Primary Resection and Anastomosis for Treatment of Acute Diverticulitis

AUDENCIO ALANIS, M.D., GEORGE K. PAPANICOLAOU, M.D.,
RAAFAT R. TADROS, M.D., L. PETER FIELDING, M.D.

Alanis A, Papanicolaou GK, Tadros RR, Fielding LP. Primary resection and anastomosis for treatment of acute diverticulitis. Dis Colon Rectum 1989;32:933–939.

The patterns of presentation and associated treatments of 65 patients with acute perforated diverticulitis of the left colon have been reviewed. Four types of operations were identified: primary resection with anastomosis (group I, N = 29), primary resection with anastomosis and protective colostomy (group II, N = 5), primary resection with Hartmann procedure (group III, N = 26), and delayed resection three-staged procedure (group IV, N = 5). The severity of disease was also classified (stages I to IV). Postoperative mortality rates in the first two groups were lower than that of the Hartmann group (3.4 vs. 15.3 percent). The mean length of initial hospitalization was 16 ± 1.2 days for group I, 18.2 ± 4.4 days for group II, 19.4 ± 2 days for group III, 26.4 ± 4.4 days for group IV ($P < .05$, *t*-test group IV *vs.* groups I, II, and III). Complications in the Hartmann group were high with a 23 percent wound infection rate and mortality after closure of colostomy and bowel reconstruction was 3.8 percent. These data demonstrate that primary resection with anastomosis is a satisfactory operation for the majority of patients with perforated diverticulitis (stages I to III), and there appears to be no clinical indication to use the three-staged operation. [Key words: Intestine, large; Colon; Diverticulitis, colonic; Intestinal perforation; Peritonitis; Surgery, operative; Colectomy; Colostomy; Postoperative complications]

From the Department of Surgery,
St. Mary's Hospital,
Waterbury, Connecticut

THE TERMS "DIVERTICULITIS" and "peridiverticulitis" were first used by Mayo *et al.*,[1] who pioneered the initial therapeutic guidelines for acute diverticulitis when they described a right transverse loop colostomy to "defunction" the left side of the colon. Thirty years passed before the three-staged resection was established as a relatively safe approach.[2–4] The first operative stage was limited to proximal fecal diversion with drainage of localized inflammation; the second stage was resection of the involved segment; and the third stage was closure of the colostomy. Experience showed that this regimen had a high patient morbidity and mortality with long periods of hospitalization.[5–9] These observations encouraged the development of a variety of two-staged methods.[8–14] The Hartmann procedure, which involves resection of the inflammatory phlegmon of the left colon and end colostomy with distal oversew of the bowel (usually the intraperitoneal rectum), gradually gained popularity because this policy had the advantage of removing the diseased bowel but avoided the risk of anastomotic leakage. Frequently there is technical difficulty during subsequent bowel reconstruction, however, and the complication rate appears high.

Many of these problems can be avoided by careful attention to operative detail during the first surgery[15] and by allowing at least a three-month interval before

Address reprint requests to Dr. Fielding: 56 Franklin Street, Waterbury, Connecticut 06706.

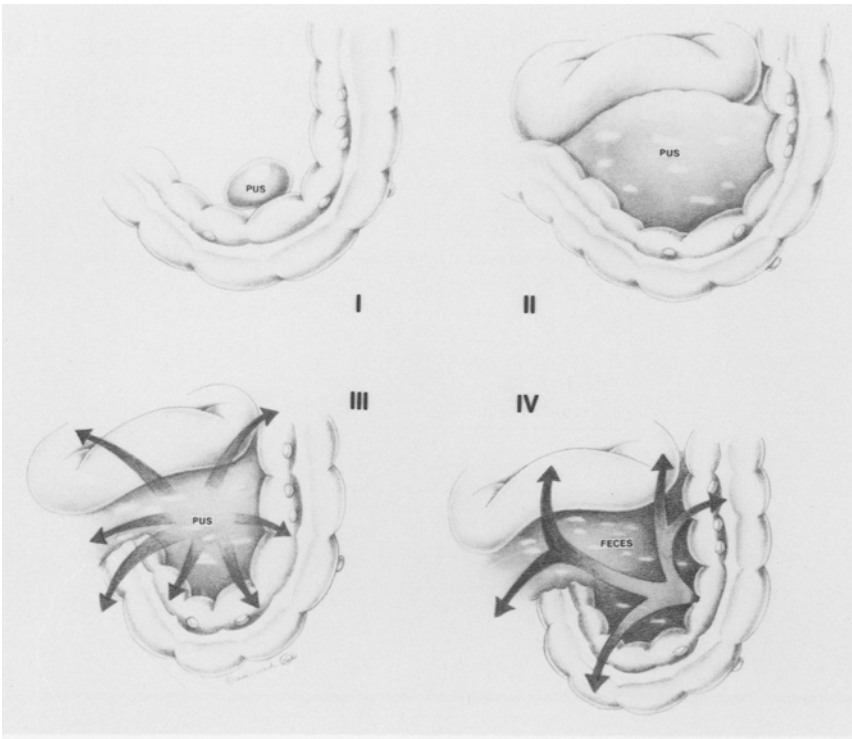

FIG. 1. Classification of perforated diverticular disease (after Hinchey, *et al.*[31]). Stage I, pericolic abscess; Stage II, walled-off abscess; Stage III, generalized purulent peritonitis; Stage IV, fecal peritonitis resulting from acute free perforation of diverticular disease.

bowel reconstruction. Nevertheless, in recent years immediate resection followed by primary bowel anastomosis has been used on selected patients.[8,9,13,14,16–25]

The choice of procedure has been influenced by the degree of peritoneal contamination, which has a major influence on prognosis[9,14,26,27] and may account for the varied mortality rates for operations carried out for perforated diverticular disease.[9,28,29]

Clearly any operative policy recommendations for this disease must be related to its severity,[9,30] and a disease classification[31] is therefore necessary. We report our institutional experience with comparison of the stage of perforated diverticular disease with operative methods and outcome.

Materials and Methods

Between January 1984 and February 1987, 152 patients were operated on in our institution for complications of diverticular disease of the large bowel. Our study was limited to those 65 patients who had perforated diverticulitis involving the left colon. Other sites of involvement, as well as patients who were operated on for bleeding secondary to diverticulitis, were not reviewed.

Patient age, sex, clinical presentation, and physical and radiological findings were recorded. The severity of disease was classified into four stages (I to IV) according to Hinchey *et al.*[31]: Stage I, pericolic abscess; Stage II, walled-off abscess; Stage III, generalized purulent peritonitis; Stage IV, fecal peritonitis resulting from acute free perforation of diverticular disease (Fig. 1). The number of patients who underwent preoperative bowel preparation was recorded along with the type of operation performed.

Most of the patients were treated by primary resection and anastomosis with or without protective colostomy ($N = 34$) and by primary resection with Hartmann procedure ($N = 26$). These two groups were compared with respect to age, sex, associated disease, clinical presentation, preoperative bowel preparation, and disease stage. Postoperative complications, length of hospitalization, and mortality rates were recorded for each group.

Statistical comparisons were carried out with the Student's *t*-test.[32]

Results

The most frequent clinical findings on admission were abdominal pain (limited to the left lower quadrant), fever, chills, and history of diarrhea and constipation (Table 1). Physical examination findings correlated well with the stage of the disease (Table 2). Two patients with stage II disease presented with the unusual complication of a perianal fistula.[33] The most common radiologic findings (Table 3) were pelvic mass

(66 percent), bowel obstruction (26 percent), pneumoperitoneum (13.8 percent), and evidence of extrinsic bladder or urinary collecting system compression (7.6 percent).

All 65 patients were operated on for more than one episode of significant symptomatic diverticulitis (Table 4). There were four types of surgical procedures performed: primary resection with anastomosis (N = 29); primary resection with anastomosis and protective colostomy (N = 5); primary resection with Hartmann procedure (N = 26); delayed resection three-staged procedure (N = 5). Stage II disease (walled-off abscess) was the most common group irrespective of operation performed (Table 5) and occurred in two-thirds of the patients.

Associated diseases that increase the surgical risk were common (*e.g.*, coronary artery disease, hypertension, congestive cardiac failure, chronic obstructive lung disease, diabetes mellitus, renal failure, use of preoperative corticosteroids, and associated collagen disease), but their distribution between types of operations performed was similar (Table 6).

The use of mechanical bowel preparation and oral antibiotics was inconsistent and was related to the urgency with which surgery was needed; emergency admissions went to the operating room, while patients who were to be observed for some days had a bowel preparation carried out (Table 7). Comparisons between operative methods for time interval between admission

TABLE 1. *Clinical Presentation in Relation to Stage of Disease*

Symptoms	Stage I (N = 12)	Stage II (N = 41)	Stage III (N = 11)	Stage IV (N = 1)
Abdominal pain	12	39	11	1
Fever	8	33	9	1
Chills	3	27	8	1
Nausea/vomiting	1	10	6	1
Diarrhea	6	21	6	1
Constipation	9	32	10	1
Hematochezia	8	4	1	-
Dysuria	2	8	1	-
Pneumaturia	-	2	-	-
Anorexia	2	3	4	-
Weight loss	-	1	2	-
Perianal fistula	-	2	-	-

TABLE 2. *Physical Findings in Relation to Stage of Disease*

Physical Findings	Stage I (N = 12)	Stage II (N = 41)	Stage III (N = 11)	Stage IV (N = 1)
Abdominal rebound tenderness	2 (16%)	11 (26%)	7 (63.6%)	1 (100%)
Abdominal mass	2 (16%)	20 (48.7%)	4 (36.3%)	1 (100%)
Rectal tenderness	- (0%)	10 (24.3%)	4 (36.3%)	1 (100%)
Rectal mass	- (0%)	10 (24.3%)	6 (54.5%)	1 (100%)
Guaiac-stools positive	8 (66%)	2 (4.8%)	2 (18.1%)	- (0%)

TABLE 3. *Radiologic Findings Classified According to Disease Stage*

Category	No. Tests	Stage I (N = 12)	No. Tests	Stage II (N = 41)	No. Tests	Stage III (N = 11)	No. Tests	Stage IV (N = 1)
Plain abdominal x-rays	2	1 Free air 2 LBO	14	3 Free air 11 SBO	7	4 Free air 3 SBO	1	1 Free air
Barium enema	2	DD	35	29 Mass effect 1 Sigmoido-vaginal fistula	2	2 External mass	0	
Abdominal ultrasound	0		7	5 Sv. DD 5 Pelvic mass 2 Normal	2	1 Pelvic mass 1 Normal	0	
Abdominal CT Scan	1	DD	5	5 Pelvic mass	2	1 Pelvic mass 1 SBO	0	
IVP	0		10	5 Urinary tract compression 5 Normal	0		0	
Fistulogram	0		2	2 Perianal rectosigmoid fistula	0		0	
Colonoscopy findings	4	1 Narrow sigmoid colon 3 DD	11	11 Narrow sigmoid colon	1	1 Narrow sigmoid colon	0	

LBO: Large-bowel obstruction; SBO: small-bowel obstruction; DD: diverticular disease.

and surgery, postoperative hospital stay and total hospital stay (Table 8), and complications (Table 9) record our findings. The results strongly suggest that primary resection with anastomosis is superior to the other methods of treatment.

Seventeen of 36 patients were readmitted for colostomy closure; the 14 from the Hartmann group had a mean hospital stay after readmission of 13 days, while the average readmission stay of the three patients from the group who had primary resection with anastomosis and protective colostomy was six days. The time interval between the primary resection and colostomy closure was 3.5 months and 1.5 months for the Hartmann group and primary resection with anastomosis and protective colostomy group, respectively. None of the five patients in the delayed resection group had colostomy closure.

The incidence of postoperative complications was higher in the Hartmann and delayed resection groups, with an incidence of wound infection of 23 percent and 40 percent, respectively. Five patients in the Hartmann group developed late complications: paracolostomy hernia (three patients), ileorectal fistula (one patient), and rectovaginal fistula (one patient). All five patients required readmission for surgical treatment. It is noted that none of the patients in whom an immediate anastomosis was carried out had clinical evidence of anastomotic leakage.

TABLE 4. *Episodes of Diverticulitis Before Surgery and Relation with Stage of Disease*

	Stage I (N = 12)	Stage II (N = 41)	Stage III (N = 11)	Stage IV (N = 1)
Second episode	3 (25%)	15 (36%)	7 (63%)	- (0%)
Third episode	6 (50%)	10 (24%)	1 (9%)	1 (100%)
More than 3 episodes	3 (25%)	16 (39%)	3 (27%)	- (0%)

Discussion

This review indicates that patients with stages I, II, or III perforated diverticular disease fair better, in terms of mortality, morbidity, and length of hospital stay, after a primary resection and anastomosis (with or without a protective transverse colostomy), than after other methods of treatment; 32 of the 34 patients so treated were restored to their usual state of health. These results follow the trend in emergency colonic surgery

TABLE 5. *Surgical Procedure in Relation to Stage of Disease*

Stage of Disease	Number of Pts.	Mean Age	Sex M	Sex F	Primary Resection with Anastomosis (N = 29)	Primary Resection with Anastomosis and Protective Colostomy (N = 5)	Primary Resection with Hartmann Procedure (N = 26)	Delayed Resection 3-Staged Procedure (N = 5)
Stage I	12	72.5	8	4	4	-	8	-
Stage II	41	64.4	18	23	24	3	11	3
Stage III	11	64.2	6	5	1	2	6	2
Stage IV	1	79.0	-	1	-	-	1	-
TOTAL	65	66.1	32	33	29	5	26	5

TABLE 6. *Medical History in Relation to Operative Procedure*

	Primary Resection with Anastomosis (N = 29)	Primary Resection with Anastomosis and Protective Colostomy (N = 5)	Primary Resection with Hartmann Procedure (N = 26)	Delayed Resection 3-Staged Procedure (N = 5)
Coronary artery disease	12	1	16	4
Congestive heart failure	10	1	12	4
Hypertension	18	1	18	2
Chronic obstructive pulmonary disease	9	3	9	3
Asthma	3	-	-	-
Diabetes mellitus	5	-	4	-
Peripheral vascular disease	3	-	4	2
Arthritis	6	1	9	1
Gout	2	-	3	-
Renal failure	1	-	-	1

TABLE 7. *Bowel Preparation for First Operation According to Operation Policy*

	Primary Resection with Anastomosis (N = 29)	Primary Resection with Anastomosis and Protective Colostomy (N = 5)	Primary Resection with Hartmann Procedure (N = 26)	Delayed Resection 3-staged Procedure (N = 5)
Bowel preparation (mechanical and oral antiobiotics)	26	4	10	3
No preoperative bowel preparation	2	1	16	2
"On-table" bowel irrigation	1	-	-	-

TABLE 8. *Length of Hospital Stay in Days (Mean ± SD) According to Operation Policy*

	Primary Resection with Anastomosis (N = 29)	Primary Resection with Anastomosis and Protective Colostomy (N = 5)	Primary Resection with Hartmann Procedure (N = 26)	Delayed Resection 3-staged Procedure (N = 5)
Time interval between admission and first surgery	5.6 (± 0.4)	4.6 (± 1.3)	2.7 (± 0.6)	11.8 (± 3.3)
Postoperative hospital stay	10.5 (± 0.9)	13.6 (± 5.3)	16.6 (± 0.5)	14.6 (± 2.3)
Total LOS for first admission	16.2 (± 1.2)	18.2 (± 4.4)	19.4 (± 2.0)	26.4 (± 4.4)
Total LOS for patients having colostomy closed	(N = 0) N.A.	(N = 3) 21.0 (± 3.1)	(N = 14) 29.7 (± 3.6)	(N = 0) N.A.

LOS: length of stay; NA = not applicable.

of reducing the number of stages in the operative policy and removing the site of principal pathology at the first operation.

Some features in surgical technique used for primary resection and anastomosis in this setting are worth listing. They include: 1) Mobilization of the splenic flexure was carried out in all cases. 2) The distal line of resection was always through the rectum; the rectosigmoid junction was taken as part of the specimen and dissection continued distally until soft pliable bowel

TABLE 9. *Complications*

	Primary Resection with Anastomosis (N = 29)	Primary Resection with Anastomosis and Protective Colostomy (N = 5)	Primary Resection with Hartmann Procedure (N = 26)	Delayed Resection 3-staged Procedure (N = 5)
Early				
Wound infection	-	-	6	2
Atelectasis	2	-	12	2
Pulmonary edema	1	-	2	1
Pneumonia	-	-	6	-
Pulmonary emboli	-	-	3	-
Congestive cardiac failure	-	-	3	-
Cardiac arrhythmias	1	-	1	-
Myocardial infarction	1	-	1	-
Anastomotic leak	-	-	-	-
Intra-abdominal sepsis	-	-	2	-
Septicemia	-	-	2	-
Prolonged ileus	4	1	5	-
Urinary tract infection	2	-	3	1
Urinary retention	4	-	-	1
Renal failure	-	-	1	-
Death	1	-	4	-
Late				
Paracolostomy hernia	-	-	3	-
Ileorectal fistula	-	-	1	-

wall was reached. 3) The proximal line of resection was through nonindurated colon. 4) The majority of anastomoses were created in two-layer fashion but some were achieved with a single-layer technique. 5) There was redundant bowel proximal to the anastomosis and the bowel wall had a confirmed good blood supply with active arterial bleeding at the resection margin. 6) The proximal line of resection was selected carefully so that no diverticulum was included in the line of anastomosis.

In 29 of the 34 patients who underwent primary resection, the anastomoses were created below the peritoneal reflection, and few protective colostomies were performed (the presence of purulent peritonitis in two patients, perianal-rectosigmoid fistula in two patients, and an extremely low anastomosis in one patient).

The most common reason to perform a primary resection with Hartmann procedure was the presence of inadequate bowel preparation rather than the presence of florid peritonitis. Thus, the more frequent use of "on-table" bowel irrigation,[34] which was used for only one patient in this series, would allow surgeons to perform primary resection with anastomosis more frequently in the management of this condition.

In the most advanced cases with diffuse peritonitis or fecal contamination, colostomy and drainage has a very high reported mortality rate, ranging from 26[8,9,30] to 40 percent.[9,35-37] More than half of these patients may die if only simple abdominal drainage is used;[9] we recommend that this method of treatment be abandoned.

Although our complication rate was low, it seems that the high morbidity after colostomy and drainage for perforated diverticular disease results in significant increased incidence of fecal fistulas,[38] persistent colostomies,[14,30] and prolonged hospital stay[14,38] when compared with resective methods undertaken at the first operation.

Our low mortality rate for patients with stage III disease is in keeping with other studies in which emergency resection was undertaken,[8,39-41] but also may be explained partly by the small number of our patients who came to emergency surgery within 24 hours of admission.

We recommend that both the three-staged operation and the drainage-only operation be abandoned and that there be greater use of primary resection with anastomosis in the management of patients with stage I and II perforated diverticular disease. This conclusion is based on two observations found in this study.

First, it is clear that preoperative clinical classification of diverticulitis complicated by perforation is both feasible and desirable because of the high correlation between the clinical and radiologic findings with the stage of the disease found at the time of laparotomy.

Second, the majority of patients with stage I and stage II perforating diverticulitis are able to undergo adequate preoperative bowel preparation and most of the remainder are suitable for "on-table" mechanical bowel cleansing.

The use of a covering "colostomy" for patients with stage I and stage II perforating diverticular disease can be reserved for the more complex or difficult cases after considering the principles of creating a colorectal anastomosis, which have been described.

Although more controversial, we believe that these same conclusions are applicable to patients with diffuse purulent peritonitis (stage III disease) leaving the Hartmann procedure as the treatment of choice for the quite rare cases of fecal peritonitis (stage IV disease).

These results and those from other authors are sufficiently clear that prospective randomized trials do not appear necessary to establish this approach for patients with stages I, II, and III perforating diverticular disease.

Acknowledgment

The authors thank Dr. W. Quigley, Dr. T. Shea, Dr. E. Gerber, Dr. C. Audet, Dr. M. Hamzi, Dr. G. Tripodi, Mr. David Godwin, Mrs. Joanne Ciarcia, and Mrs. Pam Arsenault for technical assistance.

References

1. Mayo WJ, Wilson LA, Griffin MI. Acquired diverticulitis of the large colon. Surg Gynecol Obstet 1907;5:8-15.
2. Lockhart-Mummery JP. Late results of diverticulitis. Lancet 1938;2:1401-4.
3. Smithwick RH. Experience with the surgical management of diverticulitis of the sigmoid. Ann Surg 1942;115:969-85.
4. Pemberton G, Black BM, Maino CR. Progress in the surgical management of diverticulitis of the sigmoid colon. Surg Gynecol Obstet 1947;85:523-34.
5. Rodkey GV, Welch CE. Surgical management of colonic diverticulitis with free perforation or abscess formation. Am J Surg 1969;117:265-9.
6. Byrne JJ, Garick EI. Surgical treatment of diverticulitis. Ann J Surg 1971;121:379-84.
7. Graves HA Jr, Franklin RM, Robbins LBH, et al. Surgical management of perforated diverticulitis of the colon. Ann Surg 1973;39:142-7.
8. Nagorney DM, Adson MA, Pemberton JH. Sigmoid diverticulitis with perforation and generalized peritonitis. Dis Colon Rectum 1985;28:71-5.
9. Lambert ME, Knox RA, Schofield PF, Hancock BD. Management of the septic complications of diverticular disease. Br J Surg 1986;73:576-9.
10. Boyden AM, Neilson RO. Reappraisal of surgical treatment of diverticulitis of the sigmoid colon. Am J Surg 1960;100:206-16.
11. Boyden AM. Two-stage (obstructive) resection of the sigmoid in selected cases of complicated diverticulitis. Ann Surg 1961;154(suppl):210-4.
12. Nunes GC, Robnett AH, Kremer RM, Ahlquist RE Jr. The Hartmann procedure for complications of diverticulitis. Arch Surg 1979;114:425-9.
13. Risholm L. Primary resection in perforating diverticulitis of the colon. World J Surg 1982;6:490-1.

14. Finlay IG, Carter DC. A comparison of emergency resection and staged management in perforated diverticular disease. Dis Colon Rectum 1987;30:929-33.
15. Fielding LP. Management of the obstructed large bowel. In: Todd IP, Fielding LP, Dudley HAF, Pories WJ. Operative surgery series. London: Butterworths, 1983;210-30.
16. Belding HH. Acute perforated diverticulitis of the sigmoid colon with generalized peritonitis. Arch Surg 1957;74:511-5.
17. Madden JL, Tan PY. Primary resection and anastomosis in the treatment of perforated lesions of the colon with abscess or diffusing peritonitis. Surg Gynecol Obstet 1961;113:646-50.
18. Roxburgh RA, Dawson JL, Yeo R. Emergency resection in treatment of diverticular disease of colon complicated by peritonitis. Br Med J 1968;3:465-6.
19. Ryan P. Emergency resection and anastomosis for perforated sigmoid diverticulitis. Aust NZ J Surg 1974;44:16-20.
20. Auguste LJ, Wise L. Surgical management of perforated diverticulitis. Am J Surg 1981;141:122-7.
21. Alexander J, Karl RC, Skinner DB. Results of changing trends in the surgical management of complications of diverticular disease. Surgery 1983;94:683-90.
22. Welch CE, Welch JP. Resection and anastomosis of the colon in the presence of peritonitis. In: Delaney JP, Varco RL: Controversies in surgery II. Philadelphia: WB Saunders, 1983:352-9.
23. Grant V, Rodkey GV, Welch CE. Changing patterns in the surgical treatment of diverticular disease. Ann Surg 1984;200:466-78.
24. Auguste LJ, Wise L. Surgical management of perforated diverticulitis. Arch Surg 1985;120:450-2.
25. Hackford AW, Schoetz DJ Jr, Coller JA, Veidenheimer MC. Surgical management of complicated diverticulitis: the Lahey Clinic experience, 1967 to 1982. Dis Colon Rectum 1985;28:317-21.
26. Haglund U, Hellberg R, Johns EN, Hult RN. Complicated diverticular disease of the sigmoid colon: an analysis of short and long term outcome in 392 patients. Ann Chir Gynaecol 1979;68:41-6.
27. Greif JM, Fried G, McSherry CK. Surgical treatment of perforated diverticular disease of the sigmoid colon. Dis Colon Rectum 1980;23:483-7.
28. Killingback MJ. Acute diverticulitis: Progress report, Australasian survey (1967-69). Dis Colon Rectum 1970;13:444-7.
29. Botsford TW, Zollinger RM, Hicks R. Mortality of the surgical treatment of diverticulitis. Am J Surg 1971;121:702-5.
30. Krukowski ZH, Matheson NA. Emergency surgery for diverticular disease complicated by generalized peritonitis: A review. Br J Surg 1984;71:921-7.
31. Hinchey EJ, Schaal PG, Richards GK. Treatment of perforated diverticular disease of the colon. Adv Surg 1978;12:85-109.
32. Siegel S. Non-parametric statistics for the behavioral sciences. New York: McGraw-Hill, 1956.
33. Fazio VW, Church JM, Jagelman DG, et al. Colocutaneous fistulas complicating diverticulitis. Dis Colon Rectum 1987;30:89-94.
34. Dudley HA, Radcliffe AG, McGeehan D. Intraoperative irrigation of the colon to permit primary anastomosis. Br J Surg 1980;67:80-1.
35. Sakai L, Drake J, Kaminski DL. Acute perforation of sigmoid diverticula. Am J Surg 1981;142:712-6.
36. Wara P, Sorseson L, Berg V, Ampdrup E. The outcome of staged management of complicated diverticular disease of the sigmoid colon. Acta Chir Scand 1981;147:209-14.
37. Edelman G. Surgical treatment of colonic diverticulitis: a report of 205 cases. Int Surg 1981;66:119-24.
38. Killingback M. Management of perforated diverticulitis. Surg Clin North Am 1983;63:97-115.
39. Theile D. The management of perforated diverticulitis with diffuse peritonitis. Aust NZ J Surg 1980;50:47-9.
40. Auguste LJ, Wise L. Surgical management of perforated diverticulitis. Am J Surg 1981;141:122-7.
41. Liebert CW, Deweese BM. Primary resection without anastomosis for perforation of acute diverticulitis. Surg Gynecol Obstet 1981;152:30-2.