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Original Article

Colonoscopic Perforation and Its Management at a Tertiary Care Hospital

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Abstract

Introduction: Colonoscopy is a tool for screening colorectal cancer, but colonoscopic perforation (CP), though rare, is of concern, because of its high morbidity and mortality. The objective of the present study is to determine the incidence, risk factors, management, outcome, and mortality rate of CP at a tertiary care hospital.

Methods: The present retrospective study included patients who underwent colonoscopy from January 1, 2009, to January 1, 2020 at the authors' institution. Management of patients with colonoscopic perforation were categorized into two groups according to therapeutic modality: the operative (surgery) and non-operative (endoscopic management or conservative treatment) groups.

Results: There were 71 patients with CP. Of these, 19 received endoscopic management. Endoscopic management failure occurred in 8 patients, and 60 patients underwent laparotomy after diagnosis. Segmental bowel resection with primary anastomosis was done in 37 patients. Leakage of anastomosis occurred in 3 patients. The average time to diagnosis was 9.73 ± 16.87 hours (range, 1 to 96 hours), the average time to operation after diagnosis was 6.98 ± 4.91 hours (range,1 to 24 hours). The mortality rate was 7%. Factors associated with mortality were time to diagnosis and type of operation ($p = 0.003$ and $p = 0.012$, respectively). The average hospital stay was 10.90 ± 7.96 days (range, 3 to 45 days).

Conclusion: The time to diagnosis and the injury mechanism are major factors in the choice of management. Nonoperative management is beneficial and feasible for colonoscopic perforation with early detection.

Keywords: Colonoscopic perforation, Risk factor, Management, Mortality

Introduction

Colonoscopy is an important screening modality for colorectal cancer, but it is not always safe. Complications such as splenic injury,[1] abdominal pain, bleeding, and bowel perforation occasionally occur. Bowel perforation after colonoscopy is a major complication. It can occur in both diagnostic and therapeutic colonoscopy. Its incidence varies from 0.016% to 0.2% with mortality rates between 0% to 26%.[2] The objective of the present study was to determine the incidence and risk factors of colonic perforation, as well as factors related to its mortality at a tertiary care hospital with training programs in general surgery, colorectal surgery, and gastroenterology.

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Methods

The present study was a retrospective review of medical records of patients undergoing colonoscopy from January 2009 to January 2020 at Rajavithi Hospital. Two groups of physicians performed the colonoscopy. The first group consisted of the hospital teaching staff, which included colorectal surgeons, general surgeons, and gastroenterologists. The second group consisted of trainees such as residents in general surgery, fellows in colorectal surgery, and fellows in gastroenterology training programs.

Bowel preparation regimen used in all cases included polyethyleneglycol solution (4 L) or Sodium phosphate solution (90 mL) based on patient status or preference. All patients underwent colonoscopy under intravenous sedation with pethidine 25 mg and midazolam 2.5 mg.

A database was created, which included information such as patient demographics, history of surgical treatment, endoscopic findings, and endoscopic procedure. For patients with colonic perforation, operative findings, postoperative morbidity, mortality, and length of hospital stay were collected as well.

All statistical analysis was performed using the statisti cal software SPSS version 20.0. Descriptive statistics included frequency and percentage for categorical variables, and mean and standard deviation for normally distributed continuous variables, or median and range otherwise. Patient characteristics were compared between two groups using student's *t*-test or the Mann-Whiney U test for continuous variables, as appropriate, and Chi-square tests were used for comparing categorical variables. Logistic regression analysis was performed to determine potential risk factors associated with colonic perforation or mortality after perforation.

Results

There were 12,239 colonoscopies during the study period. Of these, 1800 were excluded due to incomplete data, 200 excluded due to incomplete or abortive colonoscopy from poor bowel preparation, and 180 were excluded because sucralfate instillation was used. The remaining 10,057 patients were included in the study. Colonoscopic perforation (CP) occurred in 71 patients; an incidence of 0.7%. The comparison of characteristics between patients with and without CP is shown in Table 1. Information on the site of perforation is shown in Table 2. For patients who underwent diagnostic colonoscopy, the sigmoid colon was most common perforation site (57%) followed by the caecum (14%). The trainee was responsible for 63% of all perforations ($p < 0.001$). For patients undergoing therapeutic colonoscopy, the site of perforation was distributed more evenly along the colon. An analysis of risk factors associated with colonic perforation is shown in Table 3.

In the perforation group, 19 patients received endoscopic management. Endoscopic management included clips in 11 patients, and Ovesco clip in 8 patients. Endoscopic management failure occurred in 8 patients, all of which were treated with clips. Sixty patients underwent laparotomy after diagnosis. Operative management included segmental bowel resection with primary anastomosis in 37 patients, colectomy with primary anastomosis and protective ostomy in 8 patients, Hartman's procedure in 5 patients, diversion ostomy in 4 patients, primary repair with protective ostomy in 4 patients, and primary repair in 2 patients. Leakage of anastomosis occurred in 3 patients, all of which occurred in segmental resection with primary anastomosis.

The average time to diagnosis was 9.7 ± 16.9 hours (range, 1 to 96 hours). The average time to diagnosis of CP when colonoscopy performed by staff was 11.1 ± 21.9 hours, and that by trainees was 8.4 ± 10.0 hours ($p = 0.496$). In patients who underwent diagnostic colonoscopy there was no statistically significant difference in the time to diagnosis of CP between staff and trainees (14.4 ± 25.8 and 8.0 ± 9.9, $p = 0.288$). The average time to operation after diagnosis was 6.9 ± 4.9 (range, 1 to 24 hours). The average time to operation after diagnosis in the colonoscopy performed by staff was 6.1 ± 3.7 hours and that performed by trainee was 7.6 ± 5.7 hours ($p = 0.209$).

Figure 1 shows a perforation at the ascending colon. The mortality rate of CP was 7%. Factors associated with mortality is shown in Table 4. The average hospital stay was 10.9 ± 7.9 days (range, 3 to 45 days). Postoperative complications included surgical site infection in 9 patients, pneumonia in 6, sepsis in 5, and urinary tract infection in one patient.

Discussion

Colonoscopy is one of the screening modalities for average-risk patients beginning at the age of 50 years.[3-5] Reliable knowledge of potential adverse effects of colonoscopy is needed when weighing risks and benefits of screening programs.

Table 1 Comparison of patient characteristics between perforation and non-perforation groups

	Perforation (n = 71)	**Non-perforation (n = 9,986)**	***p*-value**
Age (mean ± SD)	58.6 ± 10.8	57.8 ± 11.6	0.100
Sex (male) (n%)	37 (52)	5710 (57)	0.390
Indication to colonoscopy (n%)			< 0.001
Therapeutic	15 (21)	90 (1)	
Diagnostic	56 (79)	9896 (99)	
Previous surgery (n%)			< 0.001
None	51 (72)	8960 (89.7)	
Abdominal surgery	0	752 (7.5)	
Pelvic (Gynecologic) surgery	18 (25)	35 (0.4)	
Colorectal surgery	2 (3)	227 (2.3)	
Thoracic surgery	0	12 (0.1)	
Type of anesthesia			< 0.001
Sedation	60 (85)	9981 (99.9)	
General anesthesia	11 (15)	5 (0.1)	
Quality of bowel preparation			0.463
Clear	55 (77)	8079 (80.9)	
Unclear	16 (23)	1907 (19.1)	
Endoscopist			< 0.001
Staff	35 (49)	9484 (94.9)	
Trainee	36 (51)	502 (5.1)	
Colonoscopy with procedure (n%)			< 0.001
Yes	56 (79)	2830 (28.3)	
No	15 (21)	7156 (71.7)	
Colonoscopic procedure (n%)			< 0.001
None	15 (21)	7156 (71.6)	
Polypectomy	37 (52)	1850 (18.5)	
EMR	6 (9)	66 (0.7)	
ESD	13 (18)	9 (0.1)	
Biopsy	0	850 (8.5)	
APC	0	27 (0.3)	
Dilatation	0	24 (0.2)	
EUS+FNA	0	4 (0.04)	

Abbreviation: EMR: Endoscopic mucosal resection, ESD: Endoscopic submucosal resection, APC: Argon plasma coagulation, EUS+FNA: Endoscopic ultrasonography + Fine needle aspiration

Table 2 Comparing perforation sites between patients undergoing diagnostic or therapeutic colonoscopy

	Diagnostic group (n = 56)	**Therapeutic group (n = 15)**	***p*-value**
Locations			0.045
Rectum	4 (7)	3 (20)	
Sigmoid	32 (57)	1 (7)	
Descending colon	6 (11)	0	
Splenic flexure	0	1 (7)	
Transverse colon	1 (2)	1 (7)	
Hepatic flexure	0	2 (13)	
Ascending colon	0	4 (27)	
Cecum	8 (14)	3 (20)	
Terminal ileum	5 (9)	0	

Table 3 Risk factors associated with colonoscopic perforation

Characteristic	*p*-value	Odds ratio	95% CI	
			Lower	Upper
History of previous surgery	< 0.001			
Abdominal surgery	0.999	-	-	-
Pelvic surgery	< 0.001	41.1	16.4	102.7
Colorectal surgery	0.137	3.1	0.69	14.2
Thoracic surgery	0.999	-	-	-
General anesthesia	0.016	7.7	1.5	40.9
Performed by trainee	< 0.001	20.7	11.2	38.2
Therapeutic colonoscopy	0.089	4.4	0.79	24.6
Endoscopic procedure	< 0.001			
Polypectomy	< 0.001	6.1	3.2	11.7
EMR	< 0.001	23.3	6.0	90.4
ESD	< 0.001	89.9	12.7	635.4
Biopsy	0.999	-	-	-
APC	0.999	-	-	-
Dilatation	0.999	-	-	-
EUS+FNA	0.999	-	-	-

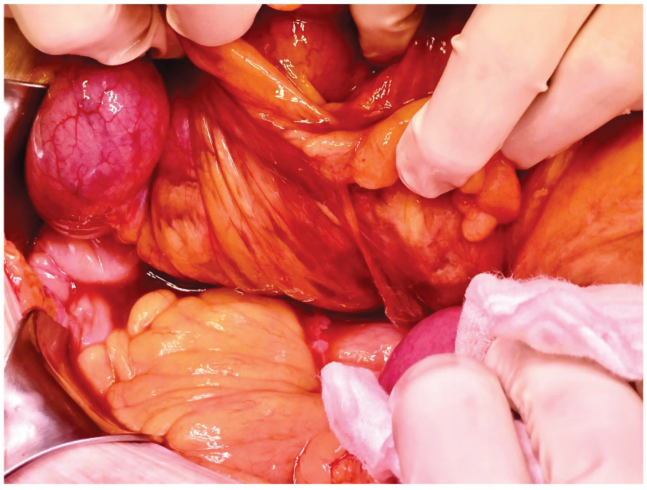

Figure 1 Showing a contained perforation at the ascending colon

Prior studies examining complications after colonoscopy have some limitations, such as lack of generalizability due to single practice settings, focus on procedures performed by gastroenterologists or consultant surgeons, and use of administrative data.

The risk of perforation in our study is slightly higher than those in other published studies.[6-9] A previous study showed an incidence of perforation of 0.9/1000 (0.09%) colonoscopies.[9] The risk factor for perforation was endoscopic polypectomy.[8] The present study also found that the endoscopic mucosal resection procedure (polypectomy, EMR, ESD) was a risk factor for perforation. The ESD procedure was a cause of perforation in 18% of all cases in the present study. Generally, ESD was reported to be a cause in 1.4 to 20.4% of cases.[10-12] Among the risk factors for perforation in previous studies include large tumor size and location of lesion in the colon, endoscopist experience, and the presence of submucosal fibrosis.[11,13,14] In the present study, the most common perforation site was the sigmoid colon, accounting for 57% of the sites in the diagnostic group. This result was concordant with other studies.[15,16] Other risk factors include previous gynecologic surgery, because previous pelvic surgery can cause sigmoid redundancy,[16] but in the present study gender was not a risk factor for perforation. There are three mechanisms of colonoscopic perforation. Firstly, direct mechanical force of the colonoscope can cause perforation. Secondly, perforations can occur during therapeutic procedures such as polypectomy. Lastly, air overinsufflation can cause barotrauma.[17,18]

The management of colonoscopic perforation can be divided into three classes: conservative, endoscopic, and surgical management. The choice of management depends on the clinical status of the patient, timing of diagnosis, the size of perforation, and surgeon experience. Endoscopic management is suitable when perforation is detected early on, e.g., during colonoscopy or immediately after.

Table 4 Factors associated with colonoscopic perforation deaths

Factors	Death		*p*-value
	No (n = 66)	Yes (n = 5)	
Men (n%)	36 (55)	1 (20)	0.187
Age > 60 (n%)	27 (41)	2 (40)	0.999
Time to diagnosis > 8 hours (n%)	18 (27)	5 (100)	**0.003**
Presence of peritonitis	36 (55)	5 (100)	0.069
Perforation site (n%)			0.924
Rectum	7 (11)	0	
Sigmoid colon	31 (47)	2 (40)	
Descending colon	5 (8)	1 (20)	
Splenic flexure	1 (2)	0	
Transverse colon	1 (2)	1 (20)	
Hepatic flexure	2 (3)	0	
Ascending colon	3 (5)	1 (20)	
Ceacum	11 (17)	0	
Ileum	5 (8)	0	
Endoscopic treatment	19 (29)	0	0.315
Failed endoscopic treatment	8 (12)	0	
Laparotomy (n%)	55 (83)	5 (100)	0.999
Time to operation > 8 hours	21 (32)	5 (100)	**0.012**
Type of operation			0.120
Segmental bowel resection with primary anastomosis	36 (55)	1 (20)	
Segmental bowel resection with primary anastomosis and protective ostomy	7 (11)	1 (20)	
Hartman's procedure	3 (5)	2 (40)	
Ostomy	3 (5)	1 (20)	
Primary repair with protective ostomy	4 (6)	0	
Primary repair	2 (3)	0	
Leakage of anastomosis	2 (3)	1 (20)	0.233
Postoperative sepsis	0	5 (100)	**< 0.001**

Conservative management is suitable for patients in good clinical condition, with no sign of peritonitis and sepsis. Surgical management is recommended in patients with generalized peritonitis, worsening clinical status after conservative or endoscopic management, and concomitant bowel pathology, since the latter, including colorectal cancer, may require surgical resection.

In previous studies, the success rate of non-operative management was lower than 20%.[19,20] In the present study, the success rate of endoscopic management was quite high because some perforations were recognized during colonoscopy.

There were four patients in the present study who underwent primary suture of the perforation site. The rate of primary repair in the present study was lower than that of previous studies, which reported rates between 30% to 60%.[16,20-22] An explanation for a low rate of primary repair in the present study might be the delay in diagnosis, large perforation size, poor bowel preparation, poor tissue perfusion, and suspected concomitant of colorectal cancer.

The morbidity and the mortality rates of CP have been reported to be between 31% to 48.7% and 8.2% to 25.6%, respectively.[23-26] Risk factors for mortality in those studies included longer time to diagnosis and longer time to operation. Delay in diagnosis and treatment can have catastrophic consequences for patients with sepsis. At the very least, such delays can result in longer hospital stay.

The importance of timing and appropriateness of sepsis management have been demonstrated in previous studies, especially for patients in septic shock.[27-29] Septic source control is one important step in management.[30,31] These studies show that early septic source control re-

sulted in lower mortality if the delay is less than 8 hours, though some previous studies did not show such timing effects.[30] The delay in septic source control may not affect mortality and morbidity in patients with good clinical status, without elevated biochemical parameters.[32]

Another aspect of source control is adequacy. Intraabdominal infection can be controlled via drainage of septic collection, closure or resection of perforation site, and resection of inflamed or infected tissues. But the completeness of septic foci elimination can be difficult to evaluate during surgery, especially in generalized peritonitis.[33,34]

Management of sepsis requires the consideration of three sets of factors. Firstly, there are factors related to the patient such as clinical stability, previous surgery and comorbidities.[35] Secondly, factors related to the disease such as the pathology or severity of disease must be evaluated. And lastly, factors related to the surgeon such as his or her capability to cope with problems during intraoperative and postoperative period[36,37] must be considered.

Surgical management should be done as soon as is feasible, where safety is priority.[38] There may be challenges to achieve adequate source control, and delays in management that have adverse consequences for patients. Septic source control and antibiotics are both important and complementary therapeutic modalities.

The present study has several limitations due to the retrospective design. Thus, information on investigations to confirm perforation, preoperative patient resuscitation, monitoring, and intraoperative findings were unavailable in some cases.

Conclusion

Currently, it is difficult to define a proper algorithm for the management of colonoscopic perforation. In the absence of guidelines, surgeons may have to rely on narrative reviews or case series studies. The risk of septic complications is the most serious consequence of CP. Careful colonoscopy with or without adding other procedures, post colonoscopy monitoring, early detection of complications and a rapid response, are important for reducing morbid and mortality.

Conflicts of interest

The authors have nothing to disclose.

Authors' Contributions

Sirikurnpiboon S. conceived the original idea. Sirikurnpiboon S. mainly carried out the experiment and wrote the manuscript. Authors discussed the results and contributed to the final manuscript.

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