Colonoscopic perforation

Perforation is an uncommon but important complication of colonoscopy. This review looks at the incidence, clinical features, diagnosis and treatment of this condition.

Since its introduction in the 1960s, colonoscopy has become the gold standard for imaging the bowel. Initially used for diagnosis, it is now an important tool in treatment, for example in the excision of polyps and tumours. General complications of this procedure include abdominal pain, nausea and vomiting, aspiration, excessive sedation, cardiorespiratory and cerebrovascular events. The important surgical complications are haemorrhage and bowel perforation, both of which are relatively uncommon. This review looks at the incidence, symptoms and signs, diagnosis and subsequent management of colonoscopic perforation.

Method

A literature search was done of PubMed, Medline, EMBASE and Cochrane review databases with the keywords 'colonoscopy' and 'perforation' up to 2005. The abstracts of all the retrieved English articles were examined and all case reports, small series (less than three cases of perforation) and retrospective questionnaire surveys were excluded. Other articles were extracted from cross-referencing the retrieved articles.

Incidence

Colonoscopic perforation is uncommon and this may explain why some units have reportedly never seen this complication. The overall incidence of perforation ranges from 0.005–1.2% (Stuart et al, 1979; Lo and Beaton, 1994). The incidence of perforation after a therapeutic colonoscopy is between 0.06 and 0.83% (Jentschura et al, 1994; Sieg et al, 2001) while the incidence after diagnostic colonoscopy is 0–0.6% (Brynitz et al, 1986; Gondal et al, 2003).

Mechanism of bowel perforation

Bowel perforation can be caused by instrument looping, pneumatic or hydrostatic pressure, and diathermy burns. The causes of bowel perforation identified in three different series were mechanical trauma (tip of scope or shaft of scope damaging the bowel) in 32–48% of cases, diathermy use in 20–36%, cold biopsy in up to 20% of cases, pneumatic distension in 15% and unknown in 27% of patients (Farley et al, 1997; Anderson et al, 2000; Cobb et al, 2004).

Perforations are more likely to occur when the colonoscopy has been 'difficult', which may be in up to 40% of cases. Saunders et al (1996) showed that the total length of the large bowel is greater in female patients, because they have a longer transverse colon. Females were therefore more likely to be classified as being a 'difficult' colonoscopy as the longer length leads to recurrent looping. Other causes of difficult colonoscopy in females are the anatomy of the female pelvis (as this is rounder, it may predispose to sigmoid looping) and because women's abdominal muscles may be weaker following pregnancy, they do not provide enough resistance which leads to looping.

Risk factor for perforation

Therapeutic colonoscopy generally has higher perforation rates than diagnostic colonoscopy although some authors have found no real difference. The therapeutic procedure most likely to cause a perforation is a polypectomy followed by biopsy and laser treatment (Reiertsen et al, 1987; Johnson, 1993; Araghizadeh et al, 2001). Excision of thick stalk polyps or sessile polyps was more likely to lead to perforation (Christie and Marrazzo, 1991). Hot biopsy forceps is more likely to cause caecal or ascending colon perforation (52.6% of cases in one series) and it has therefore been argued that hot biopsy should not be used in right-sided colonic lesions (Wadas and Sanowski, 1988).

The age of patients with perforation is between 25 and 91 years, although the mean age is between 60 and 70 years and reflects the older age of patients undergoing colonoscopy (Farley et al, 1997; Araghizadeh et al, 2001). Perforations from diagnostic procedures are more likely in older patients (82.6% *vs* 65.9% of cases) (Lo and Beaton, 1994; Cobb et al, 2004) with those over 75 years old having four times the risk of perforation than those who are 65–69 years old (Gatto et al, 2003). There are conflicting reports on whether gender has any effect on the risk of perforation.

An important factor which increases the risk of perforation is previous abdominal surgery or diverticulosis. The reported series of perforation in which previous abdominal, perineal or groin operations were noted was 37–83% (Brynitz et al, 1986; Farley et al, 1997; Orsoni et al, 1997; Viiala et al, 2003; Iqbal et al, 2005). The presence of diverticulosis in patients with perforation ranged from 16.7–62% (Jentschura et al, 1994; Orsoni et al, 1997; Gatto et al, 2003; Viiala et al, 2003; Iqbal et al, 2005).

Risk of perforation is thought to have decreased over the last decade possibly because of improvements in technology, i.e. more flexible scopes, and better training of endoscopists (Gatto et al, 2003). The experience of the

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endoscopist may also have an impact on the perforation rates. In one series, there were more perforations when a trainee was doing the colonoscopy but this was not statistically significant (20% of the cases which had been performed by the trainees led to 40% of the total number of perforations) (Anderson et al, 2000). In other series, there were more perforations from inexperienced endoscopists with the highest complication rate when the endoscopist had performed less than 40–100 colonoscopies (Araghizadeh et al, 2001; Dafnis et al, 2001) although in another series there was no difference in perforation rates with increasing experience (Farley et al, 1997).

Symptoms, signs and diagnosis

The commonest symptoms in patients with bowel perforation were abdominal pain (up to 100% of patients), abdominal distension (up to 71% of patients) and fever (up to 36% of patients) (Gedebou et al, 1996; Farley et al, 1997; Orsoni et al, 1997; Cobb et al, 2004; Iqbal et al, 2005). Abdominal pain and distension are also features in patients who have a lot of colonic air after the procedure and it may be difficult to rule out perforation without radiological imaging in these patients. Other symptoms include rectal bleeding, nausea and vomiting, tachycardia, respiratory distress, chest pain and collapse. The commonest clinical signs are of peritonitis or septic shock although patients may have no signs of peritoneal irritation.

The commonest investigation undertaken is an erect chest and abdominal radiograph which shows extraluminal air in 67–88% of patients (*Figure 1*) (Gedebou et al, 1996; Farley et al, 1997; Iqbal et al, 2005). This is usually a pneumoperitoneum although pneumoretroperitoneum, pneumomediastinum and pneumocolon have all been described. However, free air may not be demonstrated in up to one third of these patients. Some patients have other diagnostic features of perforation including pericolonic collection and/or air seen on computed tomography (*Figure 2*) and colonic leakage seen on contrast enema (Farley et al, 1997).

The perforation may be identified at the time of the colonoscopy or up to 24 days after the procedure (as a result of delayed presentation) (*Figure 3*). In one series, a patient at laparotomy had evidence of a contained sigmoid perforation 6 months after colonoscopy. Up to 60% of cases of perforation are diagnosed immediately at colonoscopy, usually in patients undergoing diagnostic colonoscopy (Araghizadeh et al, 2001; Bowles et al, 2004; Misra et al, 2004). Delayed diagnosis is usually in patients who have undergone a therapeutic procedure and is caused by micro-perforations.

Sites of perforation

The commonest sites of perforations are shown in *Figure 4*. This is generally the left colon followed by the right colon and then rectum. Some have reported that the rectosigmoid was the commonest site of perforation, but this includes mainly patients with sigmoid perforation and a small proportion of patients with rectal perforation. As

Figure 1. a. Chest and (b) abdominal radiograph showing extraluminal air following a therapeutic colonoscopy.

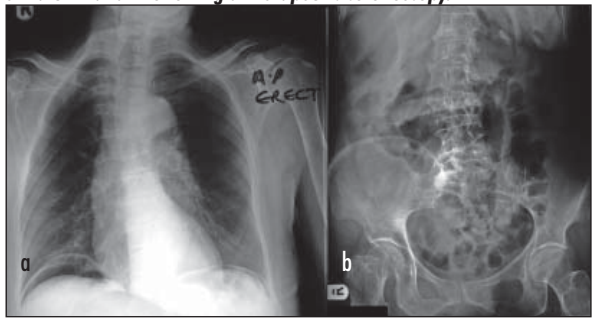


Figure 2. Computed tomography scan from the patient in* Figure 1 *at 72 hours showing persistent pericolonic air (arrowed). This patient was managed conservatively.

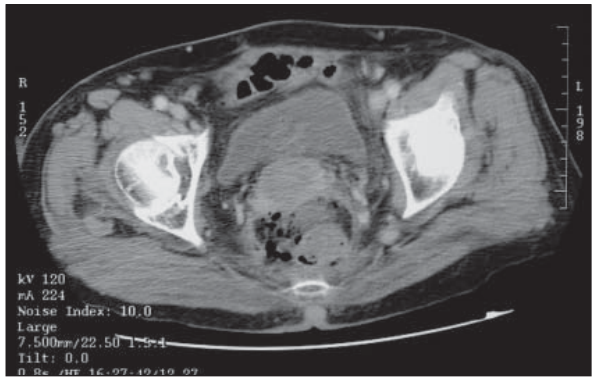


Figure 3. a. Colonoscopic view of a perforation. b. Close up of the above perforation.

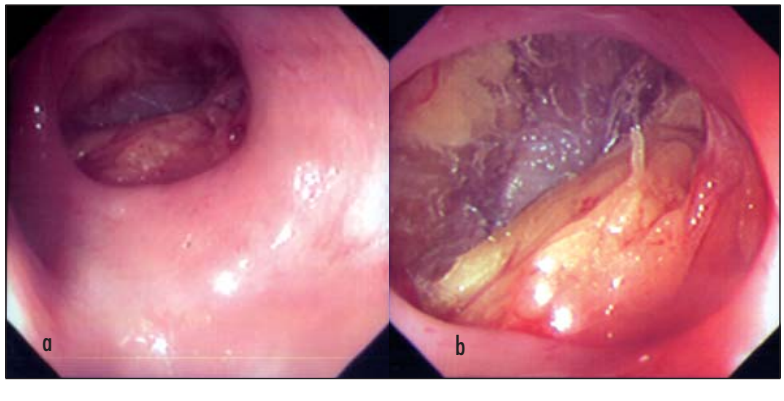
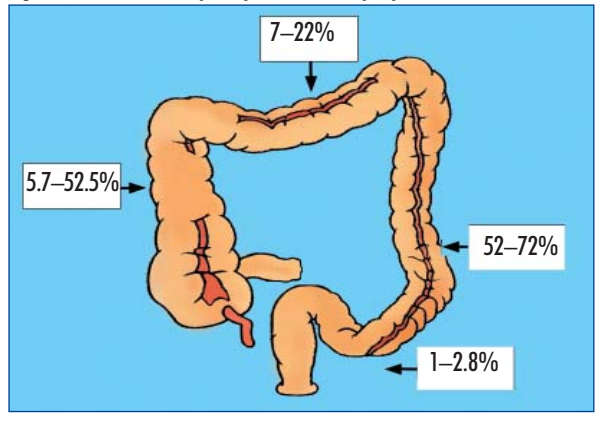


Figure 4. Sites and frequency of colonoscopic perforation.



mentioned above, the risk of caecal perforation increases after therapeutic colonoscopy, especially when hot biopsy is performed (Wadas and Sanowski, 1988; Dafnis et al, 2001). The site of perforation may not be identified in some patients. Perforation after a therapeutic procedure is usually at the site of procedure while after diagnostic colonoscopy it can be in any part of the colon.

Treatment

Conservative

Patients who exhibit minimal symptoms and signs initially should be treated conservatively but a proportion of these patients will still require surgical intervention if there is clinical deterioration. The problem with delayed surgery after failed conservative treatment may be a higher mortality rate as a result of extensive bacterial spillage.

Cases which may be treated conservatively are patients with a well-prepared colon at the time of colonoscopy, small perforations caused by transmural burns, no symptoms or signs of diffuse peritonitis, afebrile, improvement of symptoms under conservative treatment within 24 hours (although this may take up to 6 days to completely resolve), decreasing pain medication and facility for close observation of the patient with immediate surgery if no improvement or deterioration. Patients with delayed diagnosis can also be treated conservatively especially if there is no distal obstruction. The patients are treated by being given nothing orally, intravenous fluids, broad spectrum antibiotics and frequent clinical examination. Nasogastric suction may be used but may not have any additional benefit.

Table 1 summarizes the results of conservative treatment. In prospective series, 37 out of 73 (50.7%) patients were treated conservatively of which 45.9% subsequently underwent surgery. In retrospective series, 71 out of 252 (28.2%) patients with perforation were treated conservatively of which 22.5% subsequently required surgery.

It has been suggested that therapeutic colonoscopy patients are more likely to benefit and respond to conservative treatment than those who have undergone diagnostic colonoscopy. This is thought to be because diagnostic colonoscopy usually leads to larger perforation while the therapeutic perforations are smaller or may not even be found at laparotomy, i.e. mini-perforation. In three prospective studies (*Table 1*) there were complete data on both therapeutic and diagnostic perforation. These included 28 patients out of whom 21 (75%) patients had had a therapeutic procedure. Thirteen of these patients were treated conservatively of which 11 (84.6%) had had therapeutic procedure. In retrospective series, 86 patients had perforation of which 49 (56.9%) had had a therapeutic procedure. A total of 37 patients were treated conservatively of which 30 (81.8%) patients had had a therapeutic procedure. This shows that more patients were likely to be treated conservatively following therapeutic procedures. Because the number of patients treated conservatively following diagnostic perforation is small, it is difficult to draw any firm conclusion. A total of 1.4% patients died following initial conservative treatment in prospective series and 0.8% in retrospective series.

Surgery

In patients undergoing surgery, no perforation may be identified even when there is pneumoperitoneum (Brynitz et al, 1986; Donckier and Andre, 1993). Pneumoperitoneum may be the result of microscopic perforations, which are not always easy to identify. Operative findings in such patients included no intra-abdominal contamination, local soiling and diffuse faeculent soiling (Farley et al, 1993). If operative procedure is to be undertaken then early surgery is essential as peritonitis is more likely to be present in patients operated on after 5–6 hours and these patients are therefore more likely to end up with a stoma. The mean time to operation after diagnostic perforation is lower than for therapeutic procedure because it is easier to diagnose. However, 58–92.9% of perforations are identified and treated within 12–48 hours (Orsoni et al, 1997; Anderson et al, 2000; Tran et al, 2001; Cobb et al, 2004).

The size of the perforation varies between 0.1 and 7 cm. The mini-perforation closes spontaneously because

Table 1. Outcome after conservative treatment (number of patients who had a therapeutic colonoscopy in brackets)

Reference	Total no of patients	Initial conservative treatment	Conservative mortality (%)	No of patients who subsequently required surgery	Surgical mortality after failed conservative treatment (%)	Type of study
Carpio et al (1989)	14	6	16.7	1	100	Prospective
Christie and Marrazzo (1991)	7	5 (5)	0	0	0	Retrospective
Donckier and Andre (1993)	9	3	0	1	0	Retrospective
Jentschura et al (1994)	31	23	0	16	n/k	Prospective
Lo and Beaton (1994)	12	7	0	1	0	Retrospective
Seow-Choen et al (1995)	5	5 (4)	0	0	0	Prospective
Gedebou et al (1996)	18	6	n/k	3	n/k	Retrospective
Farley et al (1997)	45	3 (n/k)	0	0	0	Retrospective
Orsoni et al (1997)	48	21 (16)	4.76	8	12.5%	Retrospective
Araghizadeh et al (2001)	31	11 (9)	12.5*	3	0	Retrospective
Sieg et al (2001)	13	3 (3)	0	0	0	Prospective
Wexner et al (2001)	10	5 (4)	0	0	0	Prospective
Iqbal et al (2005)	72	10	10%	0	0	Retrospective

* patient requested no further treatment. n/k = not known

of omental adherence and thus symptoms are a result of the serosal burn rather than release of air. The degree of pneumoperitoneum does not correlate with the severity of clinical signs and is not an indication for surgery.

Surgical options are primary closure, resection and ana-stomosis, resection with end colostomy (Hartmann's procedure), exteriorization of perforation and a laparoscopic procedure as discussed later with or without a defunctioning stoma. Simple closure or a primary anastomosis is more likely to be undertaken in patients undergoing surgery within 8 hours (Jentschura et al, 1994; Cobb et al, 2004).

Table 2. Outcome following surgery for perforation

Reference	No of patients	Surgical treatment*	Overall mortality (%)	Surgical mortality (%)	Type of study
Stuart et al (1979)	6	6	16.7	16.7	Prospective
Adair and Hishon (1981)	4	3	0	0	Retrospective
Kronborg et al (1981)	4	4	0	0	Retrospective
Macrae et al (1983)	6	6	0	0	Prospective
Vincent and Smith (1983)	6	6	0	0	Retrospective
Brynitz et al (1986)	11	11	9.1	9.1	Retrospective
Reiertsen et al (1987)	6	5	0	0	Prospective
Carpio et al (1989)	14	9	21.4	21.4	Prospective
Soon et al (1990)	7	7	42.8	42.8	Retrospective
Miller et al (1991)	21	21	19	19	Retrospective
Christie and Marrazzo (1991)	7	2	0	0	Retrospective
Donckier and Andre (1993)	9	7	0	0	Retrospective
Jentschura et al (1994)	31	24	6.45	8.3	Prospective
Lo and Beaton (1994)	12	6	8.35	16.7	Retrospective
Foliente et al (1996)	5	4	75	80	Retrospective
Gedebou et al (1996)	18	12	11.1	11.1	Retrospective
Farley et al (1997)	45	42	0	0	Retrospective
Orsoni et al (1997)	48	35	10.4	10.4	Retrospective
Anderson et al (2000)	20	19	10	5.26	Retrospective
Araghizadeh et al (2001)	31	23	0	0	Retrospective
Dafnis et al (2001)	8	8	0	0	Retrospective
Sieg et al (2001)	13	9	7.7	11.1	Prospective multicentre
Tran et al (2001)	21	21		4.76	Retrospective
Wexner et al (2001)	10	5	0	0	Prospective
Gatto et al (2003)	77	N/k	N/k	5.1	Retrospective
Gondal et al (2003)	6	6	0	0	Prospective
Viiala et al (2003)	23	19	5.26	8.69	Prospective
Misra et al (2004)	10	8	10	0	Retrospective
Cobb et al (2004)	14	13	0	0	Retrospective
Iqbal et al (2005)	72	62	6.9	8	Retrospective

*includes failed conservative management. n/k = not known.

The outcome of patients undergoing surgical treatment is summarized in *Table 2*. In prospective case series, 89 out of 115 (77.4%) patients underwent surgery. The overall mortality was 8 out of 115 (6.9%) and the surgical mortality was 8 out of 89 (8.9%). In the series from Miller et al (1991), delay in surgery (12 hours to 6 days) resulted in 33.3% mortality compared to patients operated on within 4 hours where the mortality was 13.3% while Iqbal et al (2005) found their mortality was 5% in patients having early surgery compared to 14% if surgery was delayed for more than 24 hours.

Laparoscopic surgery

Wullstein et al (1999) have identified three types of perforation during laparoscopic treatment of such patients. These were type 1 (very small perforation, no thermal damage or necrosis <10 mm), type 2 (small perforation and thermal damage <25 mm) and type 3 (large perforation and large necrosis >25 mm). Laparoscopically, type 1 and 2 can be treated either by oversewing or tangential resection and suture and type 3 with segmental resection. In their series Wullstein et al converted two of their seven patients to open surgery because of a low perforation in one patient and a large perforation in the bursa omentalis in the other. Yamamoto et al (2001) have used laparoscopic repair in five patients (four with sigmoid perforation and one with caecal perforation). The size of the defect ranged from 10–50 mm. They used a passing suture to lift the defect and a linear stapler to staple across the defect. Larger defects required more than one stapler. There was no mortality in either of these series.

Conclusions

Colonoscopy is an important part of the investigation and treatment of colonic lesions, but its most feared complication is bleeding and perforation. The number of patients with these complications is likely to rise with the advent of screening colonoscopy, so it is important to understand the diagnosis and management of perforation.

The incidence of perforation is variable with the highest incidence seen during the 1970s and 80s which was during the development and refinement of colonoscopy. However, even with improvements in technology of the colonoscope, perforation remains a problem. The risk of perforation increases with the use of diathermy, in patients with previous abdominal surgery and in those with diverticulosis. It is not clear whether the number of colonoscopies performed and gender has any real impact on increasing perforation rates.

The management of these patients should initially be conservative if there is localized peritonitis. However, this can only be advocated if there are facilities for close examination of the patient and immediate surgery if there is deterioration in the patient's condition. It should be emphasized that free air is not an indication for surgery and does not reflect intra-abdominal contamination. Whether patients with diagnostic or therapeutic

perforation are more likely to need surgery is unclear. However, more patients are likely to be treated conservatively following a therapeutic than a diagnostic perforation. This is thought to be because perforations following diagnostic colonoscopy are larger and thus more likely to require surgery. A significant proportion of patients still need surgery following initial conservative treatment. Whether this has a detrimental effect on outcome is not clear from the literature because of the limited number of patients actually treated conservatively. Laparoscopic surgery has shown promising results and further work on this is needed as there have been only 12 patients on whom laparoscopic treatment has been attempted.

This review suffers from the majority of the literature being either retrospective or small series, and there is also no uniform protocol for patient management. Therefore there is a need for a large prospective database to look at the treatment of this condition. **BJHM**

Conflict of interest: none.

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KEY POINTS

- Colonoscopic perforation is uncommon with an incidence of 0.005–1.2%.
- Common risk factors are a therapeutic colonoscopy, colonoscopy in patients with diverticulosis and previous abdominal surgery.
- Typical symptoms are abdominal pain, distension and fever. Symptoms and signs may present up to 3 weeks after the procedure.
- Free air on plain radiographs only may not be present in one third of patients with perforation.
- Patients with localized symptoms may be initially treated conservatively with intravenous antibiotics and fluid but close monitoring is essential. However, 28–46% will eventually need surgery.
- Patients with therapeutic perforation are more likely to be treated conservatively.
- Laparoscopic surgery has been used in a small number of patients but has shown promising results.