Endoscopic perforation rates at a Canadian university teaching hospital

Tarun Misra MD, Eoin Lalor MB FRCPC, Richard N Fedorak MD FRCPC


BACKGROUND: Despite advances in training, operative techniques and endoscopic technology, upper and lower endoscopic procedures continue to have potential for intestinal perforation. Perforation rates provided to patients at the time of consent have frequently been derived from historical cohorts and survey datasets.

OBJECTIVE: This study examined the perforation rates of upper and lower endoscopic procedures at a major Canadian tertiary care centre.

METHODS: Inpatient and outpatient gastroscopies and colonoscopies performed during a three year period were evaluated. Endoscopies with perforations occurring within 14 days of procedure were retrospectively isolated using the International Classification of Diseases – 9th Revision code descriptions, then retrieved and hand searched to confirm a procedure-related perforation. Data were extracted to identify risk factors and patient outcomes.

RESULTS: A total of 21,217 endoscopies (13,792 gastroscopies and 7425 colonoscopies) were reviewed. Of these, 359 were identified, isolated and hand searched for confirmation of a perforation event. Eighteen were found to have an endoscopy-associated perforation. Ten perforations occurred with colonoscopy (0.13%) (incidence, 1.3/1000 procedures), resulting in one death (0.013%) (incidence, 0.13/1000 procedures). Eight perforations occurred with gastroscopy (0.06%) (incidence, 0.6/1000 procedures), resulting in zero mortality. Of colonoscopy procedures the rate of perforation with diagnostic colonoscopy was 0.13% (incidence, 1.3/1000 procedures) and with therapeutic colonoscopy was 0.14% (incidence, 1.4/1000 procedures). Of gastroscopy procedures the rate with therapeutic gastroscopy was 0.15% (incidence, 1.5/1000 procedures). No perforations occurred with diagnostic gastroscopy.

CONCLUSION: Gastroscopy and colonoscopy procedures, especially those with therapeutic maneuvers, continue to carry morbidity and mortality risks associated with perforation.

Key Words: Colonoscopy; Complication; Endoscopy; Gastroscopy; Morbidity; Mortality; Perforation

Upper and lower flexible endoscopy has evolved into an important diagnostic and therapeutic tool that has revolutionized the management of patients with gastrointestinal diseases. Although flexible upper and lower endoscopy, with current endoscopic equipment and appropriate training is considered a safe procedure, like all other procedures in medicine, current endoscopic equipment and appropriate training is considered a safe procedure, like all other procedures in medicine, there remains identifiable potential for adverse events and complications. One of the most serious of these complications is intestinal perforation.

Table 1 outlines the published reports of colonoscopy-associated perforation rates during the last 30 years. The reported rate of colonic perforation ranges from a high of 1.3% to a low of 0% (1-18). Studies with the highest reported rate of perforations are those conducted at a time when colonoscopy was a relatively new procedure, and may not be representative of current colonoscopic practice. In contrast, retrospective and prospective studies conducted since 1996 have reported lower rates of perforation, with diagnostic colonoscopic perforation...
rates ranging from 0.005% to 0.20% (10-16) and therapeutic colonoscopic perforation rates ranging from 0.06 to 0.40% (11-15). Indeed, a recent diagnostic colonoscopic screening program for colon cancer in a healthy population involving over 3000 colonoscopies had a zero rate of perforation (19), implying the risk of colonoscopy-associated perforation may be lowest during screening of a healthy outpatient population.

Table 2 outlines the published reports of gastroscopy-associated perforation rates during the last 30 years. The rate of perforation with diagnostic gastroscopy has been described as lower than that of perforation associated with diagnostic colonoscopy. The rate of perforation at the time of diagnostic gastroscopy ranges from 0.0009% to 0.10% (7,13,20-25).

Again, similar to that seen with colonoscopy, the most recent studies report the lowest rates of perforation. Therapeutic gastroscopy carries an increased risk of perforation (range 0.3% to 6.4%) and is almost always associated with dilation of malignant or benign esophageal strictures (21,25). Interestingly, upper endoscopic perforations associated with bleeding ulcers was not described until recently, when a therapeutic endoscopic upper gastrointestinal bleeding clinical trial documented a perforation rate of 1.1% and 4.2% for endoscopic treatment and re-treatment, respectively (26).

Perforation rates provided to patients at the time of consent are frequently derived from the historical cohorts and survey data sets identified in Tables 1 and 2. There are currently no published Canadian endoscopic perforation data. The aim of
this retrospective chart review was to determine recent Canadian gastroscopy- and colonoscopy-associated perforation rates at a Canadian tertiary care university teaching centre.

**METHODS**

The University of Alberta Hospital is a university teaching centre and a tertiary care referral hospital located in Edmonton, Alberta. It serves a catchment area of over 1.8 million people from central/northern Alberta, northwestern Saskatchewan, northern British Columbia and the Northwest Territories. Endoscopy at the University of Alberta Hospital is performed by three pediatric gastroenterologists, four hepatologists, six adult gastroenterologists and one general surgeon. Approximately 4500 gastroscopies and 2500 colonoscopies are performed annually. The hospital also serves as a Canadian training centre for between five to 10 gastroenterology subspecialty residents in any given year.

All inpatient and outpatient upper and lower endoscopies conducted at the University Hospital between January 1, 1998 and December 31, 2001 were evaluated. The University of Alberta Hospital uses the International Classification of Diseases (ICD) (27), on a prospective basis, to identify each procedure and diagnosis for every patient encounter. Previous reports have shown that over 90% of perforations resulting from endoscopy are diagnosed within two days of the procedure (12). Endoscopies with perforations, occurring within 14 days of the endoscopic procedure, were therefore isolated using the code descriptions listed in Table 3.

Identified records were retrieved and hand searched to confirm an endoscopic-associated perforation by consensus of two authors (TM and RF). Data were extracted to identify patient demographics, endoscopic indication and diagnosis, type of procedure, extent of insertion, preparation adequacy, trainee involvement, previous abdominal surgery, renal failure, surgical outcome and mortality. The type of procedure was recorded as either diagnostic or therapeutic depending on the presence or absence of a therapeutic endoscopic maneuver. For gastroscopy, therapeutic maneuvers included dilation, stent placement, variceal and nonvariceal hemostatic procedures, and percutaneous endoscopic gastrostomy tube placement. For colonoscopy, therapeutic maneuvers included all therapeutic procedures identified for gastroscopy, plus polypectomy and decompression. The occurrence of mucosal biopsy was recorded as a diagnostic procedure.
RESULTS

As shown in Table 4, a total of 21,217 endoscopies (13,792 gastroscopies [diagnostic 8062, therapeutic 5330] and 7425 colonoscopies [diagnostic 4470, therapeutic 2955]) were performed in the 36 months between August 1998 and August 2001. Three hundred fifty-nine (167 inpatients and 192 outpatients) records were initially isolated for review based on the search criteria outlined above. Of these 359 cases, 358 were retrieved. One record of a colonoscopy was not reviewed because it was missing from the files. After hand searching all 358 retrieved cases, 18 of these records were found to have had an endoscopy-associated intestinal perforation.

Colonoscopy

Ten colonic perforations occurred during the 7425 colonoscopies, representing an overall colonoscopic perforation rate of 0.13% (incidence, 1.3/1000; 1/769 procedures) (Table 3). Six colonoscopy-associated perforations occurred during 4470 diagnostic colonoscopies (0.13%) (incidence, 1.3/1000; 1/769 procedures), while four colonoscopy-associated perforations occurred during 2955 therapeutic colonoscopies (0.14%) (incidence, 1.4/1000; 1/714 procedures).

Table 5 demonstrates the characteristics of patients with colonoscopic perforation. The mean age was 60.3±6.2 years with male:female ratio of 4:6. One patient died following the perforation (0.013%) (incidence, 0.13/1000; 1/7692 procedures). Of the 10 colonic perforations, four of 10 (40%) were undergoing a therapeutic colonoscopic procedure (dilation of benign stricture, one patient, hemostasis, one patient, decompression, one patient, polypectomy, one patient). Of the six perforations in patients undergoing diagnostic colonoscopy, five of six (85%) occurred in association with the following comorbid conditions: two occurred in the setting of diverticulosis, one patient was on hemodialysis, one patient had previous abdominal surgery, and one patient had a combination of diverticulosis, hemodialysis and history of abdominal surgery.

Management of patients following the identification of perforation varied considerably (Table 6). The diagnosis of perforation was made during the procedure in six of 10 (60%) of the cases and on x-ray, immediately following the procedure, in three of 10 (30%) of the cases and at autopsy in one case (10%). One patient was managed conservatively, two required primary surgical closure, four required surgical resection with anastomosis, two underwent surgical resection with ostomy formation and one died. The one death occurred in a critically ill patient in the intensive care unit, following a recent lung transplant. A colonoscopy was performed up to 30 cm and terminated due to very severe colitis. The patient then became bradycardic and arrested. The autopsy report confirmed an old walled off perforation in the area of the sigmoid, which likely worsened with insufflation of air during the procedure.

Gastroscopy

Eight upper gastrointestinal perforations occurred during the 13,392 gastroscopies, representing a perforation rate of 0.06% (incidence, 0.6/1000; 1.0/1667 procedures) (Table 4). No

---

**TABLE 4**

Frequency of endoscopic perforations at the University of Alberta Hospital August 1998 to August 2001

<table>
<thead>
<tr>
<th>Procedure Type</th>
<th>Diagnostic</th>
<th>Total</th>
<th>Therapeutic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastroscopy</td>
<td>8062</td>
<td>13,392</td>
<td>5330</td>
<td>7425</td>
</tr>
<tr>
<td>Colonoscopy</td>
<td>4470</td>
<td>2955</td>
<td>2955</td>
<td>7425</td>
</tr>
</tbody>
</table>

**TABLE 5**

Characteristics of patients with perforation following colonoscopy

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age (years)</th>
<th>Procedure type</th>
<th>Diagnosis</th>
<th>Trainee associated with the procedure</th>
<th>Previous abdominal surgery</th>
<th>Renal failure</th>
<th>Adequate preparation documented</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F</td>
<td>74</td>
<td>Diagnostic</td>
<td>Diverticuli</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Not stated</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>64</td>
<td>Diagnostic</td>
<td>Diverticuli</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>44</td>
<td>Decompression</td>
<td>Ischemia, megacolon</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Poor</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>65</td>
<td>Stricture dilation</td>
<td>Colonic stricture</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>58</td>
<td>BICAP bleeding ulcer</td>
<td>Colonic ulcer</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Poor</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>70</td>
<td>Diagnostic</td>
<td>Normal</td>
<td>No</td>
<td>Appendectomy</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>75</td>
<td>Diagnostic</td>
<td>Diverticuli</td>
<td>Yes</td>
<td>Cholecystectomy, hysterectomy</td>
<td>Hemodialysis</td>
<td>Not stated</td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>61</td>
<td>Diagnostic</td>
<td>Severe colitis</td>
<td>Yes</td>
<td>No</td>
<td>Hemodialysis</td>
<td>Poor</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>70</td>
<td>Diagnostic</td>
<td>Normal</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Not stated</td>
</tr>
<tr>
<td>10</td>
<td>F</td>
<td>42</td>
<td>Polypectomy</td>
<td>Benign neoplasm</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Not stated</td>
</tr>
</tbody>
</table>

BICAP Bipolar electrocoagulation; F Female; M Male
gastroscopy-associated perforations occurred during 8062 diagnostic gastroscopies (0%), while eight gastroscopy-associated perforations occurred during 5330 therapeutic gastroscopies (0.15%) (incidence, 1.5/1000; 1/667 procedures).

Table 7 demonstrates the characteristics of the patients with a perforation during gastroscopy. The mean age of the patients involved was 62.4±8.2 years with a male:female ratio of 5:3. Of the eight gastroscopic perforations, all eight (100%) involved a therapeutic procedure (esophageal dilations for malignant lesions, six patients, esophageal wall-stent placement, one patient, placement of percutaneous feeding tube, one patient). Three patients had a positive history of abdominal surgery. No patients had dialysis-dependent renal failure. Two of eight (25%) perforations occurred in the setting of trainee involvement. There were no deaths reported following any gastroscopic perforations.

Like colonoscopy, the management of perforation following gastroscopy varied considerably (Table 8). The diagnosis of perforation was made during the procedure in three of the cases, and on x-ray, immediately following the procedure, in five of the cases (chest x-ray, three patients, gastrograffin swallow, two patients) Five patients were managed conservatively, one had an esophageal stent placed in the operating room to seal the perforation, and two underwent thoracotomies for esophageal repair. The surgically managed patients were discharged from hospital within 11 days of admission.

**DISCUSSION**

A review of previous publications suggests that the gastrointestinal perforation rate for diagnostic and therapeutic gastroscopy has remained relatively constant over the last several decades (Table 2), whereas the perforation rate for both diagnostic and therapeutic colonoscopy appears to have fallen, and then plateaued, during the last decade (Table 1). The reason for this change in colonoscopic complication rate likely relates to the more recent introduction of colonoscopy into the mainstream of gastrointestinal procedures and the advances that have since occurred in endoscopic equipment, techniques and operator training. Nevertheless, in these same reported cohorts (Tables 1 and 2) it is interesting to note that the average rate of perforation is approximately 85-fold higher for therapeutic gastroscopy (approximately 2.6%) than for diagnostic gastroscopy (approximately 0.03%); and threefold higher for therapeutic colonoscopy (approximately 0.24%) than for diagnostic colonoscopy (approximately 0.09%); while mortality is approximately 500-fold higher for therapeutic gastroscopy (approximately 1.0%) than for diagnostic gastroscopy (approximately 0.002%); and 50-fold higher for therapeutic colonoscopy (approximately 0.03%) than for diagnostic colonoscopy (approximately 0.006%).

While over-reporting of perforations was avoided by the use of hand searching, it is possible that the lower rates of perforation observed in the current study may reflect under-reporting by the use of ICD codes to retrieve cases in a retrospective manner. However, the data obtained in this study are nonetheless superior to previous documentation using survey techniques.

Perforation at gastroscopy almost always occurred with dilation of a benign or a malignant esophageal stricture. In contrast, perforation at colonoscopy occurred with polypectomy, diverticulosis, poor preparation, previous abdominal surgery (and presumably adhesions) and dialysis-dependent renal failure. Except for dialysis, these associations with perforation have been previously described. Because the prevalence of these associated diagnoses is likely to be relatively high, it is not possible to associate these with risk factors for perforation. The involvement of trainees as a significant factor in endoscopic perforation has not been previously confirmed (12). The current study had trainees involved in a minority of the cases; however, it was similarly impossible to determine the risk associated with trainees in that the total number of endoscopic cases the trainees were involved in was not

<table>
<thead>
<tr>
<th>Patient</th>
<th>Sex</th>
<th>Age (years)</th>
<th>Procedure</th>
<th>Diagnosis</th>
<th>Trainee associated with the procedure</th>
<th>Previous abdominal surgery</th>
<th>Renal failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>70</td>
<td>Esophageal dilation</td>
<td>Esophageal carcinoma</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>57</td>
<td>Feeding tube placement</td>
<td>Feeding concerns</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>79</td>
<td>Esophageal wall stent placement</td>
<td>Esophageal carcinoma</td>
<td>No</td>
<td>Gastric-esophageal resection</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>17</td>
<td>Esophageal dilation</td>
<td>Esophageal benign stenosis</td>
<td>Yes</td>
<td>Jejunostomy interposition</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>76</td>
<td>Esophageal dilation</td>
<td>Gastric cardia carcinoma</td>
<td>No</td>
<td>Gastric carcinoma resection, esophageal-jejunal anastomosis</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>86</td>
<td>Esophageal dilation</td>
<td>Esophageal carcinoma</td>
<td>No</td>
<td>Unknown</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>47</td>
<td>Esophageal dilation</td>
<td>Achalasia</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>67</td>
<td>Esophageal dilation</td>
<td>Esophageal carcinoma</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
determined. Nevertheless, operator training and experience has been clearly shown to correlate with endoscopic adverse events, including perforation (28).

Reporting of endoscopic complication rates in patient consent forms is moving from the use of historical cohort data to site specific data, and more recently, it has been suggested that individual operator rates be recorded and reported (28). In this regard, the perforation rates described in the present report reflect those at the University of Alberta Hospital and may not be relevant to individual operators, or to sites where the risk mix is different than that at the University of Alberta Hospital.

CONCLUSION
In summary, endoscopic gastroscopy and colonoscopy procedures, especially those with therapeutic maneuvers, carry risks associated with perforation morbidity and mortality. Future prospective studies are required to clearly determine the associated comorbid risk factors for endoscopic perforation.

ACKNOWLEDGEMENT: Crohn’s and Colitis Foundation of Canada

REFERENCES

Endoscopic perforation rates
Submit your manuscripts at http://www.hindawi.com