were referred for further evaluation and treatment because of clinical deterioration after failure of initial medical treatment elsewhere. The mean duration of symptoms in these patients prior to referral was 6.3 days.

**Coexistent Disease:** Two-thirds of the patients had other diseases requiring concurrent treatment: advanced cardiorespiratory disease, collagen vascular disease, diabetes mellitus, or malignancy. The mean number of associated diseases per patient was 1.8. Perforation occurred in 26 patients (21 percent) hospitalized for nonrelated medical problems and in 24 patients (20 percent) who used corticosteroids chronically. In these two subgroups of patients, the sex ratio, mean age, and signs and symptoms were not different from those in the overall patient population. Interestingly, patients who suffered a perforation during hospitalization and patients on long-term

steroid maintenance had a shorter duration of symptoms prior to operation (2.6 and 3.4 days, respectively) than the overall patient population. However, these differences were not statistically significant ( $P > 0.05$ ). Eight of the patients treated chronically with corticosteroids had diverticular perforations during hospitalization.

**Laboratory Findings:** Laboratory findings were non-specific. Eighty-four percent of the patients had a leukocytosis (mean, 13,600 cells/ $\mu\text{l}$ ) with a predominance of polymorphonuclear leukocytes (mean, 86 percent). Thirty patients (25 percent) were anemic (hemoglobin,  $< 12$  g/dl). Two-thirds of the patients had abnormal roentgenographic findings immediately prior to operation; free intraperitoneal air was evident in 53 patients (44 percent), and 28 additional patients (23 percent) had evidence of ileus or partial intestinal obstruction.

**Peritonitis:** Peritonitis was classified by its extent and gross appearance at operation. Ruptured pericolic abscess with spreading purulent peritonitis was found in 53 patients (44 percent), diffuse purulent peritonitis involving the entire peritoneal cavity in 51 patients (42 percent), and diffuse fecal peritonitis (gross feces throughout the peritoneal cavity) in 17 patients (14 percent). Clinical and laboratory findings in patients with purulent peritonitis were similar to those found in patients with fecal peritonitis.

**Comparability of Treatment Groups:** The 121 patients were divided into two treatment groups on the basis of the operation performed. Group I consisted of the 31 patients managed by local drainage of the perforation and proximal diverting transverse colostomy; Group II consisted of the 90 patients in whom the perforated segment was resected or exteriorized.

There were no differences between Group I and Group II in sex, mean age, duration of symptoms prior to operation, associated diseases, number receiving corticosteroids, number with preoperative hypotension, or distribution of types of peritonitis (Table 1). Prior episodes of clinical diverticulitis were significantly greater in Group I than in Group II.

TABLE 1. Comparison of Treatment Groups

Finding	Group I (N = 31)	Group II (N = 90)
Age, year	65	61
Sex, male:female	14:17	49:41
Duration of symptoms, days	5.2	4.9
Coexistent diseases, mean number	1.9	1.7
Previous diverticulitis,* number	16	23
Corticosteroid use, number	5	19
Preoperative hypotension, number	7	11
Peritonitis, purulent:fecal	28:3	76:14

\* $P < 0.05$ .

TABLE 2. Operative Procedures

Operation	Patients	Type of Peritonitis		
		Spreading Purulent	Diffuse Purulent	Diffuse Fecal
Group I				
Transverse colostomy and drainage	31 (8)*	13 (2)	15 (3)	3 (3)
Group II				
Resection, sigmoid colostomy				
Hartmann pouch	69 (6)	29 (3)	29	11 (3)
Mucous fistula	15	8	5	2
Resection, anastomosis, transverse colostomy	4	3	1	0
Exteriorization of perforated segment	2	0	1	1
TOTAL	121 (14)	53 (5)	51 (3)	17 (6)

\*Number of deaths shown in parentheses.

**Operative Management:** Operations performed, types of peritonitis, and associated mortality are shown in Table 2. The type of operation was selected by the attending surgeon rather than by a prospective, randomized plan of treatment. In Group I, proximal transverse loop colostomy and drainage of the perforation was performed initially in all 31 patients. In the 90 patients in Group II, 69 were treated by primary resection, end sigmoid colostomy, and Hartmann pouch; 15 had primary resection, end sigmoid colostomy, and distal mucous fistula; four had primary resection, anastomosis, and proximal transverse loop colostomy; and two had the perforated segment exteriorized.

### Mortality

**Type of Peritonitis:** Mortality was related to the type and extent of the peritoneal contamination: 9 percent of patients with spreading purulent peritonitis, 6 percent of those with diffuse purulent peritonitis, and 35 percent of those with fecal peritonitis. The difference in mortality between patients with spreading purulent and those with diffuse purulent peritonitis is not significant; however, the mortality associated with fecal peritonitis is significantly greater than that associated with purulent peritonitis ( $P < 0.001$ ). The distribution of types of peritonitis was not different between treatment groups. Moreover, the recorded descriptions of the inflammatory reaction surrounding the perforated colon were not discernibly different between groups.

**Type of Operation:** Fourteen of the 121 patients (12 percent) died after emergency operation. Overall mortality was significantly greater in Group I (26 percent) than in Group II (7 percent) ( $P < 0.05$ ). Clinical and laboratory findings in the patients who died in Group I were the same as in those who died in Group II. The mean duration of symptoms prior to operation, however, was probably significantly longer in the patients who died in Group I than in those who died in Group II (13.3 vs. 5.9 days,  $P = 0.06$ ). The mortality in patients with purulent peritonitis was not different between Groups I and II. In patients with fecal peritonitis, however, all three in

Group I died, but only three of 14 in Group II died; the small size of the sample precluded statistical analysis.

Of the 14 patients who died, nine were men and five were women; mean age was 66 years, mean duration of symptoms was 11.3 days, and mean number of associated diseases was 2.5. Seven patients (50 percent) had no history of previous diverticular disease, six used corticosteroids chronically (43 percent), and six were hypotensive preoperatively (43 percent). Nine patients died from persistent postoperative sepsis, two from arrhythmias, and one each from myocardial infarction, pulmonary embolism, and respiratory failure. Seven of the nine patients who died from persistent sepsis were in Group I. The factors predictive of mortality are shown in Table 3.

The type and number of major and minor complications, excluding deaths, after emergency operation were not different between the two groups (Table 4). The postoperative course was entirely uncomplicated in half of the patients in each group.

**Restoration of Intestinal Continuity:** Intestinal continuity was restored in all of the patients who survived emergency operation in Group I and in 75 percent in Group II. Operation to restore intestinal continuity was deemed to be contraindicated medically in 21 patients. Intestinal continuity was reestablished in two stages in all but seven patients in Group I who had a traditional three-stage procedure. One death occurred in each group secondary to sepsis from fecal fistulas at the level of the anastomosis. Major complications were not different between groups (Table 4). Minor complications, however, were significantly greater in Group I ( $P < 0.05$ ) and were principally caused by wound infections at the site of previous loop colostomy.

### Discussion

The results of our study show that, in patients with sigmoid diverticulitis, perforation, and generalized peritonitis, proximal colostomy and resection or exteriorization is associated with a significantly lower mortality than is proximal colostomy and drainage. Our findings support those of other authors<sup>8-14</sup> who claim that defini-

TABLE 3. *Factors Predictive of Mortality*

Factor	P
Persistent sepsis	0.001
Fecal peritonitis	0.01
Preoperative hypotension	0.02
Duration of symptoms	0.05
Chronic corticosteroid use	0.06

tive control of the source of sepsis—that is, excision of the perforated diseased bowel and total proximal diversion of the *in situ* fecal stream—is necessary to decrease mortality. In addition, we identified four factors—persistent sepsis, fecal peritonitis, preoperative hypotension, and prolonged duration of symptoms—associated with increased risk of death in these patients.

Some studies comparing resection with drainage in patients with perforated sigmoid diverticulitis have been difficult to evaluate critically because of the heterogeneity of the clinical findings associated with diverticular perforations.<sup>9-11</sup> In the absence of prospective clinical trials, critical comparison requires precise definition of the clinical stage of disease and the patient population. Therefore, our study was confined entirely to patients with perforated sigmoid diverticulitis and generalized peritonitis who required emergency operation. Such patients have been shown by Hinchey *et al.*<sup>8</sup> and Hughes *et al.*<sup>15</sup> to be at increased risk of death. A concerted effort also was made to identify differences in clinical features of the patients in each group but no significant differences were found. Although our study has potential selection biases, the difference in mortality between treatment groups most likely is related to the operation itself.

Our study confirmed that persistent sepsis is the major cause of death in patients with perforated sigmoid diverticulitis and generalized peritonitis.<sup>1, 8, 16-18</sup> Indeed, of our patients who died, 60 percent died from persistent sepsis and 77 percent of them had been treated by proximal colostomy and drainage of the perforation. These findings attest to the need for removal of the source of sepsis by resection rather than attempted secondary control by drainage.

Since the report by Endrey-Walder and Judd,<sup>19</sup> primary resection has evolved as the treatment of choice for perforated diverticulitis and generalized peritonitis at the Mayo Clinic. Interestingly, mortality for proximal colostomy and drainage in our current study has not changed from that previous experience.<sup>19</sup> Mortality was decreased significantly, however, in patients treated by proximal diversion and resection. Moreover, we have shown that resection can be performed without increased risk of morbidity, either at the time of emergency operation or subsequently with restoration of intestinal continuity.

Four clinical factors were associated with an increased mortality: persistent sepsis, fecal peritonitis, preoperative

TABLE 4. *Mortality and Morbidity*

	Emergency Operation, Percent		Operation for Restoration of Intestinal Continuity, Percent	
	Group I (N = 31)	Group II (N = 90)	Group I (N = 23)*	Group II (N = 73)*
	Mortality	26	7†	4
Major complication	19	30	5	12
Minor complication	8	11	22†	5
Uncomplicated	47	52	69	82

\*Not all patients were candidates for restoration.

†For difference between groups,  $P < 0.05$ .

hypotension, and prolonged duration of symptoms. Our study confirmed the previous findings by MacLaren<sup>16</sup> and by Taylor and Moore<sup>6</sup> that fecal peritonitis is predictive of mortality. Overall, 35 percent of our patients with fecal peritonitis died. Importantly, failure of patients with fecal peritonitis treated with proximal colostomy and drainage to survive illustrates the need for resection in such patients. We confirmed the association between preoperative hypotension and death previously noted by MacLaren.<sup>16</sup> In contrast to MacLaren, however, we failed to find that hypotension was inevitably caused by fecal peritonitis.

The mean duration of symptoms between onset and operation in the group of patients who died was 11 days, compared with five days in patients who lived. Although the reasons for delay in operative intervention cannot be determined precisely, contributing factors may have been that 80 percent of all patients presented with localized tenderness alone and 36 percent had their initial treatment elsewhere. Interestingly, generalized peritonitis is seldom the initial presentation of clinical diverticulitis. In contrast, however, perforation with generalized peritonitis was the initial manifestation of diverticular disease in 64 percent of our patients; therefore, chronicity may confer protection from generalized peritonitis by virtue of the presence of pericolic adhesions.

Chronic corticosteroid use approached a statistically significant relationship to mortality. The association between corticosteroid use and mortality in patients with colonic perforation was noted first by Canter and Shorb<sup>20</sup> and reemphasized by ReMine and McIlrath.<sup>21</sup> Although the mechanism of the deleterious action of corticosteroids remains unclear, the adverse effect of steroids is related to factors other than masking the symptoms of perforation. In fact, we found a shorter duration between clinical onset of signs and symptoms and operation in patients using corticosteroids than in those who were not. This finding may reflect our aggressive posture in the treatment of patients using corticosteroids who manifest any signs of peritoneal irritation or, alternatively, may be due to the fact that half of our patients were already hospitalized for other medical reasons at the time of perforation.

Our current operative approach in patients with perforated sigmoid diverticulitis and generalized peritonitis, whether purulent or fecal, has two stages: primary resection, proximal diversion, and rectal exclusion, followed by restoration of intestinal continuity in three to four months if not contraindicated medically. Resection of the perforated segment has not been precluded by local inflammatory changes. The presacral space is not violated because the diverticulitis rarely involves extraperitoneal colon. Identification of the rectal remnant during reanastomosis has not been difficult; it is the only structure present immediately anterior to the sacral prominence. If difficulty arises, however, use of a proctoscope or stapler can provide a tactile landmark intraoperatively. Alternatively, rectal exclusion can be performed by using a mucous fistula.

In conclusion, resection with proximal diversion is the treatment of choice for patients with perforated sigmoid diverticulitis and generalized peritonitis. Initial mortality and morbidity are low, and restoration of intestinal continuity is not difficult. Because resection of the source of the peritoneal contamination provides the greatest assurance of reducing postoperative sepsis, the major cause of death, we favor its application, especially in patients with one or more clinicopathologic factors associated with an increased risk of death.

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### Announcement

#### TECHNIQUES AND PROBLEM SOLVING IN THERAPEUTIC ENDOSCOPY

"Techniques and Problem Solving in Therapeutic Endoscopy" will be held from February 28-March 2, 1985 at the Doubletree Hotel in Tucson, Arizona; 16 Category 1 credit hours; \$300.00 tuition. This course is designed primarily for gastrointestinal endoscopists who are interested in updating their background knowledge and their techniques of new endoscopic procedures. Small workshop sessions and problem cases will be presented in the how-to format.