Original Article

Managements of Colonoscopy-related Colon Perforation: A 10-year Medical Center Experience

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Key Words
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Purpose. Colon perforation is an uncommon and potentially life-threatening complication following colonoscopy. Various procedures including laparoscopic repair or laparoscopy-assisted colectomy, and colonoscopic closure may have similar benefits for patients as traditional laparotomy. Sometimes conservative treatment may play a role. This study was designed to assess the effectiveness of these managements for colonoscopy-related perforation.

Methods. Patients suffering from colon perforation after colonoscopy in Far Eastern Memorial Hospital from 2012/1/1 to 2022/7/24 were included in this study. The patients were divided into three groups and subgroups, and the clinical outcomes of the patients were analyzed.

Results. Thirty-two patients suffered from colon perforation after colonoscopy were included in this study. After seven patients excluded, the patients were divided into the surgical group (n = 18) and the nonsurgical group (n = 7); the surgical group was divided into the laparoscopy group (n = 13) and the open group (n = 5). Two patients who underwent laparoscopy first and were later converted to laparotomy were enrolled in the open group. After analyzed, the hospital stay was definitely shorter in the nonsurgical group than in the surgical group ($p = 0.047$). Compared with the open group, the laparoscopy group has a smaller perforation ($p = 0.026$), shorter operation time ($p = 0.014$) and postoperative hospital stay ($p = 0.003$).

Conclusions. Laparoscopic repair and laparoscopy-assisted colectomy, colonoscopic closure, and conservative treatment could be used for the selective patients with colon perforation after colonoscopy safely. However, with a large perforation or critical status, laparotomy is still a well-established procedure for patients. The endoscopist and surgeon may choose the procedure based on their experience.

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Colonoscopy-related colon perforation is an uncommon and potentially life-threatening complication of colonoscopy.[1,2] It involves the accidental puncturing or tearing of the colon wall by the colonoscope or after a polypectomy procedure, which can lead to the leakage of bowel contents into the abdomi-

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nal cavity and cause serious infectious complications.[3] Prompt diagnosis and treatment are crucial to reduce the risk of further complications. The incidence of colonoscopy related perforation is about 0.1%~0.5%.[4,5]

Several factors can contribute to the risk of colon perforation, including the skill and experience of the endoscopist, preexisting medical conditions such as diverticulosis, or the use of therapeutic procedures such as polypectomy.[6] Sometimes, the colon wall may be weakened or inflamed due to diseases such as inflammatory bowel disease (IBD), which makes injury easier during the procedure.[7]

When a perforation occurs, the treatment typically involves surgical repair of the perforation and the administration of antibiotics to combat infection.[8] Traditional laparotomy has been used since colonoscopy was developed in the 20th century.[3] However, laparoscopy has recently become a treatment option for acute abdomen with the advancement of instruments and accumulated experience in acute care surgery, just like appendectomy or colon repair.[9,10] Compared to laparotomy, laparoscopic repair is beneficial for patients with colonoscopy-related perforations as it has been associated with reduced postoperative pain, faster recovery, fewer wound infections, and shorter hospital stays.[11] However, not all patients with colonic perforation are suitable for laparoscopic repair. The decision to treat depends on the size of the perforation, the severity of infection, the patient's overall health, and the surgeon's expertise. For patients with a perforation including a neoplasm or measuring larger than the half circumference of the colon, laparoscopy-assisted colectomy may be a better option rather than bowel repair.[12,13] The choice of surgical approach may depend on the patient's situation and the surgeon's judgment.

In terms of colonic wall defects during polypectomy, immediate endoscopic closure is the choice of treatment.[14,15] It requires skillful endoscopic techniques and specialized accessories for successful endoscopic repair. Specialized accessories, such as endoclips, endoloops, over-the-scope clips (OTSC), and overstitch systems, are vital for closure.[16] Not only is the endoscopic team critically important, both surgeons and anesthesiologists are the keys to the success of the operation.[17]

For patients who present to the emergency department (ED) and are diagnosed with colon microperforation without peritoneal signs, conservative treatment is the other choice. These patients require in-hospital observation and X-ray or computed tomography (CT) to exclude the presence of peritonitis. Conservative management consists of bowel rest, intravenous fluid support and antibiotics.[18] Enteral nutrition support should be stopped until bowel movement recovers.

In our institution, conservative treatment, colonoscopic closure, laparoscopic repair, laparoscopy-assisted colectomy, and laparotomy repair or colectomy could be performed to treat colonoscopy-related perforations. Compared to laparotomy, minimally invasive management strategies and colonoscopic closure have become increasingly accepted in recent years.[11] This study was designed to evaluate the effectiveness, feasibility and benefits of various management strategies for colonoscopy-related colon perforation.

Materials and Methods

The study protocol was approved by the institutional review board (IRB). We collected the data of all diagnostic or therapeutic colonoscopies performed from 2012/1/1 to 2022/7/24. Patients who were diagnosed with bowel perforation within 7 days after the procedures were included. The medical records of these patients were reviewed. Patients were excluded if the perforations were not located in the colon or not resulted from colonoscopy. The status of colon preparation was defined as excellent, good, fair and poor. The perforation site was classified into one of the following four categories: right colon, left colon, rectosigmoid junction or rectum, or unknown. We retrospectively collected data such as the type of operation or procedure, the interval from colonoscopy to operation, blood loss and operation time, length of hospital stay, and postoperative complications.

At our institute, there were thirty-two cases of bowel perforation occurring within 7 days after colonoscopy out of a total of 70,634 procedures conducted

over a period of almost ten years. All patients did not undergo the colorectal surgery before. Seven patients were excluded: one suffered from small bowel perforation, four encountered colon perforation due to bowel obstruction or diverticulitis, and the other patient was diagnosed as enterocutaneous fistula; one patient was excluded because of a complex course: she had a tumor perforation and underwent colectomy after recovery from conservative treatment during the same course of hospitalization. The patient selection algorithm is presented in Fig. 1.

Twenty-five patients were divided into the surgical group and non-surgical group according to the presence of operation. Eighteen patients who underwent surgery were included in the surgical group. It was also divided into subgroups: thirteen patients who underwent laparoscopic repair or laparoscopy-assisted colectomy were included in the laparoscopy group, and five patients who underwent laparotomy for colectomy or repair were included in the open group. Among the thirteen patients in the laparoscopy group; ten patients received laparoscopic primary repair with abscess drainage and three patients underwent laparoscopy-assisted colectomy. Among the five patients in the open group; two patients underwent laparotomy for colectomy and one received laparotomy repair and diverting ileostomy; besides, two patients converted to laparotomy from laparoscopy were also included in the open group: one received laparotomy for repair due to severe adhesion and the other received open Hartmann procedure due to large perforation. In both the laparoscopy and open groups, the patients should be managed carefully: the pus or bowel content needs to be drained as much as possible and irrigated with normal saline; drainage tubes are routinely placed, and the amount or positions are dependent on the surgeon's discretion.

Seven patients who received colonoscopic closure or conservative treatment were included in the non-surgical group. Four patients underwent immediate colonoscopic closure for perforation detected during polypectomy and the other three patients received conservative treatment for perforation found after the procedures. For these patients, close monitoring is very important, and the surgeon should be consulted if there is any sign of peritonitis progression.[18]

The patients including all groups stayed in the hospital and resumed an oral diet until bowel movement recovered; broad-spectrum antibiotics and intravenous fluid supply should be given, too. If there was no evidence of a leak sign or SIRS (Systemic inflammatory response syndrome), the patient would be discharged. While coming back to the out patient department, the physician will review the patient's general

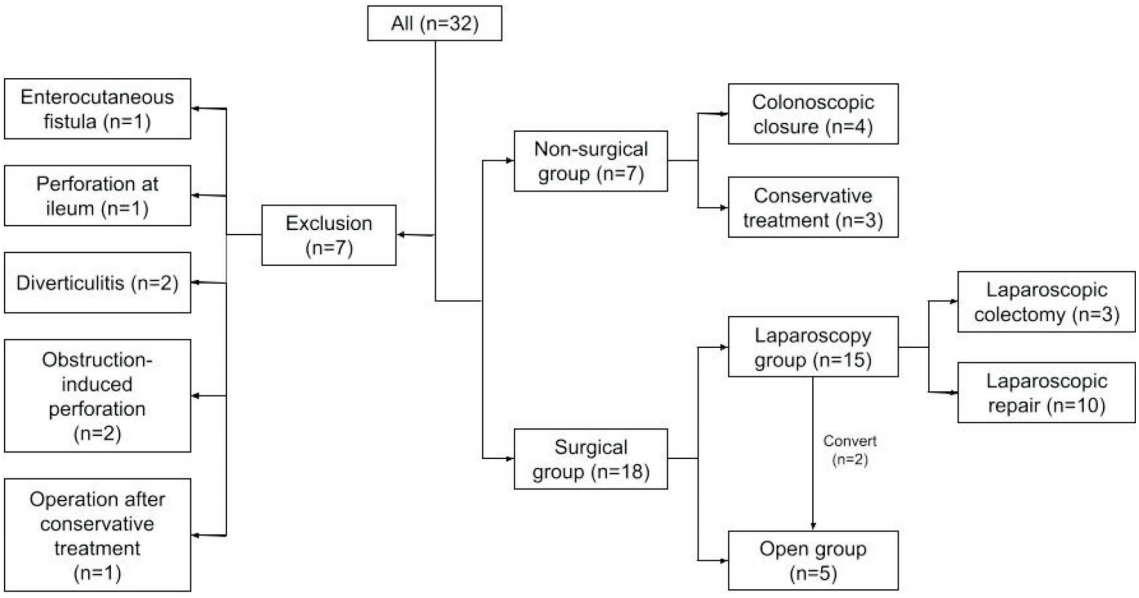

Fig. 1. The patient selection algorithm.

condition by evaluating the vital signs and digestion status and performing a physical examination.

All data are presented as the mean, or median and standard deviation for continuous variables and as numbers for categorical variables. Comparisons of the continuous data between the two groups were performed with Student's t test and the Mann-Whitney U test, and comparisons of the categorical data were performed with the Pearson chi-squared test or Fisher's exact test. We used SPSS 22.0 (IBM Corp., NY, USA). $p < 0.05$ was considered statistically significant.

Results

There were 32 cases of bowel perforation occurring within 7 days after colonoscopy out of a total of 70,634 procedures in our study. Seven patients were excluded: The characteristics of the patients in the laparoscopic group, the open group and the non-surgical group are presented in Table 1.

Thirteen patients were included in the laparoscopy group. The male/female ratio was 7:6. The median of age was 69.0 years. Five of them underwent colonoscopy under sedation. Six of them had excellent colon preparation, six had good preparation, and one had fair preparation. Seven patients (53.8%) underwent polypectomy (two of them were malignant polyps), and two underwent biopsy (one was biopsy for cancer). The median of time from colonoscopy to ED was 16.0 hours, and the median of time from colonoscopy to operation was 19.0 hours. The operation- and hospitalization-related data are presented in Table 1. The median size of the perforation was 10 mm. In terms of the site of the perforation, four were in the right colon (30.8%), four were in the left colon (30.8%), three were in the rectosigmoid colon or rectum (23.1%), and two had unknown sites (15.4%). The median of operation time was 90.0 minutes, and the median of blood loss was 10.0 ml. The median of postoperative length of stay was 8.0 days. Four patients were admitted to the intensive care unit (aged 85, 77, 69 and 80 years old) but the median of ICU stay was 0 days.

Five patients were included in the open group.

Table 1. Characteristics and hospitalization related data

	Laparoscopy (n = 13)	Open (n = 5)	Non-surgical (n = 7)
Age	69.0 (28.0)	71.0 (15.0)	68.0 (21.0)
Male (N, %)	7 (53.8%)	2 (40.0%)	4 (57.1%)
Sedation (N, %)	5 (38.5%)	3 (60.0%)	3 (42.9%)
Colon preparation (N, %)			
Excellent	6 (46.2%)	2 (40.0%)	0 (0%)
Good	6 (46.2%)	3 (60.0%)	5 (71.4%)
Fair/poor	1 (7.7%)	0 (0%)	2 (28.6%)
Therapeutic colonoscopy (N, %)			
Polypectomy	7 (53.8%)	1 (20.0%)	5 (71.4%)
Biopsy	2 (15.4%)	2 (40.0%)	3 (42.9%)
Scope to ED (hours)	16.0 (26.0)	10.5 (34.8)	12.0 (16.0)
Scope to operation (hours)	19.0 (34.5)	15.0 (26.3)	-
Perforation size (mm)	10 (8.1)	15 (30.5)	-
Operation time (minutes)	90.0 (31.9)	180.0 (45.0)	-
Blood loss (mL)	10.0 (43.6)	20.0 (110.0)	-
LOS (days)	8.0 (3.5)	15.0 (41.5)	5.0 (8.0)
Perforation site (N, %)			
Right-side colon	4 (30.8%)	0 (0%)	5 (71.4%)
Left-side colon	4 (30.8%)	2 (40.0%)	1 (14.3%)
RS junction and rectum	3 (23.1%)	3 (60.0%)	1 (14.3%)
Unknown	2 (15.4%)	0 (0%)	0 (0%)

Numerical data: median (interquartile range); Nominal data: N (percentage)

ED, emergency department; LOS, length of stay.

The male/female ratio was 2:3. The median of age was 71.0 years. Three of them underwent colonoscopy under sedation. Two of them had excellent colon preparation, and three had good preparation. One patient (20%) underwent polypectomy, and two underwent biopsy for cancer who first presented at ED for bloody stool. The median of time from colonoscopy to ED was 10.5 hours, and the median of time from colonoscopy to operation was 15.0 hours. The operation- and hospitalization-related data are presented in Table 1. The median size of the perforation was 15 mm. In terms of the site of perforation, two were in the left colon (40%) and three were in the rectosigmoid colon or rectum (60%). The median of operation time was 180.0 minutes, and the median of blood loss was 20.0 ml. The median of postoperative length of stay was 15.0 days. Two patients were admitted to the ICU but the median ICU stay was also 0 days. Diverting stoma was created in two patients of this group.

Seven patients were included in the nonsurgical group. The male/female ratio was 4:3. The median of age was 68.0 years. Three of them underwent colonoscopy under sedation. Five of them had good preparation, and two had fair preparation. Five patients (71.4%) underwent polypectomy, and three underwent biopsy. The median of time from colonoscopy to ED was 12.0 hours. The hospitalization-related data are presented in Table 1. In terms of the site of perforation, five were in the right colon (71.4%), one was in the left colon (14.3%), and one was in the rectosigmoid colon or rectum (14.3%). All patients had a smooth hospitalization course, and the median of length of stay was 5.0 days. No patients were admitted to the intensive care unit in this group. Actually, the patient who underwent colonoscopic closure had a shorter length of stay (3.5 days) than the patients who received conservative treatment (11.0 days), and a shorter time from colonoscopy to ED (5.0 hours to 20.0 hours).

We compared the surgical and nonsurgical groups. The characteristics are presented in Table 2. There was no difference in age, sex, rate of sedation, proportion of patients who underwent therapeutic colonoscopies, or result of colon preparation. There were also no statistical differences in perforation sites, even though most perforations in the nonsurgical groups were located in the right colon. The time from colonoscopy to ED was not different between the surgical group (12.0 hours) and the nonsurgical group (12.0 hours) ($p = 0.407$). The hospital results are also presented in Table 2. The hospital stay was different between these two groups: 9.0 days in the surgical group and 5.0 days in the nonsurgical group ($p = 0.047$). The complication rate was also no difference between these two groups. In conclusion, length of stay was the only

Table 2. Characteristics and results: compared the surgical and non-surgical groups

	Surgical (n = 18)	Non-surgical (n = 7)	*p*-value
Age	70.0 (25.8)	68.0 (21.0)	0.929†
Male (N, %)	9 (50.0%)	4 (57.1%)	1.000#
Sedation (N, %)	8 (44.4%)	3 (42.9%)	1.000#
Good and excellent preparation (N, %)	17 (94.4%)	5 (71.4%)	0.180#
Therapeutic colonoscopy (N, %)	8 (44.4%)	5 (71.4%)	0.378#
Perforation site (N, %)			0.140*
Right-side colon	4 (22.2%)	5 (71.4%)	
Left-side colon	6 (33.3%)	1 (14.3%)	
RS junction and rectum	6 (33.3%)	1 (14.3%)	
Unknown	2 (11.1%)	0 (0%)	
Scope to ED (hours)	12.0 (26.0)	12.0 (16.0)	0.407†
LOS (days)	9.0 (7.5)	5.0 (8.0)	**0.047**†
Complication (N, %)	4 (22.2%)	1 (14.3%)	1.000#

Numerical data: median (interquartile range); Nominal data: N (percentage).

† Mann-Whitney U test; # Fisher's exact test; * Chi-square test.

ED, emergency department; LOS, length of stay.

statistically significant difference between the surgical and nonsurgical groups.

We also compared the laparoscopy group and the open group. The characteristics are presented in Table 3. There was no difference in age, sex, rate of sedation, result of colon preparation, proportion of patients who underwent therapeutic colonoscopy, or the site of perforations. The time from colonoscopy to ED was also no difference between the laparoscopy group (16.0 hours) and the open group (10.5 hours) (p = 0.571). However, the median size of the perforation was larger in the open group (15 mm) than in the laparoscopy group (10 mm) (p = 0.026). The surgical results are also presented in Table 3. There was no difference in the time from colonoscopy to operation, blood loss or complication rate. However, a shorter operation time was definitely noted in the laparoscopy group (90.0 min.) compared with the open group (180.0 min. p = 0.014). The length of stay was also shorter in the laparoscopy group (8.0 days) than in the open group (15.0 days, p = 0.003). In fact, the patients in the laparoscopy group might have had a smaller perforation, underwent surgery for a shorter time, and stayed at the hospital with a shorter period.

Discussion

At our institute, there were thirty-two bowel perforations following a total of 70,634 colonoscopy procedures conducted during these ten years. The incidence rate was 0.045%. This rate was definitely lower than that in previous studies. C.W. Iqbal et al. reported an incidence of 0.084% for 78702 colonoscopies;[3] T. H. Luning et al. presented an incidence of 0.12% for 30366 patients;[19] H. Tulchisky et al. reported 0.058% for a series of 12067 patients.[20] This may not indicate that we had a better technique, but better equipment and systemic effort were considered. In our series, three patients suffered from colon perforation not truly related to colonoscopy, and the net incidence rate may be lower than 0.045%.

Out of the 32 cases of perforation, four patients were successfully treated with colonoscopic closure, and the other three recovered from conservative treatment. We always performed the colonoscopic closure during the same procedure after the discovery of the perforation, and it made the shortest interval from the perforation to the therapeutic intervention in our series. Trecca A et al. reported that small perforations

Table 3. Characteristics and results: compared the laparoscopy and open groups

	Laparoscopy (n = 13)	Open (n = 5)	p-value
Age	69.0 (28.0)	71.0 (15.0)	0.924†
Male (N, %)	7 (53.8%)	2 (40.0%)	1.000#
Sedation (N, %)	5 (38.5%)	3 (60.0%)	0.608#
Good and excellent preparation (N, %)	12 (92.3%)	5 (100.0%)	1.000#
Therapeutic colonoscopy (N, %)	7 (53.8%)	1 (20.0%)	0.314#
Perforation site (N, %)			0.275*
Right-side colon	4 (30.8%)	0 (0%)	
Left-side colon	4 (30.8%)	2 (40.0%)	
RS junction and rectum	3 (23.1%)	3 (60.0%)	
Unknown	2 (15.4%)	0 (0%)	
Perforation size (mm)	10.0 (8.1)	15.0 (30.5)	**0.026**†
Scope to ED (hours)	16.0 (26.0)	10.5 (34.8)	0.571†
Scope to operation (hours)	19.0 (34.5)	15.0 (26.3)	0.703†
Operation time (minutes)	90.0 (31.9)	180.0 (45.0)	**0.014**†
Blood loss (mL)	10.0 (43.6)	20.0 (110.0)	0.173†
LOS (days)	8.0 (3.5)	15.0 (41.5)	**0.003**†
Complication (N, %)	2 (15.4%)	2 (40.0%)	0.533#

Numerical data: median (interquartile range); Nominal data: N (percentage).

† Mann-Whitney U test; # Fisher's exact test; * Chi-square test.

ED, emergency department; LOS, length of stay.

occurring during procedure without peritoneal signs, non-operative management may result in a successful rate from 60% to 93%. For experienced endoscopist, colon perforation may be managed with colonoscopic closure in selective cases, even though the perforation is larger than 10 mm.[15] Conservative treatment might be used for patients who were diagnosed as colon perforation after procedure completed, and no definite pneumoperitonium or peritonitis noted via X-ray or CT.[14] No matter colonoscopic closure or conservative treatment, the patient should be kept a fast until the bowel movement noted without the peritoneal sign; intravenous hydration and broad-spectrum antibiotics should be given; the laboratory test like white cell count and C-reactive peptide level should be closely monitored. If the patient resumed oral diet without any discomfort, then he/she might be discharged.[14,15] In our series, the recovery after colonoscopic closure was also better than conservative treatment (hospital stay 3.5 days than 11.0 days), and it might be the best management for early detected colonoscopic perforation. It's a pity that our cases number is not enough to compare the result of colonsocopic closure to the surgical group. However, the success of the nonsurgical group indicates that this approach is effective in selected instances, such as in patients with small perforations. Our experience with nonsurgical treatment indicates that not all colon perforations require immediate surgical intervention.

Ten patients in our series underwent successful laparoscopic repair. This technique appears to have been effective in a considerable number of cases because it is a less invasive alternative to laparotomy. It seems to be a better method because of the shorter operation time and the shorter hospital stay. In addition, three patients underwent laparoscopy-assisted colectomy; one patient had an uncertain location of the perforation, and two patients had perforations just at the neoplasm. Laparoscopy-assisted colectomy was also necessary in cases where the perforation was hard to define or at the tumor site.

Two patients were converted from laparoscopic intervention: one with a large perforation (5 cm) and the other with severe adhesion. The former was a 77-year-old female who suffered from severe sepsis after surgery with anterior resection, and she died on the postoperative day 92 due to multiple organ failure; she was the only patient who died in our series. According to our retrospective series, three patients diagnosed with colon perforation were chosen for laparotomy. These three cases were as follows: one patient was diagnosed with disseminated stage IV colon cancer, one patient had a large tumor with perforation, and another visited the ED 50 hours after colonoscopy showing severe contamination. Because of limited cases and retrospective study, it's hard to define the choice of laparotomy if only related to the size of perforation. Actually, while laparotomy, the surgeon can better access the damaged area to perform adequate management. For a critical patient, laparotomy is a good and effective method to reduce the difficult of the operation, even though unlike a minimally invasive procedure, we seldom use it as the primary choice.

In our series, totally five patients were diagnosed as colorectal cancer. Two of them received polypectomy for the malignant polyp and perforation occurred, followed with laparoscopy-assisted colectomy later. One patient received colonoscopy for cancer biopsy suffered from tumor perforation and he underwent laparoscopy-assisted right hemicolectomy. The other two patients underwent colonoscopy with biopsy for the colorectal cancer, and tumor perforation was noted; one received open primary repair and ileostomy, and the other received anterior resection. These patients all had good recovery and no major complication was found. It means that even though the tumor perforation occurred after colonoscopy, our managements are safe and feasible for these situations.

In our series, we also collected the data of the status of colon preparation, the rate of sedation, and the time interval from colonoscopy to ED. However, there was no statistically significant difference in the rate of good or excellent colon preparation from the surgical group to the nonsurgical group (Table 2), or from the laparoscopy group to the open group (Table 3). There was also no statistically significant difference in the time interval from colonoscopy to ED or the rate of sedation, no matter between the surgical group to the nonsurgical group, or the laparoscopy group to the open group. These results give us a message that the

status of colon preparation, the presence of sedation, and the time interval from colonoscopy to ED, may not be closely related to the result of our management for colon perforations. The only factor related to the outcome was the choice of the management for colon perforation.

Overall, these data reflect a variety of management approaches for colon perforation related to colonoscopy. The success of different methods highlights the importance of individualized treatment based on the severity of the perforation, the patient's overall health and the expertise available at the medical facility. It is very important to emphasize the significance of adhering to best practices during colonoscopy procedures to minimize the risk of perforations. Additionally, maintaining proper training and protocols for managing complications during colonoscopy can further improve patient outcomes. In our series, approximately 80% of the patients underwent laproscopic procedures, colonoscopic closure and conservative treatment, and no one suffered from a critical course or severe complications with a good recovery from the colon perforation; there was also no one underwent a diverting enterostomy among these patients. When a perforation was found during colonoscopy procedure, colonoscopic closure should be taken for the first management to resolve the problem, and further hospitalization needs to be arranged. While the perforation identified in the emergency department, a generalized survey must be performed to exclude patients with high-risk factors; thus, conservative treatment or laparoscopy should be performed for first-line management. For the patient with colon perforation related to underlying malignancy, laparoscopy or laparotomy for colectomy should be performed. However, there was one death in our series even though emergency laparotomy was performed. Once a surgeon tries to perform the laparoscopic intervention to resolve the colon perforation diagnosed after colonoscopy, he or she should convert to laparotomy if laparoscopy becomes unsuitable. The surgeon or endoscopist ensures patient safety and well-being by selecting the most appropriate management approach based on their condition and the extent of the perforation.

There are some limitations to out study. The case number is too small and we did not have enough cases of open surgery, colonoscopic closure, and conservative treatment. Besides, this study is a retrospective series and totally seven surgeons were included into this study, so that the bias may influence the result. Further randomized controlled study or multiple center trial may be needed for the clearer outcome.

Finally, we can conclude that various procedures including laparoscopic repair and laparoscopy-assisted colectomy, colonoscopic closure and conservative treatment could be used for colon perforation related to colonoscopy in selective patients safely, not inferior to the laparotomy. The endoscopist or surgeon should select the best management based on their clinical expertise.

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原　著

大腸鏡相關的結腸破裂之處置 — 醫學中心十年經驗

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目的　結腸破裂是大腸鏡檢查後，罕見但有可能威脅到生命的併發症。許多處置方式，包括腹腔鏡修補或是腹腔鏡輔助大腸切除手術、以及在大腸鏡下關閉傷口等皆可被應用於結腸破裂，且和剖腹手術的效果接近。保守治療亦有其角色。我們設計了這個實驗，用來評估這些處置對於大腸鏡相關的結腸破裂之治療效果。

方法　從 2012 年 1 月 1 日到 2022 年 7 月 24 日，於本院接受大腸鏡檢查後遭遇到結腸破裂的病人皆被納入此研究。他們被分成三組及更小的次分組，且其臨床預後被拿來統計及分析。

結果　共 32 個大腸鏡檢查後發生結腸破裂的病人被納入此研究。7 位病人被排除後，剩餘病人被分為手術組 (n = 18) 及非手術組 (n = 7)；手術組又被分為腹腔鏡組 (n = 13) 及剖腹組 (n = 5)。有兩位病人原本採用腹腔鏡手術，但後來轉變成剖腹手術，均納入剖腹組。我們分析臨床資料，非手術組的住院天數顯然較手術組為短 (p = 0.047)。腹腔鏡組相比於剖腹組，破洞較小 (p = 0.026) 而手術時間 (p = 0.014) 及術後住院天數 (p = 0.003) 都較為縮短。

結論　無論是腹腔鏡修補或是腹腔鏡輔助大腸切除手術，還有在大腸鏡下關閉傷口、以及保守治療等用來治療大腸鏡檢查後的結腸破裂，在適當的病人選擇下都是安全的。然而，如果破洞太大或是病人狀況危急，剖腹手術仍然是最保險的治療方式。內視鏡專家以及外科醫師會跟據他們的經驗作出最好的選擇。

關鍵詞　大腸鏡、結腸破裂、腹腔鏡、大腸鏡下關閉傷口。