Outcomes of Laparoscopy Combined with Enhanced Recovery Pathway for Reversal of Hartmann's Procedure

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Abstract The objective of this study is to discuss the security and feasibility of the laparoscopic reversal of Hartmann's procedure (LRHP) on the concept of enhanced recovery after surgery (ERAS). The clinical data of 42 patients who underwent laparoscopic reversal of Hartmann's procedure was retrospectively analyzed, and the operative time, blood loss, intraoperative and postoperative complications, conversion to open surgery, postoperative hospital stay, and so on were observed. Twenty-nine patients (69.00 % of the study pool) received complete postoperative recovery courses as prescribed by enhanced recovery program (ERP). The postoperative length of stay (LOS) in the hospital was 5.6 (3–16 days). The overall and major (grades III to V) postoperative morbidities were 33.3 % ($n=14$) and 4.8 % ($n=2$), respectively. Our preliminary results showed that using the laparoscopic technology in reversal of Hartmann's colostomy on the concept of ERP is safe and feasible. Patients with intra- or postoperative complications were found to have statistically significant associations with greater risk of ERP failure.

Keywords Enhanced recovery after surgery · Laparoscopic reversal of Hartmann's procedure · Fast-tract recovery program · Minimally invasive techniques

Hartmann's operation was described in 1921 by Henri Albert Hartmann for resection of left-sided carcinoma of the colon [1]. The procedure was designed to reduce mortality from anastomotic dehiscence. Today, the procedure is widely used for a variety of indications, mainly perforated diverticulitis, ischemic colitis, and colonic obstruction. Other indications include traumatic perforations, volvulus, inflammatory colitis, and anastomotic leaks [2]. Reversal of Hartmann's can be a technically challenging operation that requires a major abdominal surgery and is associated with significant morbidity with anastomotic leak rates varying from 4 to 16 % and mortality rates of 0–4 % [3–5].

Minimally invasive techniques for colorectal surgery have evolved since the early 1990s. Today, laparoscopic techniques have been applied to colostomy reversal in an effort to reduce postoperative pain, hospital stay, morbidity, and mortality. However, these trials did not apply early rehabilitation programs. Enhanced recovery after surgery (ERAS) is an extension in the field of minimally invasive surgery: besides a minimally invasive surgical approach, it provides for an advanced management of anesthesia, analgesia, and digestive and motor rehabilitation, with the aim of achieving less pain, early re-alimentation and canalization, early mobilization and deambulation, reduced morbidity, rapid functional recovery, and shorter hospitalization; this will also lead to hospital cost reduction [6, 7]. Since January 2010, our unit has implemented ERAS for patients who have undergone laparoscopic reversal of Hartmann's procedure. The goals of this study were to evaluate whether it is appropriate to use enhanced recovery program (ERP) on patients who undergo reversal of Hartmann's colostomy via the laparoscopic approach and to further investigate potential factors that may affect the results of this practice modality.

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Patients and Methods

Inclusion/Exclusion Criteria

Since January 2010, our unit has implemented ERAS for patients who have undergone laparoscopic reversal of Hartmann's procedure. Records of all patients with laparoscopic reversal of Hartmann's procedure (LRHP) performed in our unit between 2010 and 2015 were retrieved using electronic database and were retrospectively reviewed. Patients were excluded for the following reasons: patients who did not receive ERAS or dropped out in the middle of the pathway.

Forty-two patients were enrolled in this study from January 2010 to March 2015.

Laparoscopic Reversal of Hartmann's Procedure: Surgical Technique

Patients are positioned in the Lloyd-Davis position. The chief surgeon and the camera assistant stand on the right side of the patient. A second assistant stands on the left side of the patient.

Pneumoperitoneum is achieved via a 12-mm trocar in the right flank, using an open technique. A second 5–12-mm trocar is inserted in the right iliac fossa and a variable number of 5-mm trocars are inserted in the right upper quadrant and suprapubic area as required.

After the establishment of pneumoperitoneum, the peritoneal cavity is first assessed. The presence of dense adhesions or difficulty in identifying the rectal stump is an indication for early conversion. In the absence of these, the descending colon and splenic flexure are mobilized. The rectal stump is dissected out and identified.

Next, pneumoperitoneum is abolished and the end colostomy is mobilized and excised. The proximal colonic stump is delivered through the protected wound and the detachable anvil of a circular stapler is placed and anchored with a purse-string suture. The stump is then put back into the peritoneal cavity.

Finally, pneumoperitoneum is re-established and intracorporeal colorectal anastomosis is performed using a circular stapler, inserted transanally. A covering ileostomy is constructed at the end of operation at the discretion of the operating surgeon.

Perioperative Care Plan

Admission Propaganda and Education

Detailed treatment procedures were explained to patients and their (family) dependents by house staff; these explanations included preparation in the preoperative period, written information regarding the surgery, complications after surgery, the

expected length of the hospital stay, etc. The house staff established a relationship of mutual trust with patients to decrease their anxiety.

Physiotherapy

A physiotherapist educated all of the patients on breathing exercises and the use of incentive spirometers preoperatively. Cigarette smoking was strongly discouraged. On the first postoperative day, patients initiated a structural mobilization plan to encourage early ambulation.

Preoperative Carbohydrate Loading and Intravenous Antibiotic Prophylaxis

Patients started nothing-by-mouth restrictions at midnight the day before surgery. Intravenous antibiotic prophylaxis (ceftriaxone 1 g and metronidazole 500 mg) was given 30 min prior to surgery and continued for 24 h afterward (i.e., two extra doses of metronidazole 500 mg).

Pain Control

Preoperatively, a trained pain nurse would visit the patients and describe postoperative pain management, including the use of epidural analgesia and patient-controlled analgesia. Perioperatively, individual anesthetists determined the type of analgesia to be used. Postoperatively, the hospital pain management team supervised pain control.

"Restricted" Fluid Administration

Fluid maintenance was limited to 1 L of crystalloids, except for patients who experienced hypotensive episodes where extra fluid boluses (300 cc) were administered. Fluid administration is altered as clinically necessary.

The Criteria for Discharge

The patient's general condition was comparatively stable after surgery, and the patient was receiving an oral diet. The surgical incision healed well, and the drainage tube was removed. The patient was normothermic, and there were no positive signs of problems in the abdomen. The results of laboratory tests and abdominal plain films were normal. There were no complications and/or comorbidities requiring inpatient treatment.

Follow-Up and Failure of ERP

Follow-up was conducted in the outpatient clinic at 1, 2, and 4 weeks after discharge. In contrast, failure of ERP was

defined as postoperative hospitalization of more than 5 days or readmission within 30 days after surgery.

Assessment of Process and Outcome Quality

The information collected included the following: demographics, indications for Hartmann's procedure, length and cost of hospital stay, the number of postoperative complications, and deaths.

The indicators of outcome evaluation included length and cost of hospital stay, postoperative complications, and mortality.

Postoperative complications were counted according to the international Clavien-Dindo classification system [8] for surgical complications (Clavien I to V). The overall complication rate and the moderate to severe (Clavien III to V) complication rate were recorded.

Postoperative mortality was defined as death resulting from any cause after surgery within 30 days.

Postoperative hospital stay was defined as the time from the day of surgery until discharge from the hospital.

Statistical Analysis

SPSS 18.0 for Windows (SPSS Inc., Chicago, IL) was used for all statistical analyses. All statistical analyses were completed using the χ^2 test, Student's *t* test, and an analysis of variance test (where relevant). A *P* value of <0.05 was considered significant.

Results

The patient demographic data and comorbidities are summarized in Table 1. Forty-two patients received laparoscopic

Table 1 Patient demographic data

Demographic data	No. of patients (%)
Age, years (median, range)	58 (26–78)
Sex (male/female)	26 (61.9)/16 (38.1)
Preoperative ASA grade (I/II/III)	28 (66.7)/12 (28.6)/2 (4.7)
Indications for Hartmann's procedure	
Sigmoid volvulus	4 (9.5)
Perforated diverticulitis	2 (4.8)
Other perforations	13 (30.9)
Colonic malignancy	15 (35.7)
Radiation enteritis	2 (4.8)
Anastomotic leakage	6 (14.3)
BMI, kg/m ² (mean, range)	24.47 (17.8–32.7)
Previous abdominal surgery (yes/no)	11 (26.2)/31 (73.8)

reversal of Hartmann's procedure on the concept of ERAS. The majority of the patients were classified as American Society of Anesthesiologists (ASA) grade I (*n*=28, 66.7 %) or II (*n*=12, 28.6 %). Twenty nine patients (69.00 %) were discharged within 5 days after operation. The postoperative length of stay (LOS) in the hospital was 5.6 (3–16 days); the detailed information is listed in Table 2. All patients have been discharged from the hospital after complying with discharge standards. The postoperative LOS in the hospital is shorter in the ASA [9] grade 1 group (4.7±3.4 days) than the ASA grade 2 group (5.5±5.2 days); the difference was not significant (*P*=0.13).

Twenty eight (66.7 %) experienced no adverse events and recovered uneventfully; 16 episodes of postoperative complications occurred in 14 patients. The overall and major (grades III to V) postoperative morbidity were 33.3 % (*n*=14) and 4.8 % (*n*=2), respectively. Postoperative morbidity according to the Clavien-Dindo classification is listed in Table 3. Two patients (4.8 %) required relaparotomy for postoperative complications. Three patients' postoperative LOS were more than 10 days, including one patient who had lung infection. Two cases received Hartmann's procedure again because of anastomotic fistula.

Five patients were readmitted within 30 days after their initial discharge. Reasons for readmission <30 days and consequent management are listed in Table 4.

According to the chi-square test, patients with intra- or postoperative complications (*P*=0.003) were the only factor that jeopardized the success of ERP (Table 5).

Discussion

Reversal of Hartmann's colostomy offers the obvious advantage of intestinal continuity, but historically has required a major abdominal surgery associated with significant morbidity with anastomotic leak rates varying from 4 to 16 % and mortality rates of 0–4 %. Given these potential risks, 40–60 %

Table 2 The postoperative length of stay (LOS) in the hospital

Mean postoperative LOS (days)	No. of patients (%)	Cumulative percentage
3	4 (9.5)	9.50
4	9 (21.4)	30.90
5	16 (38.1)	69.00
6	4 (9.5)	78.50
7	3 (7.1)	85.60
8	2 (4.8)	90.40
9	1 (2.4)	92.80
10	1 (2.4)	95.20
>10	2 (4.8)	100

Table 3 Postoperative morbidity according to the Clavien-Dindo classification

Clavien-Dindo classification	No. of patients (n=42)
Grade I	8
Diarrhea	6
Incisional infection	2
Grade II	4
Catheter infection	1
Blood transfusion postoperatively	1
Early postoperative obstruction	2
Grade III	4
Pleural effusion and drainage	1
Intra-abdominal/pelvic abscess	1
Anastomotic leak	2

of the patients do not undergo colostomy reversal after Hartmann's procedure. With the development of minimally invasive surgery, these morbidity rates may be reduced. Today, laparoscopic techniques have been applied to colostomy reversal in an effort to reduce postoperative pain, hospital stay, morbidity, and mortality. However, these trials did not apply early rehabilitation programs. Both laparoscopic surgery and early rehabilitation programs focus on minimizing surgical pain and perioperative stress and enhancing recovery after surgery. There were no related reports whether early rehabilitation programs and laparoscopic surgery can have a synergistic effect in enhancing recovery after laparoscopic surgery for Hartmann's procedure.

ERP are standardized protocols for optimizing and streamlining patient care. The pathways detail the essential steps in patient care with the goal of describing the expected progress of the patient. The literature suggests that ERP reduce the cost of care and the length of patient stay in the hospital. ERP also have a positive impact on outcomes by increasing the quality of care and patient satisfaction and by improving the continuity of information and patient education. ERP have been implemented for many types of major surgery such as colectomies, pulmonary resections, and cardiac bypasses, all with favorable results. The key principles of

these enhanced recovery programs are adequate analgesia, early ambulation, and early resumption of oral intake [10, 11]. In our study, heavy emphasis was placed on preoperative discussion and explanation of ERP. Detailed treatment procedures were explained to patients and their (family) dependents, and these explanations included preparation in the preoperative period, written information regarding the surgery, complications after surgery, the expected length of the hospital stay, etc. Two nurse practitioners were responsible for explaining ERP to the patients and keeping in contact with them after discharge to follow up on recovery improvements and issues.

Laparoscopic-assisted Hartmann's reversal (LAHR) can offer a clear advantage over open Hartmann's reversal (OHR) in cases that require mobilization of the splenic flexure by avoiding an upper abdominal incision and its potentially increased respiratory complications [12, 13].

Table 5 Chi-square tests performed on the collected statistics

Factor	No. of ERP patients		P value
	Success	Failure	
Gender			1.00
Male	18	8	
Female	11	5	
Age (years)			0.163
<60	21	6	
>60	8	7	
ASA grade			0.81
I	20	8	
II	8	4	
III	1	1	
BMI			0.083
<28	26	8	
>28	3	5	
Operative time (min)			0.429
<180	23	9	
>180	6	4	
Blood loss (mL)			0.442
<100	24	9	
>100	5	4	
Conversion			0.683
Yes	5	2	
No	24	11	
Complications			0.003
Yes	5	9	
No	24	4	
Comorbidities			0.227
Yes	12	8	
No	17	5	

Table 4 Reasons for readmission <30 days and consequent management

Reason	No. of patients	Days to readmission	Management
Ileus	2	12/14	Conservative treatment
Delayed wound infection	3	7/11/9	Wound care
Poor oral intake with dehydration	2	7/10	Supportive treatment
Total no. of patients	7		

LAHR also allows clear view of the sigmoid and descending colon so unnecessary dissection can be avoided. In this study, postoperative morbidity was 33.3 %, most commonly surgical site infection and ileus (Table 3). Similar to the results of previous literature [14, 15], our study supports that laparoscopic reversal of Hartmann's procedure is a technically feasible alternative for restoration of intestinal continuity.

In this study, the postoperative LOS in the hospital was 5.6 (3–16 days); 29 patients, 69.00 % of the study pool, received complete postoperative recovery courses as prescribed by ERP (LOS <5 days). The relevant randomized and non-randomized studies have shown that the factors that would prolong the postoperative length of stay included ASA score/postoperative complications/age/intraoperative transfusion. In our study, patients with intra- or postoperative complications ($P=0.003$) were the only factor that jeopardized the success of ERP. Though the postoperative morbidity was 33.3 %, most commonly surgical site infection and ileus, complications were a primary reason for slow recovery, and this fact is easy to understand. Postoperative complications were counted according to the international Clavien-Dindo classification system for surgical complications (Clavien I to V). Patients with the minor (Clavien I to II) complications can be managed by conservative treatment without severe consequences. However, patients with the postoperative moderate to severe (Clavien III to V) complications were hospitalized significantly longer, as long as a median period of 14 days in our series. In addition, for some patients without complications, bowel function recovery is another factor which can influence the postoperative length of stay. For these patients, if the bowel function had not recovered to preoperative conditions at 5 days of hospitalization, we let them discharge prior to return of normal bowel function with outpatient follow-up and yet no increased report of complications.

Five patients were readmitted within 30 days after their initial discharge; superficial wound complication and diarrhea are the main reasons for their readmission, and all these complications can be managed by conservative treatment. Thus, postdischarge follow-up and earlier detection and prevention are key factors that should be pursued in remedying the situation.

There were limitations in this study. Given the restricted number of cases in this study, we could not further analyze the risk factor of ERP failure through multivariate analysis; thus, large studies are needed. The samples of our study included all possible indications, thus grouping together patients with diverticulitis, cancers, inflammatory bowel disease, or trauma. However, this grouping may bias the interpretation of results.

Conclusions

Our preliminary results showed that using the laparoscopic technology in reversal of Hartmann's colostomy on the concept of ERP is safe and feasible. Nevertheless, further large, randomized studies are needed to clearly define proper ERP content and patient selection criteria for laparoscopic rectal surgery.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no competing interests.

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