Changing Patterns in the Surgical Treatment of Diverticular Disease

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This paper includes a brief historic summary of the surgical aspects of diverticular disease and of corresponding developments in the Massachusetts General Hospital from 1911 to the present. The 350 cases observed in 1974–1983 are compared with 338 seen in the previous decade. Major trends include 1) a decrease in hospital admissions for diverticular disease but a sustained number of operations; 2) increased severity of the disease in hospitalized patients manifested by an increased percentage of patients with immunosuppression or serious other diseases ($p < 0.001$), an increased number with sepsis and general peritonitis ($p < 0.001$); 3) an increased percentage of cases with one-stage resection and anastomosis ($p < 0.02$); 4) in patients with general peritonitis, resection of the perforated segment at the time of the original operation was accompanied by the lowest mortality ($p < 0.02$); 5) incidental splenectomy appears to be dangerous, with three deaths in eight cases; and 6) overall mortality in the last decade is 6.4%; for emergency cases 10.2%, for urgent 9.7%, and for elective cases 2.4%.

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COLONIC DIVERTICULAR DISEASE is a clinical entity of the twentieth century. Although there had been earlier anatomic descriptions of diverticula of the colon,[1-5] an understanding of the pathogenesis and clinical significance depends upon the development of surgical, radiologic, experimental, and therapeutic techniques of the modern era.

In 1904 Beer[6] correlated some of the histologic and clinical features of colon diverticulitis; reports of surgical resections by Monserrat,[7] Moynihan,[8] and by Mayo and associates[9] followed 3 years later. Of these, Mayo's study was the most extensive and established certain therapeutic guidelines including external drainage of abscesses and treatment of obstruction by "artificial anus" (colostomy) to be followed by resection of the obstructed segment. He expressed a very modern concept of treatment as follows: "If considerable tumor is present and symptoms continue, it is better to make a primary resection of the affected part of the bowel before abscess and fistula supervene to render patients prolonged invalids." He also defined the terms "diverticulitis" and "peridiverticulitis" and reported five resections and anastomoses with two deaths due to peritonitis.

Building upon this experience at the Mayo Clinic, in 1924 Judd and Pollock[10] reported 118 patients with colon diverticulitis who had been treated surgically; they reaffirmed the concept that preliminary colostomy followed by resection of the affected segment provided the safest plan of management. In 1930 Rankin and Brown[11] reported that 5.67% of 24,620 cases with barium enemas and 5.2% of 1925 autopsied cases at the Mayo Clinic showed diverticulosis that was located only in the sigmoid in 29%, in the sigmoid and other areas in 68%, and in other areas but not the sigmoid in three per cent of cases. Diverticulitis was present in approximately 15% of these cases. Brown[12] pointed out that some of the patients had very rapid progress of the disease from the onset of diverticulitis. Among those treated surgically, 16% required operation within the first month of symptoms and 50% required operation within the first year of the disease. This same point subsequently was observed by MacLaren,[13] who reported 36 of 75 patients with perforated diverticulitis had had no previous bowel symptoms, and in 14 of the 36 cases the first attack was fatal. Hartley[14] found that only 14% of patients with fatal diverticulitis had symptoms longer than 6 months.

Lockhart-Mummery[15] in 1938 and Smithwick[16] in 1942 established the relative safety of three-stage resection for diverticulitis, *i.e.*, proximal colostomy, resection of involved segment, and delayed closure of colostomy. At this time operations were advised only for the complications of diverticular disease—perforation with abscess or peritonitis, obstruction, hemorrhage, and fistula formation. The mortality following resection was in the neighborhood of 17%, but in the group of patients for whom a three-stage operation was possible, it was reduced to six per cent. However, the prolonged morbidity of three-stage resections later encouraged the development

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of other criteria for elective one-stage resection with anastomosis, particularly in patients who seemed likely to develop complications of the disease.[17,18] These criteria will be discussed in detail in a later section.

Perforation and peritonitis were identified as the most serious complications, and because the results from transverse colostomy and pelvic drainage alone were often unsatisfactory, excision of the primary focus of the disease at the initial operation seemed a reasonable choice. Several surgeons reported that this method decreased morbidity and mortality.[19-23] However, Smithwick[24] in 1960 had again emphasized the safety of planned three-stage resections. More recent summaries of this continuing controversy have been provided by Eng and associates[25] and by Welch and Welch.[26]

Radiologic studies of colonic diverticular disease began in 1914 with a bismuth contrast enema. Subsequent barium contrast studies led to the concept of "diverticulosis" to define divertitula that showed no sign of inflammation.[27] Contrast studies showed the sigmoid to be involved first in diverticular disease, and extension occurred proximally with the passage of time.[28] Muscular spasm, increased tonicity, and foreshortening occurred in the involved segments.

The introduction of contrast angiography of the mesenteric arteries provided significant improvement in localizing the site of bleeding in diverticular disease; an unexpected finding was that more than 50% of cases with massive hemorrhage bleed from the right colon. Previously, Drapanas and associates[29] had advocated subtotal colectomy for massive hemorrhage because multiple-stage operations often were ineffective, and the site of bleeding usually could not be determined. Since that time, arteriography has provided information making it practical to use one-stage segmental resections in many cases.

A key element in the improved surgical management of colonic diverticular disease has been the advance in understanding of its etiology and the physiologic changes that occur in the bowel. Keith[30] in 1910 described tonic contracture of both longitudinal and circular muscle fibers with foreshortening, narrowing of the lumen, and increased intraluminal pressure. He observed that diverticula are extruded at weak points along the colonic wall. White and Jones[31] described the contractile response of the rectosigmoid to emotional stress and to certain drugs and irritants. Torsoli and co-workers[32] confirmed that the sigmoid has a smaller lumen and greater motor activity than other areas of the colon. Parks and Connell[33] observed that a sensation of pain or the urge to defecate develops more readily in response to stretching of the sigmoid in patients with diverticular disease than in normal control subjects. Painter and Truelove and their associates[34] have carried out extensive studies of the patterns of intraluminal pressure in colon diverticulosis. They confirmed that emotional stress and pharmacologic stimuli such as morphine may cause markedly increased pressure in diverticular subjects as compared to controls. Colon segmentation and contracture may develop intraluminal pressures as high as 90 mmHg.

The superb studies of Edwards[35] and later of Morson[36] indicated that contracture and thickening of both longitudinal and smooth muscle fibers in the sigmoid is the initial morphologic change in diverticulosis, and that this process, once initiated, extends proximalward. These observations were confirmed by the studies of Arfwidsson and Kock[37] and by Fleischner and associates.[38] Horner's[39] clinical studies of 503 cases over a period of 18 years and Havia and Manner's[40] longitudinal study over an 11-year period supported this finding. Fortunately, follow-up studies have proved that proximal extension of diverticula after sigmoid resection rarely leads to important symptoms.

An additional etiologic factor in diverticular disease is related to the ingestion of dietary fiber. Animals fed low-residue diets have developed colonic diverticulosis. Population studies among humans have suggested a higher incidence of diverticular disease in areas where dietary fiber is deficient. Longitudinal studies of diet and fiber have suggested there is a relationship between the refined diets of the twentieth century and increasing diverticular disease in the population. Feeding of bran and other high-fiber foods to patients with diverticulosis has been reported to ameliorate some of the symptoms of the disease such as cramps, spasm and diarrhea, or constipation. Because of the pathologic muscular hypertrophy and spasm of the sigmoid, Reilly[41] developed the operation of sigmoid myomotomy. This operation never has become popular in America and has not been used in our hospital.

Medical treatment of diverticulitis was improved by the introduction of sulfonamides and, later, antibiotics. On the other hand, increasing age of the population, longer survival of patients with diabetes, and an increasing number of patients with some form of immunosuppression have tended to increase the infectious risks of diverticulitis. Specific medical therapy, improved methods of diagnosis such as air contrast x-rays, angiography, and colonoscopy have been accompanied by important advances in surgical management of the disease. Fluid and electrolyte balance, blood replacement, improved techniques of anesthesia, postoperative respiratory support, parenteral nutritional supplementation, and broad-spectrum antibiotics have supported and modified surgical techniques. Lack of space prevents further discussion of these important advances; emphasis in the remainder of this paper will be on operative considerations.

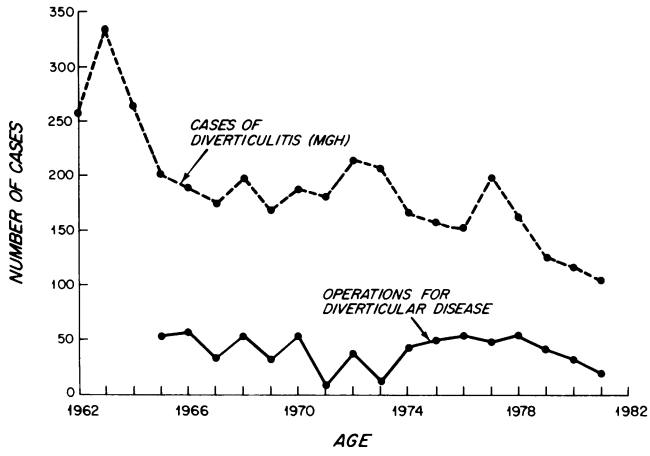

FIG. 1. Number of patients admitted for diverticulitis and number of patients with operations for diverticular disease, MGH 1962–1982.

Diverticular Disease in the Massachusetts General Hospital

During the period 1911–1983 at the Massachusetts General Hospital 1244 cases of surgically treated colonic diverticular disease have been reported.[16-18,24,42-44]

Hayden's series of 63 operations during 1911–1936 included patients with obstruction, fistula and sepsis with pericolic or pelvic abscesses, or general peritonitis. Surgical procedures included a variety of operations, the great majority of which were simple drainage. Transverse colostomy was demonstrated to be superior to cecostomy for diversion of the fecal stream. Only two patients had resection and anastomosis. Ten of the 63 patients (15.9%) died in the hospital (all of sepsis) and at least 28 more of the group (44.4%) died later of complications of the disease.[42] Thus in that period the disease was uncommon, surgical procedures were dangerous and the results were poor.

Smithwick in 1942[16] reported 33 cases treated by sigmoid resection and 42 cases treated by other operations. The indications for operation were similar to those in the earlier series. One-fourth of the cases had symptoms for less than one month. Among the 42 cases not resected, two cases (4.8%) died in the hospital, five cases (11.9%) died of the disease subsequent to discharge, and 19 cases (47.5%) had continuing disability thereafter due to the disease. Among the 33 cases treated by sigmoid resection, two cases (6.1%) died and three cases (9.1%) had continuing symptoms after surgery due to narrowed anastomoses, but there were no late deaths due to diverticular disease. Preliminary proximal colostomy protected the patients from septic consequences of anastomotic leaks, and maximum benefit in resolving local inflammation was achieved with a delay of 3 months. Resection of a segment of bowel greater than 15 cm in length added to the security of anastomotic healing by permitting the suture of more normal bowel ends. Smithwick suggested that a preliminary transverse colostomy should be done in all cases, followed in 3 to 6 months by a sigmoid resection and anastomosis. He advised the avoidance of resection for acute diverticulitis and advocated an exteriorizing procedure in those acute cases where delay was not possible.

Welch and co-workers reported a series of 114 cases of diverticular disease treated by sigmoid resection during the period 1942–1953.[17] Among 85 patients treated with preliminary transverse colostomy, 8.2% failed to resolve the inflammation in the sigmoid. One-stage resection and anastomosis was done in 40 cases (31% of all operative cases), two-stage in six, and three-stage in 65. The mortality rate after resection was 2.6%; two of the three deaths were due to anastomotic leaks. Three-stage procedures were found to be safer in cases with perforation, fistula, or obstruction, and resection of more than 15 cm of colon was associated with greater security of the anastomosis. The overall surgical mortality was 5.7% with 10 deaths in 139 cases.

The present authors studied 218 patients who had operations for diverticular disease during the period 1942–1956 and an additional 200 cases from 1960–1964.[18,43] A one-stage resection and anastomosis was carried out in 45.9% and 45.0% of cases, respectively.

By this time the criteria for operation had been expanded. They remain applicable today and are as follows:

1. Primary complications of the disease (sepsis, obstruction, hemorrhage, fistula)
2. Recurrent attacks of local inflammation (two or more)
3. Persistent tender mass.
4. Narrowing or marked deformity of the sigmoid on x-ray examination
5. Dysuria associated with diverticulosis
6. Functional colonic disturbance associated with lower-abdominal discomfort and diverticulosis
7. Rapid progression of symptoms from time of onset
8. Relative youth of the patient (<50 years)
9. Clinical or x-ray signs equivocal in ruling out carcinoma.

During the decade 1964–1973, an additional 338 cases of surgically treated colonic diverticular disease were reported.[44] The characteristics of this group are discussed more fully in the following section.

Massachusetts General Hospital Cases 1974–1983

This section includes a description of 350 cases treated surgically during the period 1974–1983 and compares the results with those of 338 surgical cases during the

decade 1964–1973. In these 20 years there were 512,200 coded discharges from the MGH; 3624 (0.7%) had the diagnosis made of diverticulitis; 688 cases, or 17.7% of those with this diagnosis, were treated surgically. (Due to late coding, a few cases have been omitted in this analysis.) There were no statistically significant changes in a comparison of the 2 decades in 1) average age, sex, location of diverticula, and duration of symptoms prior to hospital entry; 2) frequency, location of bleeding site, or mortality of patients with severe hemorrhage; 3) incidence of anastomotic leaks; 4) mortality of elective resection; and 5) overall mortality. The number of cases of diverticulitis-coded decreased from 1963 to 1982, but number of operations remained relatively constant (Fig. 1).

Age and Sex

In the decade 1974–1983, 59.1% of cases were female and 40.9% male. The average age for men was 58.8 years, for women 67.4 years and for the entire series 63.9 years. In patients under 50 years of age, men predominated (35 men, 16 women); men were comparatively less frequent in ages 50 to 70 (77 men, 100 women); and after 70 years women predominated (30 men, 92 women). In 1964–1973 the comparable sex, average age, and age distributions showed no significant differences (Fig. 2).

Location

The location of diverticular disease requiring operation during 1974–1983 included six cases in the cecum, seven in the ascending colon, four in the transverse colon, four in the descending colon, and 329 in the sigmoid colon—closely paralleling the distribution noted in the previous decade. Among 688 cases in the 2 decades combined, 651 cases or 94.6% of all operative cases involved the sigmoid colon (Fig. 3).

Associated Pathology

There was no significant difference in the associated lesions accompanying diverticular disease, *i.e.*, adenomatous polyps in 16 cases (4.7%) in 1964–1973, and 19 (5.4%) in 1974–1983, villoglandular polyps in three (0.9%) and 11 (3.1%), respectively, polypoid cancer in one and three cases, ulcerative colitis in one and zero cases, rectal prolapse in two and one cases. Operations done primarily for carcinoma have been excluded from both series. Of note is the significant increase in the numbers of patients with diabetes, steroids, other immunosuppressed states, and chronic alcoholism during the decade 1974–1983; these conditions in aggregate occurred in 11.1% of 350 total cases in that period and in only three per cent in the previous decade.

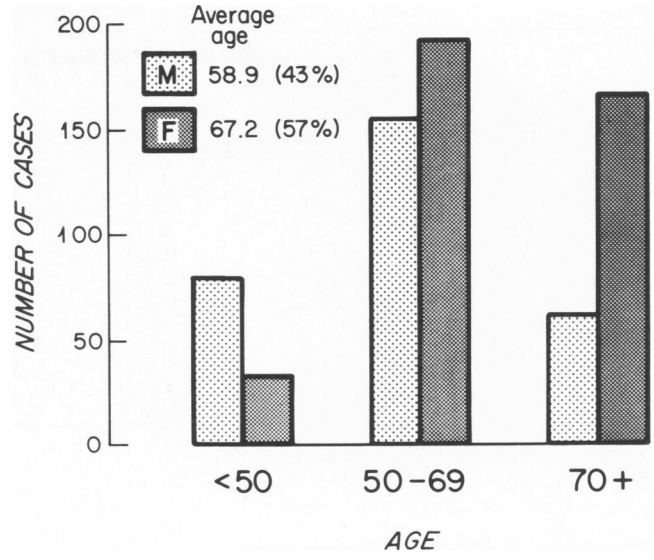

FIG. 2. Sex and age distribution—patients with diverticular disease, MGH 1964–1983.

Indications for Operation

The indications for operative treatment of diverticular disease were divided into sepsis, obstruction, bleeding, fistula, and various complaints classified as chronic pain (Table 1). Comparison with the previous decade (Table 2) shows significant changes. Inability to exclude coexisting carcinoma is another valid criterion that is less frequently applicable today with improved x-ray and colonoscopic diagnostic techniques; however, the frequency with which this influenced the decision to operate is difficult to determine in a retrospective review.

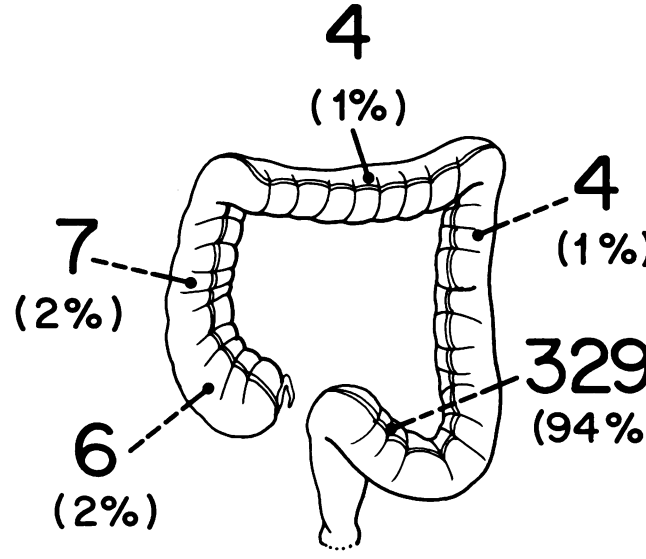

FIG. 3. Locations of primary site of diverticular disease, MGH 1974–1983.

TABLE 1. *Primary Indications for Operations, Age, and Mortality in Colonic Diverticular Disease*

Age (years)	Pericolic Abscess	Perforation with Local Peritonitis or Pelvic Abscess	General Peritonitis	Obstruction	Bleeding	Fistula	Pain	Total Cases	Per Cent
20–29	—	4	1	—	—	—	—	5	1.4
30–39	1	5	3	2	—	—	2	13	3.7
40–49	8	11	5	2	3	2	2	33	9.4
50–59	9	27 (1)	10 (2)	5	3	7	16	77	22.0
60–69	13	34 (1)	15 (5)	10	10	8	10 (1)	100	28.6
70–79	5	24 (2)	14 (2)	15	9 (3)	15	17	99	28.3
80–89	2	8 (2)	3 (2)	4 (1)	4	2	—	23	6.6
Totals	38	113 (6)	51 (11)	38 (1)	29 (3)	34	47 (1)	350 (22)	100.0
%	10.9	32.3	14.6	10.9	8.2	9.7	13.4		

Number of deaths in parentheses.

Preoperative Duration of Symptoms

The preoperative duration of symptoms (Table 3) was less than 24 hours in 16.8% of patients and less than 1 week in 36.8%; 47.8% had symptoms of greater than 1 month's duration. These figures are very similar to those of the preceding decade. One-third of the patients required surgical treatment at the first admission—a feature that has been noted for 50 years.

Operations

The operative procedures and accompanying mortality are shown in Table 4. They will be discussed with relation to the primary indication for operation.

Sepsis

Septic cases were subdivided into three broad groups in which 1) the abscess was wholly contained within the mesentery or epiploic appendages, or there was a small pericolic abscess, or there was a phlegmon of the sigmoid; 2) cases with larger pericolic abscesses or local peritonitis, or abscesses confined to the pelvis (pelvic abscess, local peritonitis); and 3) cases with free perforation and general peritonitis (general peritonitis). Septic cases accounted for 57.8% of the total in the current series, compared with 44.1% of the total in the preceding decade. Furthermore, general peritonitis was present in 14.6% of cases during 1974–1983, but only in 5.0% during 1963–1974. Sepsis has been more frequent and more severe during the last decade.

Operations performed in cases of pericolic abscesses included a one-stage resection and anastomosis in 92.1% of cases during the decade 1974–1983, while in the preceding decade this procedure was employed in only 63.6% of cases. There were no deaths among patients of this group during the past 20 years. *In toto,* 63 patients had resection and anastomosis in one stage, five in two stages, and 14 in three stages (Tables 4 and 5).

Among patients with perforation and pelvic peritonitis

TABLE 2. *Indications for Operation and Mortality, 1964–1983*

	1964–1973				1974–1983			
	Cases		Deaths		Cases		Deaths	
	Total	%	Cases	%	Total	%	Cases	%
Sepsis	149	44.1	10	6.7	202	57.8	17	8.4
Pericolic abscess	47	13.9	0	0	38	10.9	0	0
Pelvic abscess, local peritonitis	85	25.2	4	4.7	113	32.3	6	5.3
General peritonitis	17	5.0	6	35.3	51	14.6	11	21.6
Obstruction	15	4.4	0	0	38	10.9	1	2.6
Bleeding	36	10.7	3	8.3	29	8.2	3	10.3
Fistula	28	8.3	2	7.1	34	9.7	0	0
Pain	110	32.6	0	0	47	13.4	1	2.1
Total	338	100.0	15	4.4	350	100.0	22	6.3

TABLE 3. *Preoperative Duration of Symptoms of Colonic Diverticular Disease and Mortality, 1974–1983*

Days	Pericolic Abscess	Perforation with Local Peritonitis or Pelvic Abscess	General Peritonitis	Obstruction	Bleeding	Fistula	Pain	Total Cases	Per Cent	Deaths
0–1	5 (0)	12 (2)	32 (4)	1 (0)	9 (0)	0	0 (0)	59	16.8	6
1–3	4 (0)	13 (0)	9 (4)	1 (0)	7 (0)	0	1 (0)	35	10.0	4
3–7	3 (0)	21 (0)	5 (0)	3 (1)	3 (0)	0	0 (0)	35	10.0	1
7–30	14 (0)	23 (2)	5 (3)	7 (0)	3 (2)	1	1 (0)	54	15.4	7
30+	12 (0)	44 (2)	0 (0)	26 (0)	7 (1)	33	45 (1)	167	47.8	4
Totals	38	113	51	38	29	34	47	350	100.0	
Deaths	0 (0%)	6 (5.3%)	11 (21.6%)	1 (2.6%)	3 (10.3%)	0 (0%)	1 (2.1%)	22 (6.3%)		

Number of deaths in parentheses.

or abscess, a one-stage resection and anastomosis was done in 46.9% of cases in 1974–1983, but in only 10.6% during 1964–1973. Excision of the primary focus of the disease was carried out at the first operation in 77.0% of cases in 1974–1983, but in only 20.0% during the earlier decade. The mortality rate among this group of patients was 5.3% during 1974–1983, 4.7% during 1964–1973, and 5.1% over the entire 20 years (Tables 5 and 6). Deaths were due more to the extent of disease than superiority of any type of operation. In 20 years, 62 patients had a one-stage resection and anastomosis with two deaths; 16 had resection, anastomosis, and complementary transverse colostomy with zero deaths; 14 had Hartmann procedures with four deaths; 74 had a three-stage resection with four deaths.

Among patients operated on for general peritonitis, 62.7% of the current series of 51 cases had symptoms for less than 24 hours prior to operation as compared to 41.2% of 17 cases during 1964–1973 (Table 3). The primary focus of disease was excised at the first operation in 68.6% of the current series, but in only 5.9% of the cases in 1964–1973. The mortality rate in this group of cases was 21.6% in 1974–1983, compared with 35.3% in 1964–1973. One-stage resection and anastomosis was not done during 1974–1983, and was done in only one case in the prior decade (Tables 4 and 5) (Fig. 4).

Peritonitis was the cause of death in six of eight cases in which the primary focus of disease was not excised. Patients with sepsis who had the primary focus excised at the initial operation had an average hospitalization of 30 days and morbidity of 57 days; when the primary focus was not excised at the initial operation the figures were 56 and 232 days, respectively.

Obstruction

Colon obstruction was the indication for operation in 38 cases during 1974–1983 with one death (mortality rate, 2.6%). During the prior decade there were no deaths among 15 cases operated for obstruction. Duration

TABLE 4. *Operative Management of Colonic Diverticular Disease, 1974–1983*

Indication	One-stage	Two-stage*		Three-stage	Misc.	Total	Deaths
		A	B				
Pericolic abscess	35	2	0	1	0	38	0
Pelvic abscess, local peritonitis	53 (2)	9	13 (3)†	25 (1)†	13	113	6
General peritonitis	0	3	31 (3)†	15 (8)†	2	51	11
Obstruction	27	2	1 (1)†	6	2	38	1
Bleeding	22 (1)	1	2 (2)†	2	2	29	3
Fistula	12	8	2	9	3	34	0
Pain	46	0	0 (1)†	1	0	47	1
Totals	195	25	49	59	22	350	22
Per cent	55.7	7.1	14.0	16.9	6.3	100	
Deaths	3		10	9			

* A—sigmoid resection and anastomosis with concomitant transverse colostomy; B—sigmoid resection with descending sigmoid colostomy and rectal turn in.

† All deaths after first stage.
Deaths in parentheses.

TABLE 5. *First Operation for Sepsis*

	1964–1973			1974–1983		
	Cases	Deaths	%	Cases	Deaths	%
Pericolic abscess						
Primary focus excised	31	0	0	37	0	0
Primary focus not excised	13	0	0	1	0	0
Total	44	0	0	38	0	0
Pelvic abscess, local peritonitis						
Primary focus excised	17	1	5.9	87	5	5.7
Primary focus not excised	68	3	4.4	26	1	3.9
Total	85	4	4.7	113	6	5.3
General peritonitis						
Primary focus excised	1	1	100.0	35	3	8.6
Primary focus not excised	16	5	31.3	16	8	50.0
Total	17	6	35.3	51	11	21.6

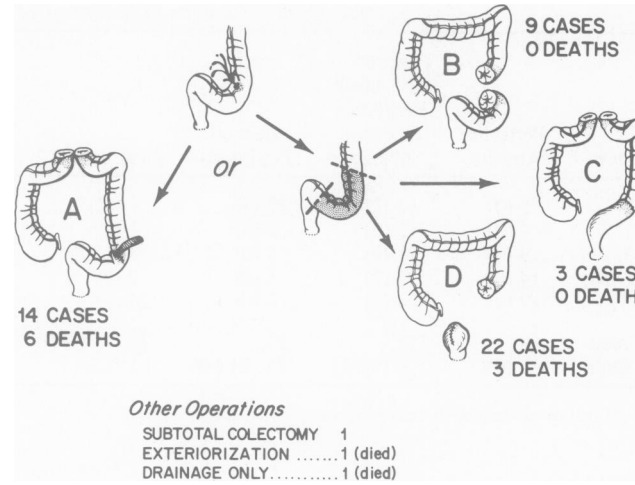

FIG. 4. Initial operations in patients with general peritonitis due to perforated diverticulitis, MGH 1974–1983.

of symptoms before surgery was greater than 30 days in 68.4% of the current series and in 60.0% of the cases during 1964–1973. One-stage resection and anastomosis was done in 71.7% of the cases during 1974–1983, and in 30.0% of cases during the prior decade.

Bleeding

Colonic bleeding was the main indication for operation in 29 cases and in 25 of the cases it was massive and acute; of these 25 cases, 18 had a segmental resection and seven subtotal colectomy. There were three deaths among those with massive hemorrhage including one patient who had a colonoscopic perforation prior to operation.

Of the 25 cases with massive hemorrhage it was possible to identify the bleeding point in 22 cases. Seven bled from the ascending colon, six from the sigmoid colon, three each from transverse and descending colon, two from the cecum, and one from the splenic flexure. In 55% of the cases, bleeding originated in diverticula proximal to the splenic flexure.

At the present time severe bleeding from the colon is most likely to be due to diverticular disease or angiodysplasia.[45] In the majority of these cases, segmental colectomy is possible when the bleeding point has been identified by arteriography. Lack of definition of a bleeding point or extensive diverticulosis are indications for subtotal colectomy (Fig. 5).

TABLE 6. *General Peritonitis–Operations and Mortality (%), 1974–1983*

	Cases	Deaths (%)
Primary lesion excised		
Resection, anastomosis, transverse colostomy	3	0
Sigmoid resection, colostomy, mucous fistula	9	0
Hartmann operation	22	3
Subtotal colectomy, ileostomy	1	0
Total	35	3 (8.6)
Primary lesion not excised		
Transverse colostomy only	2	1*
Transverse colostomy, drainage	7	2*
Transverse colostomy, suture perforation	4	2*
Transverse colostomy, small bowel resection	1	1*
Exteriorization only	1	1*
Drainage only	1	1*
Total	16	8 (50)

* Death from peritonitis.

Fistulas

Fistulas were the primary indication for operation in 35 cases or 10% of the current series. There were fistulas present that were not the primary indication for operation in an additional four cases. The locations of these fistulas included sigmoidovesical (15), sigmoidovaginal (seven), sigmoido-enteric (five), sigmoidovesico-enteric (three), sigmoidocutaneous (three), sigmoido-enteric-cutaneous (three), and assorted others (three) (Fig. 6).

Surgical treatment of these 39 cases of fistula included one-stage resection in 12 (30.8%), multistage resection in 22 (56.4%), and incompleted multistage resection and anastomosis in five (12.8%).

Chronic Pain

Chronic pain was the indication for operation in 47 cases (13.4%) of the current series. Of these, 95.7% had

symptoms for longer than 30 days before surgery. Forty-six (97.9%) were treated by one-stage resection and anastomosis. The sole death (2.1% mortality) occurred in a patient treated by one-stage resection with accidental splenic tear, splenectomy, and subsequent death from massive pulmonary embolism.

In contrast, during 1964–1973 there were 110 cases (32.5% of the total series) operated upon because of chronic pain. Of these, 82 (74.5%) were treated by one-stage resection while 28 (25.5%) were treated by multi-stage resections. There was no mortality among patients in this category.

Complications

Complications that have occurred among the 569 operations performed on the 350 cases in the current series have been classified as "operative" in 22 cases and "postoperative" in 221 cases. The most frequent operative complication was splenic injury requiring splenectomy (seven cases), followed by hemorrhage (six), colonoscopic perforation (three), and ureteral injury (two). Postoperative complications included respiratory failure (20), wound abscess (14), anastomotic leak (12), renal failure (12), peritonitis (10), incisional hernia (10), hemorrhagic shock (eight), ileus (eight), thrombocytopenia (eight), and 47 other conditions that occurred with 2.9% frequency or less.

Impaired Immune Competence

Another category of patients who may be broadly defined as having impaired immune competence seems to be increasingly associated with diverticulitis with perforation. This group of patients includes diabetics, patients on chronic steroid therapy, patients on immunosuppressive therapy associated with organ transplantation, patients with cancer who have received x-ray or chemotherapy, and chronic alcoholics. Of the current series, 11.1% fell into this category, while during the period 1964–1973 only 3.0% of patients were so classifed.

Splenectomy

Another special hazard for patients with colonic diverticular disease may be splenectomy. In the current series there were eight cases of splenectomy of whom only two made an uncomplicated recovery. Four had severe sepsis. Three patients died. Thus it seems wise to exert every effort to preserve the spleen in such cases.

Anastomotic Leaks

Anastomotic leaks occurred in 12 cases of the last 350 cases with death in two cases and prolonged hospitalization and morbidity in all. The incidence of leaks

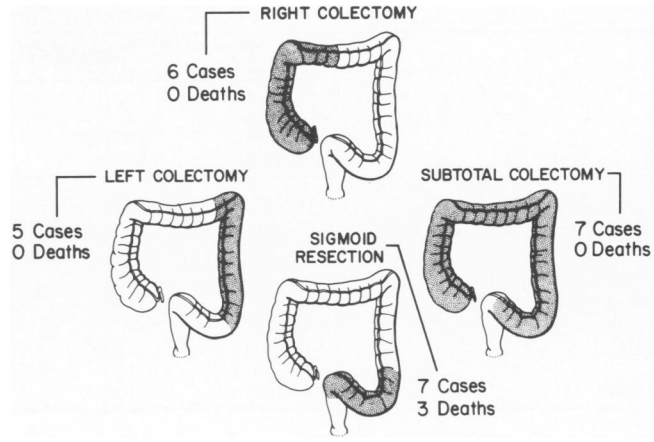

FIG. 5. Operations for acute massive hemorrhage, MGH 1974–1983.

was 3.6% and the death rate 0.6% of the total cases that had anastomoses. A transverse colostomy was present at the time the fistula developed in three patients; three were treated by transverse colostomy and drainage with one death; six had drainage only with one death.

Prevention of this complication is of prime importance and involves expert surgical judgment as to timing and type of surgical procedure as well as technical competence and antibiotic and nutritional support. The segment of bowel excised at the initial operation should encompass not only the inflamed segment but also the bowel that is contracted and foreshortened by the muscular abnormality of diverticular disease. Direct anastomosis should not be attempted in the face of gross peritoneal or pelvic sepsis. Treatment of an anastomotic leak should include prompt drainage of the pelvic abscess and transverse colostomy. While spontaneous healing occurs in approximately one-third of the cases, the majority will require re-resection of the area of failed anastomosis to

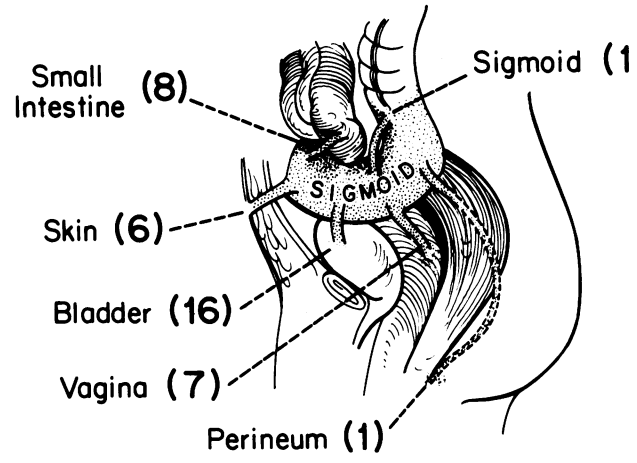

FIG. 6. Location of 39 fistulas due to diverticular disease, MGH 1974–1983.

TABLE 7. *Comparison of One-stage Resections and Anastomoses*

	1964–1973			1974–1983		
	Total Cases	One-stage Cases	Resection and Anastomosis (%)	Total Cases	One-stage Cases	Resection and Anastomosis (%)
Pericolic abscess	47	28	59.6	38	35	92.1
Pelvic abscess, local peritonitis	85	9	10.6	113	53	46.9
General peritonitis	17	1	5.9	51	0	0
Obstruction	15	5	30.0	38	27	71.1
Bleeding	36	30	83.3	29	22	75.9
Fistula	28	3	10.7	34	12	35.3
Pain	110	82	74.5	47	46	97.9
Totals	338	158	46.7	350	195	55.7

establish an adequate lumen and function before closure of the transverse colostomy.

Mortality

The postoperative length of survival in fatal cases averaged 22 days. Sepsis is the leading cause of death as it was the previous series, with general peritonitis as the most virulent form (25.0% mortality overall), followed by pelvic peritonitis or abscess (5.1% mortality overall) in the entire series of 688 cases. The mortality of one-stage resection and anastomosis was 3/195 or 1.5%, of two-stage procedures 10/72 or 13.9%, and of three-stage procedures 9/59 or 15.2%. The overall mortality was 6.3% in 1974–1983 in contrast to 4.4% in the previous decade (Tables 2, 3).

Review of the 22 cases who died among the 350 cases treated during 1974–1983 includes 11 cases that would be classified as immunosuppressed, two cases with leaking anastomosis, three cases with splenectomy, one case with wound dehiscence, one case with massive upper gastrointestinal hemorrhage, and four additional cases who developed massive sepsis without apparent predisposing cause. In the end, 18 cases died of sepsis, two cases died of pulmonary embolism, and respiratory failure occurred in one-half of the deaths. All but one case had multisystem failure at the time of death. Average survival in the group was 32.1 days, and all required intensive respiratory, nutritional, antibiotic, fluid, blood, and nursing support.

Significant differences were found in the last decade (1974–1983) when compared to the previous one (1964–1973) as follows:

1. An increased percentage of patients with impaired immunocompetence (diabetes, steroids, splenectomy, organ transplants, cancer chemotherapy, alcoholism) ($p < 0.001$) (1964–1973, 3.0% of patients; 1974–1983, 11.1%).
2. An increased percentage of patients operated upon for septic complications of diverticular disease ($p < 0.001$) (Table 2) (1964–1973, 44.1% of patients; 1974–1983, 57.8%).
3. An increased percentage of patients with sepsis who had general peritonitis ($p < 0.001$) [1964–1973, 17 of 149 patients (11.4%); 1974–1983, 51 of 202 patients (25.2%)]
4. An increased percentage of patients with general peritonitis who had the primary site of perforation resected at the initial operation ($p < 0.001$) (1964–1973, 5.9% of patients; 1974–1983, 68.6%).
5. An increased percentage of patients with local peritonitis or pelvic abscess who had the primary site of perforation resected at the initial operation ($p < 0.001$) (1964–1973, 20% of patients; 1974–1983, 77%).
6. An increase in the overall percentage of patients treated by one-stage resection and anastomosis ($p < 0.02$) (Table 7) (1964–1973, 158/338 = 46.7%; 1974–1983, 195/350 = 55.7%)

Although the mortality rate has increased in the last decade, the change is not statistically significant (1964–1973, 15/338; 1974–1983, 22/350) ($p = 0.50 > p > 0.10$).

Combining the 688 cases during the two decades 1964–1983:

1. In patients with general peritonitis, excision of the primary focus of disease at the initial operation was associated with a lower mortality rate than operations in which the primary site was not excised ($p < 0.02$).
2. In patients with local peritonitis or pelvic abscess, there was no significant difference in mortality between operations in which the primary site was excised at the first operation compared with those in which it was not (primary focus excised: 104 cases, six deaths; primary focus not excised: 94 cases, four deaths).

The major lessons learned during 1974–1983 include the need for 1) operation without delay on immunosuppressed patients with perforations, 2) resection of the primary site of perforation at the initial operation in patients with general peritonitis, 3) application of and elaboration of indications for elective resections to prevent emergency operations, 4) more frequent use of selective arteriography in cases of massive hemorrhage, and 5) care to avoid injury to the spleen during operation.

Discussion

Over the years encompassed by this longitudinal study, there has been a significant increase in the average age of patients admitted to the Massachusetts General Hospital. Thus in 1930 the average age was 36.5 years; in 1951, 44.5 years; in 1972, 47.7 years; and in 1983, 49.1 years. This gradual senescence of the hospital population should be accompanied by a higher incidence of diverticular disease, but, actually, recent admissions for diverticulitis have declined relative to admissions for all causes. In 1962, 1.0% of 25,477 admissions were for diverticular disease, while in 1982 they had declined to 0.5% of 25,536 total admissions. These changes may reflect the successful treatment of many cases of diverticulitis with antibiotics on an ambulatory status with an accompanying increase in average severity of cases that are hospitalized. It is also possible that there has been a true reduction in the number of cases of diverticulitis due to changes in diet or other undetermined factors.

When the enormous number of diverticula present in American citizens is considered, it is remarkable that so few individuals require an operation for this reason. It is impossible to establish any clear progression from diverticulosis to the serious complications of the disease in many cases. Just as it was true one-half century ago, operation is necessary as an emergency within 1 week of symptoms in approximately one-third of the patients who eventually require operation. For the majority, individual considerations will be required to make the decision as to whether or not an operation is necessary.

In addition to the criteria listed above, there has been a modest increase in the indications for operation. Persons harboring widespread diverticulosis or those with minimal symptoms are now regarded as possible candidates for prophylactic colectomy if organ transplantation is considered to be necessary (personal communication, Paul Russell). Giant diverticula have been described and are reasons for operation.[46] The dangers of diverticulitis in youth have been emphasized by Ouriel and Schwartz.[47] Morgenstern has described a type of unremitting diverticulitis that requires resection for relief as "malignant diverticulitis."[48] Diverticulitis of the right colon has not been discussed in this paper because of its relative rarity; however, it furnishes a reason for a one-stage resection and anastomosis in many instances.[49–51] Meanwhile, the results of resections done for sigmoid spasm or bowel irregularities have been shown to give relief only in a limited number of patients.[52,53]

The operative mortality is slightly but not statistically significantly higher today than in the previous decade; it is also comparable with other recent reports in the literature.[54] Sepsis remains the prime culprit. It is our belief that hospital patients now are more severely ill than they were a decade ago, when beds were more freely available, and more patients with mild disease now are treated by antibiotics at home. Furthermore, today there are more individuals with severe complicated diseases who have had immunosuppressive drugs and will have to continue their use.

The prime objectives of surgical procedures must be to assure survival, reduce morbidity, and secure relief from disabling symptoms. They can be accomplished most effectively by a one-stage segmental resection and anastomosis of the colon. Over the years there has been a steady rise in the percentage of patients who have had this procedure. Nevertheless, it remains hazardous in many instances, as for example, in patients with severe sepsis, obstruction, or long-standing colovesical fistulae. Also, multistaged operations can prove to be much safer in the hands of surgeons who are not accustomed to the great technical difficulties involved in the treatment of this disease.

The length of disability is increased by staged operations but it must be recognized in many cases they compensate by safety what is lost in terms of repeated operations and increased time of hospitalization. Thus, in 688 cases treated in the MGH in the last 20 years, a total of 1168 operations have been required, an average of 1.6 per patient.

The death rates continue to remain high in patients who require an emergency operation. If the operations done within 24 hours of admission are classified as emergencies, those from 1 to 30 days are urgent, and those from 30 days or over as elective, it is seen that the mortality of emergency operations was 10.2% (59 cases, six deaths), of urgent operations 9.7% (124 cases, twelve deaths), and of elective operations 2.4% (167 cases, four deaths). It is particularly in the group of acutely ill patients that the greatest challenges arise. Whenever possible, patients who are at risk for acute emergencies should be identified and elective resection advised before a catastrophe occurs.

Recent reports in the literature indicate great enthusiasm for resection of the primary site of perforation of the colon in the presence of general peritonitis and in

many instances of pelvic abscess or peritonitis. Our figures tend to support the use of this procedure in patients with general peritonitis. Nevertheless, it should be recognized that solid proof of the wisdom of this procedure only can be obtained by prospective, randomized trial in which only a few surgeons participate. Such a study is impossible and probably unethical in a large general hospital with the wide varieties of patients who appear with this disease. Nevertheless, we believe that our data suggest that immediate resection of the involved section of perforated bowel is the preferable one. Though the addition of an immediate anastomosis in such cases has been urged by some surgeons, we believe that it is unsafe and have not recommended it and therefore have no data to present concerning that controversy. However, support for our position has been documented in a recent publication.[26]

Colonic diverticular disease remains a demanding challenge to the surgeon. Improved results will require early diagnosis, identification of patients who should be operated upon electively before severe complications supervene, judgment concerning the necessity for and the choice of operative procedure, and technical competence, bolstered by appropriate antibiotics, respiratory, circulatory, metabolic, and nutritional support.

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Discussion

DR. DAVID B. SKINNER (Chicago, Illinois): I greatly enjoyed the paper and the opportunity to review all the excellent detail in the manuscript, which I think you will all enjoy.

We, of course, have been influenced by the experiences at the Massachusetts General Hospital over the years, and we have recently reviewed the changes in the management of these cases at our University of Chicago Medical Center over the last decade.

(Slide) Our results were reported last year at the Central Surgical Association by Drs. Jeff Alexander and Richard Karl and are remarkably similar to the results that were presented here today. I would like to bring out a few points and pose some questions to Drs. Rodkey and Welch.

One of the things that struck us is that most of the patients today present as emergency or urgent cases, and, in fact, in our series the previous history of the disease was present in only 40%. I think in the Boston experience it is about 60%. One of the dilemmas here is how to select those cases that are going to get into trouble and should have an elective operation. I would appreciate any thoughts that the authors might have on the selection of cases for elective resection.

Our indications for operation were again remarkably similar and, as in the Boston series, over one-half of our patients presented with sepsis. The authors have highlighted the issue of immunosuppressed patients and the complications they get into. In the manuscript it is suggested that such patients might undergo elective resections if they have diverticulosis. I would ask the authors to sharpen that recommendation a little bit, and tell us precisely which groups of patients they would operate on; and in a patient with pancolonic diverticulosis, would they do a subtotal colectomy or only a sigmoid resection in an immunosuppressed patient?

Finally, our results again parallel the Boston experience in that the use of primary resection and anastomosis in cases other than those with generalized peritonitis or acute bowel obstruction yielded excellent results, with no deaths in 49 such primary resections, similar to the Boston experience of a one per cent mortality in that group. However, some of our colleagues still have had good results with the three-stage approach. Again, in these very complicated, ill patients with generalized peritonitis, I wonder if Drs. Rodkey and Welch feel that there is any remaining place for the three-stage approach to the severely ill patient with diverticulitis.

DR. OLIVER H. BEAHRS (Rochester, Minnesota): I am not going to mention the number of cases, Mark; it would be disappointing.

I appreciate very much the opportunity to read the manuscript of this fine paper by Drs. Rodkey and Welch. They have carefully reviewed the state of the art in the management of diverticulitis by a review of their experience in managing the disease process by comparing data from a current decade with that of a previous decade.

Several facts, however, in their report and their manuscript are disturbing. One is that apparently there is an increase in the severity of the cases treated surgically from their hospital population. This is 18% of those patients hospitalized with the diagnosis of diverticulitis. The concern would be whether or not they are being too conservative in offering surgical management of diverticulitis to those patients not operated on.

Second, their mortality rate is about the same in the second decade as in the first; however, it is up slightly from 4.4% to 6.3%. This would raise concern regarding the change in the surgical management of their patients; that is, are they improperly selecting an operation for the specific cases, or might the resection be too extensive?

The mortality rate associated with those cases when splenectomy became necessary likewise is of concern, because undoubtedly the splenectomy was necessary because of technical error.

There is concern regarding the increased use of one-stage resection in the light of a more serious disease seen in the majority of the patients surgically treated and because of an increase in surgical mortality.

In our experience, free perforation with fecal or generalized peritonitis carries a mortality of eight per cent, and this is comparable with their mortality rate for these cases. Likewise, the best results are in those cases in which a colostomy is established and resection carried out at the first stage.

In other cases done where the operation is electively carried out, 50% of the patients with complications of abscess, perforation, localized perforation, obstruction, and 50% of the patients done at an interval between acute episodes of diverticulitis, there was no mortality.

Likewise in these cases, 42% of the patients had retained diverticulosis; the point being whether or not it is reasonable in resecting bowel for diverticulitis to attempt to remove all evidence of diverticulosis. In following these patients for as long as 7 years, less than 10% of the patients had recurrent symptoms of diverticulitis, and in this particular group of patients only four per cent required subsequent operative procedures.

In a recent study that has not been published as yet, progression of diverticulosis in patients after resection, followed for up to 10 years, there was progression of diverticulosis in 14.7%, but recurrence of diverticulitis in only 11%, and in none of these patients was reoperation necessary.

The questions that I have for the authors are these: (1) Are insufficient numbers of patients with documented diverticulitis admitted to your hospital population not being offered surgical management, and is this resulting in an increased mortality in your patients? (2) About one-half of your patients are being treated by one-stage operation, even in light of more severe disease and mortality. Might a return to a more frequent use of multistage procedures, rather than single-stage procedures produce better results? (3) Likewise, in view of the fact that diverticulosis remaining after resection for diverticulitis does not give rise to subsequent trouble, are your resections too extensive, resulting in mortality and morbidity? (4) Do you have a rule of thumb to carry out or advise surgical treatment of diverticulitis in those patients who have severe disease and are not treated surgically at the initial period of hospitalization?

PRESIDENT RAVITCH: Ollie, would you tell us whether you usually take down the splenic flexure and resect as much of the left colon as is convenient, or do you just take out the sigmoid?