Surgical Management and Outcomes of 165 Colonoscopic Perforations From a Single Institution

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Background: Increasing use of colonoscopy is making iatrogenic perforations more common. We herein present our experience with operative management of colonoscopic-related perforations.


Setting: Tertiary referral center.

Patients: A total of 258,248 colonoscopies performed in patients, from which we identified 180 iatrogenic perforations (incidence, 0.07%). Of these, 165 perforations were managed operatively.

Results: Patients underwent primary repair (29%), resection with primary anastomosis (33%), or fecal diversion (38%). Patients presenting within 24 hours (78%) were more likely to have minimal peritoneal contamination (64 patients [50%] vs 6 [17%; P = .01] and to undergo primary repair or resection with anastomosis (86 [67%] patients vs 13 [36%]; P < .01). Patients presenting after 24 hours (22%) were more likely to have feculent contamination (16 patients [44%] vs 4 [11%; P = .02] and to receive an ostomy (23 patients [64%] vs 43 [33%]; P = .02). The sigmoid colon was the most frequent site of perforation, followed by the cecum (53% and 24%, respectively; P < .001); blunt or torque injury exceeded polypectomy and thermal injuries (55% vs 27% and 18%, respectively; P < .001). Patients with blunt injuries were more likely to receive a stoma than were those with polypectomy and thermal perforations (44 patients vs 9 and 9, respectively; P = .02), as were patients with feculent peritonitis compared with those with moderate and minimal soilage (28 patients [78%] vs 28 [42%] and 6 [10%] respectively; P = .002). Operative morbidity was 36%, with a mortality rate of 7%. Multivariate analysis indicated that blunt injuries, poor bowel preparation, corticosteroid use, and being younger than 67 years were risk factors for postoperative morbidity (P = .01); no factors correlated with death.

Conclusions: Colonoscopic perforation occurs in fewer than 1 in 1000 patients and is associated with significant morbidity and mortality. Prompt diagnosis and operative therapy are critical in most cases.

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Despite improvements in radiological imaging such as computed tomographic (CT) colography, colonoscopy remains the criterion standard for screening of colorectal cancer and a central adjunct in the workup of gastrointestinal tract disorders.1-4 The volume of colonoscopy use as a screening and therapeutic tool continues to grow rapidly. At our institution, we have seen a 13-fold increase in the number of colonoscopies performed each year from 1573 in 1987 to 19,735 in 2005. The most serious complication of colonoscopy, iatrogenic perforation, has morbidity rates as high as 43% and mortality rates as high as 25%.5-10 We have previously reported a 0.08% incidence of perforation in nearly 80,000 colonoscopies, which has remained essentially unchanged over time, despite the expanding use of colonoscopy, specifically as a therapeutic tool.10,11 Despite the relatively constant perforation rate, the sheer volume of endoscopy currently being performed has increased the frequency with which surgeons encounter colonoscopic-related perforation (CRP).

Optimal operative management in these patients is unknown. Data from other mechanisms of traumatic intestinal perforation, especially in penetrating trauma, have challenged the traditional dogma of diversion or stoma formation, suggesting that single-stage procedures with immediate restoration of intestinal continuity are feasible under optimal circumstances.12-15 Furthermore, advancing endoscopic tech-
niques have created the suggestion that some iatrogenic perforations may be managed endoluminally. However, the low incidence of CRP limits the opportunity for prospective investigations to elucidate an evidence-based approach to these patients. Furthermore, until advanced technology using CT colography, capsule enterography, or some other modality has truly demonstrated safety and efficacy and has become widely available, endoscopists and surgeons must understand the mechanisms, presentation, and current management options for CRP. We herein present our experience with CRP to describe the characteristics of these injuries that influence operative decision making and look specifically at operative management and outcomes.

METHODS

After obtaining institutional review board approval, we queried the Mayo Clinic Rochester surgical database to identify all patients who underwent a colonoscopy with a CRP from 1980 through 2006. We excluded perforations referred from other institutions. Patient demographics, indications for and details of the colonoscopy, time to presentation, and management were collected via medical chart review. The operative and pathological reports were reviewed to obtain data regarding the extent of peritoneal contamination and operative intervention and the site, size, and mechanism of perforation. The mechanism of perforation was classified as blunt (direct trauma or torque from the scope), polypectomy (including electrocoagulation biopsy or other tissue removal, such as endoscopic mucosal resection), or thermal (argon beam coagulation or electrocautery to ablate tissue or control bleeding). In addition, we examined the postoperative course to calculate the 30-day postoperative morbidity and mortality rates and to identify risk factors for postoperative morbidity and mortality. We used 2-way contingency tables to compare discrete variables, implementing the Fisher exact test when low expected values were present. We used analysis of variance and paired t tests for all statistical comparisons of continuous variables; multivariate analysis was performed using a logistic fit. All statistical analyses were performed using JMP software (SAS Institute Inc, Cary, North Carolina). Continuous variables are expressed as the mean (SE), unless otherwise specified; P < .05 was considered significant. We performed Bonferroni corrections when multiple statistical comparisons were conducted.

RESULTS

From 1980 through 2006, 258,248 colonoscopies were performed at our institution, with a dramatic increase in volume during that time (Figure 1). Colonoscopies were performed or supervised by a staff gastroenterologist or by a colon and rectal surgeon. We identified a total of 180 CRPs for an incidence of 0.07%. The mean age of patients was 71 (2) years. Of the patients with CRP (hereinafter referred to as CRP patients), 61% had undergone a previous abdominal operation. Colorectal cancer screening was the indication for colonoscopy in 47% of the CRP patients, and 42% of all CRPs occurred with colonoscopic examination only. Altogether, 16% of patients underwent colonoscopy with a therapeutic intent (dilation, stenting, and known polyp), whereas the remaining 84% underwent diagnostic procedures. Thirty-five patients (19%) were hospitalized at the time of the index colonoscopy, and almost all of these examinations were performed for indications other than screening. Nineteen percent of patients overall were reported to have inadequate bowel preparation at the time of colonoscopy, as observed by the endoscopist performing the procedure. One-third of CRPs resulted from procedures that were noted to be difficult by the endoscopists; of these 9 difficult procedures, 17 were aborted.

One hundred forty patients (78%) presented within 24 hours of colonoscopy, 10% of whom were treated nonoperatively. Of the 140 patients presenting within 24 hours, 42 (30%) were identified as having a CRP at the time of colonoscopy by the endoscopist; all but 1 of these patients underwent immediate exploratory celiotomy. The remaining 40 patients (22%) presented in a delayed fashion (more than 24 hours after colonoscopy), and only 1 of these patients was treated nonoperatively. Nearly all of the patients whose CRP was not diagnosed at the time of colonoscopy was treated with abdominal pain. An abdominal plain film was obtained in 147 patients; of these studies, 128 (87%) demonstrated pneumoperitoneum (the remaining 19 [13%] had negative or equivocal findings). Twenty-four patients underwent CT, including those with negative or equivocal findings on the plain film; all 24 demonstrated positive findings consistent with a perforation.

Of the total 180 CRPs, 165 were managed operatively. All operations occurred with the patients under general anesthesia and were performed primarily by our emergency department surgical service. In all, 48 patients (29%) underwent a primary repair of the perforation, 55 (33%) underwent intestinal resection with a primary anastomosis, and 62 (38%) underwent a fecal diversion procedure (an end colostomy ileostomy or a diverting loop colostomy ileostomy with a primary repair or anastomosis). Only 16 (26%) of patients undergoing fecal diversion also underwent restoration of intestinal continuity.

At the time of operation, the rectosigmoid colon was the most frequent site of perforation (53% of all CRPs; P < .001), followed by the cecum (24%), the ascending and transverse colon (9% each), and, last, the descending colon (5%) (Figure 2). The CRPs throughout the colon were most commonly due to blunt injury in 53%
of patients (n=90, \(P<.001\)). Forty-two of these blunt injury perforations (46%) resulted from procedures that were classified as difficult by the endoscopist. Perforations from polypectomy and thermal injuries accounted for 27% and 18% of 165 injuries, respectively. The largest perforations resulted from blunt injuries (mean diameter, 2.0 cm). Polypectomy injuries resulted in a mean perforation size of 1.4 cm, and perforations from thermal injuries averaged 0.9 cm (Table 1). Most patients had minimal or moderate intraperitoneal contamination (78%) as determined by the operating surgeon at the time of intervention. The remaining patients had feculent contamination (Table 2).

Of the 129 patients presenting within 24 hours, 64 (50%) had minimal intraperitoneal contamination; in the 36 patients presenting after 24 hours, only 6 (17%) had minimal contamination (\(P=.01\)). There was a higher rate of feculent peritonitis in patients presenting in a delayed fashion (n=16) than in those presenting within 24 hours (n=14) (44% vs 11%; \(P=.02\)). A poor bowel preparation at the time of colonoscopy was predictive of feculent peritonitis at the time of exploration (\(P=.04\)); however, left-sided colon perforations were not predictive of gross contamination (\(P=.20\)).

The time to diagnosis affected the type of operative procedure performed in patients: 86 patients presenting within 24 hours (67%) underwent a single-stage procedure with either a primary repair or a resection with a primary anastomosis compared with only 13 patients presenting after 24 hours (36%) (\(P=.02\)). On the other hand, 23 of the patients presenting after 24 hours (64%) received an ostomy compared with 43 of the patients presenting within 24 hours (33%) (\(P=.02\) (Table 3). One patient among the 55 undergoing resection with a primary anastomosis developed an anastomotic leak that required reoperation with the creation of an ostomy (leak rate, 2%).

Time to diagnosis was not the only predictor of the type of procedure performed in patients. Most patients with feculent peritonitis received a stoma (n=28), compared with patients with moderate (n=28) or minimal (n=6) contamination (77% vs 42% and 10%, respectively; \(P=.002\)). In addition, 44 patients sustaining a CRP from blunt trauma or torque received a stoma, compared with 10 for polypectomy injuries and 9 for thermal injuries (\(P=.02\) (Table 1). Blunt injury perforations were also associated with a higher mortality rate than were thermal injuries (10 patients vs none; \(P=.04\)). There was no difference in mortality rates between blunt injury perforations and polypectomy injuries (10 patients vs 2; \(P=18\)), and there was no difference in morbidity among blunt, polypectomy, or thermal CRPs (29 patients vs 17 vs 13, respectively; \(P=.52\)).

The overall operative morbidity rate was 36% (Table 4). Multivariate analysis identified blunt injuries, poor bowel preparation, corticosteroid use, and being older than 67 years (median age) as risk factors for postoperative morbidity (\(P\leq.01\)). The morbidity rate was nearly 2-fold higher in the group presenting after 24 hours (n=16) compared with the group presenting within 24 hours (n=35), although this factor did not reach statistical significance (44% vs 27%; \(P=.06\)). Other risk factors, such as left-sided CRPs, anticoagulation, and feculent peritonitis (although significant by univariate analysis \(P\leq.04\)), all failed to demonstrate significance in multivariate analysis. Mortality was 7%. No risk factors for death were identified.

Nonoperative management (n=15) consisted of admission, bowel rest, intravenous fluids, antibiotic therapy, and serial abdominal examinations. Thirteen of the 15 patients undergoing nonoperative treatment were clinically stable and devoid of peritonitis on physical examination. Diagnosis of CRP occurred within 24 hours in 12 of these patients; a single patient presented after 24 hours and recovered without further sequelae. Time to presentation was not a predictor of operative vs nonoperative management (\(P=.50\)). The remaining 2 patients had been admitted to the hospital before CRP and did not fulfill our criteria for nonoperative management. However, because of comorbid conditions and poor prognosis, their families declined further intervention after the diagnosis of a CRP, and both patients died. The overall morbidity rate in the nonoperative group was lower compared with the operative group (1 patient vs 59; \(P=.02\)). There was no difference in mortality (2 patients vs 12; \(P=.44\)).

Colonoscopy remains a relatively safe procedure, with an incidence of perforation that is less than 1 per 1000 procedures. However, the growing volume of colonoscopies performed nationwide has made this complication more common. At our institution’s current volume of colonoscopy, we will be treating nearly 20 CRPs a year, which is not a negligible number of patients considering that most patients will require an emergent operation that has a morbidity rate of 36%, will leave as many as 38% with a stoma, and has a 7% risk of death. Until less invasive techniques for colorectal cancer screening such as CT colography prove their efficacy and become widely available, an aging population at risk of colorectal malignant neoplasms will continue to spur this growing volume of colonoscopy and related complications.

**Table 4**

<table>
<thead>
<tr>
<th>Type of Procedure</th>
<th>mortality rate</th>
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<tr>
<td>Single-stage</td>
<td>36%</td>
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<tr>
<td>Primary repair or resection</td>
<td>2%</td>
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<td>Primary anastomosis</td>
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**Figure 2.** Schematic representation of the distribution of colonoscopic perforations throughout the colon. * \(P<.001\) comparing the sigmoid colon with all other sites.
A common misconception is that screening or diagnostic colonoscopy carries a far lower rate of CRP compared with therapeutic or interventional colonoscopy. However, iatrogenic perforations at our institution during colonoscopy occur most frequently in the sigmoid colon as the result of blunt injury. Therefore, we do not believe that interventional colonoscopy necessarily poses a significantly increased risk of perforation compared with screening or examination-only procedures, which accounted for 42% of the perforations in this series. In fact, as interventional colonoscopies have increased, we have seen a slight decrease in the incidence of CRP from 0.08% through 2000 to 0.05% in the past 6 years. In our experience, injuries to the sigmoid colon result in larger perforations, which are more likely to require fecal diversion, reflecting the propensity for more intraperitoneal contamination and inflammation in these patients.

A second misconception regarding CRPs is that these injuries occur in conjunction with a prepared colon and that one can anticipate a minimal amount of intraperitoneal contamination such that there should be little need for fecal diversion. The present series demonstrates that this is not the case and that nearly one-quarter of patients will present in a delayed fashion with a 45% incidence of feculent peritonitis. In addition, not all patients have an adequate bowel preparation; among our CRP patients, 19% had a suboptimal preparation. The resultant inflammatory changes associated with feculent peritonitis clearly limit the operative options, precluding a single-stage procedure and resulting in fecal diversion in 38% of patients. To make matters worse, these patients tend to be older and have significant comorbidities that diminish their ability to compensate for abdominal sepsis, putting them at a higher risk for postoperative complications such as anastomotic leaks. These complications prompt a predilection for diversion procedures, which have a low rate of reversal in this subset of patients.

Nearly all of our patients (97%) found to have a perforation at the time of colonoscopy underwent immediate operative intervention. These injuries tend to be quite large, especially when they can be visualized during endoscopy, and are less amenable to nonoperative management. Moreover, the suggestion of perforation in the remaining patients resulted from hemodynamic instability due to massive pneumoperitoneum that prompted emergent abdominal radiography and surgical consultation.
All of these findings highlight the importance of a prompt diagnosis with immediate intervention to maximize the likelihood of primary repair, intestinal resection with a primary anastomosis, or nonoperative management. Primary repair or anastomosis can be performed safely in up to two-thirds of patients if the diagnosis is made within 24 hours compared with only 17% of patients presenting after 24 hours. For this reason, we advocate immediate operative intervention for those patients in whom the diagnosis is made intraprocedurally, obtaining as much information as possible from the endoscopist to guide operative decision making.

Patients presenting after colonoscopy with complaints of abdominal pain should raise a very high index of suspicion for perforation. History and physical examination should be the cornerstone in the evaluation, including a discussion with the endoscopist to obtain pertinent information that may help guide preoperative decision making. We have found abdominal radiographs to be diagnostic in 87% of patients. For patients with negative or equivocal findings on abdominal radiographs, CT is useful in diagnosing a perforation. Patients who are clinically unstable or who exhibit peritonitis on physical examination results warrant immediate exploration. Highly select, clinically stable patients devoid of peritonitis can be observed with bowel rest, intravenous fluids, antibiotic therapy, and serial examinations with the intent of avoiding an operation. Fewer than 6% of our patients met these criteria. The 2 deaths of patients whose families refused intervention (both patients had peritonitis) lead us to support these strict criteria for managing CRP nonoperatively. Therefore, the surgeon must be highly selective in whom he or she chooses to observe and must intervene at the first indication of nonoperative failure.

Factors from the index colonoscopy can be useful in determining whether a patient can be observed or whether immediate operative intervention is indicated. Procedures that did not involve any interventions should make the surgeon highly suspicious of blunt injuries in the sigmoid colon (which will account for > 50% of CRPs and carry a higher mortality rate than thermal injuries) and should prompt immediate exploration. Interventional procedures, such as snare polypectomy of a small, pedunculated polyp or argon beam coagulation of a small vascular lesion, may indicate a smaller perforation that may be observed in the clinically stable patient devoid of peritonitis. Abdominopelvic CT also can help in assessing the location, site, and extent of intraperitoneal inflammation associated with the perforation. In this series, CT was not included as part of the diagnostic workup for most patients. The broader application and improving quality of CT may prove useful in selecting patients who may undergo nonoperative management; however, it should not be the only determinant (Figure 3).

Although the present study is unable to assess patient-specific factors that increase an individual’s risk of CRP, one cannot ignore the fact that 61% of CRP patients in this series had undergone a previous abdominal operation. Postoperative adhesions that fixate the colon can add to the difficulty in reducing loops during colonoscopy. This tethering can lead to perforation and should be a very serious consideration while performing colonoscopy in patients who have undergone a previous abdominal operation. Moreover, any patient in need of colorectal surveillance with a history of a difficult colonoscopy or in whom a difficult colonoscopy is anticipated (previous abdominal operation, need for excessive sedation, etc) should be considered for CT colonography.

The advent of natural orifice transluminal endoscopic surgery (NOTES) has led endoscopists to question whether endoscopic perforations will be managed endoscopically in the future, because NOTES technology will give rise to devices specifically designed to close iatrogenic gastrointestinal tract perforations. In fact, we had a single patient in the nonoperative group who sustained a small perforation identified at the time of colonoscopy that was closed by the endoscopist using hemorrhoids. This patient had a successful outcome, but, in the absence of additional experience demonstrating safety and efficacy, we do not currently advocate this type of intervention. Although our highly selected patients treated nonoperatively benefited from lower morbidity and mortality rates, this retrospective experience reflects the extreme bias in deciding whose CRP is managed nonoperatively in our practice. Moreover, the 2 patients treated nonoperatively who did not meet our criteria for nonoperative therapy rapidly deteriorated and died, indicating how precipitous abdominal sepsis after a CRP can be. Furthermore, failure of nonoperative interventions will likely limit surgical options, committing the surgeon to a 2-stage procedure in addition to subjecting the patient to complications inherent in abdominal sepsis and septic shock. In addition, 62% of patients will have moderate to feculent peritonitis, which may be difficult to manage endoluminally.

Perhaps, as endoluminal technology evolves, a more imminent intervention to minimize morbidity and expedite recovery will be laparoscopy. Admittedly, we do not have a large enough experience using laparoscopy in this setting to report any data, but several case reports describing its successful role have been published.

In conclusion, colonoscopy remains a safe screening and interventional tool with a perforation rate of 50% of CRPs and 70% of high-risk CRPs.
0.07%. Perforations associated with colonoscopy carry significant morbidity and mortality rates. Diagnostic and therapeutic colonoscopies may have a similar incidence of perforation. Although a few patients may be amenable to nonoperative therapy, most patients warrant prompt operative intervention to minimize the extent of intraperitoneal contamination and to maximize the opportunity to perform a single-stage procedure and potentially to reduce postoperative complications.

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The discussions that follow this article are based on the originally submitted manuscript and not the revised manuscript.

REFERENCES


DISCUSSION

Mario R. Villalba, MD, Royal Oak, Michigan: Dr Farley and his group need to be congratulated for their continued interest in this topic. They have published 2 previous papers related to CRPs in 1997 and 2005. The present study is their experience of 25 years at the Mayo Clinic. Two hundred fifty-eight thousand two hundred forty-eight colonoscopies were performed with 180 CRPs, with an incidence of 0.07%. One hundred sixty-five (91.6%) of them were treated operatively with a postoperative morbidity of 36% and an overall mortality of 7%.

Seventy-eight percent of patients with CRPs were seen in less than 24 hours. This, indeed, is a remarkable achievement and a tribute to excellent perioperative care at their institution. My first question pertains to this: How do you do it? Are there routine postprocedural radiological examinations, physical examinations, or follow-up phone calls?

I compared these data with those of my own institution, William Beaumont Hospital in Royal Oak. From the years 2000 through 2007, we as an institution performed 100 142 colonoscopies with 56 iatrogenic perforations, for an incidence of 0.06%. Of these patients, 45 (80.4%) were treated operatively and 11 patients (19.6%) were managed conservatively. Our experience has very similar rates of morbidity and mortality to those presented here in this study.

Laparoscopic repair with intracorporeal suturing of CRPs in the appropriate patient is being more widely practiced, especially when laparoscopy does not exclude conversion to laparotomy when indicated. My second question is, do you think that your emergency surgical service will start managing a larger proportion of patients laparoscopically? This would seem feasible considering that such a high percentage of patients (78%) are diagnosed in less than 24 hours from their iatrogenic injury.

My last question is related to the recognized increase in the risk of colonoscopic examinations in certain patients, such as those with a redundant sigmoid colon or a female patient with previous pelvic surgery. Specifically, you report that 53% of the injuries encountered were due to a blunt/torque mecha-
nism. Have you observed any association between injury and the role of “endoscopists in training” during these difficult examinations?

Dr Farley: Question No. 1 was, How do we do it? How do we identify these patients in less than 24 hours? Twenty percent of them are identified by the endoscopist at the time of the procedure, so that eliminates one-fifth of them. The endoscopists have a very low threshold calling for surgical help. They are asked to get a plain abdominal film in the recovery area if there is concern for abdominal distention. The Mayo Clinic is a very collegial institution and we do like to work together. The threshold is very low by both the nurses and the gastroenterologists for involving surgeons early on. I suspect the patient population may have some differences as well. Many of our patients come from a long way. Whereas in Royal Oak, perhaps, they head back home, our patients may go to the hotel. That may make a difference, as patients may elect to head to the emergency department instead of sleeping in their own bed.

The second question involves laparoscopy. It is reasonable to use. We have done so more frequently in the last year, but laparotomy remains our standard. It is also likely that the endoscopists will attempt to solve this problem as well with their endoluminal clips. We had one such repair in this study that worked fine and was a nonobservational success.

The last question related to the experience of the endoscopists. Like anything else in life, experience is important. We could not comment on this because at each of the endoscopic reports there would be a fellow or a student or a resident there, and we could not tell who did what. I do think that this is a great opportunity for training with simulators, cadavers, and pigs, because people need to know how hard you can push and how much gas you can insert. An endoscopist training on humans never learns what point is too much until he or she perforates the bowel.

As others have shown, this is a very rare complication, and people can go years without injuring colon and then have 2 in a week. Some of our most experienced endoscopists suffered perforations as well. We did not find a difference between gastroenterologists and colorectal surgeons.

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