Operative Management of Diverticular Emergencies

Strategies and Outcomes

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Hypothesis: A selective surgical approach using either a 1- or a 2-stage resection is relatively safe and effective in the management of acute complicated colonic diverticulosis.

Design: A consecutive cohort study.

Setting: A university hospital.

Patients: Eighty-nine consecutive patients who underwent emergency operations for diverticular disease between July 1, 1984, and June 30, 1999. There were 53 male and 36 female patients (mean age, 47 years). The ethnic background was predominantly Mexican American (58 patients [65.2%]).

Interventions: Resections of the affected colon (n = 83) plus construction of a Hartmann pouch or mucous fistula (n = 72) or primary anastomosis (n = 11).

Main Outcome Measures: Morbidity, mortality, and length of hospital stay.

Results: Sixty-eight operations were performed for perforation at an annual rate that has increased greater than 75% in the past 15 years. Another 14 patients underwent operations for obstruction, and 7 underwent operations to control unremitting hemorrhage. Surgical therapy included resection of the affected segment of the bowel in 83 (93%) of the 89 patients, and a Hartmann pouch or mucous fistula was added in 72 (81%). A primary anastomosis was performed in 4 (80%) of 5 rightsided lesions but in only 7 (8%) of 84 left-sided lesions. Morbidity occurred in 38 (43%) of the 89 patients, and the mortality was 4%, with 4 deaths occurring secondary to sepsis in high-risk patients with perforations (n = 3) or obstructions (n = 1). The average length of hospital stay was 19.7 days (range, 5-80 days).

Conclusions: Emergency operations for diverticular disease are uncommon but may be associated with substantial morbidity and occasional mortality. Complicated diverticulosis may present at a relatively young age, and perforated forms appear to be increasing rapidly in prevalence. Most diverticular lesions can be satisfactorily managed using a selective approach based on resection with either a primary anastomosis or a temporary colostomy.

Arch Surg. 2000;135:558-563

In industrialized nations, diverticular disease has reached the status of a modern-day epidemic, affecting two fifths of all individuals in their seventh decade of life.¹ The responsible factors remain poorly defined, but advancing age and deficiencies in dietary fiber are known to contribute. Fortunately, only a few of the affected individuals will ultimately develop symptoms and most can be managed conservatively. Nevertheless, 10% to 20% of those who are hospitalized will require an urgent operation for such complications of diverticular disease as perforation, obstruction, and bleeding.² The attendant mortality is a reflection of the degree of intra-abdominal contamination and the presence of comorbid risk factors in this generally older patient population.³

Efforts to control contamination and improve mortality were reported as early as 1907 when Mayo et al⁴ first described the operative management of 5 diverticular abscesses. Since then, the operative approach for diverticular emergencies has continued to evolve slowly, stimulated by the advent of effective antibiosis and by improvements in resuscitative and anesthetic techniques.

For the past 15 years, we have approached diverticular emergencies aggressively, usually performing a colon resection during the initial operation. As reviewed by Schoetz,⁵ we have selectively used a 1-stage procedure in low-risk patients who have localized disease...
PATIENTS AND METHODS

Between July 1, 1984, and June 30, 1999, 89 consecutive patients with complicated colonic diverticulitis underwent emergency operation at the University Hospital, San Antonio, Tex, and were prospectively enrolled in our computerized surgical database. Medical records and operative reports were reviewed to measure or confirm selected indicators of outcome, such as morbidity, mortality, and the length of hospital stay.

There were 53 male and 36 female patients (mean ± SEM age, 47.0 ± 1.5 years; age range, 22-87 years). Fifty-eight patients (65.2%) were Mexican American; 20 (22.5%), non-Hispanic white; and 11 (12.4%), black. All patients were classified according to their specific indications for surgery based on their reported symptoms, physical examination findings, and laboratory and radiological reports. Computed tomography was used selectively to confirm the diagnosis in equivocal cases or to identify potential sites for percutaneous drainage.

Study patients were separated into 3 clinical patterns. Perforation was the most common pattern and was defined as free if pneumoperitoneum was evident on the abdominal x-ray film or if feculent intraperitoneal contents were observed at operative exploration. It was defined as localized if a contained intra-abdominal or pelvic abscess was present with or without intraperitoneal purulence. Diverticular obstruction was characterized by total cessation of bowel movements; it commonly occurred after several days of progressively severe obstruction and pain. Diverticular hemorrhage was usually brisk and not controllable with nonoperative methods. All patients required multiple transfusions for hemodynamic stabilization.

An analysis of variance was used for the statistical treatment of multiple continuous variables, and a \( \chi^2 \) analysis was applied to all discrete variables. Statistical significance was defined as \( P<.05 \). Where appropriate, each value was reported as the mean ± SEM.

and a 2-stage approach in most others. This report uses the clinical information abstracted from our large database to evaluate the results of this surgical paradigm and to assess the influence of various demographic factors and comorbid conditions.

RESULTS

The demographic profiles and comorbidities of the patients in the study are presented in Table 1. The ethnic-racial distribution reflects the community profile and does not differ among groups. (The 1990 US census indicated a ratio of 55.6% Mexican Americans, 35.9% non-Hispanic whites, 7.0% blacks, and 1.5% other nonwhites in San Antonio.) Of interest, only 6 (6.7%) of 89 patients had a history of diverticular disease at the time of their index hospitalization.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Perforation</th>
<th>Obstruction</th>
<th>Bleeding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean ± SEM, y</td>
<td>44.7 ± 1.6</td>
<td>49.1 ± 3.3</td>
<td>64.7 ± 6.0†</td>
</tr>
<tr>
<td>Male-female ratio</td>
<td>9:5</td>
<td>3:4</td>
<td></td>
</tr>
<tr>
<td>Ethnic or racial background‡</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mexican American</td>
<td>45 (66)</td>
<td>9 (64)</td>
<td>4 (57)</td>
</tr>
<tr>
<td>White</td>
<td>16 (24)</td>
<td>2 (14)</td>
<td>2 (29)</td>
</tr>
<tr>
<td>Black</td>
<td>7 (10)</td>
<td>3 (21)</td>
<td>1 (14)</td>
</tr>
<tr>
<td>Asian</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Comorbidity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>10 (15)</td>
<td>1 (7)</td>
<td>2 (29)</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>5 (7)</td>
<td>1 (7)</td>
<td>2 (29)</td>
</tr>
<tr>
<td>Pulmonary disease</td>
<td>3 (4)</td>
<td>3 (21)</td>
<td>2 (29)</td>
</tr>
<tr>
<td>Hepatic disease</td>
<td>4 (6)</td>
<td>1 (7)</td>
<td>1 (14)</td>
</tr>
</tbody>
</table>

*Data are given as number (percentage) of patients unless otherwise indicated.
‡Percentages may not total 100 because of rounding.

Most patients in this study (68 [76%] of 89) were admitted for the management of acute perforations (Table 2). This group included 44 free perforations (Hinchey stage 4) and 24 localized perforations (Hinchey stage 3). There were no free perforations of the ascending or transverse colon. In 4 patients, computed tomographic–guided percutaneous drainage had been attempted but was unsuccessful. Only 5 patients with perforations underwent proximal colostomy without resection: 4 because of their critical condition and 1 because of the dense attachment of a large abscess with multiple retroperitoneal structures. One of these patients required emergency reoperation and resection to control sepsis, and another died of unremitting sepsis. The remaining 3 were subsequently managed with elective resection. Fifty-seven (84%) of the 68 patients with perforations were managed with an initial resection but without a primary anastomosis; in most of these patients, a Hartmann pouch was also constructed. A single patient was treated with a primary anastomosis protected by a proximal loop colostomy.

The actual frequency of emergency operations for diverticular perforation has changed dramatically, increasing by more than 75% between the first period and the last. This increase is equally distributed between free and localized perforations. In contrast, the difference in prevalence in the other 2 diagnostic categories has been more gradual.

Overall, major complications occurred in 30 (44%) of the 68 patients with perforations, necessitating a subsequent operation in 11 (16%). The gastrointestinal tract was the most involved system, with 7 cases of prolonged ileus and single episodes of hemorrhagic gastritis, small-bowel obstruction, and acute pancreatitis. The 9 wound complications included 4 dehiscences that required reclosure and 2 necrotic colostomies in massively obese patients. Six (9%) of the 68 patients with perforations required extended care for sepsis, and 3 (4%) of them died; all were patients with a free perforation and multiple comorbid conditions (atrial fibrillation with
chronic obstructive pulmonary disease, pneumonia with alcoholism, and type 1 diabetes mellitus with cerebrovascular disease).

Of the 14 patients who presented with obstruction, 3 exhibited symptoms typical of small-bowel obstruction with numerous loops of ileum adherent to a diverticular abscess (n = 2) or a sigmoid-enteric fistula (n = 1). The remaining patients had colonic obstruction caused by a densely fibrotic inflammatory process. One (7%) of the 14 patients in this group, a 58-year-old patient with cirrhosis, died of sepsis 46 days after undergoing a total colectomy for toxic megacolon.

Diverticular hemorrhage was present in only 7 patients, and their age was significantly higher than all other groups. Preoperatively, the site of bleeding was localized in 4 patients by angiography (n = 3) and/or a tagged red blood cell scan (n = 3). In a single patient, transient control of bleeding was achieved by the selective infusion of vasopressin; however, operative intervention was ultimately required when bleeding recurred. Three patients underwent total colectomy; a Hartmann pouch was added in 2. In the other 4 patients, 2 right and 2 left hemi-colectomies were performed with a primary anastomosis. Recurrence of colonic bleeding has not been observed in any of these patients. Nevertheless, one patient required an emergency reoperation for control of retroperitoneal bleeding and another required repair of a disrupted, infected wound.

This study underscores the multidimensional and sometimes perilous nature of colonic diverticulosis. It confirms that various acute clinical symptoms may prompt urgent surgical intervention and, in turn, may be responsible for a substantial morbidity and an occasional mortality. In the latter regard, our mortality rate (3.5%) compared favorably with the 5% to 10% found in several earlier series, presumably as a result of the unusually young age of our cohort. Indeed, the mean age in the present series is nearly 2 decades younger than values reported previously. This difference is not easily explained but could be related to regional dietary factors or as yet unidentified genetic predispositions. In another report from the southwestern United States, the mean age in 116 patients with acute diverticulitis was also relatively young (56 years), and 26.7% of the affected patients were younger than 50 years. By comparison, two thirds of the patients in our series were aged 50 years or younger.

Youth may not always be an advantage. Some contemporary studies regarding age have noted that the appearance of diverticulosis before the age of 50 years is likely to be associated with a more virulent clinical course. This suggestion remains controversial since several other investigators have been unable to demonstrate meaningful increases in operative or complication rates in younger patients. Still, the many young patients in our series who required emergency operation seem to provide at least indirect support to the concept of increased virulence.

Our demonstration that perforation is the most common cause for emergency surgery confirms the observations of most other researchers. We were surprised, however, to find such a dramatic increase in the perforation rates during the past 15 years. Whether this changing time trend is also occurring in other communities is not yet clear, neither is its explanation. Local demographic patterns have been relatively stable, and reporting methods and clinical practices have not changed appreciably during the reporting period. Possible roles for cigarette smoking and for nonsteroidal anti-inflammatory drugs have been suggested by recent case-control studies but more evidence is needed.

The successful management of patients with a suspected perforation requires early and accurate assessment of the degree of intra-abdominal contamination. Increasingly, collections that are localized are being controlled with computed tomographic-guided percutaneous drainage, an approach that allows postponement of definitive surgery until the colon can be adequately prepared and fully evaluated. However, this approach occasionally fails, as illustrated by the need for urgent operation in 4 patients in our cohort who had initially undergone drainage percutaneously. In fact, many patients require a more aggressive approach from the outset. By 1984, an extensive survey of pooled data already had concluded that the mortality following resection for sigmoid perforation was less than half that observed when resection was deferred. Less invasive approaches also have been advocated. One single-center randomized trial purports to show that the combination of suture closure of a perforation and a transverse colostomy produces a lower postoperative mortality than resection. Another nonrandomized study suggests that laparoscopic exploration and selective peritoneal lavage is generally sufficient. We continue to favor a more

Table 2. Operations and Outcomes

<table>
<thead>
<tr>
<th>Reason for Surgery</th>
<th>Perforation (n = 68)</th>
<th>Obstruction (n = 14)</th>
<th>Bleeding (n = 7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of operation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colectomy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With anastomosis</td>
<td>6 (9)</td>
<td>1 (7)</td>
<td>4 (57)</td>
</tr>
<tr>
<td>Without anastomosis</td>
<td>57 (84)</td>
<td>12 (86)</td>
<td>3 (43)</td>
</tr>
<tr>
<td>No resection</td>
<td>5 (7)</td>
<td>1 (7)</td>
<td>0</td>
</tr>
<tr>
<td>Caseload, annual rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1984-1989</td>
<td>1.8</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>1989-1994</td>
<td>4.2</td>
<td>1.2</td>
<td>0.2</td>
</tr>
<tr>
<td>1994-1999</td>
<td>7.6</td>
<td>1.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Complications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wound</td>
<td>9 (13)</td>
<td>1 (7)</td>
<td>1 (14)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>6 (9)</td>
<td>2 (14)</td>
<td>0</td>
</tr>
<tr>
<td>Intestinal</td>
<td>10 (15)</td>
<td>3 (21)</td>
<td>1 (14)</td>
</tr>
<tr>
<td>Respiratory tract</td>
<td>3 (4)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>1 (1)</td>
<td>1 (7)</td>
<td>1 (14)</td>
</tr>
<tr>
<td>Unplanned reoperation</td>
<td></td>
<td>1 (7)</td>
<td>2 (29)</td>
</tr>
<tr>
<td>Mortality</td>
<td>3 (4)</td>
<td>1 (7)</td>
<td>0</td>
</tr>
<tr>
<td>Length of hospital stay, mean ± SEM, d</td>
<td>19.4 ± 1.7</td>
<td>21.9 ± 3.5</td>
<td>17.9 ± 5.2</td>
</tr>
</tbody>
</table>

*Data are given as number (percentage) of patients unless otherwise indicated.

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aggressive approach. During the past 10 years of our study, 95% of all patients with perforations have undergone early resection of the involved segment of the colon.

Following resection, the remaining bowel can be approached in various ways. The selective operative strategy used in the present study is generally consistent with the guidelines promulgated by a national task force on this issue.20 Thus, we have favored the use of a Hartmann pouch in most patients who present with generalized intraperitoneal contamination, but we have selectively performed primary anastomosis in the management of well-localized collections. Some researchers have recommended a more liberal use of primary anastomoses, citing the technical difficulties and excessive morbidity associated with eventual colostomy closure. Low mortality rates (1%-6%) and an acceptable anastomotic leak rate (1%-7%) have been reported when using this approach.21,22 Further prospective studies are needed to determine the proper role of primary anastomosis.

The management of a diverticular obstruction can be particularly difficult, but few studies of this complicated problem have been reported. When the obstruction is partial, a carefully monitored attempt at mechanical preparation of the bowel is appropriate, but special caution is necessary to avoid inadvertent perforation. Furthermore, care needs to be taken to assure that the diagnosis is accurate since a colonic malignant neoplasm can mimic a benign diverticular stenosis. Complete obliteration of the colonic lumen by diverticular inflammation and fibrosis is commonly associated with gross colonic dilation and the retention of a large volume of highly contaminated feces. As a result, total obstruction is best managed by resection of the stenotic segment and creation of a Hartmann pouch.23 On-table lavage has been recommended as an adjunct in patients who are candidates for primary anastomosis.24 In our experience, none of the patients were treated with a primary anastomosis. Even so, one patient with toxic megacolon died of persistent sepsis 51 days after resection while another developed cecal necrosis but survived.

We found that hemorrhage was the least common indication for emergency surgery, undoubtedly a reflection of the fact that diverticular bleeding stops spontaneously in 70% to 80% of all cases.25 Moreover, various nonoperative methods of control are available, including vasopressin administration, embolization, and endoscopic therapy.26 Diverticulosis may account for as much as 40% of acute lower gastrointestinal tract bleeding but must be distinguished from such other causes as malignant neoplasms, colitis, angiodysplasia, and hemorrhoids.27 Once operative intervention is considered, localization of the bleeding site is critically important. An algorithmic approach to diagnosis and localization has been recommended, using colonoscopy, radionuclide studies, and arteriography.28 The accuracy of tagged red blood cell study and selective arteriography results is controversial and beyond the scope of this article. However, we found that these imaging studies helped to limit the size of our resections in 4 (57%) of our 7 patients with bleeding; in the remainder, a total abdominal colectomy was considered necessary as a “last resort.”29 In all patients, resection resulted in successful control of hemorrhage without a mortality.

In summary, this study establishes the continuing clinical importance of complicated colonic diverticulosis and defines the increasing impact of involvement in younger patients. The observation of an expanding need for emergency surgery in patients with perforated diverticular disease suggests special implications for future planning. A selective therapeutic approach has proved acceptably safe, but the presence of excessive morbidity and prolonged hospitalizations remains problematic. Further improvements in diagnosis and in surgical and resuscitative techniques will help to achieve better overall results.

Presented at the 107th Scientific Session of the Western Surgical Association, Santa Fe, NM, November 17, 1999.

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REFERENCES

Roger E. Alberty, MD, Portland, Ore: This is a timely paper: (1) It is the centennial of diverticulitis, first described in 1899. (2) It is also timely because it is an ongoing controversy: the disease appears to be evolving, and there is still a lot of confusion about what to do with diverticulitis. It is appropriate because this is a western civilization disease, and this is the Western Surgical Association.

William Mayo, who was referenced, the brother of one of our presidents, presented what had to be the smallest series ever out of Mayo Clinic: 5 patients. He resected all of them, a feat we are still trying to emulate. In the 1950 and 1957 meetings, 2 presidents of this organization, Dr Allen Boyden and Dr Alexander Walt, respectively, reported. They were advocating 2-stage resections. They were tilting their lances at the procedure that was au courant at the time, the 3-stage procedure. Southwick was still advocating that as late as 1960. There is a long heritage of diverticulitis reporting from this organization.

Dr Schuwesinger and his colleagues have continued in their footsteps. They have a series of patients dealing with the acute complications of diverticulitis. Their judicious surgical judgment and management have led to a very acceptable morbidity and a highly morbid disease. You have to understand that these statistics do not reflect the reoperation to take down the colostomy. These people are sick, and the morbidity data reflect that. They also have an excellent mortality. Another member of this organization, Dr Bucky Shields, always told me that there is no substitute for a live patient. This paper reflects that admirably. They had a very high rate of perforations and appropriately a correspondingly high rate of 2-stage procedures. Their primary anastomoses were a highly select group as you have seen, based mostly on right-sided disease, very localized inflammation. The low average age is disturbing. I have in the last couple of years operated on 4 patients, none of whom were over 35. I used to worry as I was getting older that I would be over 35. I used to worry as I was getting older that I would be subject to this disease. Now I find that being young does not protect me either.

I hope my residents read this paper. It reflects very much on the topic presented yesterday, by Dr Aust et al, regarding surgical wisdom and judgment beyond technical efficiency. I have only 3 questions. The thing that scares us all with a primary anastomosis is anastomotic leak superimposing an iatrogenic complication on an already devastating situation. Could the authors comment on their anastomotic leak rate in their population? I am curious if they do intraoperative lavage? Lastly, I have been one of Burkett's devotees for years. Burkett said he made a big mistake calling it roughage. He said he should have called it smoothage.

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Ro...
are trying to ascertain how many of these Hartmanns actually are put back together and what the morbidity of that procedure is. At this point, more than 60% of the patients have had their Hartmann taken down, but I hope that once we get full data, the figure is much higher.

In terms of what decision parameters we use in performing primary anastomosis, the major one is related to the degree of contamination of the peritoneal cavity. Certainly, we are reluctant to do anything in the way of a primary anastomosis in the face of either feculent or purulent peritonitis. The other factor which was used was the general condition of the patient. There were several patients in whom, because of a cardiac condition or an unresectable lung cancer, we elected not to do anything further. Finally, I am aware of O'Sullivan's work using laparoscopic irrigation as primary therapy. It is very interesting data, and the fact that it was a prospective study makes one consider its use in that very select group of patients who do not have a free, open perforation.

Dr Peck, all of the appendicitis patients were actually surprises. The primary diagnosis entering the operating room with these patients was acute appendicitis. Most of them, but not all, had a right lower quadrant incision that was then converted.

Dr Richardson, you raised the point of the use of CAT scan and whether it is going to modify our treatment. My assessment is that it will change our management of some of these patients. There is a recent report that helical CAT scan, non-enhanced, improves our ability to diagnose more accurately the cause of right lower quadrant pain and tenderness that may redirect our therapeutic efforts.

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**Surgical Anatomy**

The blood supply to the head of the pancreas comes from the branches of the gastroduodenal artery which divide into the superior, posterior, and anterior pancreaticoduodenal arteries (celiac axis). Additional blood supply to the pancreatic head comes from the superior mesenteric artery branches (inferior, posterior, and anterior branches of the pancreaticoduodenal arteries). The arterial supply to the body and tail of the pancreas is as follows: the dorsal pancreatic artery from the splenic artery branches and joins a branch from the SMA to form the inferior pancreatic artery. Multiple branches from the splenic artery, along with the inferior pancreatic artery, supply the tail of the pancreas.