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Original Article

Analysis of Surgical Outcomes of Diverticular Disease of the Colon

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We analyzed retrospectively the surgical outcomes of diverticular diseases of the colon at the surgical division of Fukuyama Medical Center. Data were collected from 39 patients who underwent surgery for diverticular disease at Fukuyama Medical Center. Thirty-nine patients were admitted between 2005 and 2010. The mean age of the 39 patients was 63.6 years. The collected data included patient demographics, patient history, type of surgery and complications. Patients were divided into 2 groups, Elective vs. Emergent group, right vs. left colon group and laparotomy vs. laparoscopic approach. Multivariate analysis of the logistic model of morbidity revealed a significantly higher rate in the left colon and the Cox proportional hazards model clearly showed fewer postoperative hospital days with the laparoscopic approach. Surgical procedures should be decided in reference to the particular clinical and pathological features of diverticular disease to gain an acceptable morbidity and mortality rates.

Key words: diverticular disease, emergent operation, elective surgery, laparoscopic surgery

Diverticular disease of the colon is an acquired condition that results from herniation of the mucosa through defects in the muscle layer. Epidemiological and anatomic studies have revealed that diverticular formation of the colon is primarily a disease that occurs in industrialized and westernized countries [1, 2]. It is widely accepted that chronic diverticular formation occurs due to a lack of fiber in the diet [3, 4]. Of major importance is that approximately 25–30% of these patients will develop complications such as diverticulitis, bleeding or perforation [5, 6].

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The cause of acute diverticulitis remains obscure. It has been speculated that obstruction at the mouth of the diverticulum results in diverticulitis, similar to appendicitis, but this is no longer the accepted theory, and some feel that chronic inflammation precedes clinical diverticulitis [6]. Descriptions of diverticular disease may be divided as follows diverticulitis with either pericolitis (microabscess), pericolic phlegmon, pericolic abscess, pelvic or intraabdominal abscess, and free perforation leading to bowel obstruction, fistulization, or bacteremia and septicemia [7].

The treatment depends on the severity of the disease, varying from light symptomatic diverticulosis to perforated diverticulitis. For years it was thought that the risk of perforation and other complications increased after each recurrence. Therefore, the

American Association of Colorectal Surgeons suggested performing an elective colon resection after 2 episodes of acute diverticulitis, after a single episode in young patients or when complications such as stenosis or fistula occur [8].

The rise of laparoscopic surgery since the 90s resulted in decreased morbidity and mortality rates, making it the preferred approach in elective colon resection [9]. Whether a laparoscopic approach can also be applied to patients with perforated diverticulitis and generalized peritonitis remains to be confirmed. Laparoscopic colon resection cannot be accomplished completely because of extensive pericolic infiltration and fecal or purulent contamination. Hartmann's procedure is the treatment of first choice for diverticular diseases of the left side colon for most surgeons.

However, several recent studies has shown that a primary anastomosis with or without a diverting ileostomy can be performed [10]. Even laparoscopic lavage can be a safe alternative to Hartmann's procedure in case of perforated purulent diverticulitis. The aim of this study was to evaluate indications for surgery, morbidity, mortality and postoperative days in reference to location and operative procedures. We analyzed 39 patients with diverticular disease at Fukuyama Medical Center. Since the patients treated for acute diverticulitis have a worse prognosis compared with the electively treated patients, we analyzed these cases in separate groups: emergent vs. elective, and also analyzed the right vs. left colon group and the laparoscopic vs. laparotomy group. Although this was a retrospective analysis at a single site and the number of the cases was limited, this study is novel in that the data were analyzed statistically using not only separate univariate but also multivariate analyses for the 3 groups, respectively.

Patients and Methods

In June 2010, we collected and pooled the data for the most recent 39 patients with diverticular disease treated surgically at Fukuyama Medical Center. The following data were collected: gender, age, type of operation (emergent vs. elective), location (right vs. left colon), operative technique (laparoscopy vs. laparotomy), morbidity, mortality and postoperative hospital days. Elective surgery was defined as the case of planned hospitalization and operation after the symptoms were relieved. On the other hand, the definition of the emergent surgery was the case of the failure of conservative therapy after hospitalization or immediate surgery after emergent transfer due to acute panperitonitis. The definition of the left and right colon is as follows the feeding arteries of the right and left colon are the superior and inferior mesenteric arteries, respectively. Therefore, the right colon consists of the cecum, ascending and transverse colon, and the left colon consists of the descending, sigmoid colon and rectum. Mortality was defined as death within 30 days after operation. Values are expressed as means and ranges for continuous variables. Distributions of dichotomous data are given in percentages. Continuous variables with normal distribution were compared using Student's *t* test. Pearson X 2 test was used for the analysis of discrete variables. Multivariate analysis was performed to evaluate the factors contributing to the morbidity and the postoperative hospital days.

Results

Population. The last 39 patients with diverticular disease treated surgically in our hospital were included; all were admitted between January 2005 and June 2010. Patient populations are shown in Table 1. Of these, 19 were male and 20 female averaging 63.6 years. Nineteen patients were emergently operated (Emergent group), and 20 were in the elective group. In the location of diverticular disease, the right and left colon percentages were 38.5% and 61.5%, respectively. Death occurred in only 1 case, in which the diverticular lesion was located in the sigmoid colon. This case was emergently transferred due to fecal panperitonitis. Hartmann's procedure was performed, however, DIC and multiple organ failure (MOF) unfortunately occurred, and the patient ended up dying.

Patients' characteristics and surgical data. Patients' characteristics and surgical data are shown in Table 2. No difference was found in age, location, operating time, morbidity, mortality and postoperative hospital days between the emergent and elective groups. Perforated diverticulitis with generalized peritonitis was the main operative indication in the emergent group. Other acute indications were anal bleeding, intraabdominal abscess and the failure of

Table 1 Patients population

	Number (%)
Total	39 (100)
Age (mean)	25–89 (63.6 years old)
Gender	
Male	19 (48.7)
Female	20 (51.3)
Group	
Emergent	19 (48.7)
Elective	20 (51.3)
Surgical approach	
Laparotomy	26 (66.7)
Laparoscopy	13 (33.3)
Location	
Right colon	15 (38.5)
Cecum	3 (7.7)
Ascending	12 (30.8)
Left colon	24 (61.5)
Descending	1 (2.6)
Sigmoid	22 (56.4)
Rectum	1 (2.6)
Complications	
Morbidity	18 (46.2)
Mortality	1 (2.6)

conservative therapy. In over half of the acute patients, surgery was performed on the day of admission. Indications for elective colon resection were: inflammatory relapse, intestinal stenosis, anal bleeding and vesico-intestinal fistula.

Surgical indications of generalized peritonitis and failure of conservative therapy were significantly higher in the emergent group than the elective group. On the other hand, those of inflammatory relapse and intestinal stenosis were significantly higher in the elective group than the emergent group. No statistical significance was observed in anal bleeding and intraabdominal abscess between the groups.

Resection with primary anastomosis was performed in 57.9% and 95.0% of the emergent and elective groups, respectively, and its rate was significantly higher in the elective than the emergent group. Out of the surgical procedure of resection with primary anastomosis, laparoscopic surgery accounts for only 47.4% (9/19), although it is elective colon resection. On the other hand, 36.3% (4/11) of laparoscopic surgeries were performed in the emergent setting, of which the percent was lower than in the elective group, although no statistical significance was observed. In the acute setting, Hartmann's procedure was performed in 26.3% of patients. On the other hand, no patients received Hartmann's procedure in the elective group, although this difference was not statistically significant. A covering ileostomy was created in 10.5% and 5.0% of emergent and elective groups respectively (Table 2).

Comparison of morbidity and postoperative hospital days in reference to location and laparotomy or laparoscopy. The laparoscopic approach was attempted in 53.3% and 24.8% of cases of diverticular diseases of the right and left colon, respectively, indicating a statistically higher rate of laparoscopic approach in the right colon. The overall morbidity rate in the right colon was 20.0%, which was significantly lower than that in the left colon (62.5%). Especially, the occurring rate of wound infection in the right and left colon were 0% and 25.0%, respectively, such that diverticular disease in the right colon was associated with significantly better outcomes. The postoperative hospital days for diverticular disease of the right colon were also significantly shorter than that of the left colon (19.7 vs. 29.0) (Table 3). Following laparotomy-based surgery, 57.7% of patients had postoperative complications, of which wound infection was most frequent. After laparoscopic operation, the morbidity was 23.1%, which was significantly lower than that of laparotomy-based surgery. The postoperative hospital days with the laparoscopic approach was significantly shorter than that with laparotomy (15.5 vs. 30.4) (Table 4).

Multivariate analyses were also performed in terms of the morbidity rate and the postoperative hospital days. A logistic model of morbidity clearly revealed a significantly higher rate of morbidity in the left colon (Table 5), and the Cox model showed that the laparoscopic approach significantly shortened the postoperative hospital days compared with open surgery (Table 6).

Discussion

This study describes the current surgical practice in diverticular disease in Fukuyama Medical Center. Diverticular disease is associated with substantial

Table 2 Patients characteristics and surgical data

Group	Emergent	Elective	*P*-value
Number	19 (100%)	20 (100%)	
Age (mean)	26–89 (61.3)	25–80 (65.8)	0.385
Right colon	6 (31.6%)	9 (45.0%)	0.389
Left colon	13 (68.4%)	11 (55.0%)	
Operating time (min.)	168.3 ± 17.7	200.8 ± 16.2	0.185
Surgical indication			
Generalized peritonitis	6 (31.6%)	0	0.006*
Anal bleeding	4 (21.1%)	4 (20.0%)	0.935
Failure of conservative therapy	4 (21.1%)	0	0.030*
Intraabdominal abscess	4 (21.1%)	1 (5.0%)	0.134
Inflammatory relapse	1 (5.3%)	7 (35.0%)	0.047*
Intestinal stenosis	0	6 (30.0%)	0.009*
Vesico-intestinal fistula	0	2 (10.0%)	0.157
Surgical procedure			
Resection with primary anastomosis	11 (57.9%)	19 (95.0%)	0.047*
Laparotomy	7 (63.6%)	10 (52.6%)	0.855
Laparoscopy	4 (36.4%)	9 (47.4%)	0.113
Hartmann's procedure	5 (26.3%)	0	0.134
Resection with covering ileostomy	2 (10.5%)	1 (5.0%)	0.517
Drainage	1 (5.3%)	0	0.299
Morbidity	10 (55.6%)	8/20 (40.0%)	0.429
Wound infection	4	2	0.339
Anastomotic leakage	1	1	0.970
Intraabdominal abscess	1	1	0.970
Ileus	1	1	0.970
DIC	1	0	0.299
Anastomotic bleeding	0	1	0.323
Postoperative hemoperitoneum	0	1	0.323
Recto-vesical fistula	1	0	0.299
Pseudo-membranous colitis	1	0	0.299
Gastric ulcer bleeding	0	1	0.323
Mortality	1	0	0.299
Post operative hospital days	29.2 ± 3.9	21.8 ± 2.6	0.122

*significant

postoperative morbidity (46.2%) and mortality rate (2.6%) (Table 1). In our study, no statistically significant difference was observed in morbidity and mortality rates between the emergent and the elective group (Table 2), which was inconsistent with previous reports that the morbidity and mortality rates are significantly higher in the acute setting than the elective case [11, 12]. A recent report described little improvement in the morbidity and mortality rates, possibly due to improvement in peri-operative care and enhanced precautionary practices in ICU [13, 14].

The morbidity rate in the left colon was significantly higher than that in the right colon by both separate univariate and multivariate analyses (Table 3, 5). The postoperative hospital days for the left colon was significantly longer than that for the right colon (29.0 vs. 19.7) by univariate analysis (Table 3), however, the multivariate analysis by the Cox model indicated no statistically significant difference in postoperative days between the left and right colon (Table 6). In

Table 3 Comparison of morbidity, mortality and post operative hospital days with reference to location of lesion

Location	Right colon	Left colon	*P*-value
Number	15 (100%)	24 (100%)	
Laparotomy	7 (46.7%)	19 (79.2%)	0.036*
Laparoscopy	8 (53.3%)	5 (20.8%)	
Morbidity	3 (20.0%)	15 (62.5%)	0.010*
Wound infection	0	6 (25.0%)	0.035*
Anastomotic leakage	0	2 (8.3%)	0.251
Intraabdominal abscess	0	2 (8.3%)	0.251
Ileus	2 (13.3%)	0	0.066
DIC	0	1 (4.2%)	0.423
Anastomotic bleeding	0	1 (4.2%)	0.423
Postoperative hemoperitoneum	0	1 (4.2%)	0.423
Recto-vesical fistal	0	1 (4.2%)	0.423
Pseudo-membranous colitis	0	1 (4.2%)	0.423
Gastric ulcer bleeding	1 (6.7%)	0 (4.2%)	0.200
Mortality	0	1 (4.2%)	0.299
Post operative hospital days	19.7 ± 3.4	29.0 ± 3.0	0.050*

*significant

Table 4 Comparison of morbidity, mortality and postoperative hospital days with reference to surgical approach

Surgical procedure	Laparotomy	Laparoscopy	*P*-value
Number	26 (100%)	13 (100%)	
Emergent	15 (57.7%)	4 (30.8%)	0.113
Elective	11 (42.3%)	9 (69.2%)	
Morbidity	15 (57.7%)	3 (23.1%)	0.041*
Wound infection	5 (19.2%)	1 (7.7%)	0.346
Anastomotic leakage	1 (3.8%)	1 (7.7%)	0.608
Intraabdominal abscess	2 (7.7%)	0	0.305
Ileus	2 (7.7%)	0	0.305
DIC	1 (3.8%)	0	0.474
Anastomotic bleeding	0	1 (7.7%)	0.152
Postoperative hemoperitoneum	1 (3.8%)	0	0.474
Recto-vesical fistula	1 (3.8%)	0	0.474
Pseudo-membranous colitis	1 (3.8%)	0	0.474
Gastric ulcer bleeding	1 (3.8%)	0	0.474
Mortality	1 (3.8%)	0	0.474
Post operative hospital days	30.4 ± 2.9	15.5 ± 2.4	0.002*

*significant

terms of surgical approach, univariate analysis showed that laparoscopic approach significantly decreased the morbidity rate and the postoperative hospital days, however, multivariate analysis showed only a significant decrease in postoperative days (Table 4, 5, 6). No statistically significant differences were observed in the morbidity rate and the postoperative hospital days between the emergent and the elective group

Table 5 Logistic model of morbidity

Variable	HR	95% CL	*P*
Right/Left	0.195	0.041–0.933	0.041*
Elective/Emergent	0.861	0.202–3.666	0.839
Laparoscopy Laparotomy	0.336	0.065–1.750	0.195

*significant

Table 6 Cox proportional hazards model of postoperative hospital days

Variable	HR	95% CL	*P*
Right /Left	0.670	0.331–1.354	0.264
Elective/Emergent	0.976	0.477–1.996	0.946
Laparoscopy/Laparotomy	0.254	0.114–0.567	0.001*

*significant

(Table 2, 5, 6). Usually, a prominent share of morbidity is accounted for by wound infection, of which the rates in the right and left colon were 0% (0/15) and 25.0% (6/24), respectively (Table 3), resulting in a significantly graeter morbidity rate in the left colon. Other factors of morbidity such as anastomotic leakage, intraabdominal abscess and ileus showed a low percentage of influence.

As can be expected in surgical procedures, the rate of a resection with primary anastomosis was significantly higher in the elective group than in the emergent group (95.9% vs. 57.9%) (Table 2). Perhaps primary anastomosis in the acute setting was only considered under favorable conditions, resulting in a positive selection bias. The number of primary anastomoses in the acute setting has been on the increase with or without a covering ileostomy. In this series, 57.9% of the emergent group received a primary anastomosis, which is a substantial increase compared to 27–39% in previous reports [14, 15]. In the acute setting, Hartman's procedure is no longer the only option in generalized peritonitis. In fact, Hartman's procedure was only performed in 26.3% (5/19) of the emergent group. In the elective setting, no patients undertook Hartman's operation, as also can be expected.

Indications for elective surgery are based on complaints and complications of diverticular diseases, such as inflammatory relapse, intestinal stenosis, anal bleeding and vesico-intestinal fistula (Table 2). When elective surgery is indicated, the laparoscopic approach has a tendency to be adopted. Still, out of all elective surgical procedures involving resection with primary anastomosis, laparoscopic surgery accounted for only 47.4% (9/19). The rate for such patients in emergent situations was even lower – 36.3% (4/11) – though not significantly lower than the elective group (Table 2). These results suggested that laparoscopic surgery was difficult to undertake in some elective cases, possible due to inflammatory changes, and in these cases patients may benefit more from an open colon resection than a laparoscopic surgery.

Indeed, elective colon resection should be proactively approached to allow for laparoscopic surgery. Not only is laparoscopy safer than open techniques, but also several advantages have been demonstrated in recent trials [9]. This study also clearly demonstrated that both postoperative hospital days and morbidity rates were significantly decreased in laparoscopic surgery as compared with open surgery (Table 4, 6). As described above, the adaption rate of laparoscopic surgery in the elective group was only 47.4%, which is partially attributable to differences in laparoscopic experiences and skills among operators. At our hospital, one doctor always attempts laparoscopy for colon resection, whereas another doctor has a preference for the open technique. At any rate, this retrospective study suggested that laparoscopic surgery has advantages in morbidity and postoperative hospital days compared with open surgery. Yet it must be realized that the beneficial effects of laparoscopic surgery are exclusively generated by experienced laparoscopic surgeons.

In conclusion, diverticular disease is a common disease that necessitates surgery in emergent or elective settings. Our surgical division is up-to-date, such that new developments like laparoscopic approaches and intensive care, are implemented in daily practice, resulting in acceptable morbidity and mortality rates. Even in the acute setting, Hartmann's procedure is no longer the only option in generalized peritonitis. Furthermore, when elective surgery is indicated, laparoscopic surgery has been increasingly adopted in recent years, depending on the experience of the surgeons, largely because of its beneficial effects.

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