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Intraperitoneal Barium From Gastrointestinal Perforations: Reassessment of the Prognosis and Long-Term Effects

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OBJECTIVE. The purpose of this study was to reassess the outcome and potential consequences of intraperitoneal barium leakage during radiologic evaluation of the gastrointestinal tract.

MATERIALS AND METHODS. This retrospective study included 18 patients who had significant intraperitoneal leakage of barium from gastrointestinal perforations that were not suspected or diagnosed before the radiologic procedures. This complication occurred during a barium enema examination in nine patients, an upper gastrointestinal study in seven, and a small bowel series in two patients. All patients underwent urgent laparotomy for repair of perforation, with vigorous peritoneal lavage and antibiotic therapy.

RESULTS. All patients had an uneventful recovery and were followed for 4–17 years (mean, 8.5 years). Radiographs obtained during this interval showed that a significant amount of residual barium was retained in the abdominal cavity. Six patients had a total of 10 subsequent abdominal operations for unrelated conditions, and some had developed barium granulomas and peritoneal adhesions. However, none of the patients in this series experienced intestinal obstruction or any clinical symptoms related to barium deposits in the abdominal cavity.

CONCLUSION. Intraperitoneal leakage of barium is a rare complication of radiologic gastrointestinal examinations, and this series of 18 cases reflects 3 decades of experience at two major medical centers. The presented data indicate that the commonly held and perpetuated concept about the high rate of morbidity and mortality of this complication would not be valid in the modern era of medical and surgical management.

Intraperitoneal leakage of barium is a rare complication of radiologic studies of the gastrointestinal tract. It can occur if an existing perforation is not suspected clinically or the resulting pneumoperitoneum is not detected before the examination. In most instances a perforation may develop in the course of diagnostic or therapeutic procedures such as a barium enema performed for the reduction of colonic intussusception, evaluation of inflammatory or neoplastic lesions of the colon, or bowel entrapment within an incarcerated hernia [1–5].

There is a widespread belief among clinicians and radiologists that intraperitoneal barium represents a dreadful complication with high morbidity and mortality. This notion is mainly a result of an article by Zheutlin and colleagues [6], published in 1952 and cited as reference in 129 subsequent papers according to a Google Scholar search. These authors reviewed 53 cases of colon perforation during barium enema studies at 35 teaching hospitals in the United States. They found that 51% of the patients died and 30% of survivors required repeated laparotomy because of bowel obstruction by barium-induced adhesions. These complications occurred in the 1940s or earlier, before the era of modern surgery and antibiotic therapy; therefore, it would be important to reassess the long-term effects of intraperitoneal barium in a more recent series of patients.

Materials and Methods

We retrospectively reviewed the radiologic and medical records of 18 patients who had a moderate to large volume of barium spillage into their peritoneal cavity during radiologic examinations of the alimentary tract. These were performed at two academic medical centers during a 30-year period (1978–2007). This series included two infants and 16 adults who ranged in age from 19 to 80 years (mean age, 58.6 years).

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TABLE 1: Summary of 18 Patients With Intraperitoneal Barium After Perforation

Patient No.	Age (y)	Sex	Examination	Cause and Site of Perforation	Time of Follow-Up (y)
1	80	M	Upper GI	Spontaneous perforation of duodenal ulcer	13
2	73	M	Upper GI	Tear of GE junction after pneumatic dilatation	4
3	68	F	Upper GI	Iatrogenic perforation into the lesser sac	5
4	63	M	Upper GI	Gastric ulcer perforation into the lesser sac	6
5	42	M	Upper GI	Dehiscence of Billroth II anastomosis	14
6	42	M	Upper GI	Disrupted sutures in gastrojejunal bypass	10
7	78	F	Upper GI	Delayed rupture of GE junction in achalasia	6
8	54	F	Small bowel	Jejunal defect, laparoscopic lysis of adhesions	5
9	19	F	Small bowel	Transmural ulceration in Crohn disease	12
10	6 mo	M	Barium enema	Reduction of ileocolic intussusception	10
11	9 mo	F	Barium enema	Colo-anal anastomosis, Hirschsprung disease	8
12	34	M	Barium enema	Pancreatitis causing splenic flexure necrosis	8
13	56	M	Barium enema	Incarcerated inguinal hernia, ischemic sigmoid	17
14	76	M	Barium enema	Perforated sigmoid diverticulitis	5
15	75	M	Barium enema	Incarcerated inguinal hernia, sigmoid tear	4
16	55	F	Barium enema	Crohn disease, anastomotic leakage	12
17	60	F	Barium enema	Ruptured colon, Crohn disease with ileostomy	6
18	64	F	Barium enema	Tear of colostomy for sigmoid diverticulitis	8

Note—M = male, GI = gastrointestinal, GE = gastroesophageal, F = female.

Six of these mishaps occurred during studies performed by the authors with expertise in gastrointestinal radiology, and the remaining 12 were performed by other faculty members or residents. None of the patients had a clinical suspicion of perforated viscus or documented pneumoperitoneum before administration of barium, including 11 patients who had a preliminary supine radiograph of the abdomen before their small bowel or colon examinations. In fact, none of the 18 patients had presented with peritoneal signs, fever, or leukocytosis to warn about the possible perforation or its impending development; otherwise, the examinations would have been performed with a water-soluble contrast material as the standard practice [2–5].

No radiographs of the chest or abdomen were routinely obtained in patients who were referred for upper gastrointestinal examination. However, the initial upright radiographic studies in cases 2, 5, and 6 showed a small amount of free air beneath the diaphragm that was not seen at the time of fluoroscopy.

The demographic and pertinent clinical data are listed in Table 1. All patients underwent urgent laparotomy for the repair of the perforation and vigorous peritoneal lavage to remove most of the extraluminal barium. Antibiotic therapy was also initiated and electrolyte levels in blood were monitored. All patients survived and had an uneventful recovery.

Results

Abdominal radiographs obtained during follow-up periods of 4–17 years (mean, 8.5 years) showed a significant amount of residual barium scattered throughout the abdominal cavity. Six of these patients had a total of 10 abdominal operations during the fol-

low-up period. These included repair of incisional hernia in three, cholecystectomy in two, partial colectomy for diverticulitis in two, and one case each of appendectomy, total hysterectomy, or ileocolic anastomosis for Crohn disease. In their reports of reoperations of cases 1 and 15, the surgeons noted the presence of barium deposits on the mesentery and peritoneal surface, as well as multiple nonobstructive interloop adhesions of the bowel. However, no patient in this series developed clinical symptoms of intestinal obstruction or manifestations of it on CT or radiographic examinations that were performed for various unrelated conditions.

The following four cases are presented to show the occurrence and long-term radiographic appearance of intraperitoneal barium leakage.

Case 1

An 80-year-old man with a 3-day history of persistent epigastric pain and provisional diagnosis of gastritis or peptic ulcer disease was referred for upper gastrointestinal examination as an outpatient. The supine abdominal radiograph was normal. The initial upright radiographs of the air-contrast study were unremarkable, but additional images obtained in a recumbent position showed a hiatal hernia with reflux and tertiary contractions of the esophagus. A small amount of aspiration caused a vigorous cough and sudden perforation of a duodenal bulb ulcer, leading to massive extraluminal leakage of barium (Figs. 1A and 1B). He was promptly transferred to the operating room. The ulcer was oversewn and gastrojejunostomy was performed after extensive peritoneal lavage for the removal of barium. His postoperative recovery was uneventful, but he required a subsequent repair of an incisional hernia.

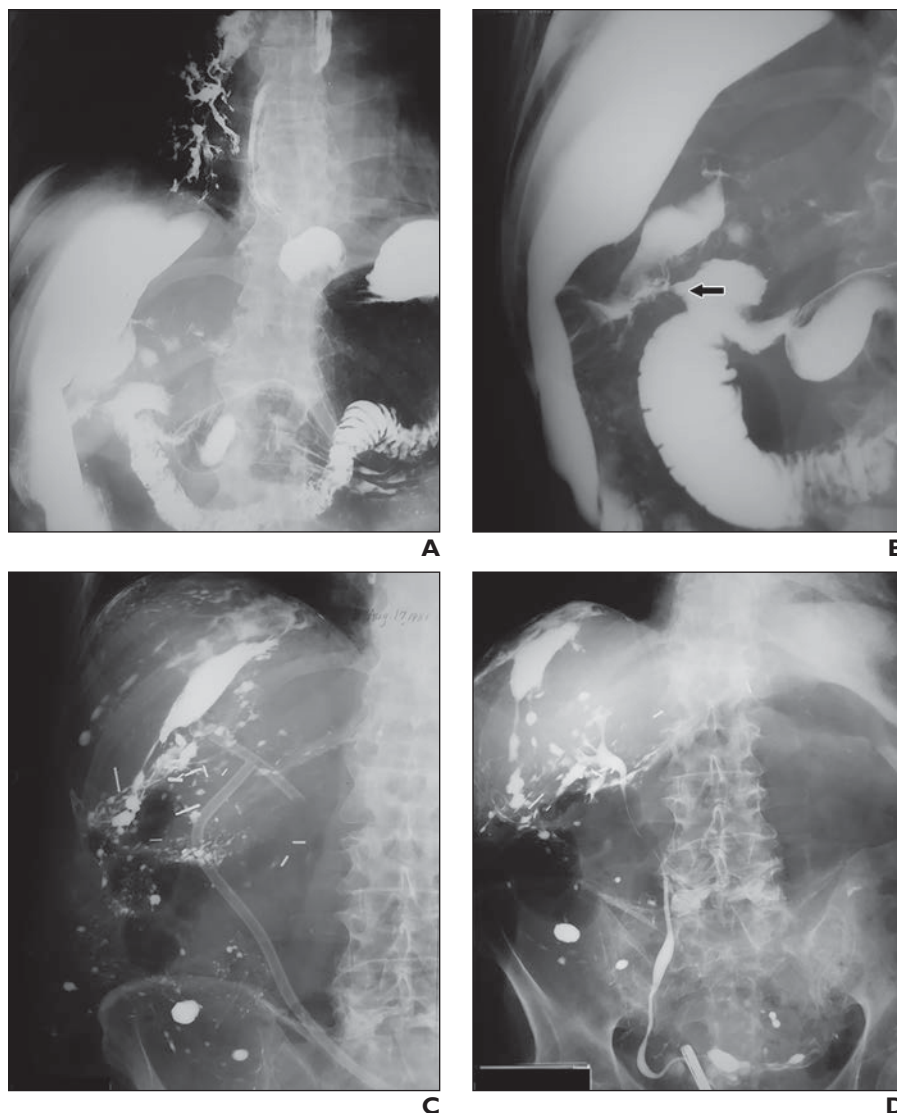


Fig. 1—Perforated duodenal ulcer in 80-year-old man.

A and B, Supine radiographs from air-contrast upper gastrointestinal examination show hiatal hernia with reflux and aspiration (**A**), which led to coughing and massive extraluminal leakage of barium from duodenal bulb ulcer (arrow, **B**). (Fig. 1B is reprinted from Ghahremani GG. Radiologic evaluation of suspected gastrointestinal perforations. *Radiol Clin North Am* 1993; 31:1219–1234, with permission from Elsevier)

C, Radiograph obtained 7 years after **A** and **B** during retrograde urography shows persistent deposits of barium in abdominal cavity. (Reprinted by permission from Springer Nature Customer Service Centre GmbH: Springer Nature Modern imaging of the alimentary tube by Ghahremani GG [Margulis AR, ed.] © 2000)

D, Radiograph after cholecystectomy 10 years after **C** shows residual barium, which remained unchanged throughout patient's 13-year follow-up.

Three years later he developed acute cholecystitis and underwent open cholecystectomy. At surgery a loop of jejunum was found adherent to the gallbladder, and barium-induced granulomas were scattered throughout the abdominal cavity.

Seven years after the initial incident he had an excretory urography because of an enlarged prostate. Radiographs of this examination showed persistent barium deposits, but no intestinal distention (Fig. 1C).

Two years later he developed obstructive jaundice as a result of a common duct stone, which was removed by endoscopic sphincterotomy and basket extraction. Abdominal radiographs at that time and 13 years after the initial incident showed the unchanged appearance of residual barium (Fig. 1D). He died at 94 years old, without experiencing any bowel obstruction or complications related to the intraperitoneal barium collections during the 13-year follow-up.

Case 7

A 78-year-old woman with a history of long-standing achalasia had been treated with several pneumatic dilatations, and the last

procedure was performed 3 weeks earlier. Evaluation with Gastrografin (diatrizoate meglumine and diatrizoate sodium solution, Bracco Diagnostics) did not show any complications.

She presented after an acute episode of nausea, vomiting, and severe epigastric pain. An upper gastrointestinal examination revealed a perforation of the gastroesophageal junction that resulted in barium leakage into the lesser sac and subhepatic region (Fig. 2A).

At surgery a 2-cm transmural tear of the distal esophagus was repaired and a chest suction tube was inserted because of a left-sided pneumothorax. It was postulated that a focal ischemia of the esophageal wall had led to its postmenses rupture.

Abdominal radiographs on postoperative days 1 and 7 showed the retained barium mainly in the lesser sac region (Figs. 2B and 2C). The same finding was visible with minimal change on the imaging studies performed in the next 6 years, but it did not cause any bowel obstruction or abdominal complaints.

Case 13

A 56-year-old man was referred for a routine barium enema as an outpatient before a scheduled hernia repair. A supine radio-

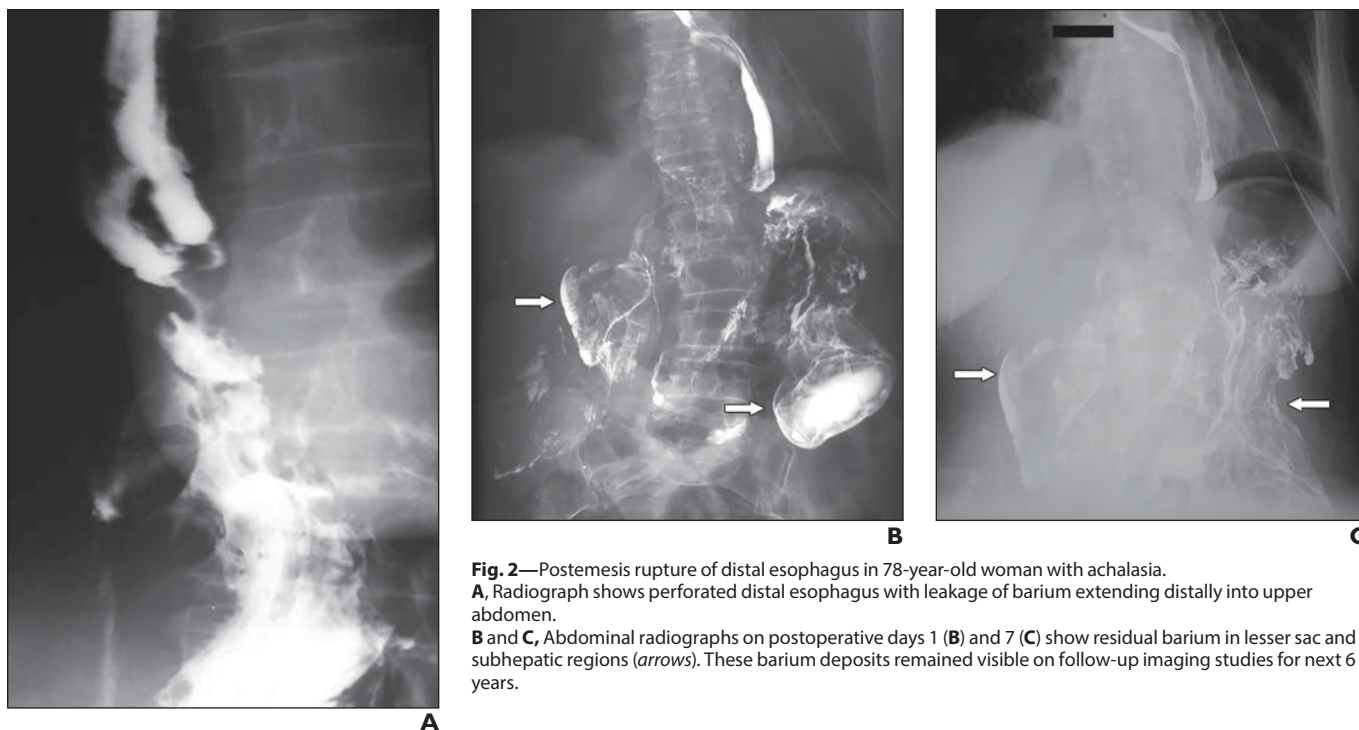


Fig. 2—Postemesis rupture of distal esophagus in 78-year-old woman with achalasia. **A**, Radiograph shows perforated distal esophagus with leakage of barium extending distally into upper abdomen. **B** and **C**, Abdominal radiographs on postoperative days 1 (**B**) and 7 (**C**) show residual barium in lesser sac and subhepatic regions (arrows). These barium deposits remained visible on follow-up imaging studies for next 6 years.

graph of the abdomen did not show any evidence for bowel obstruction or pneumoperitoneum. During the performance of the barium enema, a loop of the sigmoid colon within an incarcerated left inguinal hernia spontaneously ruptured and caused a massive intraperitoneal leakage of barium (Fig. 3A).

At laparotomy an 8-cm segment of ischemic sigmoid colon was resected and a colorectal anastomosis was performed. The operating surgeon noted that most of the barium suspension was easily removed by peritoneal irrigation, and there was no

spillage of stool because of prior cleansing of the colon. The patient's recovery was unremarkable. Radiographs of the abdomen obtained postoperatively and 4 years later showed a small amount of residual barium in the right subphrenic region and left upper abdomen (Fig. 3B). A similar finding was seen 17 years after the initial incident when he was hospitalized because of blunt chest trauma and rib fractures (Fig. 3C). However, no abdominal complications developed during his 17-year follow-up at our hospital.

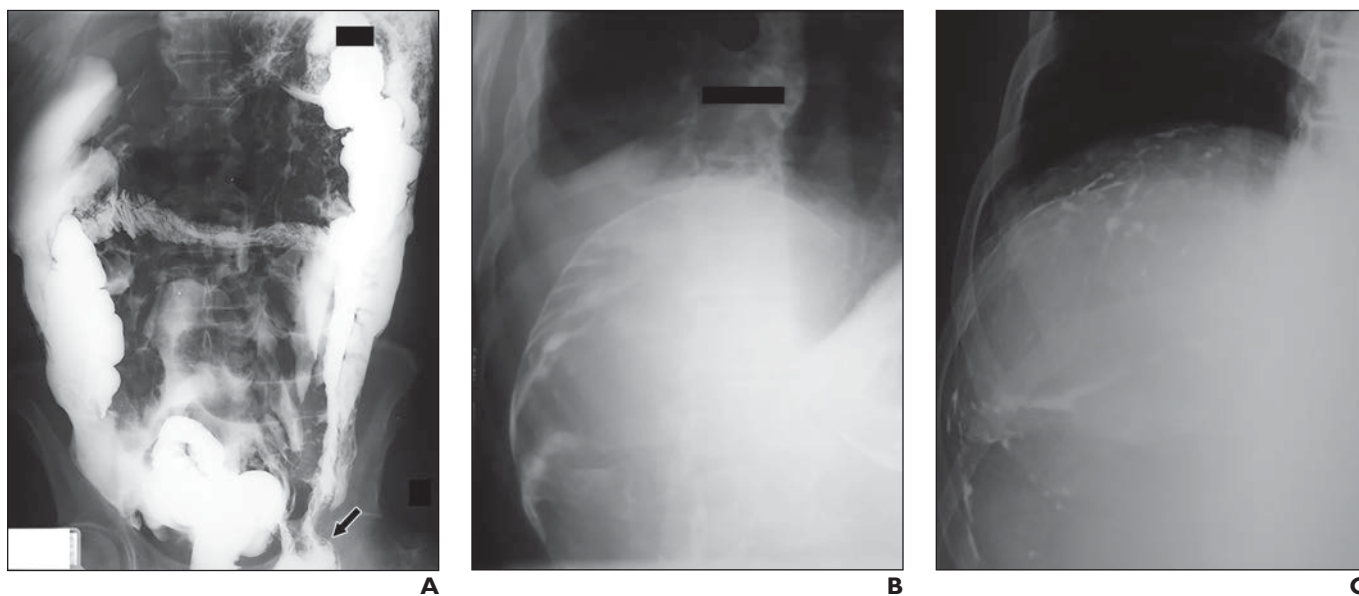


Fig. 3—Perforation of sigmoid in 56-year-old man. **A**, Radiograph after barium enema examination shows large amount of intraperitoneal barium from ruptured sigmoid (arrow) in incarcerated inguinal hernia. **B** and **C**, Radiographs of right upper abdomen show residual barium 4 (**B**) and 16 (**C**) years later.

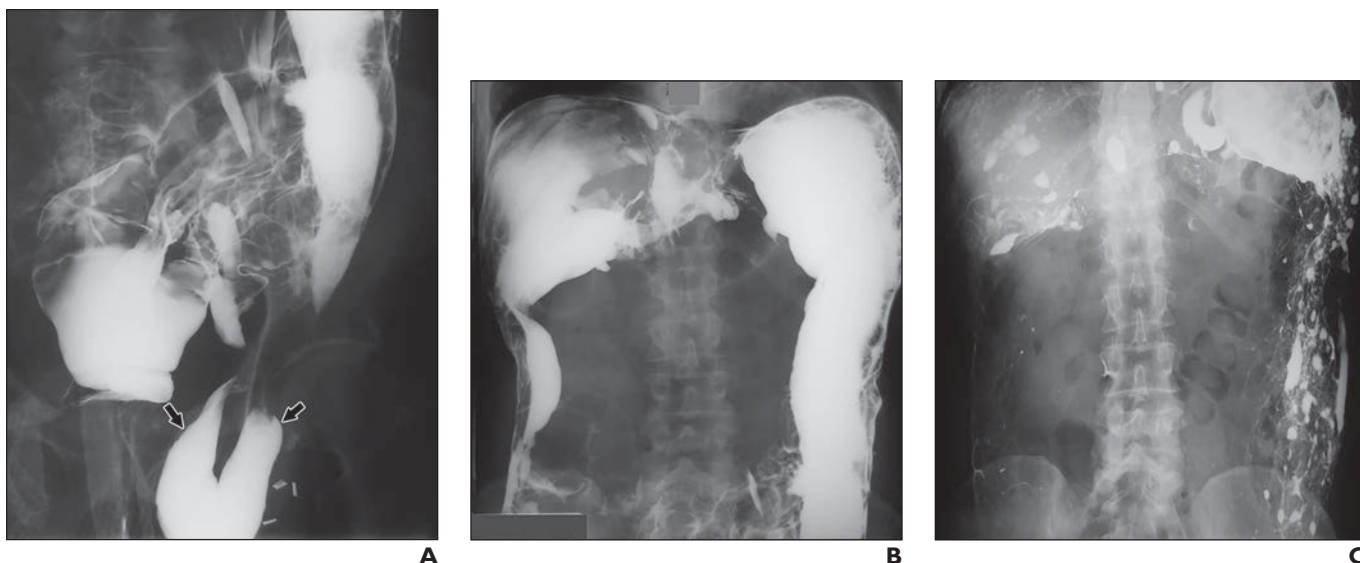


Fig. 4—Perforation of incarcerated sigmoid in 75-year-old man with recurrent inguinal hernia.

A. Radiograph from air-contrast colon examination reveals intraperitoneal leakage (arrows) from narrowed proximal sigmoid.

B. Supine radiograph of abdomen shows massive amount of barium collection in paracolic gutters and subdiaphragmatic regions.

C. Abdominal radiograph 3 years after **A** shows retained barium even after vigorous peritoneal lavage with 28 L of saline during laparotomy.

Case 15

A 75-year-old man with recurrent left inguinal hernia was referred as an outpatient for an air-contrast enema to evaluate suspected diverticular disease as the cause of intermittent left lower abdominal pain. During this examination the incarcerated sigmoid colon ruptured at its narrowed proximal part of herniation, causing rapid spillage of barium and air into the peritoneal cavity (Figs. 4A and 4B). He was promptly taken to the operating room for an urgent laparotomy. A 7-mm transmural perforation was repaired, and peritoneal lavage with 28 L of saline removed most of the high-density barium. However, the postoperative radiographs of the abdomen showed significant collections of retained barium in the paracolic gutters and subphrenic space.

During the next 2 years he underwent a suprapubic cystectomy and repair of an incisional hernia, during which the peritoneal adhesions and barium deposits were observed. He was also hospitalized in the following year for coronary bypass surgery complicated by a loculated left pleural effusion. Abdominal radiographs again showed the same residual barium beneath the diaphragm (Fig. 4C). However, the patient did not develop any abdominal pain or obstruction during the 4-year follow-up after the incident of colon perforation.

Discussion

Gastrointestinal perforations are caused by a wide spectrum of etiologic factors, and radiologic studies play an important role in determining their nature and location [3–5]. It is a common practice to use iodinated water-soluble contrast agent in cases of apparent or imminent perforation. However, barium sulfate suspension is the standard contrast material when a perforation is not suspected clinically or confirmed by the presence of pneumoperitoneum [2–5]. Abdominal radiographs may not reveal an existing pneumoperitoneum in at least 30% of cases, particularly when the extraluminal gas is trapped within the mesenteric

leaves or under the greater omentum of patients in a supine position [2, 3]. Furthermore, a perforation may actually occur during the examination and lead to the leakage of barium as we have illustrated in this article (cases 1, 3, and 4).

The term “barium peritonitis” is often used to denote this complication, but it may be a misnomer [7–9]. Barium sulfate is an inert insoluble substance, and experimental studies have shown that installation of sterile barium or stool into the abdominal cavity will not incite an inflammatory reaction [10]. However, barium sulfate does act as a foreign body that induces peritoneal adhesions and fibrotic granulomas, which were noted during reoperations in cases 1 and 15. Animal experiments have also confirmed that barium sulfate has no deleterious effect on healing of gastrointestinal wounds or colorectal biopsy sites [11, 12]. Several authors have pointed out that the combination of barium with spillage of intestinal content and fecal material loaded with bacteria accounts for the development of peritonitis in such cases [8–10].

Nine of our 18 patients had a perforation of the colon shown on barium enema examination. These may have been caused by the increased intraluminal pressure during the procedure itself or its aggravating effect on the already friable colonic wall lesions (cases 10–18). Perhaps a manual reduction of inguinal hernias immediately before barium enema in cases 13 and 15 would have prevented those perforations. In case 17, a long-standing ileostomy for Crohn disease caused colonic atrophy and its spontaneous rupture during a barium enema [2]. In case 18, the insertion of an inflated Foley catheter into the colostomy for administration of a barium enema was the likely causal or contributing factor for the perforation.

Such mishaps are reported to occur in 0.02–0.04% of all barium enema studies [3, 13, 14]. However, a higher incidence is likely if the colonic wall is weakened by an ischemic, inflammatory, or neoplastic process. Furthermore, such perforations can also oc-

cur during colon examination with Gastrografin or even the administration of cleansing enemas [15–17].

Although rectal perforation by an inserted enema tip or an overinflated retention balloon is a well-recognized complication of colon examination, we have not included such cases in this study because of the extraperitoneal location of barium leakage [2–5, 13].

Extraluminal barium was shown on upper gastrointestinal examinations of seven patients. Spontaneous perforation of a gastric or duodenal ulcer during an upper gastrointestinal study occurred in cases 1 and 4 (Fig. 1). It is postulated that the increased intraluminal pressure during an air-contrast examination may have forced open an ulcer that had been sealed by adherent neighboring structures. This complication has also been reported by others [3, 9, 18], but it is encountered rarely since the introduction of pharmacotherapy of peptic ulcer disease with proton pump inhibitors.

Six of our patients had iatrogenic causes of perforations resulting from prior pneumatic dilatation for achalasia, instrumentation, or disrupted sutures after gastrojejunal anastomosis (Table 1). In three patients (cases 2, 5, and 6), a retrospective review of the obtained radiographs revealed that small pneumoperitoneum had been present but not recognized during fluoroscopy; otherwise, the upper gastrointestinal examination would have been performed with Gastrografin. Case 7 had developed a postemesis tear of the gastroesophageal junction 3 weeks after pneumatic dilatation for achalasia (Fig. 2). This delayed complication of such an interventional technique has also been described in several case reports [19–21].

Small bowel studies of two patients revealed extraluminal barium. Case 8 had undergone laparoscopic lysis of adhesions that had caused focal cauterization damage to the jejunal wall. Case 9 had extensive transmural ulcerations of the distal ileum resulting in leakage of barium, and some of it remained visible on postoperative CT images. Because these patients were examined in a supine position, the probably associated pneumoperitoneum was not seen until the leakage of barium had confirmed the perforations.

Twelve of our 18 patients had been referred as ambulatory outpatients, and their often nonspecific clinical symptoms reflected the already known underlying disease (Table 1). Even the six hospitalized patients did not exhibit the classic signs of peritonitis with fever and leukocytosis to suggest an existing or imminent perforation. Therefore, their examinations were performed with barium suspension instead of water-soluble contrast material.

All 18 patients underwent urgent laparotomy for the repair of perforation, copious peritoneal lavage, and antibiotic therapy. They had unremarkable recoveries and no mortality during their prolonged follow-up period of 4–17 years. Several other studies also show a favorable prognosis and similar rate of survival in patients who are treated promptly [7, 8, 14, 22, 23]. Therefore, the widely held and perpetuated notion about the enormous morbidity and mortality rates of gastrointestinal perforations associated with intraperitoneal barium is no longer accurate in the modern era of surgery and medicine.

The majority of our patients retained a substantial amount of barium in their abdominal cavity even after aggressive peritoneal irrigation during the laparotomy (Figs. 1–4). Barium-induced granulomas and peritoneal adhesions were seen in patients who

had subsequent abdominal operations for unrelated conditions as noted in cases 1 and 15. According to our retrospective review of medical and radiologic records, however, none of these 18 patients developed intestinal obstruction or any other abdominal complications that may be attributed to the residual barium deposits.

Barloon and Shumway [24] reviewed 38 malpractice claims against radiologists concerning colon examinations. There were 17 cases related to colon perforation during barium enema and its consequences and another 18 cases involved missed diagnosis of colon cancer. In our series, only one patient (case 13) filed for malpractice, alleging failure to reduce the hernia before barium enema administration and failure to terminate the study soon after sigmoid perforation, thereby causing massive intraperitoneal spillage. This case was settled out of court on behalf of the hospital and radiology resident.

Because of the decreased volume of gastrointestinal barium studies during the past 3–4 decades, the new generations of residents and radiologists will have less experience in performing these examinations [25–27]. In the same period, however, there has been an increasing frequency of iatrogenic gastrointestinal perforations caused by endoscopic and interventional or surgical procedures [2–5]. We hope that this article will enhance the knowledge of radiologists about the diagnosis, management, and sequelae of gastrointestinal perforations that may be encountered in their clinical practice.

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