Outcomes of Hand-Assisted Laparoscopic Surgery for Colorectal Disease in an Emergency Setting

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Purpose: Laparoscopic surgery is accepted as a standard alternative to open procedures in the management of both benign and malignant colorectal disease. However, the safety and efficacy of the laparoscopic approach for emergency colorectal surgery has not been established. Hand-assisted laparoscopic (HAL) surgery might be a suitable option for colectomy in an emergency setting. The aim of this study was to report our experience of emergency HAL colectomy.

Methods: This was a retrospective review of consecutive colorectal emergency cases that were treated using HAL colectomy. Patient demographics, indications for surgery, operative details, and postoperative complications were examined.

Results: From March 2015 to April 2016, 18 patients underwent emergency HAL colectomy for complicated colorectal disease. Eight patients (44%) had an obstruction that required intraoperative decompression procedure. Sixteen patients (89%) had a perforation (five of which were sealed perforations involving large abscesses and inflammatory changes). Eight patients underwent sigmoidectomy, four underwent anterior resection, one underwent low anterior resection, two underwent left hemicolectomy, and three underwent Hartmann's procedure. There were two instances of open conversion (11%). The median duration of surgery was 178 minutes. The median time to bowel function recovery and median postoperative stay were 3 days and 10 days, respectively. The postoperative complication rate associated with the operation was 33% (6/18). There was one postoperative mortality.

Conclusion: For the experienced surgeon, HAL can be a reasonable option for emergency colorectal surgery.

Keywords: Hand-assisted laparoscopy, Laparoscopy, Emergency, Colectomy

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INTRODUCTION

Laparoscopic colectomy, which was designed to reduce the surgical stress and pain associated with large incisions, has been demonstrated to improve short-term patient outcomes and has been accepted as an alternative method to the traditional open procedure.^{1,2} Because of its obvious advantages

including reduced pain, faster recovery, less postoperative morbidity, and shorter hospital stay, laparoscopic surgery is generally preferred over open procedures for patients having elective surgery for uncomplicated colorectal disease.

However, there is not the same confidence in the use of laparoscopic colorectal surgery in an emergency.^{3,4} Although several reports have suggested that laparoscopic colectomy

is safe and feasible even in emergency cases if the patients are appropriately selected,⁵⁻⁹ the adoption of laparoscopy as a routine procedure in emergency colorectal surgery has been hampered. It is not only because of insufficient evidence of literature but also because of its technical difficulty. The application of laparoscopy to colorectal surgery in an emergency setting involves dealing with obstacles such as friable tissue and a deteriorated view caused by obstruction and inflammation. The greater technical demands and fears about the consequent inadequacy of the procedure are the main reasons that even experienced laparoscopic surgeons hesitate to undertake laparoscopic colectomy in an emergency setting.

Hand-assisted laparoscopy (HAL) is a laparoscopic technique that is performed with the aid of one hand inserted into the abdomen through a small incision.^{10,11} It was expected to reduce the technical difficulties of conventional laparoscopy by preserving the benefits of direct sensation and movement of the human hand. We hypothesized that HAL might be suitable for patients requiring emergency colectomy because of obstruction or perforation resulting from complicated colorectal disease. The aim of this study was to report our experience and to evaluate the clinical outcomes to assess the feasibility of HAL colectomy for variable pathologies in an emergency setting. This descriptive series aimed to promote understanding of the outcomes associated with this approach.

MATERIALS AND METHODS

Patients and data collection

This was a retrospective review of consecutive emergency colorectal cases that were treated with HAL performed by a

single surgeon in Kangbuk Samsung Hospital between March 2015 and April 2016.

The surgery was considered an emergency case and included in the study when the operation was scheduled immediately after evaluation by the surgeon and performed as soon as the anesthesiologist and operating room staff were ready. Emergency surgery was indicated when the patients had complete or near complete bowel obstruction for any reason, a perforated viscus, fulminant colitis, ischemic colitis accompanying transmural necrosis, or uncontrolled hemorrhage.

All data were retrieved from a prospectively compiled computer database. Patient demographics, indications for surgery, operative details including anesthesia and operation time, estimated blood loss (EBL), conversion from the planned surgery, postoperative recovery, and complications were evaluated.

Surgical technique

HAL colectomy was performed using the GelPort® Laparoscopic System (Applied Medical, Rancho Santa Margarita, CA, USA). The hand port was placed through a transumbilical midline incision, usually 7 cm in length, and two additional 12-mm trocars were inserted for the camera and instrumentation. We used a 10-mm 30° rigid scope in all cases. The scope operator stood on the same side as the surgeon, toward the patient's head. The surgeon's left hand was inserted into the hand port device, mainly acting in an assistive role, and the operative procedure including sharp dissection was performed via a 12-mm trocar using the instrumentation on the right hand.

During the surgical procedure, the hand port was used for various purposes in addition to specimen extraction during the

Fig. 1. Abdomen-pelvis computed tomography image and the intraoperative finding of the patient who had sigmoid colon cancer obstruction and failed to insert a colonic stent.

Table 1. Clinical characteristics and disease entity of the patients

Case no	Age (yrs)	Sex	BMI (kg/m ²)	ASA	Diagnosis	Obstruction	Perforation	Underlying disease	Previous history of abdominal operation
1	70	F	23.8	3	Sigmoid colon diverticulitis	No	Yes	HTN, DM	TAH, RSO
2	45	M	25.6	1	Sigmoid colon diverticulitis	No	Yes	No	No
3	39	M	34.3	2	Sigmoid colon diverticulitis	No	Yes	No	No
4	58	F	22.8	2	Sigmoid colon lymphoma*	Yes	Yes	No	Tubal ligation
5	65	F	25.3	2	Iatrogenic sigmoid colon perforation [†]	No	Yes	No	No
6	89	F	20.0	3	Sigmoid colon cancer	Yes	Yes	HTN	No
7	87	M	20.4	2	Rectal cancer	Yes	Yes	HTN	No
8	71	M	22.4	3	Sigmoid colon cancer	Yes	No	BPH	No
9	60	M	19.8	2	Distal descending colon cancer	Yes	Yes	BPH	No
10	66	F	23.1	3	Sigmoid colon stercoral perforation	No	Yes	HTN	No
11	54	M	27.4	2	Sigmoid colon cancer	Yes	Yes	No	No
12	47	M	23.1	2	Sigmoid colon cancer	No	Yes	No	No
13	63	M	23.4	2	Sigmoid colon diverticulitis	No	Yes	HTN, DM	No
14	46	F	26.6	1	Descending colon lipoma [‡]	Yes	No	No	No
15	68	F	19.6	4	Ischemic colitis in descending colon	No	Yes	HTN, DM, CKD	No
16	61	F	20.0	3	Iatrogenic sigmoid colon perforation [†]	No	Yes	No	No
17	67	M	27.5	3	Sigmoid colon cancer	Yes	Yes	HTN	No
18	59	F	22.2	3	Sigmoid colon perforation [§]	No	Yes	No	TAH, RSO
			62 (55 ~ 68)	M = 9 (50%)	23.1 (20.8 ~ 25.5)	Yes = 8 (44%)	Yes = 16 (89%)	Yes = 9 (50%)	Yes = 3 (17%)

BMI = body mass index; ASA = American Society of Anesthesiologists; HTN = hypertension; DM = diabetes mellitus; TAH = total abdominal hysterectomy; RSO = right salpingo-oophorectomy; BPH = benign prostatic hyperplasia; CKD = chronic kidney disease. *Which involved cecum and was required combined resection. [†]Iatrogenic perforation induced by endoscopy: enabled to primary repair due to massive contamination and delayed detection. [‡]Which induced complete obstruction with colo-colic intussusception and transmural ischemia. [§]Due to adhesive ileus involving distal ileum and sigmoid colon. ^{||}Median (interquartile range).

anastomotic procedure (Fig. 1). For example, when the dilatation of the proximal bowel was too severe to secure a clear view even after full pneumoperitoneum was achieved, decompression was performed prior to the main procedure. A small incision was made on the antimesenteric wall of the small bowel, which was retracted through the hand port. For the anastomosis of an obstructed colon, intraoperative antegrade colonic irrigation was performed if required.

In cases of colon cancer, even for palliative procedures, colectomy was performed in accordance with the principles of curative resection including *en bloc* resection, adequate lymphadenectomy with ligation of the lymphovascular pedicles and clear resection margins.

Conversion to an open surgery was indicated in the event of any extension of the incision for the hand port for a purpose other than specimen retrieval.

Perioperative management

None of the patients underwent bowel preparation before surgery. All patients received subcutaneous low-molecular-weight heparin postoperatively to prevent deep vein thrombosis and used elastic compression stockings. Early mobilization was encouraged when vital signs were stable. Diet progression was based on the physical signs of bowel function.

Statistics

Statistical analysis was performed using SPSS software version 19.0 (IBM SPSS Statistics, Armonk, NY, USA). Because this was a descriptive study, only descriptive analyses were performed. We intentionally present the raw data for all patients to allow the reader to interpret them.

RESULTS

During the study period, 18 patients underwent emergency surgical interventions using the HAL technique including colorectal resection for complicated colorectal disease.

Table 1 shows the clinical characteristics and disease entities of all patients. The median age of the patients was 62 years (interquartile range, 55~68 years). The median body mass index was 23.1 kg/m² (interquartile range, 20.8~25.5 kg/m²). Half of the patients had comorbidities including hypertension, diabetes mellitus, benign prostate hyperplasia, and chronic kidney disease requiring dialysis. Three patients had a history of abdominal surgery, mainly gynecologic. However, none of these patients had extensive abdominal adhesions requiring substantial adhesiolysis that might prolong the operation time.

The pathologies responsible for the emergency were located on the left-sided colon or rectum in all cases. This was not the result of patient selection but because most patients presenting as emergencies during the study period had left-sided pathologies. Eight patients (44%) had an obstruction that required intraoperative decompression procedure. Sixteen patients (89%) had a perforation of their colon. Of these 16, 11 had free perforations with abundant fecal spillage inducing panperitonitis and five had sealed perforations associated with large abscesses and severe inflammation in the adjacent tissues.

Details of the operative and perioperative outcomes are described in Table 2. Eight patients underwent sigmoidectomy, four underwent anterior resection, one underwent low anterior resection, two underwent left hemicolectomy, and three underwent Hartmann's procedure. Although our surgical principle was to restore intestinal continuity and avoid stoma as much as possible, we decided not to make anastomosis in these three cases because we thought the risk of anastomosis leakage was very high: two were frail elderly close to ninety years old, and another one was hemodynamically unstable during the operation. The median durations of anesthesia and surgery were 230 minutes (interquartile range, 206~274 minutes) and 178 minutes (interquartile range, 156~219 minutes), respectively. The median EBL was 200 ml (interquartile range, 113~300 ml). Of the 18 procedures, 16 were completed laparoscopically and two (11%) were converted to open surgery. The reasons for conversion were a limited field of vision because of tumor volume and ureter invasion that required the participation of a urologist. The median time to bowel function recovery and median postoperative stay were 3 days (interquartile range, 2~3 days) and 10 days (interquartile range, 7~15 days), respectively.

Postoperative complications developed in six patients (33%). Most of the complications were related to infection. Of these six patients, four recovered with conservative management, one required radiologic intervention for drainage and the other underwent reoperation. There was one postoperative mortality; this was patient 17 who had sigmoid colon cancer and multiple liver metastases. After two years of chemotherapy, the patient developed an obstruction. The endoscopist tried to insert a colonic stent, which resulted in a gross perforation. The patient was already in septic shock when he first consulted the surgeon and did not recover after the source of infection was surgically removed. He developed necrosis of the descending colon and despite reoperation died 35 days postoperatively.

Of the five patients who had complicated colon cancer and distant metastases, one died in hospital as described above, and two patients died from cancer progression after 9 months of follow-up. The other two patients are alive under chemotherapy. Three patients who underwent radical resection for complicated colon cancer were alive with no evidence of

Table 2. Operative details and perioperative outcomes of the patients

Case no	Procedure	Anesthesia time (min)	Operation time (min)	EBL (ml)	Conversion	Bowel function recovery (days)	Postoperative hospital stay (days)	Complication
1	Sigmoidectomy	210	145	300	No	3	6	No
2	Sigmoidectomy	290	240	100	No	1	7	No
3	Sigmoidectomy	190	170	100	No	4	7	No
4	Anterior resection & ileocecectomy	285	230	300	Yes	2	18	No
5	Sigmoidectomy	185	150	150	No	3	33	Superficial SSI
6	Hartmann's procedure & RSO	205	186	100	No	3	9	Atelectasis, delirium
7	Hartmann's procedure	230	160	100	No	1	12	Deep SSI, ileus
8	Anterior resection	205	155	200	No	2	7	No
9	Anterior resection	270	230	500	Yes	2	8	No
10	Sigmoidectomy	220	160	300	No	2	14	Deep SSI
11	Anterior resection	295	220	100	No	2	8	No
12	Low anterior resection	330	270	300	No	4	12	No
13	Sigmoidectomy	260	215	150	No	5	10	No
14	Left hemicolectomy	230	160	200	No	3	7	No
15	Left hemicolectomy	230	150	400	No	3	10	No
16	Sigmoidectomy	205	120	500	No	1	15	No
17	Hartmann's procedure	275	200	500	No	-	35	Stoma necrosis
18	Sigmoidectomy & SBRA	250	206	200	No	7	15	Ileus
		230 (206 ~ 274)*	178 (156 ~ 219)*	200 (113 ~ 300)*	Yes = 2 (11%)	3 (2 ~ 3)*	10 (7 ~ 15)*	Yes = 6 (33%)

EBL = estimated blood loss; RSO = right salpingo-oophorectomy; SSI = surgical site infection; SBRA = small bowel resection and anastomosis. *Median (Interquartile Range).

recurrence at the most recent follow-up. None of the other patients who underwent HAL colectomy because of benign colorectal disease died during the follow-up. The patients were followed for a median of 9 months (interquartile range, 7~22 months) after surgery.

DISCUSSION

Laparoscopic colorectal resection was started in the very early days of laparoscopic surgery and has become a standard treatment option, even for advanced lesions.^{1,2} In Korea in 2013, about two-thirds of patients with colorectal cancer were treated using a laparoscopic technique, and the percentage of patients treated with laparoscopic resection continues to increase.¹² In recent years, the trend to adopt a laparoscopic technique as the first option for colorectal surgery, which began among university and specialized hospitals, has extended to general hospitals. However, this trend is not maintained in the case of emergency surgery.

A significant percentage of colorectal surgery is performed in an emergency setting, owing to the nature of colorectal disease itself, and open surgery persists as a treatment option for these conditions. Although the utilization of laparoscopic approaches in emergency colorectal surgery is slowly increasing,^{6,13,14} there remains a distinct resistance and hesitation. Studies focusing on the safety and feasibility of emergency laparoscopic colectomy have been reported for over a decade, including two systematic reviews by Harji et al.³ and Chand et al.⁴ However, the majority of these studies were case series or retrospective reviews, and might include a selection bias toward technically easier cases being performed laparoscopically. In fact, most of the studies emphasize the importance of patient selection in their conclusions. In other words, technical difficulty is the major obstacle to the acceptance and widespread use of laparoscopic colectomy in an emergency setting, where the technical difficulty is increased compared with elective surgery because of obstruction accompanied by fecal stasis and upstream bowel dilatation, perforation resulting in gross spillage of fecal material, or severe inflammatory changes in surrounding tissue.

The HAL technique, which is usually thought of as an intermediate between open and conventional laparoscopy, was initially introduced with the purpose of mitigating the technical difficulty and steep learning curve of conventional laparoscopy by the addition of tactile feedback and the ability to directly manipulate tissue by hand. HAL has performed this predicted role well for about a decade, although its use and these technical advantages have languished as many surgeons became familiar and experienced with laparoscopy. However, in special conditions with increased technical demand, such as

in emergency colorectal surgery, HAL still offers an important benefit. With HAL, surgeons can use touch to assist the exploration of tissues and to more easily determine how to proceed. It also allows traction or pushing of tissue with carefully adjusted pressure, blunt dissection between inflamed tissues with minimal injury, and digital vascular control, all of which allow complex laparoscopic operations to be performed more safely and effectively in an emergency. Moreover, the hand port can be used as a minilaparotomy without conversion and without any extension from its initial size.

In this study, we report our techniques and experience of HAL colectomy in an emergency setting. This is a consecutive series of emergency colectomies by a single surgeon who is proficient at laparoscopic colorectal surgery. During the study period, the surgeon applied HAL technique to every emergency cases expected to need colectomy, non-selectively. As a result, our series included cases of severe disease that might not have been performed laparoscopically if the patients had been 'carefully selected' according to traditional standards. As described above, 44% of our series had an obstruction requiring intraoperative decompression or antegrade colonic irrigation. A 7-cm transumbilical midline incision for the hand port was large enough to perform any decompression procedure. The whole small bowel could be retracted through the hand port without any injury or dissection of the mesenteric root. In cases that needed intraoperative antegrade colonic lavage, the cecum was retracted to the hand port after minimal dissection of the right colon, and a Foley catheter was inserted through the appendiceal orifice. The hand port was also used for irrigation at the start and the end of the operation in those cases with perforation and fecal soiling. When soiling was too abundant to allow the procedure to proceed, fecal material was wiped out with gauze through the hand port and an open irrigation was performed. Warm saline was poured directly through the hand port incision, which was much faster and more effective than laparoscopic irrigation. The overall complication rate of this series was 33%, which is quite acceptable considering the high morbidity and mortality rate of emergency colorectal surgery.¹⁵⁻¹⁷ A patient's postoperative hospital stay was in many cases prolonged at the patient's request, notably in the patient with iatrogenic perforation after endoscopy. If these elective extensions of hospital stay are excluded from the calculations, the hospital stay would be much shorter. In fact, most of the patients reached 'status able to discharge' 2~3 days before their discharge.

The role of the HAL technique in previous studies of laparoscopic emergency colectomy is not clear. Some surgeons do not separate laparoscopy and HAL and combine them in the 'laparoscopy' category, while others strictly limit their experiences to 'straight' laparoscopy. HAL has rarely been

highlighted as a separate procedure, and to the best of our knowledge, this is probably the only report focused on HAL emergency colectomy except for a report from Watanabe et al. concerning HAL emergency subtotal colectomy for severe ulcerative colitis.¹⁸

Despite the various advantages of HAL mentioned above, it also has a limitation. There still exist conversion cases; in our series, two patients were converted to open because of the cancer volume and infiltration to adjacent organ. It is clear that HAL cannot completely replace open surgery in all situation. Moreover, HAL seemed to be associated with prolonged operation time especially when the original pathology is severe and extensive. It may be faster than conventional laparoscopy, however, still expected to be longer than open. In hemodynamically unstable cases as like patient 17 in our series, open approach which can minimize anesthesia and operation time would be the best option. Therefore, true benefit of HAL technique in emergency colectomy and indication for patient selection should be determined thoroughly with further studies.

However, based on our experience from this consecutive series, we cautiously propose HAL as a treatment option for emergency colorectal surgery. For the experienced surgeon, HAL can be a reasonable option and a good method to expand the indications for laparoscopy to more severe cases, thereby providing the benefits of minimally invasive surgery.

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