Outcomes and Predictors of Mortality and Stoma Formation in Surgical Management of Colonoscopic Perforations

A Multicenter Review

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Objectives: To perform a retrospective review of all patients with colonoscopic perforations managed in hospitals within the Eastern New Territories region of Hong Kong and to determine the predictors of mortality and stoma formation in patients with colonoscopic perforations.

Design: Retrospective computer-based review.

Setting: Multicenter (1 university teaching hospital and 2 district hospitals).

Methods: We reviewed the outcomes of patients with colonoscopic perforations surgically managed between January 1, 1998, and December 31, 2005. Predictors of mortality and stoma formation were identified with multivariable analysis.

Main Outcome Measures: Mortality and stoma rates and their predictors.

Results: A total of 37 971 colonoscopies were performed during the study period, and 43 colonoscopic perforations were identified. The overall perforation rate was 0.113% and represented a decreasing trend. There was no significant difference in the perforation rate between gastroenterologists (0.148%) and surgeons (0.091%) ($P=.15$). Perforations that occurred during diagnostic colonoscopies were significantly larger than those that occurred during therapeutic colonoscopies ($P=.04$), and the patients presented earlier ($P=.02$). Surgical intervention was performed in 39 patients. The overall morbidity and mortality rate was 48.7% and 25.6%, respectively. The stoma rate was 38.5%. The predictors of stoma formation include moderate to severe peritoneal contamination and the presence of malignant colonic neoplasms ($P=.01$ and $P=.008$, respectively). The predictors of mortality include American Society of Anesthesiologists class 3 or higher and antiplatelet therapy ($P=.009$ and $P=.001$, respectively).

Conclusions: Colonoscopic perforations were in a decreasing trend. Patients with predictors of mortality should not be treated conservatively. Other options of large bowel investigations should be considered in high-risk patients when the potential diagnostic yield is low.

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COLONOSCOPIC PERFORATION remains an uncommon complication of colonoscopy, yet it represents one of the most frequent causes of malpractice claims for gastrointestinal endoscopy in the United States.[1] The total number is expected to increase as more colonoscopies are being performed following the widespread implementation of national screening programs.[2,3] Previous rates of perforation of 0.2% to 0.4% for diagnostic colonoscopy and 0.3% to 1% for therapeutic colonoscopy are improving, with lower overall rates of 0.005% to 0.196% reported in recent large-scale series.[4-15] Treatment of these patients remains controversial with increasing use of nonoperative and laparoscopic approaches in selected patients.[13-19] However, selection criteria remain unclear, and none of the studies have identified predictors of mortality and stoma formation in these patients.

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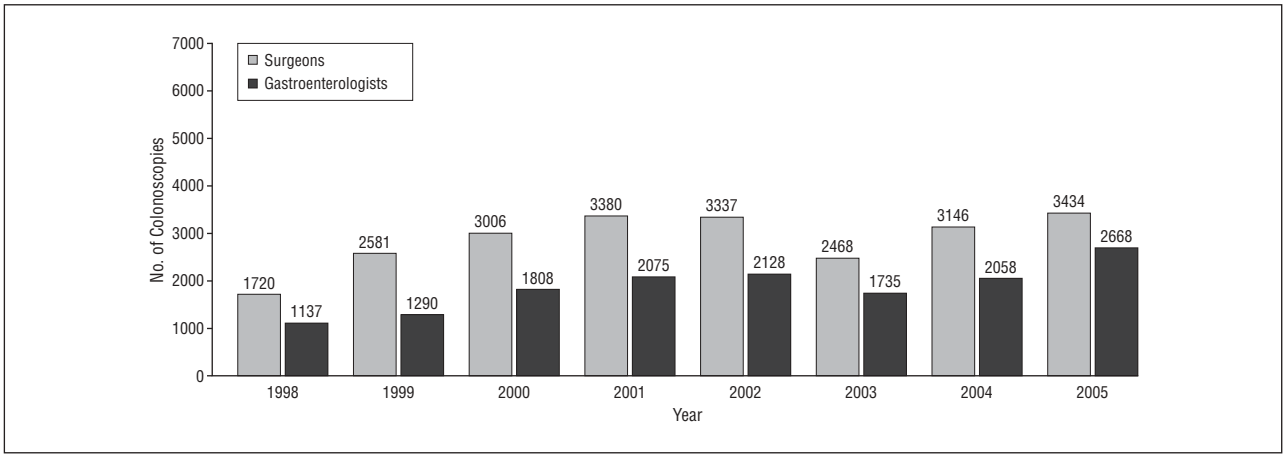

Figure 1. Total number of colonoscopies per year (1998-2005).

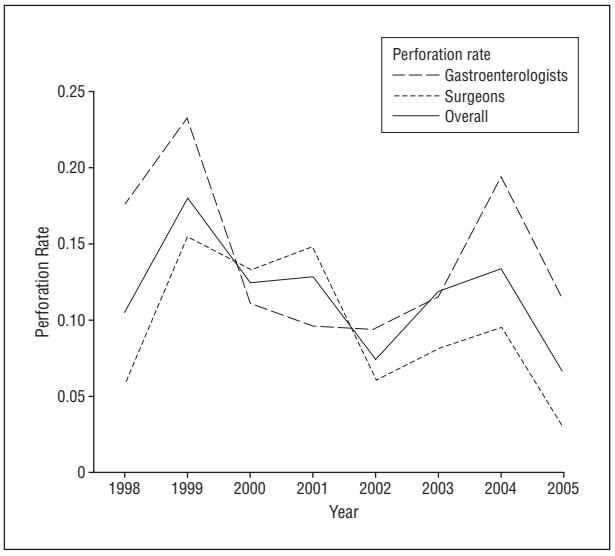

Figure 2. Trend in colonoscopic perforation rates.

METHODS

We conducted a multicenter computer-based search of records of patients with diagnosed colonoscopic perforations from January 1, 1998, to December 31, 2005, in 3 hospitals (1 university hospital and 2 district hospitals). Together, the 3 institutions provide government-supported hospital services to the Eastern New Territories region of Hong Kong, comprising a population of approximately 1 million people. Patient records were reviewed, and data retrieved, including indications for and procedural details of colonoscopy, demographics, and the presentation, treatment, and outcomes of patients with colonoscopic perforations. The diagnosis of perforation was based on clinical evidence of peritonitis, radiologic evidence of perforation (such as free gas under the diaphragm or presence of intra-abdominal collection), and operative confirmation of the perforation.

PROCEDURE

Each of the 3 hospitals has a combined endoscopy unit where both gastroenterologists and surgeons are responsible for colonoscopy and other endoscopic procedures. Colonoscopy was performed or supervised by a trained gastroenterologist or surgeon. Two main types of colonoscopes were used in the 3 hospitals, 1.3 m and 1.6 m (models CF-Q140L/I, CF-Q140L, CF-Q240L/I, CF-Q240L; Olympus Corporation, Tokyo, Japan). Pediatric colonoscopes were not used. Bowel preparation was achieved with either 90 mL of sodium phosphate soda or 4 L of polyethylene glycol preparations. Analgesics and sedation were administered to patients at the discretion of the endoscopist before the procedure (2.5-10 mg diazepam emulsion or 2.5-5 mg midazolam maleate was used in conjunction with 12.5-50 mg meperidine hydrochloride). A similar regimen was followed in each of the 3 hospitals.

A colonoscopy was classified as diagnostic when mucosal biopsy by forceps was the only procedure performed and as therapeutic when an endoluminal procedure was carried out (polypectomy, dilation, and coagulation). Complete colonoscopy was defined as one in which cecal or terminal ileal intubation was achieved.

STATISTICAL ANALYSIS

Statistical analyses were performed using *t* test, Fisher exact test, and χ^2 test as appropriate. Predictors of stoma formation and mortality after surgical management of colonoscopic perforation were analyzed by multivariable logistic regression. $P<.05$ was considered statistically significant (by 2-tailed test). Statistical analyses were performed using SPSS 11.0 statistical software (SPSS Inc, Chicago, Illinois).

The factors considered for regression analysis included age, sex, American Society of Anesthesiologists (ASA) class, use of anticoagulation currently taken by the patient, use of corticosteroids currently taken by the patient, quality of bowel preparation, time to presentation, degree of peritoneal contamination, size of perforation, and presence of colonic diseases.

RESULTS

TREND IN COLONOSCOPIES

A total of 37 971 colonoscopies were performed during the study period, and 43 colonoscopic perforations were identified. **Figure 1** shows the number of colonoscopies performed by both surgeons and gastroenterologists, with an increasing trend since 1998. The severe acute respiratory syndrome epidemic in 2003 resulted in a dramatic decrease in the number of colonoscopies performed, with its effects filtering into 2004. **Figure 2** shows the trend in perforation rates of gastroenterolo-

Table 1. Characteristics of Colonoscopic Perforations[a]

Characteristic	Diagnostic Colonoscopy (n=27)	Therapeutic Colonoscopy (n=16)	*P* Value[b]
Severe looping	8	0	.02
Incomplete colonoscopy	16	3	.01
Fair to poor bowel preparation	15	9	1.0[c]
Perforation recognized by endoscopist	10	3	.31
Time to presentation, h			
<24	21	7	.02[c]
24-48	1	5	.02
>48	5	4	.71
Site of perforation			
Sigmoid colon	10	11	. . .
Rectosigmoid junction	7	1	. . .
Transverse colon	4	3	. . .
Size of perforation, cm	1.82 (1.51)	0.98 (0.53)	.04[d]
Moderate to severe contamination	8	7	.35[c]
Mechanism of injury			
Mechanical force	24	3	<.001
Polypectomy		11	
Cold biopsy	3		
Electrocoagulation		2	
Predisposing factors for difficulty in colonoscopy	20	7	.046[c]

[a] Data are given as number of patients except for "Size of perforation," which is given as mean (SD).
[b] Fisher exact test unless indicated otherwise.
[c] χ^2 Test.
[d] *t* Test.

gists and surgeons. The overall perforation rate was 0.113%, and that of gastroenterologists and surgeons was 0.148% and 0.091%, respectively, with the difference being insignificant (*P*=.15). Two perforations occurred in procedures performed by trainee surgeons.

DEMOGRAPHICS

There were 22 male patients and 21 female patients who had colonoscopic perforations, and they ranged in age from 16 to 91 years (median age, 76 years). Twenty-six patients (60.5%) were of ASA class 3 or higher, 5 patients had previous abdominal surgery (2 with cholecystectomy and 3 with colonic surgery for malignancy), and 6 patients were taking antiplatelet therapy (eg, aspirin) owing to a history of ischemic heart disease or cerebrovascular disease.

ENDOSCOPIC PROCEDURE

The major indications of colonoscopy were for investigation of rectal bleeding, iron deficiency anemia, and screening for colonic polyps and cancer. Of the 43 perforations, 27 colonoscopies were diagnostic and 16 were therapeutic. The characteristics of these perforations are given in **Table 1**. Both severe looping during colonoscopy and incomplete colonoscopy were significantly more frequent in the diagnostic group. Six patients had colonic diverticula and 3 patients had suspected large-bowel malignant tumors on colonoscopy. Polypectomy was performed in 13 patients.

Table 2. Methods of Surgical Repair of Colonoscopic Perforations

Method	No. of Patients
Simple suture	11
Colonic resection with anastomosis	13
Simple suture with stoma	1
Loop colostomy	3
Colonic resection with stoma	11

CLINICAL PRESENTATION

Twenty-eight patients (65.1%) presented within 24 hours after colonoscopy, 6 patients (14.0%) presented 24 to 48 hours after colonoscopy, and 9 patients (20.9%) presented after 48 hours. Significantly more patients in the diagnostic group presented within 24 hours (*P*=.02) (Table 1). Significantly more patients with perforations in the therapeutic group presented between 24 and 48 hours after colonoscopy (*P*=.02). The most common presenting symptom was abdominal pain (22 patients). Radiographs identified free gas under the diaphragm in 17 patients. Three patients required computed tomography scanning to identify free gas that was not present on radiographs. One patient sustained a massive left pneumothorax and free gas under the diaphragm simultaneously. Water-soluble contrast enema was performed in 1 patient to confirm a sealed-off perforation. Sixteen patients underwent surgery on the basis of generalized peritonism without radiologic evidence of perforation.

SURGICAL MANAGEMENT

Surgical intervention was performed in 39 patients. One patient was admitted 1 week after colonoscopy with free gas on abdominal radiographs and absence of peritonism and was treated conservatively. Three patients refused surgical intervention. The sigmoid colon was the most common site of perforation (21 patients [53.8%]), followed by the rectosigmoid junction (8 patients), transverse colon (7 patients), and hepatic flexure, ascending colon, and rectum (1 patient each). The size of perforations ranged from 1 mm to 5 cm, with a mean (SD) of 1.43 (1.22) cm. Perforations sustained during diagnostic colonoscopies were significantly larger than those in therapeutic colonoscopies (*P*=.04) (Table 1). The degree of peritoneal contamination was none to mild in 20 patients, moderate in 7 patients, grossly feculent in 8 patients, and not mentioned in 4 patients. The methods of surgical repair are shown in **Table 2**, and the overall stoma formation rate was 38.5%. Multivariable logistic regression analysis identified moderate to severe peritoneal contamination and the presence of malignant colonic neoplasms as significant predictors of stoma formation (*P*=.01 and *P*=.008, respectively) (**Table 3**). Neither the time to presentation, the quality of bowel preparation, nor age older than 60 years was a significant predictor.

Table 3. Multiple Logistic Regression Analysis for Predictors of Stoma Formation

Factor	Relative Risk (95% CI)	*P* Value
Moderate to severe contamination	13.50 (2.25-80.79)	.01[a]
Presence of malignant colonic neoplasms	3.55 (0.16-0.48)	.008[a]
Fair to poor bowel preparation	0.64 (0.16-2.63)	.51
Time to presentation >48 h	0.69 (0.11-4.18)	.82
Age >60 y	2.80 (0.28-27.80)	.96

Abbreviation: CI, confidence interval.
[a]Statistically significant.

Table 4. Multiple Logistic Regression Analysis for Predictors of Mortality

Factor	Relative Risk (95% CI)	*P* Value
ASA class ≥3	11.73 (1.35-102.20)	.009[a]
Antiplatelet therapy	8.28 (1.26-54.71)	.001[a]
Age >60 y	1.43 (0.14-14.35)	.45
Time to presentation >48 h	0.32 (0.04-2.93)	.21
Fair to poor bowel preparation	3.25 (0.59-18.03)	.35
Moderate to severe contamination	12.67 (1.32-121.47)	.16

Abbreviation: CI, confidence interval.
[a]Statistically significant.

OUTCOME

The mean (SD) hospital stay was 18.3 (15.5) days. Eight patients were admitted to the intensive care unit postoperatively. The 30-day morbidity and mortality rates were 48.7% and 25.6%, respectively. Common morbidities included wound infection in 7 patients, both chest and urinary tract infection in 2 patients each, and both heart failure and stroke in 2 patients each. None of the patients with simple suturing or primary large bowel anastomosis had an anastomotic leak. Multivariable analysis identified an ASA class of 3 or higher and presence of antiplatelet therapy to be significant predictors of mortality ($P=.009$ and $P=.001$, respectively) (**Table 4**).

MECHANISM OF INJURY

The mechanism of perforation was deducted from reports of the endoscopist, surgeon, and pathologist. The perforation was secondary to mechanical force in 27 patients (62.8%), polypectomy in 11 patients (25.6%), cold biopsy in 3 patients (7.0%), and electrocoagulation in 2 patients (4.7%). Significantly more perforations in diagnostic colonoscopies were caused by mechanical force ($P<.001$) (Table 1).

Predisposing factors for increased difficulty during diagnostic colonoscopies were also analyzed. These factors include a history of pelvic operations, pelvic inflammatory diseases, pelvic radiotherapy, diverticular disease, sigmoid volvulus, peritoneal dialysis, pseudo-obstruction, and presence of intra-abdominal adhesions. Significantly more patients from the diagnostic group had 1 or more of these factors ($P=.046$).

Table 5. Summary of Studies With Nonoperative Management of Colonoscopic Perforations

Source	No. of Colonoscopies	Perforation Rate, %	No. of Patients	
			Nonoperative Management	Operative Management
Orsoni et al[16]	36 000	0.135	21	27
Iqbal et al[15]	78 702	0.084	10	62
Lo and Beaton[25]	26 708	0.044	7	5
Adair and Hishon[24]	NA	NA	4	4
Farley et al[6]	57 028	0.075	3	42
Cobb et al[13]	43 609	0.032	3	11

Abbreviation: NA, not available from the study.

COMMENT

Endoscopy services in our region are provided by a combined unit, where gastroenterologists and surgeons are responsible for colonoscopies and other endoscopic procedures. The setting offers complementary advantages in patient management as well as in research and development. An increasing number of colonoscopies performed per year were observed during the study period. This is compatible with the worldwide trend in a rising number of colonoscopies being performed as the procedure becomes more available and screening programs for colorectal cancer are being implemented.[3,6,11,15] The overall perforation rate of 0.113% was in a decreasing trend and comparable to that of recently published large-scale studies.[4-15] There were no significant differences in perforation rates between gastroenterologists and surgeons. The finding was supported by several authors and suggests that, with adequate training and supervision, gastroenterologists and surgeons can achieve equal standards of low morbidity and mortality.[10,20-22]

Perforations seen in diagnostic colonoscopies were significantly larger and presented earlier.[5,12,16,23] Severe looping and incomplete colonoscopies were encountered more frequently. This may be explained by the mechanism of perforation in diagnostic and therapeutic colonoscopies.[7,13,15,23] Moreover, the number of perforations sustained during diagnostic colonoscopies appeared to be more than in the therapeutic group. This may be partly explained by the presence of significantly more patients with predisposing factors for difficult colonoscopies in the diagnostic group.

Optimal surgical strategy remains controversial. The potential risks of litigation further complicate the issue in management.[1] Conventional open surgical options include suturing of the perforation, resection with primary anastomosis, and creation of a colostomy. The laparoscopic approach is increasingly reported and is an acceptable option when the technical expertise is available in the emergency setting.[17-19] The predictors of stoma formation identified in our study include the presence of severe peritoneal contamination and malignant colonic neoplasms. This finding illustrates the unwillingness of surgeons across the region to risk an anastomotic leak given unfavorable surgical circumstances, in the event of a colonoscopic complication. Furthermore,

the degree of contamination is likely to be dependent on the interplay between the quality of bowel preparation and the time to presentation. However, these factors were not shown to independently predict stoma formation.

Nonoperative management of colonoscopic perforations has been described since the 1980s.[24] However, results from only several small case series are available (**Table 5**). The largest series was from Orsoni et al[16] and included 21 cases; the authors concluded that nonoperative management could be attempted in selected patients with perforations occurring after therapeutic colonoscopies, good bowel preparation, absence of other colonic diseases, satisfactory clinical condition, and rapid improvement within 24 hours. Drawing from experiences in the nonoperative management of perforated peptic ulcers, it is indisputable that a nonoperative strategy may be successful in selected patients with colonoscopic perforations.[26] However, the absence of clear selection criteria, the uncertainty in the size of perforation, and the possibility of a delay in treatment when nonoperative management fails should prompt judicious use of such a strategy. The predictors of mortality (Table 4) should be considered as criteria that exclude nonoperative management.

Nevertheless, the outcomes of surgery remained poor as evident from our high morbidity and mortality rates. The literature reports a morbidity rate ranging from 39% to 63.6% and a mortality rate ranging from 0% to 50%.[4-16,24,25,27] Physicians should weigh the risk of colonoscopy against the potential diagnostic yield of the procedure and the impact on life expectancy gains.[28] Patients with low risk of large-bowel diseases and a high risk of mortality in an event of perforation should be offered options of other methods of large-bowel investigation.

In conclusion, colonoscopic perforation rates were in a decreasing trend. The complication carries a high risk of morbidity and mortality, and patients with predictors of mortality should not be treated conservatively. Other options of large-bowel investigations should be considered in high-risk patients when the potential diagnostic yield is low.

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