

## Comparison of the surgical outcomes of laparoscopic versus open surgery for colon perforation during colonoscopy

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**Purpose:** Colonoscopy is a safe and commonly used method for the screening of colon cancer, but sometimes major complications, such as, colonic perforation or hemorrhage occur during the procedure. The aim of this study was to compare the surgical outcomes of laparoscopic and open surgery for colon perforation after colonoscopy.

**Methods:** A retrospective review of patient records was performed on 25 patients with iatrogenic colon perforation during colonoscopy during the 7-year period from January 2005 to June 2012. Demographic data, operative procedures, operation times, postoperative complications, hospital course, and morbidities in the laparoscopic surgery group (LG) and open surgery group (OG) were compared.

**Results:** Seventeen of the 25 patients underwent laparoscopic surgery (68%) and 8 patients open surgery (32%). The most common surgical methods were primary repair in the LG, and Hartmann's operation in the OG. Average time to first flatus was 2.9 days in the LG and 4.5 days in the OG, and average times to first meals were 4.5 days and 5 days, respectively. Mean hospital stays were 10.8 days in the LG and 17 days in the OG. After surgery, complications occurred in two patients in the LG, but no complication occurred in the OG.

**Conclusion:** Laparoscopic repair for iatrogenic colonic perforation during colonoscopy seems to be useful and safe surgical method in early period after perforation. However, open surgery is also needed for the delayed cases after perforation.

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**Key Words:** Laparoscopy, Intestinal perforation, Colonoscopy

### INTRODUCTION

Colonoscopy is a safe and common means of screening for colon cancer, but sometimes a major complication, such as, colonic perforation or hemorrhage, is encountered during the procedure. The frequency of hemorrhage after colonoscopy has been reported to range between 1%–2% [1], and the frequencies of colonic perforation during diagnostic colonoscopy and therapeutic colonoscopy have been reported to be 0.1%–0.8% and 0.15%–3%, respectively [1-3]. Although, the frequencies

of such complications is low, perforation is a serious complication, and if proper diagnosis and management after colonic perforation are delayed, enteric contents will enter the abdominal cavity and result in peritonitis, sepsis, or even death [4].

Debate continues regarding the most appropriate method for treating colonic perforation following colonoscopy. In the past, colonic perforation after colonic perforation was managed by explorative laparotomy with primary perforation closure or bowel resection [4,5]. However, during the last decade, laparoscopic surgery has been accepted to be a safe surgical

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modality [6-9].

However, few comparative studies have been published on the merits of laparoscopic and open surgery for the treatment of colon perforation after colonoscopy, and those that have been performed failed to show that laparoscopic surgery has any strong advantage. The aim of this study was to compare the surgical outcomes of laparoscopic and open surgery for colon perforation after colonoscopy.

## METHODS

From January 2005 to June 2012, 25 patients underwent laparoscopic or conventional open surgery for iatrogenic colonic perforation caused during colonoscopy at a single center. Patients were divided into two groups: a laparoscopic surgery group (LG, n = 17) and an open surgery group (OG, n = 8). Medical records were retrospectively reviewed, and group demographic data, operative procedures, operation times, post-operative complications, hospital courses, and morbidities were compared.

Colon perforation was diagnosed by direct visualization during colonoscopy or by abdominal plain radiography. Clipping and/or band ligation of colon perforations were performed based on the experience of an expert endoscopist. Type of surgical approach and the procedure used were decided on by a surgeon based on the time elapsed between colonoscopy and diagnosis and on the severity of intra-abdominal contamination. The indications of open surgery were in case of conver-

sion to open method after putting in camera due to fecal peritonitis, technical difficulty in laparoscopic primary repair because of many endoscopic clippings, and patient's refusal of laparoscopic surgery.

Statistical analysis was performed using PASW Statistics ver. 18.0 (SPSS Inc., Chicago, IL, USA). The Mann-Whitney test was used to analyze continuous variables, and categorical and ordinal variables were cross-tabulated and analyzed using Fischer exact test. Probabilities of less than 0.05 were considered significant.

## RESULTS

### Clinical characteristics

Seventeen of the 25 patients underwent laparoscopic surgery, and the remaining 8 underwent open surgery. Baseline characteristics were similar in the two groups in terms of; body mass index, American Society of Anesthesiologists (ASA) score, and site and size of perforation. Mean time to surgery after colonoscopy in the LG was shorter than in the OG (P = 0.011) (Table 1).

The most frequent site of perforation in both groups was the sigmoid colon, and this occurred in 11 patients (64.7%) in the LG and in 4 patients (50%) in the OG. Mean lengths of perforations were 2.0 cm and 1.6 cm in the LG and OG, respectively (P = 0.264). The mean duration between perforation and operation was 170 hours.

**Table 1.** Demographics of 23 patients underwent laparoscopic surgery or conventional open surgery following iatrogenic perforated colon

Variable	LG (n = 17)	OG (n = 8)	P-value
Gender			0.613
Male	8 (47.0)	4 (50.0)	
Female	9 (53.0)	4 (50.0)	
Age (yr)	63.5 (46.0–78.0)	57.6 (43.0–79.0)	0.268
Body mass index (kg/m <sup>2</sup> )	22.9 (19.5–27.0)	21.8 (18.0–25.1)	0.484
ASA score			0.543
1	2 (12.5)	2 (28.6)	
2	13 (81.3)	5 (71.4)	
3	1 (6.3)	0 (0)	
Time <sup>a)</sup> (hr)	11.4 (3.0–120.0)	169.5 (7.0–792.0)	0.011
Perforation site			0.607
Cecum	0 (0)	1 (12.5)	
Descending colon	1 (5.9)	1 (12.5)	
SD junction	2 (11.8)	1 (12.5)	
Sigmoid colon	11 (64.7)	4 (50.0)	
RS junction	3 (17.6)	1 (12.5)	
Perforation size (cm)	2.0 (0.3–5.0)	1.6 (0.5–5.0)	0.264

Values are presented as number (%) or mean (range).

LG, laparoscopic surgery group; OG, open surgery group; ASA, American Society of Anesthesiologists; SD, sigmoidodescending; RS, rectosigmoid.

<sup>a)</sup>Interval to surgery after colonoscopy.

**Table 2.** Postoperative outcomes after laparoscopic and open surgery

Variable	LG (n = 17)	OG (n = 8)	P-value
Operative technique			0.005
Primary repair	14 (82.4)	2 (25.0)	
Hartmann's operation	0 (0)	3 (37.5)	
Segmental resection	3 (17.6)	0 (0)	
Left hemicolectomy	0 (0)	1 (12.5)	
Partial cecectomy	0 (0)	1 (12.5)	
Primary repair & exteriorization	0 (0)	1 (12.5)	
Operation time (min)	161.2 (120.0–270.0)	190.0 (150.0–240.0)	0.075
First flatus passage (day)	2.9 (1.0–5.0)	4.5 (3.0–7.0)	0.023
Resumption of meal (day)	4.5 (3.0–10.0)	5.0 (3.0–7.0)	0.184
Hospital stay (day)	10.8 (6.0–28.0)	17.0 (8.0–46.0)	0.192
Complications			0.600
Leakage of repair site	1 (5.9)	0 (0)	
Intra-abdominal infection	1 (5.9)	0 (0)	
Mortality	0 (0)	0 (0)	

Values are presented as number (%) or mean (range).  
LG, laparoscopic surgery group; OG, open surgery group.

**Table 3.** Characteristics of patients who had complication after laparoscopic surgery

Sex/age	Perforation site	Time to surgery (hr)	Initial management	Complication	Management of complication	Hospital stay (day)
F/61	Rectosigmoid junction	120	Primary repair	Repair site leakage	Hartmann's operation	28
M/54	Sigmoid	6.75	Primary repair	Intra-abdominal infection	Conservative management	27

## Operative results

The most common surgical method in the LG were primary repair (n = 14, 82%) and Hartmann's operation in the OG (n = 3, 38%). In addition, 3 patients (18%) in the LG underwent segmental resection of the sigmoid colon and 2 patients (25%) in the LG underwent primary repair. Left hemicolectomy, partial cecectomy, and primary repair & exteriorization were also performed in one patient (12.5%) each in the OG (Table 2).

Group postoperative courses were compared after surgery. The average operation times were 161.2 and 190 minutes in the LG and OG (P = 0.075). Average days to first flatus passage were 2.9 and 4.5, respectively, and this difference was significant (P = 0.023). Meal resumption took an average of 4.5 days in the LG and 5 days in the OG (P = 0.184), and mean hospital stays were 10.8 days and 17 days, respectively (P = 0.192).

## Postoperative complications

After surgery, complications occurred in two patients in the LG (Table 3). One underwent primary repair due to a perforation in the rectosigmoid Junction; Hartmann's operation was performed when peritonitis occurred due to the leakage of repair site, and this patient stayed in hospital for 28 days. The other patient underwent primary repair of a sigmoid colon perforation. This patient, who stayed in hospital for 27 days,

subsequently developed an intra-abdominal infection, which was treated conservatively. No complication occurred in the OG.

## DISCUSSION

Colon perforation is the most serious complication of diagnostic and therapeutic colonoscopy, and can present a threat to life if intracolonic bacteria spread into the peritoneal cavity. The number of colonic perforations has increased during the last decade because of the increasing numbers of diagnostic and therapeutic colonoscopies performed. In the present study, we were not able to determine number of colonoscopies performed in hospitals and medical clinics, and hence, could not calculate perforation frequencies.

Some risk factors of colon perforation have been identified. In particular, the risk in patients over 75 years of age is 4–6 times higher in than younger patients [10]. Furthermore, flexible sigmoidoscopy has been reported to have a 2- to 4-fold lower rate than colonoscopy [2,10]. Patients with diverticular disease, chronic pulmonary disease, congestive heart failure, diabetes mellitus, myocardial infarction, cerebrovascular disease, peripheral vascular disease, liver disease, dementia, and renal insufficiency are also at greater risk of perforation. Other risk factors include a history of interabdominal surgery, doctor

inexperience, a colonic pathology (e.g., colitis or megacolon), inappropriate intestinal preparation, and a female sex, the latter of which is due to a greater colonic length and a movable transverse colon [10-13]. In the present study, 52% of our patients were female.

Colon perforation following colonoscopy is usually in the adherent sigmoid colon caused by previous surgery [14]. In the present study, the sigmoid colon was also the main perforation site, and accounted for 15 of the 25 patients. Perforations arise via three principal mechanisms, that is, mechanical injury, barotrauma, and thermal injuries during therapeutic colonoscopy [5-7,11,15-17]. Mechanical injuries are the most common cause, and perforations can arise due to forceful instrument insertion, moving the colonoscope towards the mucosal surface without direct view. Confusing diverticulum with colon and adhesions due to previous surgery may result in directly colon injury, and indirectly injury may result from stretching or bowing the distal part of the scope [13,16,17]. Barotrauma is another important cause of perforation during diagnostic colonoscopy. Excessive gas insufflation can result in linear tears of the serosa that may progress to full-thickness perforation. Perforations due to barotrauma are more likely to occur at the cecum level, as the pressure required to perforate the cecum is only 81 mmHg, which is less than half that required to perforate the sigmoid colon (169 mmHg) [12,13,16]. During therapeutic colonoscopy, perforation can occur from as in diagnostic colonoscopy of from thermal or electrical injury. Frequencies of perforation are higher after polypectomies, biopsies, and the excessive use of electrocautery. Thermal injuries are associated with the smallest perforations, and thus, are usually detected at a later stage [5,13,16].

The clinical presentations of patients with colon perforation differ with respect to affected site, size and mechanism of perforation, extent of peritoneal contamination, and patient status. Abdominal pain and distension are the most common symptom. Diagnosis is usually made promptly after colonoscopy, but can be delayed for up to 72 hours [6,12,13]. In the present study, most patients in the LG underwent surgery within 24 hours of colonoscopy, although maximal delays in the LG and OG were 120 and 792 hours, respectively.

A perforation was demonstrated in fewer than 10% of patients by abdominal x-ray, computed tomography, or endoscopy but they are asymptomatic. By x-ray, a perforation manifests as free air in the peritoneal cavity, mediastinum, retroperitoneum, subcutaneous tissue. Sometimes abdominal radiographs are normal, but computed tomography will usually depict free air in these patients [10,12].

Treatments for perforation caused by colonoscopy are classified into two categories: nonoperative and operative, and considerable controversy exists regarding the merits and demerits of operative and nonoperative treatment. Prospective

study is difficult because of the rarity of perforations caused by colonoscopy [8]. Thus, the optimal treatment of perforation should be determined based on considerations of the mechanism, location, and size of perforation, symptom severity, time to surgery after perforation, concomitant disease, and patient status [1,5,10,16]. In the present study, we decided on the type of operation based on considerations of physical status on a case-by-case basis.

Nonoperative treatment means hospitalization, intestinal rest, intravenous fluids, and the administration of antibiotics, which is similar to the treatment used to treat acute diverticular disease. Operative treatment should be considered when conservative treatment fails. The indications for operative management are diffuse peritonitis, failure of nonoperative management, and a large injury. Operative management is clearly but more invasive [16,18,19].

Endoscopic clipping system is used to treat a perforation site that is easily identified and approached. Endoscopic clipping to close a perforation has been suggested for small (10 mm) perforations. This procedure must be done immediately, and thus, endoscopic repair is used only if the endoscopist finds the perforation during colonoscopy [5,20]. In the present study, three patients underwent endoscopic clipping; one patient underwent laparoscopic treatment and the other two patients underwent laparotomy.

Bleier et al. [4] and Coimbra et al. [8] compared the results of laparoscopic and open treatment. Bleier et al. [4] found that the time of laparoscopic treatment was greater (104 minutes vs. 98 minutes) and that mean hospital stay in their laparoscopic group was shorter (5.1 days vs. 9.2 days). Coimbra et al. [8] found that postoperative hospital stay was short in their laparoscopic group than in their laparotomy group (10.1 days vs. 16.6 days), and that laparoscopic treatment had lower morbidity rate ( $P = 0.017$ ) with no mortality. In our study, operative time in the OG was longer than that in LG, but without significance. Complications occurred to two patients in the LG; they had primary repairs by laparoscopic technique after perforation. One patient was performed Hartmann's operation due to leakage of repair site, and the other was treated for an intra-abdominal infection.

This study was limited by its retrospective design and by its small cohort size, which prevented our investigating relations between types of endoscopy and causes of perforations. In our nonrandomized and retrospective study, a true comparison of postoperative complication rates between laparoscopic and open surgery cannot be performed because the two groups of patients are not identical in terms of time interval to surgery after colonoscopy, and operative technique. The delay of surgery results mainly from conservative treatment using endoscopic clipping and/or ligation at the site of colonic perforation after colonoscopy. The type of surgical procedure itself such as

primary repair, bowel resection was decided by the surgeon's experience with laparoscopic surgery and patient's status.

Nonetheless, this study is one of the few to compare laparoscopic and open surgery with respect to colon perforation. We believe the study contributes because it helps treatment decision-making.

In conclusion, laparoscopic repair for iatrogenic colonic perforation during colonoscopy seems to be useful and safe surgical method in early period after perforation. However,

open surgery is also needed for the delayed cases after perforation. Further large-scale, prospective observational study is necessary to better define the benefits of laparoscopic surgery.

## CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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