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Laparoscopically Assisted Reversal of Hartmann's Procedure for Perforated Diverticulitis

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The aim of this study was to retrospectively review the clinical outcomes of laparoscopically assisted and open surgical reversal of Hartmann's procedure (HR). We reviewed all patients undergoing laparoscopic or open HR at Tri-Service General Hospital, Taipei, Taiwan, between January 2002 and January 2010. A total of 34 perforated diverticulitis patients initially treated by exploratory laparotomy with Hartmann's procedure were enrolled and divided into 2 groups: laparoscopic and open HR. Data relative to patient age at the time of HR, sex, body mass index, operative time, longest incision length, estimated blood loss, intraoperative complications, postoperative complications, time to bowel function return, duration of hospitalization, and length of follow-up were reviewed. The median colostomy closure period was significantly higher in the laparoscopic group than in the open group ($P = 0.011$). The median longest incision length, estimated blood loss, time to first oral intake, and hospital stay were significantly lower in the laparoscopic group compared with the open group. Laparoscopic HR may be a technically safe, feasible approach that provides better cosmesis, less blood loss, and faster recovery compared with open HR.

Key words: Laparoscopic reversal – Hartmann's procedure – Perforated diverticulitis

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Diverticular disease is one of gastrointestinal conditions that is prevalent in Westernized countries.[1] It is considered as a functional disease attributed to altered neuromuscular activity.[2] Inflammatory complications occur in up to 25% of patients with diverticular disease leading to diverticulitis. Treatments of diverticulitis vary according to severity, including antibiotics treatment, abscess drainage, and surgery.[3] Complicated diverticulitis such as perforated diverticulitis can be fatal, which requires operative approaches.[4,5] The most common surgical procedures in these cases include Hartmann's procedure removing affected segment and operation reestablishing colon continuity.[6,7] Restoration of colon continuity secondary to Hartmann's procedure in cases of perforated diverticulitis is associated with a significant risk on postoperative morbidity and even mortality in emergency setting.[8]

Hartmann's procedure is a common surgical procedure consisting of sigmoidectomy, rectal stump closure, and terminal colostomy. It is indicated for treating complicated left-sided colon diseases such as complicated perforated diverticulitis, distal neoplastic perforations, and traumatic lesions.[9,10] After initial surgery, many patients are left with permanent stoma due to infeasibility to restore the intestinal continuity whereas some receive colostomy reversal.[11] Reestablishment of colonic continuity after Hartmann's procedure is a challenging operation, which is associated with significant morbidity rates and relatively high mortality rates of 5%.[12,13] Laparoscopic approaches have been performed for colorectal surgery with favorable results as a fast recovery and short hospital stay.[14] Laparoscopic HR has been demonstrated for its feasibility and safety in several gastrointestinal disorders.[15,16]

The present study was aimed to review our experience with laparoscopic Hartmann procedure and laparoscopic reversal after Hartmann procedure with an emphasis on intra- and postoperative adverse events in the patients with perforated diverticulitis.

Materials and Methods

Patients

Retrospective data of 34 patients who were diagnosed with perforated diverticulitis of the left-sided colon and treated with a reversal of Hartmann's procedure in the Division of Colon and Rectal Surgery, Tri-Service General Hospital, Taipei, Taiwan, between January 2002 and January 2010, were collected. The enrolled patients initially underwent exploratory laparotomy and Hartmann's procedure.

Of the enrolled subjects, 17 underwent laparoscopic HR, and the others underwent open HR. All patients were fit to undergo either the laparoscopic or the open HR procedure, under general anesthesia; all patients accepted preoperative evaluations, including assessment of the remaining colon and rectal stump by colonoscopy and rectoscopy. This study protocol was reviewed and approved by the Institutional Review Board of the Tri-Service General Hospital, National Defense Medical Center (TSGHIRB No.: 2-104-05-013). It was conducted in compliance with the tenets of the Declaration of Helsinki. The patients provided written informed consent prior to surgery and patient information was anonymized and de-identified prior to analysis.

Surgical technique

The laparoscopic HR surgical procedures were performed by 5 experienced colorectal surgeons as previously described. In brief, each patient underwent mechanical bowel preparation and a course of antibiotics before surgery. The open HR procedure was performed through a vertical, abdominal, midline incision, and the dissections of the peritoneal attachments and rectal stump were performed using electrosurgery devices. Mechanical colorectal anastomosis was performed. Under general anesthesia, each laparoscopic operation was performed with the patient in a modified lithotomy position, with the lower limbs slightly flexed on stirrups. The surgeon stood on the right side of the patient, with the assistant standing on the left. The first surgical procedure involved excision of the colostomy and mobilization of the colon; a stapler anvil was introduced into the lumen of the descending colon by using purse string suturing. The descending colon, with the anvil secured, was placed into the abdominal cavity. The fascia of the colostomy site was closed, and the colostomy site was used as the 5-mm port site. A 10-mm port was inserted to provide access to the peritoneal cavity and establish the pneumoperitoneum above the umbilicus. Under clear vision, 2 additional ports were directly inserted. A 12-mm port was placed in the right lower iliac fossa, and a 5-mm port was placed into the right upper quadrant of the abdomen. Intra-abdominal adhesiolysis was performed by sharp dissection. Mobilization of the descending colon and the splenic flexure was performed to ensure a tension-free colorectal anastomosis. We used a laparoscopic linear

Table 1 Demographics and clinical characteristics

Characteristic	Open group, n = 17	Laparoscopic group, n = 17	*P* value
Age at diagnosis, y (median [IQR])	61 (46–73)	57 (48.5–70)	0.904
Sex, n (%)			1.000
Male	9 (52.9%)	9 (52.9%)	
Female	8 (47.1%)	8 (47.1%)	
Body mass index (median [IQR])	24.2 (22.5–27.3)	24.6 (23.2–25.1)	1.000
Surgical indication for Hartmann's procedure			
Perforated diverticulitis	17 (100%)	17 (100%)	

Continuous variables are presented as medians and IQRs. Categorical variables are presented as counts and percentages.

stapler to resect the residual distal sigmoid colon to the junction of the rectosigmoid colon. The rectal stump was mobilized to facilitate the transanal insertion of the circular stapler or Hegar dilator. Finally, we performed a transanal, end-to-end anastomosis using a circular stapling device.[6]

Data collection

Data regarding patient age at the time of HR, sex, body mass index, operative time, longest incision length, estimated blood loss, intra-operative complications, postoperative complications, time to first oral intake, time to bowel function return, duration of hospitalization, and length of follow-up were assessed. The postoperative ileus was defined as a period of bowel function cessation lasting longer than 5 days after surgery.

The discharge criteria for the open and laparoscopic reversal groups were identical, including tolerance of 3 meals without nausea or vomiting, the passage of flatus and stool, and adequate pain control with oral analgesia.

Statistical analysis

Continuous variables are presented as medians and interquartile ranges (IQRs), with the Wilcoxon rank sum tests were used to compare the differences between the open and laparoscopic groups. Categorical variables are presented as counts and percentages, with Fisher's exact tests used for group comparisons. Statistical analyses were performed using statistical software (SPSS, version 22 for Windows; IBM Corp, Armonk, New York). Values of $P < 0.05$ were considered significant.

Results

Patient demographics and clinical characteristics

A total of 34 patients who were diagnosed with perforated diverticulitis of the left-sided colon and initially treated using exploratory laparotomy and Hartmann's procedure were enrolled. Of the patients, 17 underwent laparoscopic HRs and the others underwent open procedures. Among the patients, the median age was 61 years in the open group, and 57 years in the laparoscopic group; there were 9 men and 8 women were in each group (Table 1). No significant differences were found regarding age, sex, body mass index, or surgical indication for Hartmann's procedure ($P > 0.05$). Among the laparoscopic cases, there were no open conversions.

Intra- and postoperative results

The median colostomy closure period was significantly longer in the laparoscopic group than in the open group (4 versus 3 months, $P = 0.011$). As shown in Table 2, the median longest incision length, estimated blood loss, time to first oral intake, and hospital stay were significantly lower in the laparoscopic group compared with those of the open group (longest incision length: 4 versus 18 cm, $P < 0.001$; estimated blood loss: 100 versus 200 mL, $P < 0.001$; time to first oral intake: 3 versus 5 days, $P < 0.001$; hospital stay: 8 versus 11 days, $P = 0.012$). There were no significant differences observed in operative time, time to first flatus, time to first stool, pain control medication use, Meperidine dose, and follow-up duration (all, $P > 0.05$) between 2 groups (Table 2).

Intra- and postoperative complications

Of the patients, 13 (76.5%) in the open HR group and 15 (88.2%) in the laparoscopic group did not experience intraoperative complications; 11 (64.7%) patients in the open HR group and 13 (76.5%) in the laparoscopic group were free of postoperative complications. The observed intraoperative complications included 4 (23.5%) bowel injuries in the open HR group and 1 (5.9%) bladder injury and 1 (5.9%) bowel injury in the laparoscopic group. In the

Table 2 Intra- and postoperative results

Variables	Open group, n = 17	Laparoscopic group, n = 17	*P* value
Colostomy closure period, mo	3 (3–4)	4 (4–6)	0.011*
Median operative time, min (range)	245 (199.5–346.5)	240 (210–270)	0.629
Longest incision length, cm (range)	18 (15–22.5)	4 (4–5)	<0.001*
Estimated blood loss, mL (range)	200 (150–300)	100 (50–100)	<0.001*
Median time to first flatus, d (range)	3 (2–4)	3 (2.5–3)	0.417
Median time to first stool, d (range)	4 (3–5)	4 (3–4)	0.111
Median time to first oral intake, d (range)	5 (4–6)	3 (3–3)	<0.001*
Pain control medication use, n (%)	9 (52.9%)	6 (35.3%)	0.491
Meperidine dose, mg (range)	50 (0–175)	50 (0–50)	0.335
Median hospital stay, d (range)	11 (8.5–15)	8 (7–10.5)	0.012*
Follow-up, mo (range)	16 (9–30)	12 (7–19.5)	0.428

Continuous variables are presented as medians and IQRs. Categorical variables are presented as counts and percentages.

*$P < 0.05$, significant differences between the open and laparoscopic groups.

laparoscopic group, the organ repairs were accomplished laparoscopically. During the postoperative period, there was 1 (5.9%) urinary tract infection; 1 (5.9%) incisional hernia; and 1 (5.9%) case of postoperative ileus These complications were observed in the open HR group of patients. There were 3 (17.6%) colostomy-site wound infections in the open HR group and 4 (23.5%) in the laparoscopic group. There were no operative mortalities among the 34 patients. There were no significant differences between the groups in intra- or postoperative complications (both, $P > 0.05$; Table 3).

Discussion

In the present study, we described the clinical outcomes of HR with or without laparoscopic assistance in perforated diverticulitis. We showed that laparoscopically assisted HR resulted in favorable outcomes compared to conventional technique.

Hartmann's procedure is commonly performed for managing complicated diverticulitis, tumor perforations, and rectal injuries, which minimizes the risk of intra-abdominal sepsis caused by anastomotic site leakage.[13] HR has been suggested to have a high rate of operative morbidity and mortality, particularly in elderly patients and those in poor health.[17] Midline laparotomy wounds are suggested to be associated with the severe postoperative pain and compromised pulmonary function, leading to high morbidity and mortality.[13] Laparoscopic assistance has been shown to improve HR with several advantages over conventional colorectal procedures.[16,18,19] Different laparoscopic HR techniques have been reported. A mini laparotomy technique for colostomy mobilization utilizing a commercial device (Pneumo Sleeve; Dexterity, Blue Bell, PA) has been described, which combines the advantages of a minimally invasive approach with the direct access of the surgeon's hand into the abdominal cavity.[20] On the other hand, recent research has reported an approach which involves initial port insertion using the open Hasson technique in the right lateral abdomen before mobiliza-

Table 3 Intra- and postoperative complications

Characteristics	Open group, n = 17	Laparoscopic group, n = 17	*P* value
Intraoperative complications, n (%)			0.335
None	13 (76.5)	15 (88.2)	
Bowel injury	4 (23.5)	1 (5.9)	
Bladder injury	0 (0)	1 (5.9)	
Postoperative complications, n (%)			0.757
None	11 (64.7)	13 (76.5)	
Urinary tract infection	1 (5.9)	0 (0)	
Colostomy-site wound infection	3 (17.6)	4 (23.5)	
Postoperative ileus (over 5 days)	1 (5.9)	0 (0)	
Incisional hernia	1 (5.9)	0 (0)	

There were no significant differences between the groups with intra- or postoperative complications ($P > 0.05$). Categorical variables are presented as counts and percentages.

tion of the colostomy from the abdominal wall.[13] The surgeons advocated the use of the colostomy site as a safe and convenient initial port for establishing pneumoperitoneum.[13] For patients with perforated diverticulitis, most of surgeons mobilize the splenic flexure during the initial operation to facilitate laparoscopic HR, followed by a mobilization of the rectal stump and resection of the residual distal sigmoid colon.[16,17,21,22] In the present study, we showed that the median colostomy closure period was significantly higher in the laparoscopic group than that of the open group. The findings supported the results of a previous study in which an adequate interval is an important factor for a successful laparoscopic approach because adhesions tend to be denser during the initial period.[13] The median operative time for laparoscopic surgery is suggested to be longer than that for open surgery.[11,13,22] In our study, the difference in the mean operative time between 2 groups was insignificant A possible explanation is that the perforated diverticulitis patients enrolled in this study had no histories of abdominal surgeries. Our results also revealed less intraoperative estimated blood loss and shorter length of hospitalization in the patients with perforated diverticulitis undergoing laparoscopic HR, suggesting that laparoscopic HR might be beneficial for reducing intraoperative patient blood loss, shortening hospital stays, and potentially, decreasing the overall morbidity.

Researches have reported that HR is associated with high overall average complication rate for and the overall mortality rate.[8,17,23] The most commonly reported postoperative complication is surgical wound infection and the most frequent late complication is anastomotic site stricture.[17,23] The high mortality is suggested to be attributed to septic shock and related complications caused by anastomotic site dehiscence or by intra-abdominal abscess formation.[16,17,19] In this study, patients undergoing laparoscopic HR exhibited a lower mean complication rate than those undergoing the open procedure. Additionally, the incidences of the most frequent complications, which are wound infections (laparoscopic, 10.8%; open, 14.2%), anastomotic site leakage (laparoscopic, 1.2%; open, 5.1%), and cardiopulmonary complications (laparoscopic, 3.6%; open, 5.1%) are lower among patients undergoing laparoscopic HR in comparison with those of open HR group. Moreover, the intraoperative complication rate was higher after open HR (23.5%) than after laparoscopic HR (11.8%). The postoperative complications in the laparoscopic group were surgical wound infection, whereas open HR groups experienced urinary tract infection, surgical wound infections, postoperative ileus, and incisional hernia. it is indicated that the postoperative complication rate of open HR is higher than that of laparoscopic HR. Most of the postoperative complications observed in this study could contribute to colostomy site infections. However, there were no significant differences between the open and laparoscopic groups with respect to intra- and postoperative complications (both, $P > 0.05$). Conversion of Laparoscopic HR is suggested to be attributed to extensive abdominopelvic adhesions.[13,17] In multiple prospective randomized trials comparing laparoscopic and open colectomies for colon cancer, the conversion rates were reported as 17% to 29%.[24,25] Adhesiolysis is a markedly difficult procedure to accomplish during laparoscopic HR, requiring the conversion of some patients to an open laparotomy procedure. In this study, there was no conversion required, possibly due to the enrolled patients who had fewer comorbidities and no histories of abdominal surgeries. In conclusion, laparoscopic HR is shown to have low risks of operative morbidity and mortality. The laparoscopic HR results were favorable in terms of better cosmoses, less blood loss, and faster recovery. Laparoscopically assisted HR is suggested to be beneficial for promoting an early return of bowel function and shortening patient hospitalization.

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