

## AN APPRAISAL OF RESECTION OF THE COLON FOR DIVERTICULITIS OF THE SIGMOID\*

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THE THERAPY OF diverticulitis of the sigmoid colon has undergone profound change in recent years. A better appreciation of the severity of the complications of this disease and the increasing frequency of diverticulitis in an aging population, combined with a falling mortality rate from resection of the colon, are the most important factors that have led to revision of older therapeutic methods. It is not surprising that more radical measures carried out in an earlier phase of the disease have become more common.

These changes have occurred in the last ten, and particularly in the past five years. From January 1, 1942, to March 1, 1953, 582 patients with diverticulitis have been observed and 114 treated by sigmoid resection in the Massachusetts General Hospital (Fig. 1). From this group of patients, a number of concepts have evolved, and data have been secured on many aspects of the disease. This paper will consider the material derived from a study of these cases (Table I).

Prior to the advent of antibiotics, the surgical therapy of diverticulitis was restricted essentially to that of its complications. A definitive attack on the offending section of colon was made comparatively rarely, while palliative procedures, such as colostomy, were frequent. The importance of sigmoid resection as a method of cure of

the disease was emphasized by Smithwick<sup>11</sup> in 1942, and has been confirmed by many others, such as Pemberton, Black and Maino,<sup>8</sup> Mayo and Blunt,<sup>5</sup> Morton,<sup>5</sup> Boyden,<sup>1</sup> and Colcock.<sup>2</sup> Smithwick had found 333 cases of sigmoid diverticulitis in the Massachusetts General Hospital from 1926 to 1942, of which 19.2 per cent were treated surgically, with resection being performed in 33 cases, or 10 per cent of the total. His observation that by far the best results were obtained with resection stimulated further investigation. He preferred a three-stage operation in most instances. In later years a much more radical attack has been urged by some surgeons, particularly by Boyden, believing that the indications for surgery should be extended, and that most of these resections can be accomplished in one stage (Table II).

### INCIDENCE

The incidence of diverticulosis and diverticulitis of the colon is of great interest, and depends, as has been shown by many investigators, on the age of the patient. While the exact frequency in the population at large is impossible to determine, it is usually assumed that diverticula are present in 5 to 10 per cent of all individuals over 40 years of age, that about a fifth of them develop clinical diverticulitis, and that a fifth of those with diverticulitis will require surgery.

Diverticula were noted in 7 per cent of a series of autopsies from the Mayo Clinic

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reported by Ochsner and Bargaen,<sup>7</sup> while Morton<sup>6</sup> found diverticulosis in 6.5 per cent of 8500 autopsies. This corresponds fairly closely with an 8.5 per cent incidence found by barium enema in a series of 47,000 such examinations performed in the Mayo Clinic, reported by Pemberton, Black and Maino. An 8 per cent incidence was also noted by Grout<sup>3</sup> in a series of 2179 consecutive barium enemas.

Pemberton *et al.* found diverticulitis was present in 15 per cent of all cases with diverticulosis, and surgical treatment was carried out in 24 per cent of the cases of diverticulitis.

The incidence of diverticulitis in patients undergoing barium enemas in hospitals will tend to exaggerate the frequency of the disease in the general population since sick, symptomatic patients are much more likely to be examined than are those without bowel symptoms. However, from the point of view of the surgeon, these figures are of more interest than those obtained from the general population.

A check of 2000 consecutive barium enemas done in the Massachusetts General Hospital in the last three years has revealed some interesting facts (Fig. 2). Essentially, neither diverticulosis or diverticulitis were observed below the age of 35. From that point onward, there was a steady increase in the frequency of the disease as age progressed, so that at age 85, diverticula could be demonstrated in approximately two-thirds of the patients. The incidence of diverticulitis likewise showed a steady rise which lagged well behind the curve for diverticulosis, but ascended more sharply with age. Thus, in the sixth decade, approximately one-fifth of all patients with diverticulosis demonstrated radiologic evidence of diverticulitis, while in the ninth decade, this fraction had increased to one-third.

These figures demonstrate that a very important feature in the increasing frequency of this disease is the rising average

age of our population. It is of interest in this respect to note that the average age of patients admitted to our hospital was 36.5 years in 1930, and 44.5 years in 1951. At the present time, diverticulosis is demonstrated in a third of all patients who have barium enemas, and diverticulitis in 8.9 per cent. It will be observed that this incidence of the lesion is considerably higher than that reported by other authors.

The age and sex incidence of the 114 patients undergoing resection is shown in Table III. The ages varied from 29 to 87, with males predominating in the younger age groups and females in the later.

#### INDICATIONS FOR OPERATION

It has been accepted that surgery is not indicated for diverticulosis of the colon. Uncomplicated diverticulitis also has been treated in the past by the physician rather than the surgeon, but a revision of this policy now is occurring. The chief indications for surgery have been those of the complications of diverticulitis—perforation, obstruction, and bleeding. Finally, in some instances, the possibility of cancer is great enough to warrant surgical extirpation of the disease. The chief indication for operation in this series of cases is shown in Table IV.

Perforations furnish the most common reason for surgery. They vary greatly in significance. Undoubtedly many instances of exacerbations of diverticulitis are actually small, walled-off perforations that later, after conservative therapy, drain spontaneously into the bowel. On the other hand, when the perforation involves the general peritoneal cavity, the necessity for surgery is immediately apparent. Midway in significance between these two groups are the localized perforations with abscess formation. If they occur above the pelvis, a tender mass usually is palpable; if they occur within the pelvis, fistula formation to blad-

der, vagina, small intestine, ureter, urethra, or perineum is frequent.

The great majority of the deaths from diverticulitis is due to perforation. Unfortunately, premonitory symptoms are absent in about a quarter of the cases before the perforation occurs. On the other hand, the slow perforations that finally result in fistula formation demonstrate a long period of symptoms before the fistula appears.

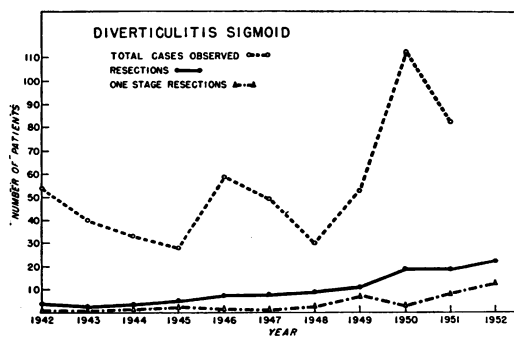


FIG. 1

Local perforations with abscess formation usually respond immediately to conservative measures and to antibiotics. However, the recurrence rate tends to be high. We believe that, unless contraindicated by other disease, an aggressive surgical attack should be carried out on these patients. A transverse colostomy is done and local drainage avoided when possible. A later resection of the involved area of the bowel is carried out.

*Obstruction* is a common indication for operation. It is usually not acute nor complete. Repeated attacks of diverticulitis usually result in a long, narrow segment of sigmoid that produces a slow distention of the proximal colon which consequently becomes edematous and technically difficult to use for an anastomosis.

*Bleeding* is not an uncommon symptom of diverticulitis. It has been reported in 16.5 per cent of 200 patients observed by Le-Royer and White,<sup>4</sup> and in from 15 to 20 per cent of patients by other observers. Young

and Young<sup>12</sup> found bleeding in 26 per cent of their patients. In the present series, rectal bleeding had been noted in 27 per cent of the patients who had resection, and subsided in all but one instance that will be mentioned below, after the sigmoid had been removed.

While bleeding was usually small in amount, and noted infrequently in bowel movements, in five cases it furnished the

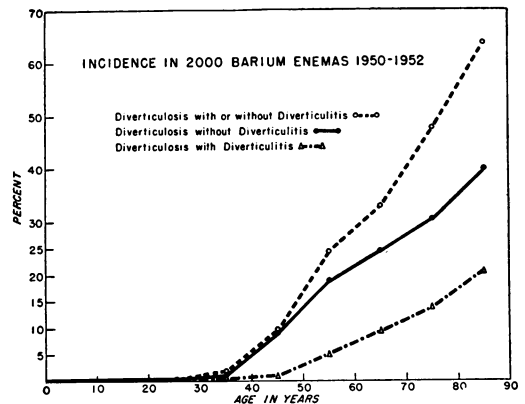


FIG. 2

major indication for operation. In three instances, truly massive hemorrhage occurred; two of these patients going into shock from acute blood loss. One patient had a sigmoid resection for massive bleeding from diverticulitis; extensive diverticulosis of the colon was present, and a second major hemorrhage necessitated a total colectomy. The patient has remained well since the second operation (Fig. 3).

The site from which the bleeding originates is of great interest, but is impossible to determine in most instances. Coincidental hemorrhoids, cancer, polyps, pseudo-polyps, acute non-specific ulcers occurring in an area of diverticulitis, or the diverticulitis itself all may be involved. Persistent daily bleeding is much more suggestive of cancer than diverticulitis. An aggressive attitude toward a lesion of the sigmoid of indeterminate etiology is indicated when it is realized that, in our hospital, bleeding from sig-

moid cancer is encountered approximately five times as frequently as bleeding from sigmoid diverticulitis.

*Uncomplicated diverticulitis* now must be considered an important indication for operation and one that will be of increased significance in the future. However, this attitude has developed only recently and has not been accepted generally. Acute diver-

TABLE I. *Diverticulitis of Sigmoid Colon Mass. General Hospital 1942-1953.*

	Total Cases	Died	%
No operation. . . . .	443	3	0.6
Laparotomy only . . . . .	12	1	8
Colostomy or cecostomy only . . . . .	13	4	31
Resection, in 1, 2, or 3 stages . . . . .	114	3	2.6
Total . . . . .	582	11	1.7

ticulitis with spasm has been considered to be a self-limited disease which should be treated expectantly and not by operation. There are several considerations that suggest this older plan should be modified in favor of a much more active policy. In the first place, repeated attacks of diverticulitis are a real hazard to the life of the patient. The longer symptoms persist, the more frequently serious complications appear. Secondly, the attacks of diverticulitis, even though no complications develop, are most unpleasant for the patient; there is no reason why they should be endured if there is any way to avoid them. Finally, if resection is carried out for diverticulitis in the absence of complications, it will be possible in most of the cases to carry out a one-stage resection and anastomosis, avoiding the prolonged illness and colostomy care that is necessary with the two or three-stage operations. It should not be inferred, however, that resection is being urged while the diverticulitis is acute. An attempt to quiet down the active manifestations of the disease should be made, and operation planned in the interval phase.

It is to be hoped that increasing experience will lead to a more exact definition of patients in this category who should have a resection. At the present time, several groups of patients may be isolated who should, in the absence of serious contraindications, be treated in this way. They are:

1. *Patients who have repeated attacks of diverticulitis while on a good medical regimen.* If a patient will lose weight, follow a diet carefully, is a good operative risk and continues to have repeated attacks of cramps, diarrhea, bloating, tenesmus, or low back pain, resection is advised. An illustrative example is shown in Figure 4.

2. *Diverticulitis appearing in patients under 50 years of age.* There is evidence which indicates that this disease in young patients tends to be more severe than in the older groups. For example, while only 6 per

TABLE II. *Diverticulitis of Sigmoid Reported Series of Cases.*

Year	Author	% of all Cases Resected	Number of Resections	Number of 1-stage Resections
1942	Smithwick . . . .	10	33	6
1946	Morton . . . . .	15	16	9
1947	Pemberton . . . .	18	301	24
1950	Boyden . . . . .	?	32	20
1953	Present Series	17	114	40

cent of all observed cases of diverticulitis occurred under 50 years of age, of those who required resection, 18 per cent were under 50. Furthermore, as shown above, increasing age will lead to more diverticulitis, and it is wise to resect while the patient is in good condition.

3. *Patients demonstrating severe persistent deformity of the the sigmoid on radiologic examination.* Such changes indicate major organic changes rather than spasm, and furnish a definite prognosis of serious complications unless resection is done.

4. *Patients who develop urinary symptoms in the presence of diverticulitis.* This is a serious sign, particularly in the male pa-

tient. It is frequently the premonitory warning of a sigmoid-vesical fistula and indicates early operation. Mayo and Blunt found the average duration of symptoms of diverticulitis to be 16.8 months before a vesico-sigmoidal fistula developed.

In our series of 114 resections, 38 per cent were done for uncomplicated diverticulitis.



FIG. 3. Extensive diverticulosis of entire colon with recurrent hemorrhage after sigmoidectomy. Cure followed resection of remainder of colon and ileoproctostomy.

Two-thirds of these were treated by single stage operations.

*Suspected cancer* is the final indication for resection. In this series, the preoperative diagnosis was cancer in 18 per cent of the patients who had resection performed. Pemberton *et al.* have stated that nearly 25 per cent of all resected specimens of diverticulitis cannot be distinguished from cancer until the bowel has been opened by the pathologist. In other instances, where the radiologist has reported typical diverticulitis, cancer has been found on resection. The differential diagnosis of cancer and

diverticulitis depends chiefly on the radiologist and has been considered thoroughly by Schatzki.<sup>10</sup> Co-existing diverticulitis and cancer are rare, as pointed out in the collective review by Rowe and Kollmar.<sup>9</sup> In a series of 430 resected carcinomas of the sigmoid observed during the last decade in the Massachusetts General Hospital, the pathologist noted diverticulosis in 18 cases and diverticulitis in five others. Obviously, unless all cases of diverticulitis are resected, fine clinical judgment is often required and errors will occur occasionally. These errors will be minimized if resection is urged for the following cases:

- (a) Those with repetitive bleeding, particularly if it is of daily occurrence.
- (b) Those with obstruction.
- (c) Those with a radiologic picture that is not entirely typical of diverticulitis.
- (d) Patients treated conservatively, whose symptoms do not subside rapidly on medical therapy.
- (e) Patients who have had colostomy performed and fail to improve, and particularly those who continue to discharge bloody mucus by rectum.
- (f) Patients with cytologic smears of rectal washings that are positive for cancer.

#### OPERATIONS FOR DIVERTICULITIS

In general terms, operations for diverticulitis are either palliative, when one of the complications is treated without removal of the sigmoid, or curative, when the involved area of colon is resected. The palliative procedures must be discussed briefly, chiefly to point out their inadequacies.

*Exploratory laparotomy* has been employed in several cases. An erroneous preoperative diagnosis, particularly of acute appendicitis, left ovarian cyst, or pelvic tumor, may have led to operation or a low-grade peritonitis due to a perforated diverticulum encountered that, in the surgeon's opinion, required no other specific therapy than diagnosis. Incision and drainage of a

localized abscess has often been added, usually at the price of a fecal fistula. Of 12 cases treated by this method in the Massachusetts General Hospital during this period, four have required resection at a later date because of a recurrence of symptoms.

A *cecostomy* was made in several instances because of complete obstruction. It will tide the patient over this particular episode, but an unmanageable fecal fistula will result, unless the sigmoid is resected. As a preliminary operation preceding resection for diverticulitis, in contrast to most carcinomas, it has proved to be a most inadequate operation. The large amount of induration and inflammation about diverticulitis requires preliminary defunctioning of the bowel rather than decompression. Of the five cases in which cecostomy for diverticulitis was performed during this period, the procedure could not be called satisfactory in any.

*Colostomy* has, in the past, been used as a definitive surgical procedure for diverticulitis. A transverse colostomy has been made with the expectation that it could be closed at a later date when the sigmoid inflammation subsided. In our hospital, this method was abandoned long ago, so that its efficacy cannot be assessed from recent figures. However, in Smithwick's earlier series, later closure of the colostomy without colon resection was unsuccessful in over 45 per cent of the cases. Pemberton found that of 29 patients treated by colostomy without bowel resection, 20 had further exacerbation after closure of the colostomy.

It should not be assumed that colostomy will result in symptomatic improvement in all patients with diverticulitis, since a self-perpetuating abscess or phlegmon of the colon or fistula may have been established which will not subside, even with fecal diversion. This failure to respond to colostomy was noted by Smithwick in 25 per cent of his cases. In our series, failure to improve

after colostomy was manifested by unremitting symptoms in three patients and by death in four others. Since 85 colostomies were made during this period, this means that 8.2 per cent of the patients did not respond to colostomy. Also, whenever colos-

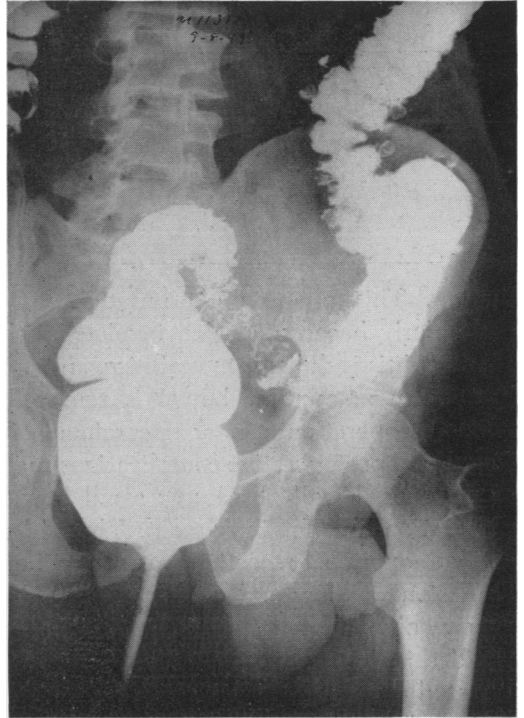


FIG. 4. Localized diverticulitis of the sigmoid treatment by one-stage resection and anastomosis.

tomy results in no improvement, the possibility of an erroneous diagnosis always must be considered, since the lesion actually may be cancer, rather than diverticulitis.

Our experience with these palliative operations, therefore, is not happy. Operations that treat only one of the complications of diverticulitis and do not remove the area involved are apt to be unsatisfactory. We believe that if a patient is ill enough to require an operation for diverticulitis, that he ultimately should have a sigmoid resection, and that all palliative procedures should be planned with that objective.

## SIGMOID RESECTION FOR DIVERTICULITIS

In brief, resection of the sigmoid can be performed in five ways. The Mikulicz, or obstructive resection, has been recommended highly by Pemberton *et al.* In our hospital, this operation has been discarded, except in the rare instance in which a free perforation can be exteriorized easily in this

TABLE III. Age and Sex Incidence: 114 Resections for Sigmoid Diverticulitis.

	20-29	30-39	40-49	50-59	60-69	70-79	80-89
Males.....	1	3	12	19	15	3	0
53 or 46.5%							
Females.....	0	1	6	20	20	13	1
61 or 53.5%							

fashion. This operation is unsatisfactory, particularly because a colon involved with diverticulitis is difficult to mobilize, and too limited an amount of bowel is removed. Also, the operation is poor if carcinoma is found, and postoperative complications such as abdominal wall abscess or small bowel obstruction are not infrequent. The Miles abdominoperineal resection was used when the lesion was low and was believed to be cancer; obviously, it should be possible to avoid this destructive operation, unless associated cancer of the rectum is present.

Resection with anastomosis can be carried out in three, two, or one stages, depending on whether a colostomy is made preliminary to the resection, concomitantly with it or omitted entirely. Increasing experience has shown that one-stage operations can be carried out much more frequently than in the past. In some quarters, an attempt has been made to extend this procedure to nearly all cases. Other surgeons maintain an essentially conservative attitude, staging nearly all operations. Certainly, the selection of the type of resection and anastomosis that is to be used in the individual case is one of the most important decisions that the surgeon must make.

Most important, the three-stage resection is safer than the one-stage. The two deaths

following resection in this series due to technical reasons occurred after anastomosis with inadequate decompression, and both were due to dehiscence of the anastomosis in poorly prepared bowel.

We believe one-stage operations should be performed when the following conditions obtain. The patient must be in good general condition, with normal blood chemistry. Patients with uncomplicated diverticulitis, or those in whom the chief indication for operation is bleeding, are preferred. There must be a flexible rectum of good calibre, as determined by the sigmoidoscope and barium enema, so that the anastomosis can be made above the peritoneal floor. The barium enema must demonstrate diverticulitis without excessive dilatation of the proximal colon, and the bowel must not be acutely or

TABLE IV. Diverticulitis of Sigmoid Colon Mass. General Hospital 1942-1953.

Indications for Resection	
	Per Cent of Total
Diverticulitis.....	38
Complications of diverticulitis	
Perforation.....	27
Fistula formation.....	10
Obstruction.....	20
Bleeding.....	5
Preoperative diagnosis cancer in 18% of total.	

subacutely obstructed. There should be no evidence of peritonitis or of fistula formation. Small abscesses in the mesentery can be excised with the colon and do not contraindicate a one-stage operation. The operation requires a well-prepared colon, and hence should not be done when surgery has been necessary as an emergency procedure.

If a one-stage operation is planned, a laparotomy is carried out. If it appears probable that the sigmoid can be mobilized and essentially normal colon is available above and below the area of diverticulitis, resection is done. If the sigmoid is too extensively adherent to mobilize, it is better to do a colostomy and plan on a later resection. If resection is possible but the anastomosis is

not completely satisfactory, a concomitant transverse colostomy should be done.

In the present series, one-stage resections with anastomoses were carried out in 40 instances, two-stage in 6, and three-stage in 65. There is an increasing tendency toward the one-stage operation, so that in the past two years 57 per cent of the cases have been

tensive in the descending colon as well, and a long paramedian incision may be necessary to free the left transverse colon for the anastomosis, the colostomy must be on the right.

Regardless of the site of the abdominal wall incision, the transverse colon is delivered and pulled well to the left so that the

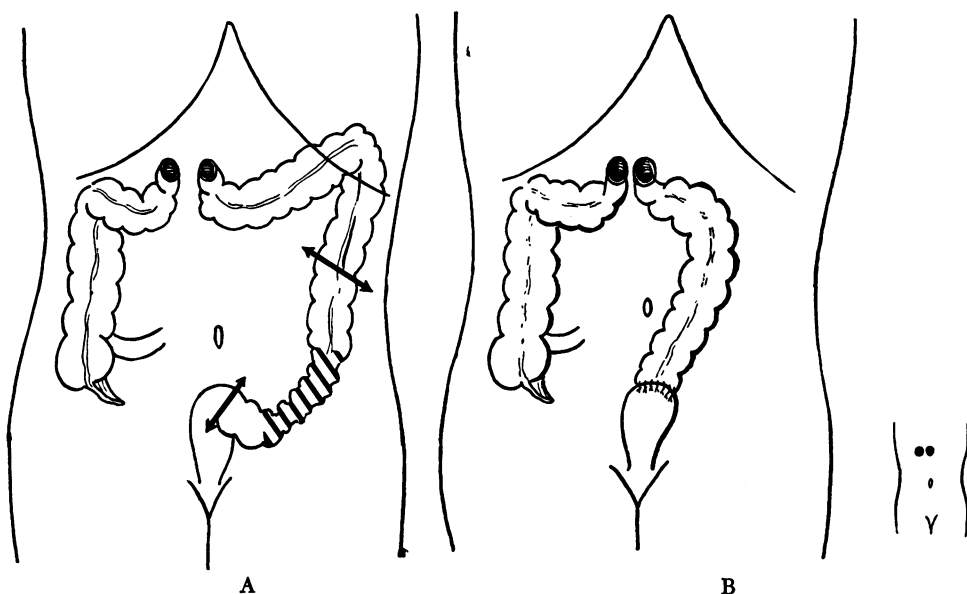


FIG. 5 A. Three-stage resection. First stage—transverse colostomy. Area to be resected shown by arrows.

B. Three-stage resection. Second stage—sigmoid has been resected. At the third stage the colostomy will be closed.

done in that fashion. The other three cases had Miles' abdominoperineal resections.

#### TECHNICAL DETAILS

Certain technical details of the various operative procedures merit discussion. The three-stage operation will be considered first (Fig. 5).

The *colostomy* is made in the transverse colon. Whether the incision is to be made to the right or left of the midline usually is determined on an individual basis. Well-localized sigmoid diverticulitis that will not require mobilization of the splenic flexure, or the presence of gallstones, or a duodenal ulcer make a left upper quadrant incision feasible. However, when diverticula are ex-

colostomy is made in the right half of the colon. The omentum is freed sufficiently so that it will not be drawn into the incision when the wound is closed. The colon is cut between Kocher clamps with the cautery, and the mesentery divided so that the two ends of the colon can be separated by a bridge of skin. The incision is then closed in layers. No attempt is made to suture the afferent and efferent limbs of the colon to form a spur, since a formal operative closure is planned for a later date.

Several warnings are necessary. Altogether too frequently the colostomy is made in the descending colon immediately above the area of diverticulitis. Occasionally the colostomy may be made close to the splenic



flexure, or the transverse colon withdrawn through the upper end of a left lower abdominal exploratory incision. In all of these cases, the surgeon's freedom of action at the time of resection is compromised seriously.

Furthermore, a loop colostomy should not be made. The distal colon should be defunctioned completely, a feature not always

age interval between colostomy and resection was slightly over three months in this series.

Difficult technical problems occur when the disease continues to progress after colostomy. In some patients, evidence of obstruction continues, since the small intestine may be obstructed simultaneously by adhesions to the inflamed sigmoid. If this is suspected, an exploratory laparotomy is necessary. The adhesion should be divided whenever possible, and if this is not practical, a side-to-side anastomosis of the small intestine made about the adherent area in addition to the colostomy.

In other instances, evidence of sepsis continues or increases after colostomy. Incision and drainage is usually unsuccessful and may be dangerous unless preceded by laparotomy. For example, recently a large fluctuant mass in the pouch of Douglas in the presence of extensive diverticulitis was found to be a suppurating dermoid cyst rather than an abscess originating from the diverticulitis. At any rate, in nearly all of these cases, excision of the involved colon will be required before improvement occurs.

*Resection and anastomosis.* Preferably a long oblique left lower quadrant incision is used. The rectus muscle is freed and retracted medially. A left paramedian incision is made whenever complete mobilization of the splenic flexure is contemplated. The sigmoid flexure is mobilized completely when there are numerous diverticula in the descending colon, so that if necessary, the entire left colon can be resected. No attempt is made to remove all isolated diverticula that are visible on the barium enema. Enough colon is removed to eliminate the sigmoid loop and to secure flexible, relatively normal bowel for the anastomosis. The left ureter is often densely adherent, and must be identified so that it can be retracted gently and its blood supply spared. Preliminary left ureteral catheterization can be done to aid in the identification of the

TABLE V. *Diverticulitis of Sigmoid Colon  
Mass. General Hospital 1942-1953.  
Poor Results Following Resection.*

	Number of Cases	Cause
Operative Deaths.....	3	Dehiscence, anastomosis (2) Bronchopneumonia (1)
Recurrence		
Recurrent Fistulae....	2	Inadequate resection
Recurrent Hemorrhage.	1	Inadequate resection
(Cure in all cases by secondary resection).		
Persistent Mild Symptoms	2	

accomplished if the transverse colon is not completely divided. For the same reason, a skin bridge between the two stomas is desirable.

The use of the ascending colon for the colostomy has been advocated by some surgeons to allow greater mobility of the left colon at the time of resection. However, such a colostomy is such a terrible problem to manage that we do not advise it.

The time period that should elapse between colostomy and resection has been determined on several bases. There is no doubt that this interval has been protracted unduly in the past. The patient should be gaining weight and evidence of peritoneal irritation should have disappeared. If the patient does not improve, concomitant cancer is highly probable and resection is planned three to four weeks after the colostomy. On the other hand, if peritonitis has been extensive, a delay of six months is desirable. While the operation may still be very difficult at the end of this long interval, it is unlikely that it would be made any simpler by further procrastination. Most of the resections should be done not later than three months after the colostomy. The aver-

ureter, although we have never felt this maneuver necessary.

Fistulous tracts must be divided. Usually they will have healed at this time, but any defect in the wall of the bladder in particular must be closed carefully. If the lesion does not suggest cancer, only a small wedge of mesentery needs to be resected, and the superior hemorrhoidal artery does not need to be sacrificed. Usually the lower margin of the section of colon to be removed will be 3 to 4 cm. above the peritoneal floor. If the lesion is unusually low, the extraperitoneal rectum may be used for the anastomosis.

After mobilization is complete, the bowel is divided proximally and distally between Allen clamps. At least 15 cm. of colon should be removed. The specimen is examined immediately by the pathologist to rule out any coincidental carcinoma that would demand a wider resection of the mesentery.

The anastomosis usually is difficult, since it is made in defunctioned, narrow bowel that still is edematous and thickened. It is not surprising that in the past, strictures sometimes followed these anastomoses. Important factors contributing to stricture formation were, (1) the use of badly inflamed bowel for the anastomosis after too conservative resection; (2) the Parker-Kerr aseptic anastomosis with the inversion of a wide diaphragm; (3) the use of two layers of continuous catgut sutures; or (4) the use of extraperitoneal rectum for the anastomosis.

A meticulous open anastomosis is made. When the lumen of the colon is of reasonable size, a two-layer anastomosis is preferred. The outer layer is of interrupted cotton. The inner, of very fine catgut, is made either with interrupted sutures, or a running lock suture, so that a purse-string effect is avoided. When the lumen is unusually narrow, hemostasis is secured by individual ligation of vessels, and a single layer of non-absorbable sutures used.

Finally, the rent in the mesentery is closed. No attempt is made to peritonealize the left gutter.

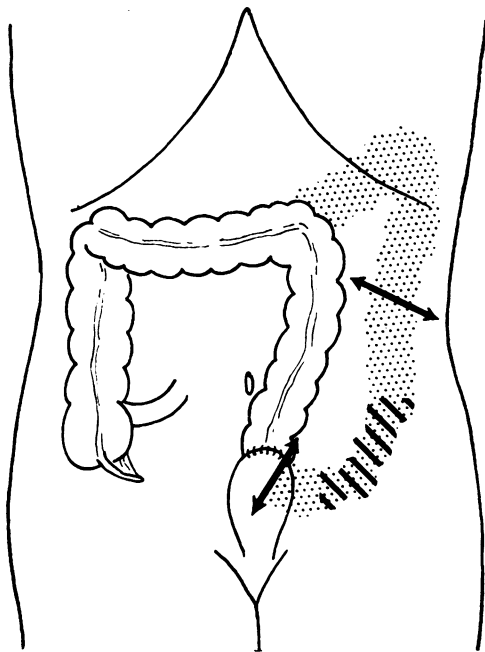


FIG. 6. One-stage resection. Resected area shown between arrows.

#### CLOSURE OF THE COLOSTOMY

The date of closure of the colostomy depends on several factors. Usually when the lumen of the anastomosed colon is wide and a technically satisfactory anastomosis has been obtained, closure can be carried out ten days after the resection. Under other circumstances, the closure is made a month later. In this series of cases, the average interval between resection and colostomy closure was three weeks. It is always preceded by saline irrigations of the left colon to assure functional competence. In only rare instances have barium enemas been necessary to confirm the adequacy of the anastomosis.

The colostomy is closed under general anesthesia. The stomas are mobilized completely and omental adhesions about the incision are divided. Both limbs of the colon are sectioned through normal bowel, and an

open end-to-end, two-layer anastomosis performed. The mesenteric rent is closed, and the colon returned to the peritoneal cavity. The incision is closed in layers if the patient is thin, but if he is obese or there has been wide dissection in the abdominal wall, secondary closure is done.

#### ONE-STAGE RESECTION

Assuming that the requirements for the one-stage resection mentioned above have been met, the resection is carried out on a well-prepared colon. Preliminary administration of sulfathalidine for five days is advisable. The resection and anastomosis are carried out in the same fashion as described above (Fig. 6). In rare instances, technical difficulties may make concomitant colostomy wise. A narrow lumen of the bowel, undue bleeding deep in the pelvis, a hematoma near the anastomosis, or any contamination will make it wise to defunction the colon completely.

#### COMPLICATIONS AND DEATHS

Resection of the sigmoid for diverticulitis was followed by three deaths and 30 other complications in 24 patients. Two deaths occurred in old, depleted subjects with chronic obstruction. The first patient, known to be a poor risk, was subjected to a one-stage resection and anastomosis after a month's observation in the hospital. The second patient had a cecostomy, followed by a resection and anastomosis ten days later. Both patients died of peritonitis secondary to dehiscence of the anastomosis. In retrospect, transverse colostomies should have been employed in both of them and the resections should have been postponed until their condition improved.

The third death followed a planned, three-stage procedure five days after resection from bronchopneumonia. At that time, penicillin was not available.

The most important non-fatal complications were referable to the anastomosis. Pelvic abscesses were encountered in five cases; in three of them a sigmoido-vaginal

fistula resulted. Stenosis of the anastomosis probably was the underlying factor in two of these cases, while in another the section of sigmoid resected was so short that abnormal colon must have been used for the anastomosis. Other manifestations of sepsis were general peritonitis, subdiaphragmatic abscess, and wound infection. Serious post-operative intestinal obstruction was encountered twice, requiring a cecostomy for decompression in one instance. Thrombophlebitis was observed in three instances. The other complications were generally of little significance.

Minor palliative procedures were followed by four deaths. In one, a colostomy was made in preparation for a resection of a sigmoido-vesical fistula. The patient died suddenly two weeks later, apparently of cardiac failure, though autopsy revealed only pyelonephritis. A second patient died of uncontrolled urinary tract infection from a large fistula. Another patient developed a necrotizing ileo-colitis proximal to a chronic diverticulitis and succumbed to peritonitis after a transverse colostomy. The last one died of a gangrenous loop of ileum that was adherent to an obstructing diverticulitis.

#### RESULTS OF OPERATION

The effects of operation can be assessed most accurately by division into the short-term and long-term results. Within a year from the date of operation, poor results were noted in three instances in this series. Recurrent fistulae followed inadequate resections in two instances. In the third, massive hemorrhage recurred after sigmoid resection. The first two patients were relieved by a further limited resection, while in the third instance, a nearly total colectomy with anastomosis of ileum to rectum was necessary for cure.

The length of the removed segment of colon has an important bearing on the immediate results. The lengths of sigmoid resected in these three cases were 7.5, 12,

and 15 cm. Since the average length of resected colon measured by the pathologist in the entire series was 20 cm., it is clear that these resections were too conservative. In recent years, the tendency has been to excise longer segments of the colon. However, in nearly all instances, isolated diverticula have been left proximal to the line of anastomosis. This apparently has had no influence on the final outcome.

Further studies on the late follow-up results after resection are necessary. Since most of our patients have had their operations comparatively recently, we do not have extensive data on this point. However, 24 patients have been followed four to ten years after resection, with an average of six years. During this time, two patients have had isolated mild attacks of pain, suggesting recurrent diverticulitis. Both responded readily to dietary measures.

#### SUMMARY AND CONCLUSIONS

Diverticulosis of the colon is demonstrated in approximately a third of the patients who have barium enemas in the Massachusetts General Hospital, and diverticulitis in 8.9 per cent. Of 582 patients observed with the clinical diagnosis of diverticulitis during the years 1942 to 1953, 114 had resections of the colon performed with a resection mortality of 2.6 per cent. While the complications of diverticulitis—perforation, obstruction, and hemorrhage—and the confusion with cancer have furnished the main indications for operation in the past, uncomplicated diverticulitis now must be accepted as an important reason for sigmoid resection. In this category are included patients who have repeated attacks of diverticulitis while on a good medical regimen, who are under 50 years of age, who have severe persistent deformity of the sigmoid, or who develop urinary symptoms in the presence of this disease.

Palliative operations have proved unsatisfactory, so that whenever surgery is necessary for this disease, resection and anasto-

mosis of the involved segment should be planned as the ultimate procedure. While in 40 of these cases this operation was done in a single stage, it is suggested that a rather cautious attitude be maintained concerning the applicability of the single stage procedure. The three-stage operation was found to be safer, particularly in poor-risk patients or in those with perforation, fistula, or obstruction. A wide resection, that now averages 20 cm. of colon, is recommended to prevent recurrence. The final results have been excellent.

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