

A comparative study between open versus laparoscopic Hartmann reversal

A single-center experience and analysis

Hye Jung Cho, MD, Woo Ram Kim, MD*, Jong Woo Kim, MD, PhD

Abstract

As one of the most challenging procedures in colorectal surgery, Hartmann reversal (HR) carries a burden of morbidity and mortality. We report our experience and compare open and laparoscopic HR.

Between December 2012 and January 2020, 30 patients who underwent Hartmann reversal were reviewed. All patients either received laparoscopic or open reversal.

Of the 87 patients who underwent Hartmann operation (HO), 30 patients received HR (Laparoscopic Hartmann Reversal, [LHR], n=20; Open Hartmann Reversal, Open Hartmann Reversal [OHR], n=10). There were 15 males and 15 female patients. The mean operation time was 223.8 minutes (range 115–350 minutes) with mean blood loss of 252.5 mL (range 0–700 mL). There was no conversion from LHR to OHR, and there was no ileostomy formation. Mean time to flatus was 5.0 days (range 2–13 days). There were 15 early postoperative complications and 5 late postoperative complications, but only 1 case of grade 3A. No anastomosis leakage was reported.

HR is an operation that can be performed safely in well-selected patients. Minimally invasive techniques, such as LHR, is an attractive option resulting in shorter operation time, less blood loss, less pain, and shorter hospital stay.

Abbreviations: ASA = American Society of Anesthesiologists classification, HO = Hartmann operation, HR = Hartmann reversal, LHR = laparoscopic Hartmann reversal, OHR = open Hartmann reversal, RHR = robotic Hartmann reversal.

Keywords: Hartmann operation, Hartmann reversal, laparoscopy, minimally invasive

1. Introduction

Hartmann operation (HO) is a widely utilized procedure first introduced by Henri Albert Hartmann in 1923 for diseases in rectosigmoid colon. Its use expanded including but not limited to complicated diverticulitis, perforation or obstruction of the left colon, and ischemic colitis complicated by fecal contamination or edema.^[1,2] Advantages of Hartmann operation include reduced

operation time in unstable patients and prevention of anastomosis leakage via formation of a colostomy. However, a decreased quality of life is a major impediment for most patients. With the use of stapling devices from the mid-1980s, Hartmann reversal (HR) has been an attractive option for selected patients.^[3] Hartmann reversal is one of the most challenging procedures in colorectal surgery. Anastomosis leakage rates vary from 4% to 6% with mortality up to 10%.^[4,5] For this reason, minimally invasive surgeries, such as laparoscopic or robotic Hartmann reversal gained the spotlight by reducing both morbidity and mortality rates. We here report our experience of laparoscopic and open Hartmann reversal and compared perioperative outcomes of the 2 techniques.

2. Materials and methods

Between September 2011 and November 2019, 87 patients received HO of whom 30 patients underwent HR at OO Medical Center by 2 colorectal surgeons. Twenty patients received laparoscopic hartmann reversal (LHR) while 10 received open hartmann reversal (OHR) as shown in Figure 1. Patient's data, such as age, sex, body mass index, American Society of Anesthesiologists classification (ASA), initial indications for HO, initial surgical method, and HR surgical method were analyzed. Perioperative data including operation time, blood loss, complication classified by Dindo-Clavien classification system, length of hospital stay, time to first flatus, patient's status, and last follow-up time were also evaluated. Postoperative pain score was evaluated on post-operative day 0, 1, 3, and 7. The highest score per day was collected and the average was compared. Early

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Division of Coloproctology, Department of General Surgery, Bundang CHA Medical Center, CHA University College of Medicine, Seongnam, Republic of Korea.

* Correspondence: Woo Ram Kim, Division of coloproctology, Department of General Surgery, Bundang CHA Medical Center, CHA University College of Medicine, 59 Yatap-Ro, Bundang-gu, Seongnam-si, Gyeonggi-do 13496, Republic of Korea (e-mail: christtome81@chamc.co.kr).

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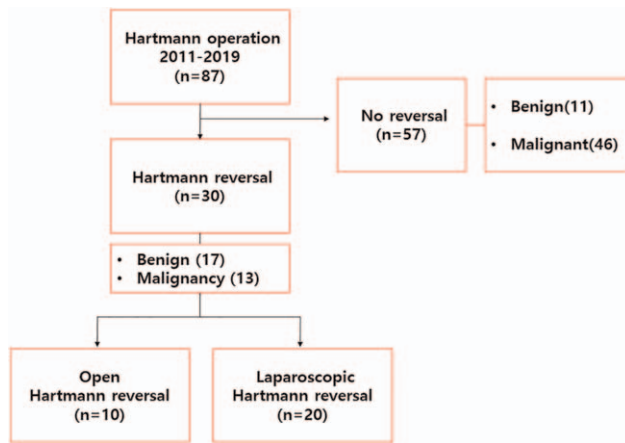


Figure 1. Flowchart of selection of patients.

postoperative complication was defined as events within 3 months after the operation while that of late was designated to more than 3 months.

All patients underwent preoperative work-up including computed tomography, colonoscopy, and tumor markers, if indicated. Of the collected data, perioperative variables and complications were categorized into 2 groups (LHR vs OHR) and were analyzed.

The patients were all placed in a lithotomy position. The colostomy was first dissected and mobilized into the peritoneum with adhesiolysis around the stoma site. Depending on the extent of intraabdominal adhesions and after visualization of the abdominal cavity, the appropriate method of reversal was adopted. For LHR, a wound retractor with two-way gas port (SurgiTractor [ST0306], SurgiCore Co., Ltd., Gwangju, Korea) was inserted into the stoma site to gain pneumoperitoneum. Additional 5 mm trocars were inserted into the suprapubic and left upper quadrant for further adhesiolysis. During this process, the surgeon stood on the left lower side of the patient with the scopist on the ipsilateral side towards the patient's head. After adhesiolysis, the scopist and the surgeon moved to the other side in the same ventrodorsal configuration. The assistant stood below between the patient's legs. Additional 5-, and 12-mm trocars were placed into right middle quadrant and right lower quadrant, respectively. With the patient re-positioned in a Trendelenburg, adhesions in the pelvic cavity were lysed. The mobilized small bowel was pushed to the left side in order to identify and dissect the rectal stump. If needed, the proximal stump was transected with a stapling device (Signia stapling system, Covidien Medtronic, Minneapolis, MN, US). Finally, using a circular stapler (EEA Covidien Medtronic, Minneapolis, MN, US), end-to-end anastomosis was carried out. An air leak test was performed to evaluate the intactness of the anastomosis. If the test was positive, a diverting ileostomy was matured, which was not necessary in any of our cases.

This study is a retrospective study with prospectively recorded data. For statistical analysis, SPSS (IBM, SPSS Statistics for Windows, Version 25, IBM Corp., Armonk, NY) was used for all analysis. Continuous data are described as mean standard deviation (range), while categorical data are reported as number of cases (percentage of cases). A P value of $\leq .05$ was considered statistically significant.

This study was approved by the Institutional Review Board (IRB No. 2020-03-055) ethics committees of OO Medical Center, and was conducted according to the principles of the Declaration of Helsinki.

3. Results

Thirty patients underwent HR between December 2012 and January 2020 at our hospital. There were 15 males and 15 females. The mean age was 66.4 years (range 42–84 years) with the LHR group having older group of patients. The mean BMI was 24.7 kg/m² (range 17.8–31.2 kg/m²). ASA scores varied with 4 patients with ASA I, 14 patients with ASA II, and 12 patients with ASA III. Seventeen patients underwent initial HO due to benign causes while 13 patients had malignancies. The most common benign indication for HO was ischemic colitis (n=10) followed by diverticulitis (n=6) and fecal impaction (n=1). Malignancies warranting HO included sigmoid colon cancer (n=10), rectosigmoid junction cancer (n=2), and placental trophoblastic tumor (n=1). Comparing the method of HR, the 2 groups showed statistically significance in the cause of initial HO. Sixteen patients (80%) with benign indications were treated with LHR and 9 patients with malignant indications were (90%) treated with OHR. All 10 patients who underwent laparoscopic HO were treated with LHR. Of the 20 patients managed with open HO, the repair method was split in half. The average interval duration upto HR was 7 months with no statistical significance between 2 groups. Median follow-up duration was 21.4 months (1–84 months). The above mentioned clinical characteristics of the patients are shown in Table 1.

Perioperatively, the 2 groups showed statistically significance in operation time, estimated blood loss, time to flatus, postoperative pain score, and length of hospital stay as shown in Table 2. The mean operation time was 223.8 minutes (OHR group 263.0 minutes; LHR group 204.3 minutes; $P = .016$). There was neither conversion nor ileostomy formation in both groups with no major leakage reported. The mean estimated blood loss was 252.5 mL (OHR group 396.0 mL; LHR group 180.8 mL; $P < .001$). The time to flatus and the length of hospital stay were shorter with 4.0 days and 9.5 days in LHR group compared to 5.5 days and 16.5 days in OHR group ($P = .018$), respectively. The mean postoperative pain score showing the average of the highest pain recorded on postoperative day 0, 1, 3, and 7 was lower in LHR group (OHR group 2.75; LHR group 1.38; $P = .037$).

There were no significant differences between the 2 groups regarding early and late postoperative complications as shown in Table 3. There were 15 reported early postoperative complications with only 1 patient with grade IIIa Dindo-Clavien classification. The most common early complication was postoperative ileus (n=6), followed by seroma, intra-abdominal infection, and wound infection. Five patients reported late postoperative complication of incisional hernia (n=4) and rectovaginal fistula (n=1).

4. Discussion

Hartmann's procedure involves resection of the lesion in question, usually the sigmoid colon, and a formation of rectal stump and a colostomy. The restoration of bowel continuity via HR is irresistible for improved quality of life and stoma-related complications.^[6] However, not everyone who underwent HO is a candidate for HR.

Table 1
Patient demographics and clinical characteristics of Hartmann reversal.

	All patients (n = 30)	OHR (n = 10)	LHR (n = 20)	P value
Age, mean ± SD (yrs)	66.43 ± 11.8	60.2 ± 8.1	69.6 ± 12.2	.019
Gender, n (%)				
Male	15 (50)	8 (80)	7 (35)	.050
Female	15 (50)	2 (20)	13 (65)	
BMI, mean ± SD (kg/m ²)	24.7 ± 3.5	25.3 ± 4.3	24.4 ± 3.1	.592
ASA classification, n (%)				
I	4 (13)	4 (40)	0 (0)	<.001
II	14 (47)	6 (60)	8 (40)	
III	12 (40)	0 (0)	12 (12)	
Cause of initial operation, n (%)				
Benign	17 (57)	1 (10)	16 (80)	
Diverticulitis	6	0	6	
Ischemic colitis	10	1	9	
Fecal impaction	1	0	1	<.001
Malignant	13 (43)	9 (90)	4 (20)	
Sigmoid colon cancer	10	9	1	
Rectosigmoid junction cancer	2	0	2	
Placental trophoblastic tumor	1	0	1	
Initial operation method				
Open	20 (67)	10 (100)	10 (50)	.011
Laparoscopy	10 (33)	0	10 (50)	
Median interval duration before HR, mo (range)	4 (1–41)	8.5 (4–16)	3 (1–41)	.001
Median follow-up duration, mo, (range)	21.4 (1–84)	35 (1–84)	11.5 (1–41)	.050

ASA = American Society of Anesthesiologists, BMI = body mass index, HR = hartmann reversal, LHR = laparoscopic hartmann reversal, n = number, OHR = open hartmann reversal, SD = standard deviation.

Although reports vary, HR rates range from as little as 19% to little over half.^[7,8] Accounting for the original indications of HO, reversal rate for malignancies plummet to 17%.^[9] Our reversal rate was 34.5%, well-within the norm, with 43% of who were malignant indications. 17 patients (57%) had benign indications for original HO; unlike other reports, the most common benign cause in our study was ischemic colitis followed by diverticulitis.^[1] We also had equal number of HR patients with sigmoid colon cancer given the high prevalence of sigmoid cancer and low prevalence of diverticulitis in Asian population.^[8,10]

Patients under consideration for HR should be in tolerable condition and comprehend the morbidity of the procedure. Due to the low percentage of the reversal rate, many studies investigated factors contributing to the reversal rate. Park et al argued that age was the most important influencing factor in their study^[11], while high ASA score may reduce the reversal rate.^[12]

Nonetheless, other study contradicts such claim by arguing that high ASA did not contribute to higher postoperative complication rate.^[13] In our study, only 13% of patients had ASA of I while 87% were II or more. There were no patients with ASA of grade IV or more in the reversal group, but there were 7 patients with grade IV or more in the HO group. Benign indications for HO definitely increase the likelihood of reversal.^[6,14,15] Some studies even argue male patients have higher prevalence of HR,^[6,15,16] which was not the case in our study with only 15 patients (31.25%) out of 48 male patients underwent HR whereas 15 patients (38.46%) were females.

As expected, 80% of benign cases underwent LHR. Patients with higher ASA were treated with LHR with statistical significance (*P* < .001). Moreover, the LHR group had older mean age. Incorporating these data, we can deduct that ischemic colitis is common in old age patients whom co-morbid conditions

Table 2
Perioperative outcomes.

	All patients (n = 30)	OHR (n = 10)	LHR (n = 20)	P value
Operative time, mean ± SD (min)	223.8 ± 61.3	263.0 ± 58.2	204.3 ± 54.0	.016
Estimated blood loss, mean ± SD (mL)	252.5 ± 183.5	396.0 ± 199.3	180.8 ± 127.7	<.001
Conversion rate, n (%)	0	0	0	–
Ileostomy formation, n (%)	0 (0)	0 (0)	0 (0)	–
Transfusion, n (%)	2 (6.7)	2 (20)	0 (0)	.103
Time to flatus, days (range)	5.0 (2–13)	5.5 (4–9)	4.0 (2–13)	.018
Postoperative pain score, median (range)*	1.83 (0–4.75)	2.75 (1–4.75)	1.38 (0–3)	.037
Length of hospital stay, days (range)	14.0 (6–29)	16.5 (10–22)	9.5 (6–29)	.018
Perioperative complication, n (%)	15 (50)	6 (60)	9 (45)	.700

LHR = laparoscopic hartmann reversal, n = number, OHR = open hartmann reversal, SD = standard deviation.

* Mean pain score during postoperative day 1 to 7 by VAS (Visual analogue scale; 1–10).

Table 3
Early and Late Postoperative complications.

	All patients (n = 30)	OHR (n = 10)	LHR (n = 20)	P value
Early postoperative complication, n (%)*	15 (50)	6 (60)	9 (50)	
Clavien-Dindo classification				
0	15 (50)	4 (40)	11 (55)	.700
I	6 (20)	2 (20)	4 (20)	
II	8 (26.7)	4 (40)	4 (20)	
IIIa	1 (3.3)	0	1 (5)	
Type of early postoperative complication				
Seroma	3 (10)	1 (10)	2 (10)	
Wound infection	2 (6.7)	0 (0)	2 (10)	
Intra-abdominal infection	3 (10)	1 (10)	2 (10)	–
Postoperative ileus	6 (20)	4 (40)	2 (10)	
Angina	1 (3.3)	0 (0)	1 (5)	
Late postoperative complication, n (%)**	5 (16.6)			
Incisional hernia	4 (13.3)	0 (0)	4 (20)	.368
Rectovaginal fistula	1 (3.3)	0 (0)	1 (5)	

OHR = open hartmann reversal, LHR = laparoscopic hartmann reversal, n = number.

* Early postoperative complication within 3 months after operation.

** Late postoperative complication more than 3 months after operation.

exist leading to poorer general condition and higher ASA scores. In order to minimize the morbidity associated with HR, laparoscopic approach was adopted in these patients.

The mean operation time between LHR and OHR vary widely among the studies. In the 2 large meta-analysis conducted by Celentano group and Van de Wall group^[9,17], the operation time was comparable between the 2 groups. However, the most recent meta-analysis conducted by Guerra et al comparing 26 studies, showed a statistically significant mean difference in favor of LHR.^[18] Looking at our data, LHR operation time was significantly shorter than that of OHR ($P=.016$). Likewise, estimated blood loss was also significantly lower in the LHR group ($P<.001$) in sync with numerous published data.^[17–20] In 2 of our 10 OHR cases, liver resection of a metastatic lesion was performed cooperatively, which lengthened the operation time. Moreover, cases with severe abdominal adhesions often required the conventional open method also contributing to a longer operation time.

The perioperative benefits of laparoscopic surgery in colorectal surgery in less postoperative pain, less time to normalization of bowel function, less time to resume normal diet, and fewer days of hospital stay have been appraised.^[21–23] Median postoperative pain score was significantly lower in LHR group (range 1–4.75 in OHR; 0–3 in LHR). Time to flatus ranged from 4 to 9 and 2 to 13 days in OHR and LHR group, respectively, and length of hospital stay elicited statistical significance in LHR group ($P=.018$) with numerous studies reporting similar results.^[24–27]

There is no consensus on the *proper* method of gaining pneumoperitoneum. Our first step was takedown of the colostomy and adhesiolysis around the stoma site similar to the first LHR described by Gorey et al in 1993.^[28] Such method is utilized by many authors performing LHR.^[11,29–31] Another method of access is through direct trocar placement into the abdominal wall away from the colostomy site.^[10,20] Others begin with colostomy takedown, but place an optical-access trocar at another site.^[32,33] The surgical method of choice rests on the hands of the surgeon, but as Carus et al mentioned^[32], mobilizing the colostomy first reduces operation time and risk of injury by

avoiding the loss of pneumoperitoneum and by visualizing both adhesions and bowel.

Conversion rate from LHR to OHR reach as high as 50%.^[17] A large number of studies agree that postoperative adhesions, rectal stump identification, and dissection are the main causes of conversion from laparoscopic to open surgery.^[34] Laparoscopic surgery has many benefits compared to open surgery, one of which is the formation of fewer adhesions.^[35] Our study reports zero conversion rate with all of the patients previously treated with laparoscopic HO consequently treated with LHR. 50% of patients who initially underwent open HO were also treated with LHR. We believe there are 2 factors contributing to our low conversion rate: the surgical method and the surgeon. By acquiring pneumoperitoneum via the colostomy site, we were able to accurately assess the patient's extent of his or her intraabdominal adhesions. By adopting the optimal method, LHR or OHR, after visualizing the abdominal cavity, we were able to avoid making the wrong choice to begin with. Moreover, 2 colorectal surgeons performed the surgeries with 9 patients treated by 1 surgeon and 21 patients treated by the other. All 9 patients treated by 1 surgeon underwent open HO and consequently OHR.

HO-HR time frame vary significantly between OHR and LHR group (8.5 months vs 3 months, $P=.001$). As mentioned above, patients whose initial indications for HO were malignancies more often endured OHR. These patients often underwent adjuvant chemotherapy prior to HR, which lengthened the HO-HR time frame. On the contrary, benign diseases do not require additional treatment yielding shorter duration to HR. Given the fact that of the 17 patients who underwent initial HO due to benign causes 16 patients underwent LHR, HO-HR time frame is shorter in LHR group. Timing of the reversal is crucial as it relates to postoperative complications, yet reports from numerous studies are conflicting. Later reversal is favored by Pearce et al reporting higher postoperative complication, such as anastomosis leakage in HO-HR time frame of less than 6 months.^[7] Keck et al reported no difference in morbidity, but the severity of the adhesions was greater in the early group (<15 weeks).^[36] Earlier reversal

proponents argue 5 times higher number of complications in patients with more than 6 months time frame.^[37] Roe et al divided the patients into 2 groups and reported favorable results in early reversal of less than 4 months.^[38] In our study, there was no difference in the number of early complications between the early (<6 months, n=8) and the late (≥6 months, n=7) group. However, all 5 late complications were in the early group possibly favoring later reversal in reducing late complications. The timing of the reversal is still in debate and further investigation is required.

The 2 groups showed no statistically significant difference in early or late complications. Definitions of early and late complications vary widely in other studies comparing LHR and OHR making comparisons difficult and inaccurate. Haughn et al reported higher complication and reoperation rates at 6 month follow-up in OHR group mainly due to incisional hernia ($P=.015$).^[19] Celentano et al reported 30-day overall mortality, morbidity, reoperation rate, and readmission rate with only the morbidity in favor of LHR.^[17] A meta-analysis performed by Van de et al reported higher mean overall morbidity rate in OHR group (12.2% vs 20.3%), especially for wound infection, anastomosis leakage, and cardiopulmonary complications.^[9] In our study, the most common early postoperative complication was ileus in 6 patients of whom 4 underwent OHR and 2 LHR. Seroma, wound infection, and intra-abdominal infection were more common in LHR group, which can be explained by the fact that LHR group was composed of patients with ASA 3. Surprisingly, late complications, although insignificant, were all in LHR group with 4 colostomy site incisional hernia and 1 rectovaginal fistula. We believe the fact that LHR group has higher ASA score, infection-prone initial diagnoses, and short HO-HR time frame of less than 3 months may be contributory factors. Although our study did not yield any mortality for comparison, nearly all studies agree that the 2 groups do not show statistical significance in overall mortality.^[9,17,39]

We report 1 case of rectovaginal fistula postoperatively. The patient suffered from systemic lupus erythematosus on steroid therapy. We also observed severe adhesion of the vagina and the rectal stump, which was impossible to properly dissect during the operation. The patient underwent laparoscopic re-do colorectal anastomosis and hysterectomy due to the fistula.

Some surgeons have even incorporated single-port LHR and Robotic HR (RHR). Choi et al utilized the colostomy site with single-port device and underwent 22 single-port laparoscopic hartmann reversal with only minimal complications.^[29] The advantages mentioned include minimization of bowel injury, fewer trocar sites, and close proximity to the rectal stump. However, technical difficulties arise in dissecting peritoneal adhesions and identification of the rectal stump. Such frustration can be overcome by RHR. First reported by de'Angelis et al in 2014,^[40] RHR compensates for the difficult dissection of peritoneal adhesions often encountered by LHR. However, RHR should only be considered for surgeons comfortable with the robotic platform, and further research comparing LHR and RHR should be evaluated as adhesions often increase blood loss requiring frequent suction. Swift changing of instruments is difficult in robotic platform, and the skill of an assistant is ever-more important in RHR.

Our study carries few limitations. It is a retrospective study on prospectively collected data in a single-institution. Due to the small number of complications reported, comparison between the 2 groups is meager.

5. Conclusion

With careful selection of patients, HR is a safe, valuable procedure in restoring patient's quality of life. Using minimally invasive techniques, patients can experience significant advantages in faster recovery with less operation time, less estimated blood loss, shorter time to flatus, less postoperative pain, and shorter length of hospital stay. Although controversial, time to reversal of more than 6 months yield favorable outcome in reducing late complications. When possible, laparoscopic Hartmann reversal should be encouraged.

Author contributions

Conceptualization: Woo Ram Kim.

Data curation: Woo Ram Kim.

Formal analysis: Hye Jung Cho.

Investigation: Woo Ram Kim, Jong Woo Kim.

Supervision: Woo Ram Kim, Jong Woo Kim.

Validation: Woo Ram Kim, Jong Woo Kim.

Writing – original draft: Hye Jung Cho.

Writing – review & editing: Hye Jung Cho, Woo Ram Kim, Jong Woo Kim.

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