Abstract

Objectives: The present study was performed to examine operative cases of perforated diverticulitis and to consider the corresponding treatments.

Methods: In the 10-year period from January 2007 to December 2016, 20 cases of perforated sigmoid diverticulitis were treated surgically in our hospital. We examined the background factors, physical findings, preoperative diagnoses, surgical findings, and postoperative courses.

Results: Twenty patients with sigmoid colon diverticulitis, eleven males and nine females with a median age of 67.5 years (25 to 87 years), were included in the analysis. Preoperative complications included chronic kidney failure, including post-transplantation failure in 4 cases (20%), among others. Surgery was performed using open methods, including 15 patients who underwent the Hartmann procedure and 5 patients who underwent colon resection or suture closure with stoma construction. Among the postoperative complications, stoma dropout, deep venous thrombosis with pelvic abscess formation, pneumonia, and wound dehiscence were detected in one case each. Postoperative polymyxin-direct hemoperfusion (PMX-DHP) was effective in 2 cases (10%). No deaths occurred.

Conclusions: For perforated sigmoid diverticulitis, we performed colon resection or suture closure with stoma construction by open methods. The postoperative course was relatively favorable.

Key words: hartmann procedure, hinchey classification, lavage

Introduction

Accurate diagnosis and treatment of perforated sigmoid diverticulitis are important considering its frequency among serious operative emergencies\(^1\)\(^-\)\(^3\). The efficacy of laparoscopic lavage has recently been reported in Europe for the treatment of perforated diverticulitis\(^4\)\(^-\)\(^7\). However, compared to the conventional Hartmann procedure, some reports have revealed high rates of postoperative abscess formation among other severe complications, including mortality\(^8\)\(^,\)\(^9\). In this study, we analyzed operative cases of perforated sigmoid diverticulitis and examined their corresponding management.

Methods

In the 10-year period from January 2007 to December 2016, 20 cases of perforated sigmoid diverticulitis were treated surgically in our hospital (Table 1, 2). We examined the background factors, physical findings, preoperative diagnoses, surgical findings, and postoperative courses and considered the treatments applied for perforated sigmoid diverticular disease. The severity of diverticulitis is graded with the use of Hinchey's criteria\(^10\). Patients with Hinchey class I have small pericolic or mesenteric abscesses, whereas those with Hinchey class II have larger abscesses. Hinchey class III is present when a peridiverticular abscess has ruptured and caused
| Age-Sex | Operation                                | Period from onset to operation | Hinchey class | Preoperative complication                                      | Steroid use |
|---------|------------------------------------------|---------------------------------|---------------|---------------------------------------------------------------|-------------|
| 1 74-M  | Hartmann operation                       | 0                              | 4             | Cerebral infarction, Hypertension, Pancreatic cyst            | None        |
| 2 35-M  | Hartmann operation                       | 6                              | 3             | None                                                          | None        |
| 3 80-M  | Hartmann operation                       | 7                              | 4             | Postoperative percutaneous coronary intervention, Kidney failure | None        |
| 4 25-F  | Hartmann operation                       | 1                              | 3             | Chronic kidney failure (dialysis), Focal glomerulosclerosis   | Yes         |
| 5 77-M  | Hartmann operation                       | 1                              | 3             | Carotid artery stenosis, Diabetes, Cerebral infarction        | None        |
| 6 39-M  | Hartmann operation                       | 2                              | 3             | None (after gastroscopy with barium)                          | None        |
| 7 67-F  | Hartmann operation                       | 1                              | 3             | Primary biliary cholangitis, Scleroderma, Sjögren’s syndrome  | None        |
| 8 53-F  | Hartmann operation                       | 10                             | 4             | Chronic kidney failure (dialysis), Postoperative breast cancer | None        |
| 9 53-F  | Hartmann operation                       | 1                              | 3             | Granulomatosis with polyangitis, Orbital tumor, Vertebral compression fractures | Yes        |
| 10 71-F | Hartmann operation                       | 0                              | 3             | Chronic kidney failure (post-transplantation)                  | Yes         |
| 11 68-M | Hartmann operation                       | 5                              | 3             | Crohn’s Disease                                               | Yes         |
| 12 54-F | Hartmann operation                       | 1                              | 4             | Multiple myeloma, Behçet’s disease, Asthma                     | Yes         |
| 13 49-M | Hartmann operation                       | 9                              | 3             | None                                                          | None        |
| 14 68-F | Hartmann operation                       | 1                              | 3             | Case                                                          | None        |
| 15 73-F | Hartmann operation                       | 1                              | 4             | Rheumatoid arthritis                                          | Yes         |
| 16 83-F | Colon resection and anastomosis with ileostomy | 1                 | 3             | Postoperative breast cancer, Postoperative colon cancer (right colectomy) | None        |
| 17 59-M | Perforation site stoma construction      | 0                              | 4             | Multiple myeloma, Diabetes, Chronic kidney failure (dialysis)  | Yes         |
| 18 87-M | Colon resection with double-hole sigmoid colostomy | 5                 | 3             | None                                                          | None        |
| 19 76-F | Suture closure of perforation site with ileostomy | 4                 | 4             | Postoperative lung cancer, Metastatic brain tumor              | Yes         |
| 20 62-F | Suture closure of perforation site with transverse colon colostomy | 1                 | 4             | Postoperative ovarian cancer (receiving chemotherapy with DTX and CBDCA) | None        |
### Table 2  Twenty cases of perforated sigmoid diverticulitis

| Type of perforation | Blood loss (ml) | Operative time (min) | Postoperative complications | PMX-DHP | Length of stay (days) | Outcome                                      |
|---------------------|-----------------|---------------------|-----------------------------|---------|-----------------------|----------------------------------------------|
| Free                | 150             | 152                 | None                        | None    | 26                    | Hospital discharge                          |
| Free                | 75              | 186                 | None                        | None    | 21                    | Hospital discharge                          |
| Free                | 223             | 156                 | None                        | None    | 62                    | Hospital discharge                          |
| Cover               | 101             | 205                 | None                        | None    | 24                    | Transfer to internal medicine for treatment of the original disease |
| Free                | 30              | 136                 | None                        | None    | 15                    | Hospital discharge                          |
| Cover               | 603             | 280                 | None                        | None    | 12                    | Hospital discharge                          |
| Free                | 91              | 225                 | None                        | None    | 20                    | Hospital discharge                          |
| Free                | 230             | 186                 | None                        | None    | 30                    | Hospital discharge                          |
| Free                | 235             | 180                 | Stoma dropout               | Yes     | 41                    | Hospital discharge                          |
| Cover               | 122             | 113                 | None                        | None    | 18                    | Hospital discharge                          |
| Free                | 145             | 206                 | None                        | None    | 27                    | Hospital discharge                          |
| Free                | 10              | 144                 | Pneumonia                   | None    | 10                    | Transfer to internal medicine for treatment of pneumonia |
| Cover               | 25              | 91                  | None                        | None    | 19                    | Hospital discharge                          |
| Free                | 462             | 178                 | Deep venous thrombosis, Pelvic abscess | None    | 89                    | Transfer to another hospital                 |
| Free                | 110             | 177                 | None                        | None    | 14                    | Transfer to another hospital                 |
| Free                | 163             | 174                 | None                        | None    | 26                    | Hospital discharge                          |
| Free                | 10              | 118                 | None                        | None    | 2                      | Transfer to internal medicine for treatment of the original disease |
| Free                | 100             | 145                 | Wound dehiscence            | Yes     | 51                    | Hospital discharge                          |
purulent peritonitis. Rupture into the free peritoneal cavity with fecal contamination signifies Hinchey class IV. Surgery for sigmoid diverticulitis in our hospital is indicated for Hinchey class III or IV perforation, and Hinchey class I or II conditions including refractory cases, repeated cases, and fistula formation cases. We reviewed cases of Hinchey class III or IV perforation. The perforation type was classified as free perforation or cover perforation according to intraoperative findings during laparotomy. Free perforation applies to a perforated segment that is exposed in the free abdominal cavity, with digestive juice and fecal discharge. Cover perforation applies to a perforated segment that is covered by other organs, such as the intestinal canal and omentum. Depend on the situation of perforation site, we selected colon resection including Hartmann procedure, or suture closure. Regarding postoperative abscesses, an abdominal pelvic CT examination was generally performed within the first week after the operation for evaluation. Polymyxin-direct hemoperfusion (PMX-DHP) was applied in cases of septic shock after surgery.

**Results**

1. **Background factors / physical findings**

Twenty patients with perforated sigmoid colon diverticulitis, including eleven males and nine females with a median age of 67.5 years (25 to 87 years), were included in the analysis. Preoperative complications included 4 cases of chronic kidney failure (20%), including post-transplantation failure, 2 cases of multiple myeloma (10%) (Table 3). Seven patients (35%) with long-term steroid use (including previous use) were included. Four patients (21%) had no complications. In addition, sigmoid colon diverticulum was found to have developed in one patient after gastroscopy with barium.

2. **Preoperative diagnosis**

By the Hinchey classification, 12 cases (60%) were class III, and 8 cases (40%) were class IV. Free abdominal gas was observed in all cases. Twelve patients (60%) underwent surgery within 24 hours from the onset of symptoms, Four patients (20%) underwent surgery from 2 to 5 days after symptom onset, and Four patients (20%) underwent surgery from 6 to 10 days after symptom onset. The median preoperative white blood cell count was 10,095/ul (910 to 21,230/ul), and the median CRP level was 11.72 mg/dl (0.12 to 57.2 mg/dl).

3. **Operation**

According to the intraoperative findings, 14 cases of free perforation (70%) were diagnosed, and 6 cases of cover perforation (30%) were diagnosed. Eight Hinchey class IV cases were diagnosed as free perforation according to intraoperative findings. Of the 12 cases diagnosed as Hinchey class III, 6 cases were diagnosed as free perforationting by intraoperative findings, and 6 cases were diagnosed as cover perforation. Surgeries were performed by open methods, including 15 patients who underwent the Hartmann procedure, 4 patients who underwent colon resection or suture closure of the perforation site with stoma construction, 1 patient who underwent perforation site stoma construction (Table 4). The median operative time was 175.5 minutes (91 minutes to 282 minutes), and the median bleeding volume was 116 ml (10 ml to 603 ml). All patients underwent intra-

| Table 3 Preoperative complications          | Cases (including duplicates) |
|---------------------------------------------|------------------------------|
| Chronic kidney failure (including after transplantation) | 4 (20%)                     |
| Multiple myeloma                           | 2 (10%)                     |
| Systemic disease                           |                             |
| Granulomatosis with polyangiitis           | 1 (5%)                      |
| Rheumatoid arthritis                      | 1 (5%)                      |
| Behcet's disease                           | 1 (5%)                      |
| Crohn's disease                            | 1 (5%)                      |
| Cancer                                      |                             |
| Lung cancer                                | 1 (5%)                      |
| Ovarian cancer (receiving chemotherapy with DTX + CBDCA) | 1 (5%)                     |
| Primary biliary cholangitis                | 1 (5%)                      |
Operative management for perforated diverticulitis

4. Postoperative course

Regarding postoperative complications, stoma drop-out, deep venous thrombosis with pelvic abscess formation, pneumonia, and wound dehiscence were detected with one patient for each case (Table 5). Reoperation was required in 3 cases (15%). In one case, washout and drainage were performed due to an unknown puncture site, but pandemic peritonitis developed, and reoperation was performed due to a diagnosis of perforated sigmoid colon diverticulitis. Reconstruction for stoma dropout after surgery and split-skin grafting for wound dehiscence were performed in one patient each. Postoperative PMX-DHP was effective in 2 patients (10%). No deaths occurred. Fourteen patients were discharged postoperatively, and the median hospitalization period was 25 days (12 to 62 days). Six patients (32%) were postoperatively transferred to other departments or other hospitals, and the median hospital stay was 19 days (2 days to 89 days). The reasons for transfer to other departments were treatment of the original disease (2 cases) and treatment of postoperative pneumonia (1 case).

Discussion

In the 8 Hinchey class IV cases, the surgical findings revealed free perforation. Six of the 12 Hinchey class III cases were cover perforations, and abscesses were localized to the omentum and small intestine; the ascites fluid was serous, and no contamination was observed. Currently, the Hartmann procedure is generally performed for perforated colon diverticulitis, but for patients with localized abscesses and intraperitoneal contamination, laparoscopic lavage may also be indicated. Six cases diagnosed as Hinchey class III before surgery were later determined to be Hinchey class I or free perforation. Laparoscopic intraperitoneal contamination must be considered when evaluating recent reports of laparoscopic lavage. Depending on the size of the perforation and the presence of blood flow disturbances, intestinal resection should be selected for cases with large perforations and a lack of blood flow, even in cases without localized abscesses and intraperitoneal contamination.

On the preoperative status, the patients had chronic kidney failure, systemic diseases and cancer. The status and treatment of the diseases should be correlated to the perforated diverticular disease[10]. Without a good course on the treatment of perforated diverticular disease, the situation would become more serious because of the disease. We should select the operation depending on the situation. Among the postoperative complications, only one persistent abscess was detected. Therefore, intraperitoneal lavage and resection of the perforated colon can be considered effective. The perforated hole of the persistent abscess was 2 cm in size, and a large fecal lump was found in the Douglas fossa. Among the preoperative complications, many patients with long-term steroid use and systemic disease were observed. Oral corticosteroids are reportedly associated with an increased risk of diverticular perforation[11]. As a postoperative complication, stoma dropout was observed in an obese patient with a body mass index (BMI) of 31 who used high-dose steroids for treatment of granulomatosis with polyangiitis (GPA), suggesting the influence of the underlying disease. In some cases, the

| Table 4 Operations for perforated sigmoid diverticulitis |
| Operation | Cases |
| Hartmann procedure | 15 (75%) |
| Colon resection and anastomosis with ileostomy | 1 (5%) |
| Colon resection with double-hole sigmoid colostomy | 1 (5%) |
| Suture closure of perforation site with ileostomy | 1 (5%) |
| Suture closure of perforation site with transverse colon colostomy | 1 (5%) |
| Perforation site stoma construction | 1 (5%) |

| Table 5 Postoperative complications |
| Postoperative complication | Cases |
| Stoma dropout | 1 (5%) |
| Deep venous thrombosis and pelvic abscess | 1 (5%) |
| Pneumonia | 1 (5%) |
| Wound dehiscence | 1 (5%) |
site of perforation could not be confirmed during surgery. We found free air in the upper abdomen, initially leading us to suspect upper gastrointestinal perforation. During surgery, the perforation site could not be identified, even by intraperitoneal observation, and even though extensive washout and drainage were performed. Then, peritonitis recurred, requiring reoperation. Although this situation is relatively infrequent, the perforation site may not be identifiable, especially in cases of small perforations of the diverticula. In particular, when the entire small intestine is expanded due to edema with general peritonitis, the visual field is poor, complicating identification of the perforation site. When surgery is indicated, these considerations must be noted, and as much information as possible should be obtained before surgery.

In recent years, several reports on the utility of laparoscopic lavage for perforated diverticulitis have been published in Europe. However, the Ladies trial compared laparoscopic peritoneal lavage and sigmoidectomy for perforated diverticulitis with purulent peritonitis of the colon in 34 teaching hospitals from 2010 to 2013 in Belgium, Italy, and the Netherlands. Major morbidity and mortality within 12 months were observed in 30 (67%) of the 45 patients in the laparoscopic peritoneal lavage group and in 25 (60%) of the 42 patients in the sigmoidectomy group (odds ratio 1.2895% CI 0.54–3.03, p=0.58). The researchers concluded that laparoscopic lavage was not superior to sigmoidectomy for the treatment of purulent perforated diverticulitis. Additionally, the SCANDIV Randomized Clinical trial did not support laparoscopic lavage. Currently, laparoscopic lavage for Hinchey class III perforated diverticulitis treatment remains controversial.

There are general consensus for Hinchey class IV cases not to be selected for laparoscopic peritoneal diverticulitis. Although some cases of severe preoperative complications and poor general condition with Hinchey class III were observed, surgery could be conducted relatively safely by performing removal and thorough lavage of the abdominal cavity. Intraperitoneal contamination and preoperative complications must be carefully considered in the context of laparoscopic washout and drainage for Hinchey class III cases.

In conclusion, we performed colon resection or suture closure with stoma construction by open methods for 20 cases perforated sigmoid diverticulitis at our hospital. Many patients had preoperative complications, but no deaths occurred postoperatively, and the postoperative course was relatively favorable. When considering laparoscopic lavage for Hinchey class III, intraperitoneal contamination and preoperative complications should be considered.

Conflicts of interest: None.

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