Computed Tomographic Analysis of Colonic Perforation: "Dirty Mass," a New Computed Tomographic Finding

Mitsuaki Saeki, M.D., Yoshikazu Hoshikawa, M.D., Osamu Miyazaki, M.D., Fumie Nakayama, M.D., Eimei Okamoto, M.D., and Tohru Ishikawa, M.D.
Department of Radiology, St. Marianna University School of Medicine, Kawasaki, Japan

The purpose of this study was to determine the potential of computed tomography (CT) for the diagnosis of colonic perforation. Abdominal CT and plain radiographic images in 29 cases of surgically proved colonic perforation were reviewed retrospectively. Three radiologists evaluated the presence of free air, the site of free air on CT, the finding of the focal collection of extraluminal fecal matter ("dirty mass"), and other CT findings. Plain radiographs depicted free air in 13 cases (44.8%); CT demonstrated free air in all cases except one (96.6%). The locations of free air on CT were as follows: peritoneal space only in 23 cases, pararenal space only in 2, both in 3, and no free air in 1. In 5 cases, pneumoperitoneum was demonstrated only in the lower abdomen. The finding of dirty mass was seen in 15 cases (51.7%). CT is particularly valuable for the diagnosis of colonic perforation.

Key Words

Abdomen, plain radiography; Colon, perforation; Colon, CT; Pneumoperitoneum

Address correspondence and reprint requests to: Mitsuaki Saeki, M.D., Department of Radiology, St. Marianna University School of Medicine, 2-16-1 Sugao, Miyamaeku, Kawasaki, 216 Japan.

1070-3004/98/**140-145**/$3.00 Volume 5, Number 3

Perforation of the colon is a life-threatening complication of the colonic diseases; it requires early recognition and treatment (1). Preoperative diagnosis is sometimes difficult because of nonspecific clinical presentation. Radiologic examination is very important for the diagnosis of intestinal perforation. Peritoneal free air is a useful sign of gastrointestinal perforation. However, previous studies revealed poor sensitivity on plain radiography for the detection of free air in patients with colonic perforation (2–4). Computed tomographic (CT) scans can define the anatomic extent of a wide variety of alimentary tract pathologies (5). CT scans also are extremely sensitive for the detection of intra-abdominal gas collections (6, 7) and have been used increasingly for the evaluation of patients with acute abdominal symptoms (8). To our knowledge, however, a large series of CT findings in colonic perforation has not yet been reported in the English language literature. We discuss the CT findings in acute colonic perforation, especially the finding of a focal collection of extraluminal fecal matter ("dirty mass").

MATERIALS AND METHODS

We reviewed the medical records of 55 patients with colonic perforation occurring between June 1982 and October 1996. Among these 55 patients, 29 patients underwent plain abdominal radiographic and CT scans within 24 hours before surgery. The patients included 13 men and 16 women ranging in age from 40 to 90 years, with an average age of 66.4 years. CT scans were obtained with an X-peed CT scanner (Toshiba, Tokyo, Japan) using a 10-mm thickness at 10-mm contiguous intervals from the level of the diaphragm to the pubic bone. Intravenous contrast medium was administered in 19 patients. Oral contrast medium was not used in any patient. Plain abdominal radiographs were obtained for all patients: in the upright position in 13 patients, in the supine position in 21, and, additionally, in the left lateral decubitus position in four. Three radiologists, who had clinical information on the patients' colonic perforation, evaluated both types of images for the following findings: (a) the presence of free air (on plain radiographs and CT scans); (b) the site of free air on CT, divided into three spaces: peritoneal space

in the upper abdomen (around the liver), peritoneal space in the lower abdomen (just behind the abdominal wall below the level of the liver), and pararenal space; (c) other CT findings (ascites, thickening of bowel wall, dilatation of bowel, dirty fat sign); and (d) the finding of dirty mass.

Definition of "dirty mass"

Feces in the large bowel can be recognized as a low-attenuation soft tissue mass containing small air bubbles on CT (Fig. 1). We recognized the evidence of the focal collection of extraluminal fecal matter in patients with colonic perforation and used the term "dirty mass" to describe this CT finding of colonic perforation (Fig. 1). In all cases showing the finding of dirty mass on CT, fecal spillage was confirmed at surgery.

RESULTS

In our series of 29 perforations, the most frequent perforation site was the sigmoid colon (13 cases, 44.8%). The rectum was the next most common site (7 cases, 24.1%). The transverse colon accounted for approximately 17.2% (5 cases). Perforation of the cecum (1 case), ascending colon (2), and descending colon (1) was rare. The cause most frequently associated with colonic perforation was spontaneous rupture, accounting for 14 of 29 perforations (48.3%). The vast majority of these occurred in the rectosigmoid colon (71.4%). Diverticulitis was the second most frequent cause of colonic perforation (7 cases), followed by ulcer (3 cases), iatrogenic injury (2), tumor (2), and volvulus (1).

Free air

Plain abdominal radiographs depicted free air in 13 of 29 cases (44.8%). The upright and/or left lateral decubitus radiographs were obtained in 15 of 29 cases. In these 15 cases, free air was demonstrated only in 5 patients (33.3%). CT demonstrated free air in all cases except one.

The locations of free air on CT were as follows: peritoneal space in 23 cases (79.3%), pararenal space in 2 (6.9%) (Fig. 2), both peritoneal and pararenal spaces in 3 (10.3%), and no free air in 1. In 18 of 26 cases (69.2%), free air was located in both the upper and lower abdomen (Fig. 3). However, in 5 cases (19.2%), free air was demonstrated in the lower abdomen only (Fig. 4). The perforation site of these cases was the sigmoid colon in 3, rectum in 1, and transverse colon in 1. CT failed to depict free air in only 1 case. This case was an ulcer of the rectum with a 3-mm perforation.

The finding of dirty mass

CT depicted the finding of dirty mass in 15 of 29 cases (51.7%). This finding was easily recognized on CT as a localized low-attenuation area containing conglomerate air bubbles in all 15 cases (Figs. 1 and 3-5). The sizes of the dirty masses were variable, ranging from 1 cm to 6 cm. The focal collection of extraluminal fecal matter was very close to the perforation site; this proximity was confirmed at the time of surgery.

Other CT findings

Ascites, bowel wall thickening, and bowel dilatation were present in 16 (55.2%), 13 (44.8%), and 5 (17.2%) patients, respectively. The dirty fat sign was present in 18 cases (62.1%). Both the dirty fat sign and the dirty mass coexisted in 11 of 29 cases (Fig. 5).

DISCUSSION

Colonic perforation causes fecal peritonitis, which is associated with a high incidence of mortality (2, 3). Therefore, early diagnosis and treatment are imperative to save the patient. The diagnosis of acute colonic perforation is sometimes difficult owing to nonspecific clinical presentation (9), especially in elderly patients (10). Therefore, colonic perforation is often overlooked clinically, and a life-threatening peritonitis develops. For early diagnosis, the detection of free air is a useful sign in patients with gastrointestinal tract perforation (7, 10). The demonstration of extraluminal air on plain radiographs of the chest and abdomen is frequently the initial clue to the diagnosis (11). Miller and Nelson (12) were able to detect as little as 1 cc of free intraperitoneal gas on conventional radiographs. However, some reports have indicated that plain radiography is limited for depicting free air in cases of colonic perforation (2, 4).

In our series, the causes of colonic perforation were spontaneous rupture, diverticulitis, ulcer, iatrogenic injury, tumor, and volvulus, which have also been reported as the

Figure 1

Figure 1. 64-year-old man with spontaneous perforation of the sigmoid colon. Feces can be clearly seen in the sigmoid colon (arrow). An abnormal low-attenuation soft tissue mass containing a conglomerate of small air bubbles (dirty mass) is also noted in the small pelvic cavity near the sigmoid colon (arrowheads).

Figure 2

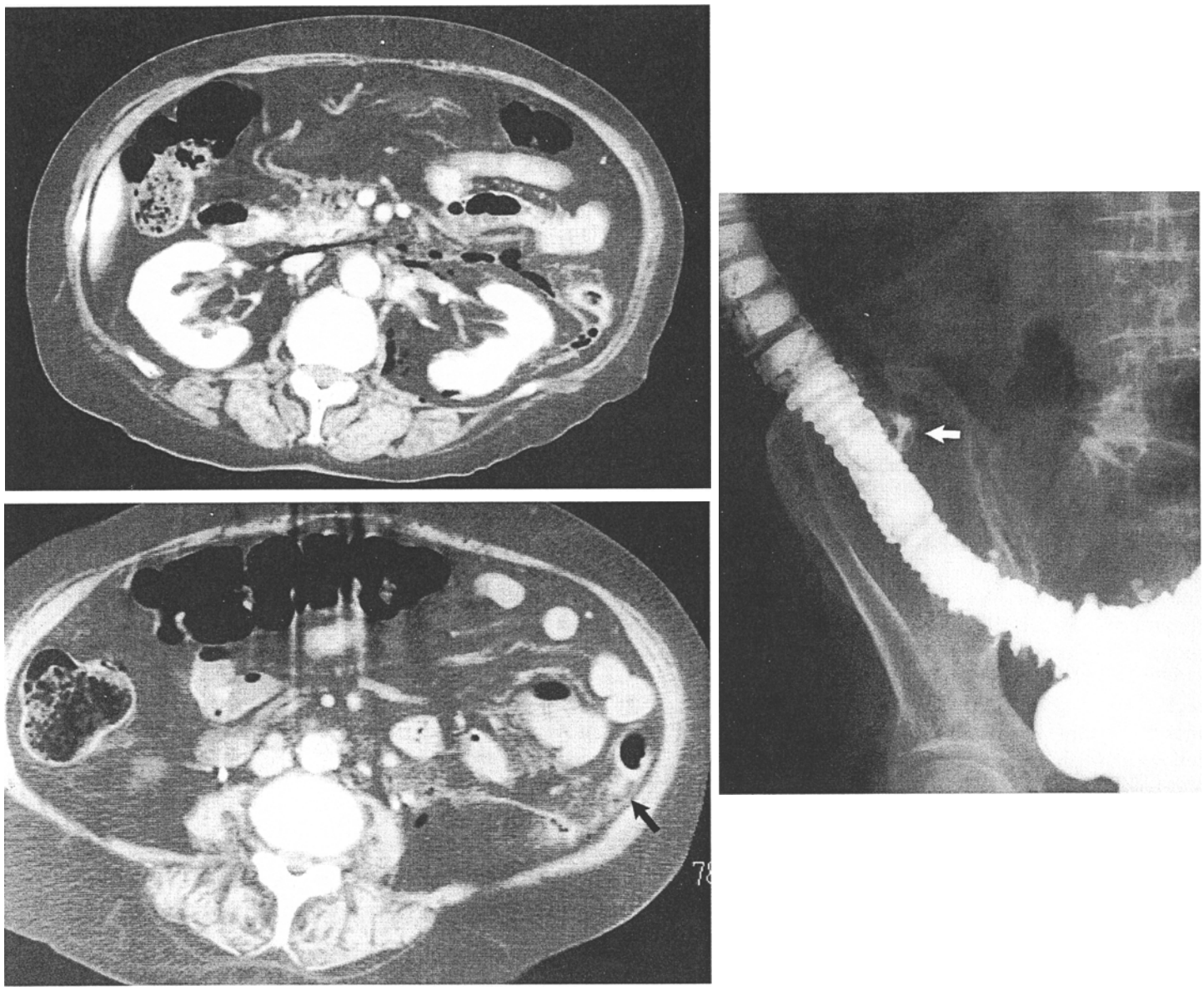

Figure 2. 78-year-old woman with perforation of diverticulum of descending colon. Top left, multiple instances of free air present in anterior and posterior pararenal spaces. **Bottom left,** lower CT image shows a small amount of retroperitoneal air and the dirty fat sign just behind the descending colon (arrow). **Right,** contrast enema obtained in the prone position shows extravasation of contrast medium from the descending colon (arrow).

most common causes of colonic perforation in other studies (2, 4). The most frequent perforation site was the rectosigmoid colon, accounting for approximately 69%.

The plain radiographs depicted free air in 44.8% of all cases. In particular, free air was demonstrated in 5 of 15 cases (33.3%) for whom plain abdominal radiographs were obtained in the upright and/or left lateral decubitus positions.

In our emergency center, CT examination is available 24 hours a day (7 days a week). Therefore, we use CT routinely for patients presenting with an abdominal emergency. The CT scan can define the anatomic extent of a wide variety of alimentary tract pathologies (5) and has excellent contrast resolution to depict the presence of small amounts of free air in the abdomen due to various intestinal perforations (13–16). Usually, free air is located anterior to edge of the liver (17). Several authors have reported that air in the extraperitoneal space, such as retroperitoneal air or mesenteric air, can be recognized on CT in patients with colonic perforation (18–20). To our knowledge, however, a large series for CT evaluation of colonic perforation has not been reported to date. In our series of 29 cases, CT demonstrated free air in all except 1 patient (96.6%). The location of free air is important to diagnose colonic perforation. In 23 of 26 cases (88.4%) showing the presence of pneumoperitoneum, free air was demonstrated in the

lower abdomen. However, sometimes CT showed only subtle amounts of free air, and detection required careful inspection of the images (20) and observation at a wide window setting (17, 21). The major cause of spontaneous pneumoperitoneum is perforation of the gastrointestinal tract. There are, however, a variety of benign causes that can present with free air (22). Other CT findings are important to support the detection and diagnosis of colonic perforation.

Lee et al. (14) described several CT signs of bowel perforation: mesenteric thickening, confined phlegmonous soft tissue mass, positive peritoneography or pneumoperitoneum, and extraluminal fluid collection. Among these, positive peritoneography and pneumoperitoneum are considered as direct signs of bowel perforation. Mirvis et al. (20) reported two other direct CT signs of bowel rupture: bowel wall discontinuity and extravasation of feces in traumatized patients. This was the first report of the identification of a focal collection of extraluminal, extravasated feces on CT. We have been taking notice of spilled feces on CT. When colonic perforation occurs, extravasation of air or intestinal contents is the first CT finding at the perforation site. We can easily recognize the feces on CT. In our experience, extravasated colonic content usually is characterized by the presence of a low-attenuation soft tissue mass containing small air bubbles. This finding was different from the usual CT features of an abscess, typically a well-circumscribed, homogeneous, low-density lesion (14). Therefore, we used the term "dirty mass." In our series, CT depicted this finding in 15 cases (51.7%). The focal collection of extraluminal fecal matter was very close to the perforation site. This finding may be the first CT clue to the diagnosis of colonic perforation; even inflammatory change is not as evident. Furthermore, we also found very tiny amounts of peritoneal free air in the lower abdomen just behind the abdominal wall. This finding would easily be missed if we did not notice the dirty mass.

Figure 3

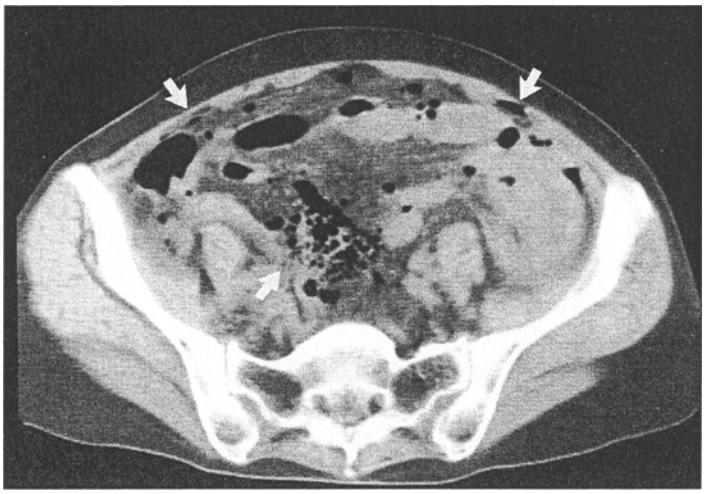

Figure 3. 63-year-old woman with spontaneous rectal perforation. CT image shows the finding of dirty mass in the center of the small pelvic cavity (arrow). Multiple areas of intraperitoneal free air can also be noted just behind the abdominal wall (arrows).

In two cases with subtle clinical findings, we performed contrast enema using water-soluble contrast medium after CT, which confirmed colonic perforation by extravasation of contrast medium. We recommend a contrast study if the finding of dirty mass or free air in the lower abdomen is the only finding on CT in patients with subtle clinical symptoms.

We also evaluated other CT findings such as ascites, bowel wall thickening, bowel dilatation, and the dirty fat sign. Ascites is commonly seen on abdominal CT in various conditions; therefore, it is a nonspecific finding for colonic perforation. Colonic bowel wall thickening is the most common finding in colonic disease, but it is not specific (23).

Figure 4

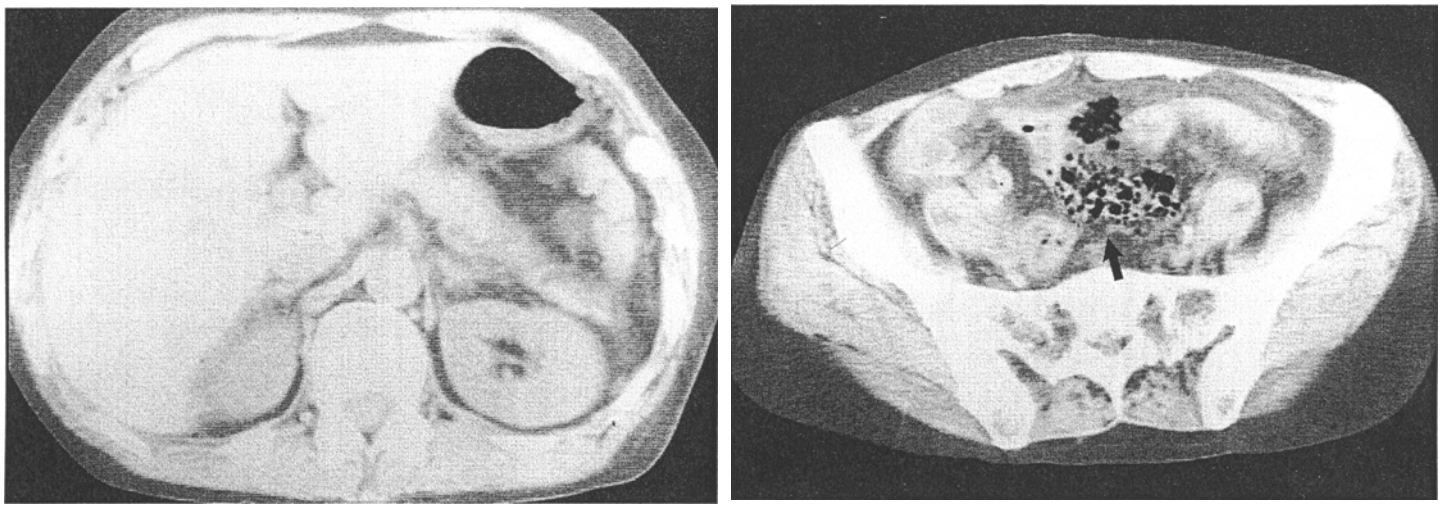

Figure 4. 50-year-old woman with perforation of diverticulum of sigmoid colon. Left, there is no free air around the liver. **Right,** lower CT image reveals typical finding of dirty mass (arrow).

Figure 5

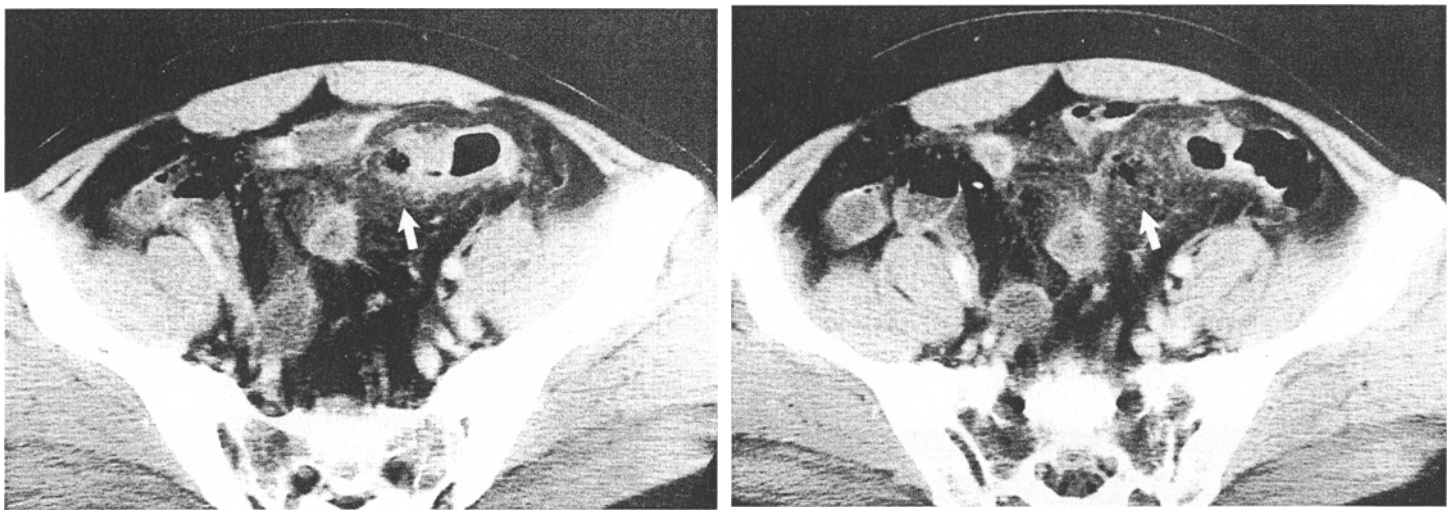

Figure 5. 50-year-old man with spontaneous perforation of sigmoid colon. Left and right, two continuous CT sections reveal the small size of the dirty mass (arrow) near the sigmoid colon. The dirty fat sign is obvious around the dirty mass.

It more often indicates the presence of colonic neoplastic or inflammatory diseases (23–26). The dirty fat sign is a well-known CT finding in many intestinal or mesenteric lesions. In our series, 18 cases (62.1%) demonstrated this sign on CT. Both the dirty fat sign and the dirty mass coexisted in 11 of 29 cases (37.9%). It is important to look for the dirty mass if the dirty fat sign is present.

CONCLUSION

For the diagnosis of colonic perforation, CT is particularly valuable because of its superior ability to demonstrate tiny amounts of free air and extraluminal abnormalities such as fecal spillage or the dirty fat sign. The dirty mass and pneumoperitoneum in the lower abdomen are specific indicators for colonic perforation. Meticulous observation with a wide window setting is important to find these subtle CT findings, especially in the early clinical course.

REFERENCES

1. McPhedran NT. Rupture of the colon in the absence of any pathological abnormality. Can J Surg 1964;7:293–5.
2. Huttunen T, Larmi TKI, Heikkinen E, Rasanen O. Free perforation of the colon. Acta Chir Scand 1974;140:535–41.
3. Lonzon AA, Duff JH. Acute perforation of the colon. Can J Surg 1976;19:48–1.
4. Wood CD. Acute perforations of the colon. Dis Colon Rectum 1977;20:126–9.
5. Kressel HY, Callen PW, Montagne JP, Korobkin M, Goldberg HI, Moss AA, et al. Computed tomographic evaluation of disorders affecting the alimentary tract. Radiology 1978;129:451–5.
6. Seltzer SE. Abnormal intraabdominal gas collections visualized on computed tomography: a clinical and experimental study. Gastrointest Radiol 1984;9:127–31.
7. Jeffrey RB, Federle MP, Wall S. Value of computed tomography in detecting occult gastrointestinal perforation. J Comput Assist Tomogr 1983;7:825–7.
8. Cho KC, Baker SR. Extraluminal air: diagnosis and significance. Radiol Clin North Am 1994;32:829–44.
9. Cope Z. Early diagnosis of the acute abdomen. London: Oxford University Press, 1972;79–94.
10. Phatak MG, Frank SJ, Ellis JJ. Computed tomography of bowel perforation. Gastrointest Radiol 1984;9:133–5.
11. Ghahremani GG. Radiologic evaluation of suspected gastrointestinal perforation. Radiol Clin North Am 1993;31:1219–34.
12. Miller RE, Nelson SW. The roentgenologic demonstration of tiny amounts of free intraperitoneal gas: experimental and clinical studies. AJR Am J Roentgenol 1971;112:574–85.
13. Glazer GM, Buy JN, Moss AA, Goldberg HI, Federle MP. CT detection of duodenal perforation. AJR Am J Roentgenol 1981;137:333–6.
14. Lee H, Vibhakar SD, Bellon EM. Gastrointestinal perforation: early diagnosis by computed tomography. J Comput Assist Tomogr 1983;7:226–9.
15. Fultz PJ, Skucas J, Weiss SL. CT in upper gastrointestinal tract perforation secondary to peptic ulcer disease. Gastrointest Radiol 1992;17:5–8.
16. Stapakis JC, Thickman D. Diagnosis of pneumoperitoneum: abdominal CT vs. upright chest film. J Comput Assist Tomogr 1992;16:713–6.
17. Bulas DI, Taylor GA, Eichelberger MR. The value of CT in detecting bowel perforation in children after blunt abdominal trauma. AJR Am J Roentgenol 1989;153:561–4.

18. Feldberg MAM, Hendriks MJ, van Waes PFGM. Role of CT in diagnosis and management of complications of diverticular disease. Gastrointest Radiol 1985;10:370-7.

19. Nguyen BD, Beckman I. Silent rectal perforation after endoscopic polypectomy: CT features. Gastrointest Radiol 1992;17:271–3.

20. Mirvis SE, Gens DR, Shanmuganathan K. Rupture of the bowel after blunt abdominal trauma: diagnosis with CT. AJR Am J Roentgenol 1992;159:1217-21.

21. Cho KC, Morehouse HT, Alterman DD, Thornhill BA. Sigmoid diverticulitis: diagnostic role of CT—comparison with barium enema studies. Radiology 1990;176:111–5.

22. Miller RE, Becker GJ, Slabaugh RD. Nonsurgical pneumoperitoneum. Gastrointest Radiol 1981;6:73–4.

23. Fisher JK. Abdominal colonic wall thickening on computed tomography. J Comput Assist Tomogr 1983;7:90–7.

24. Lieberman JM, Haaga JR. Computed tomography of diverticulitis. J Comput Assist Tomogr 1983;7:431–3.

25. Hulnick DH, Megibow AJ, Balthazar EJ, Naidich DP, Bosniak MA. Computed tomography in the evaluation of diverticulitis. Radiology 1984;152:491–5.

26. Hulnick DH, Megibow AJ, Balthazar EJ, Gordon RB, Surapenini R, Bosniak MA. Perforated colorectal neoplasms: correlation of clinical, contrast enema, and CT examinations. Radiology 1987;164:611–5.

Reviewer's Commentary

This article, similar to many others, shows the superiority of CT compared with plain radiography in demonstrating extraluminal gas. This report is notable in bringing attention to the finding of a "dirty mass," defined as a low-attenuation soft tissue mass containing small air bubbles, as pointing to the colon as the site of perforation. The illustrations provided indicate that this sign will be found (understandably) in perforations of segments of the colon usually containing fecal debris (rectum and sigmoid). The sign was noted in 51.7% of the cases analyzed (15 or 29 patients). This reflects the distribution of most of the colonic perforation in this report (13 sigmoid and 7 rectum). Segments of colon not containing fecal debris will be unlikely to demonstrate this sign and may demonstrate the "dirty fat" sign instead. Although radiologists dealing with abdominal CT in emergent situations have seen this finding, the authors should be commended for defining the sign and its importance in localizing the site of perforation.

— *Dean D. T. Maglinte, M.D.*
Department of Radiology,
Methodist Hospital of Indiana,
Indianapolis, Indiana