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Ischemic Colitis: CT Evaluation of 54 Cases[1]

PURPOSE: To review the computed tomographic (CT) scans and medical records of 54 patients with proved ischemic colitis, define the spectrum of CT findings, and assess the effect of CT imaging on treatment.

MATERIALS AND METHODS: The mean age of the patients was 72 years. CT scans were analyzed for the presence of colonic abnormalities and associated findings. Ischemia was clinically unsuspected in 16 patients (30%).

RESULTS: Segmental involvement was seen in 48 patients (89%), with a mean length of involvement of 19 cm (range, 5–38 cm). Wall thickness varied between 2 and 20 mm (mean, 8 mm). All parts of the colon were involved. The CT appearance of the colonic wall varied: (*a*) A wet appearance with heterogeneous areas of edema was seen in 33 patients (61%). (*b*) A dry appearance with mild homogeneous thickening was seen in 18 patients (33%). (*c*) Intramural air was present in three patients (6%). Ischemia resolved in 41 patients (76%), and complications occurred in 13 patients (24%).

CONCLUSION: CT can be used to confirm the clinical suspicion of ischemic colitis, to suggest ischemia when it is unsuspected, and to diagnose complications. Intrinsic colonic abnormalities cannot be used to diagnose or predict the development of infarction.

Ischemic injury of the colon is still poorly understood but has been a well-defined clinical and radiographic entity since Boley et al (1,2) and Schwartz et al (3) published their original observations. Ischemic colitis encompasses a wide spectrum of pathologic and clinical findings, ranging from a mild self-limiting form to bowel infarction and perforation.

The histopathologic manifestations of ischemic colitis are mucosal necrosis and ulcerations, submucosal edema and hemorrhage, or transmural infarction; these manifestations can be patchy, can affect the entire colon, or, more often, can have a segmental distribution (4). Although in some patients an obvious precipitating etiologic factor may be established, in other patients the ischemic process is considered spontaneous or idiopathic; that type is seen mainly in elderly patients (4–10).

The conventional findings on abdominal radiographs and barium enema studies have been well described (3,8,9,11,12). Computed tomographic (CT) evaluation, however, is still limited to a small number of cases and mainly to severe forms of bowel infarction affecting the small bowel and colon (13–19).

We undertook a retrospective review of the CT scans and medical charts of 54 patients with ischemic colitis in an attempt to better define the CT findings and to assess the effect of CT imaging in the detection of ischemic colitis and the treatment of these patients.

MATERIALS AND METHODS

This is a retrospective evaluation of 54 patients with abnormal CT findings who were proved to have ischemic colitis on the basis of clinical findings, radiologic work-up, and discharge diagnosis and who were imaged in our institution between 1988 and 1997. Among the initial 83 patients from our CT database who were identified as having ischemic colitis, 54 were included in the study. Twenty-nine patients in whom there was no confirmation by means of endoscopy, surgery, barium enema studies, or an obvious sudden precipitating factor were excluded from this series. In addition, patients with extensive

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Guarantor of integrity of entire study, E.J.B.; study concepts and design, E.J.B.; definition of intellectual content, E.J.B.; literature research, B.C.Y.; clinical studies, B.C.Y., R.B.G.; data acquisition, B.C.Y., R.B.G.; data analysis, E.J.B., B.C.Y.; statistical analysis, E.J.B., B.C.Y., R.B.G.; manuscript preparation, E.J.B., B.C.Y.; manuscript editing and review, E.J.B.
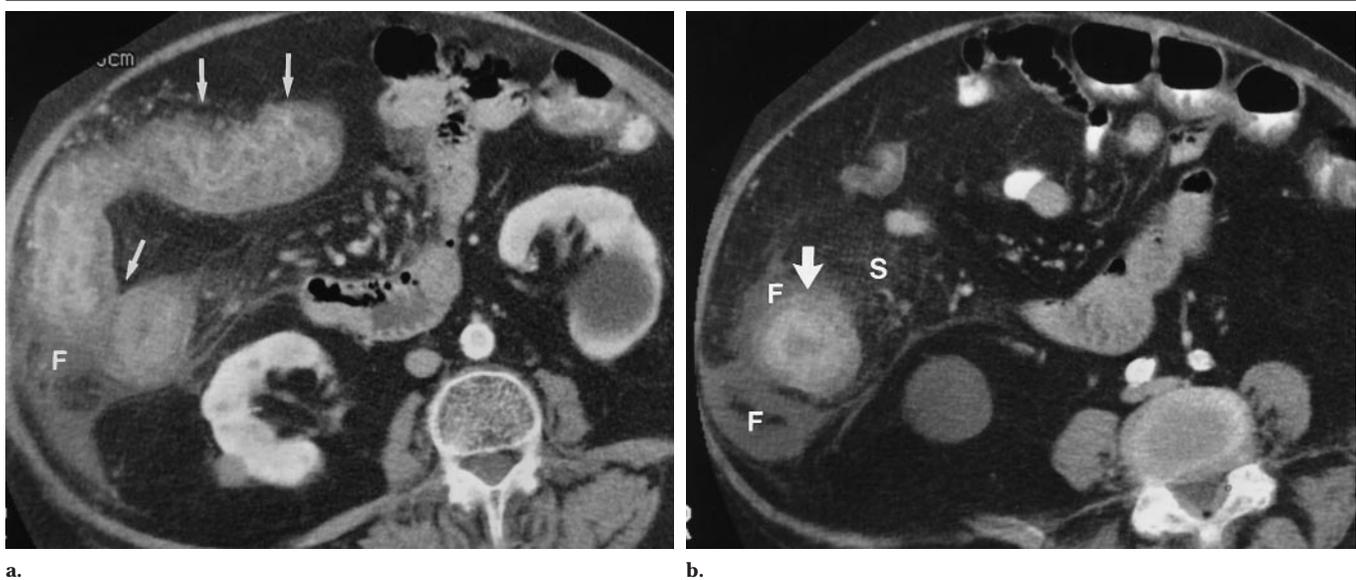
a.   b.

Figure 1.   Ischemic colitis of right colon in an 83-year-old woman with a recent history of atrial fibrillation and a hypotensive episode, who presented with right lower quadrant pain and rectal bleeding. **(a, b)** Contrast-enhanced CT scans at two different levels show segmental distribution involving the entire ascending colon and hepatic flexure (arrows in **a**, arrow in **b**). Circumferential wall thickening and heterogeneous enhancement with layers of low and high attenuation are consistent with colonic edema. Right colon has a shaggy, wet appearance with pericolic streakiness (*S* in **b**), pericolic fluid collections (*F*), and loss of haustra. Diagnosis was confirmed at colonoscopy, and ischemia resolved without complications with conservative therapy. Fluid-filled cysts are present in both kidneys.

combined small intestinal and colonic infarction were not included. Of the 54 patients in the study, there were 26 women and 28 men, with a mean age of 72 years (range, 45–99 years). Clinical charts and CT scans were reviewed.

CT scans had been requested because of the following clinical findings: sudden-onset abdominal pain in 41 patients (76%), bloody diarrhea or bright red rectal blood in 27 patients (50%), nausea and vomiting in 17 patients (31%), diarrhea in 12 patients (22%), and an elevated white blood cell (WBC) count and fever in 15 patients (28%). The results of serum amylase assays were available in 20 patients and showed an increased serum amylase level (at least three times the normal level) in four of the 20 patients (20%).

In 31 patients (57%), no definite precipitating cause was recognized, although most of these patients had arteriosclerotic cardiovascular disease on the basis of the findings from clinical evaluation, chest radiograph, or cardiac work-up or some combination of these. Their mean age was 73 years.

In the remaining 23 patients (43%), the following precipitating causes were most likely responsible for the development of ischemic colitis: hypotensive episodes associated with recent cardiac or aortic surgery or cardiac arrest (2–7 days before CT scanning), nine patients (17%); vasculi-

tis, six patients (11%) (two patients with nonspecific small-vessel vasculitis and one patient each with systemic lupus erythematosus, relapsing polychondritis, polymyalgia rheumatica, and cryoglobulinemia); distal colonic obstruction, four patients (7%) (three with carcinoma and one with fecal impaction); and miscellaneous, four patients (7%) (necrotizing pancreatitis, pancreatic carcinoma with vascular occlusion of the right colic and ileocolic arteries, and two patients with sudden-onset atrial fibrillation).

Mesenteric angiographic studies were performed in only six patients. The results of five studies were normal, and one showed severe stenosis of the inferior mesenteric artery associated with arteriosclerotic disease.

The diagnosis of ischemic colitis was suspected on the basis of the clinical presentation and CT findings. The diagnosis was confirmed in 49 patients: In 39 patients, an endoscopic procedure (sigmoidoscopy or colonoscopy) and biopsy were performed; in 12 patients, surgery was performed; and in three patients, barium enema studies were performed. Three patients underwent endoscopy and surgery, and three patients underwent barium enema examination and endoscopy. In five patients in whom a severe precipitating ischemic episode was obvious (hypotensive episode, cardiac arrest, or pancreatic carcinoma), the final diag-

nosis was based only on the typical clinical presentation, the CT findings, negative stool culture results, and the findings from the clinical follow-up examination. The duration of the clinical follow-up of the 42 patients who did not undergo surgery varied from 8 to 27 days.

On the basis of the clinical evaluation alone (review of chart and CT request), the diagnosis of ischemic bowel disease was strongly suspected in 14 patients (26%), was mentioned but considered only part of the differential diagnosis in 24 patients (44%), and was unsuspected in 16 patients (30%). CT examinations were performed within a mean of 3 days (range, 1–7 days) after the clinical onset of symptoms.

CT scanning studies were performed on model 9800 CT scanners (GE Medical Systems, Milwaukee, Wis). A nonhelical technique was used in 35 patients, with contiguous axial 10-mm-thick sections obtained over the entire abdomen and pelvis in 27 patients, or with prospectively programmed 10-mm sections obtained over the abdomen followed by 5-mm sections obtained over the pelvis in eight patients. Helical scanning (HiSpeed Advantage; GE Medical Systems) was performed over the entire abdomen in 19 patients, with 7-mm collimation and a pitch of 1.0.

All patients received oral contrast material (100–700 mL of diluted barium [Readi-
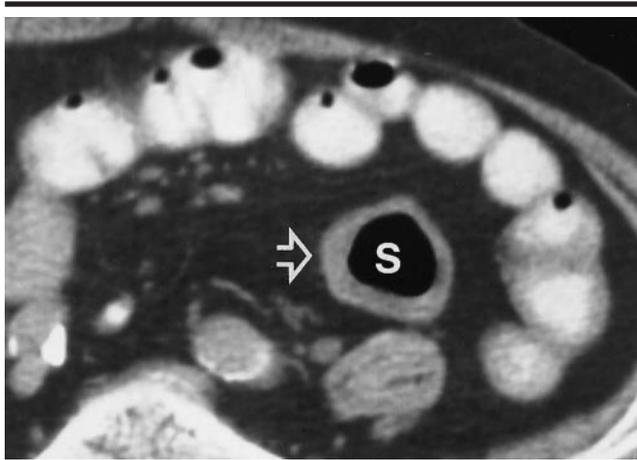
Figure 2. Ischemic colitis of left colon in a 67-year-old man with left lower quadrant pain and an elevated WBC count, who was suspected of having diverticulitis. Contrast-enhanced CT scan reveals segmental colitis involving the descending and sigmoid colon (arrow, *S*). The thickened wall of the sigmoid colon has a dry appearance with a sharply defined, homogeneously enhancing wall, without pericolic streakiness or fluid collections. Sigmoidoscopy showed hemorrhagic mucosa with patchy areas of mucosal necrosis. Surgery 18 hours later revealed full-thickness necrosis of the left colon, which necessitated resection. The rectum was normal.

Cat; E-Z-Em, Westbury, NY] or a diatrizoate meglumine-diatrizoate sodium mixture [Gastrografin; Bristol-Myers Squibb, Princeton, NJ]) 1 hour before scanning, and 150 mL of intravenous contrast material (diatrizoate meglumine [Reno-60; Bracco Diagnostics, Princeton, NJ] or iopamidol [Isovue; Bracco Diagnostics]) was given to 44 patients as a single bolus at 2 mL/sec. At the time of CT scanning, oral contrast material had reached the right colon in only 21 patients. Rectal air or rectal contrast material was not administered.

CT scans were analyzed by two gastrointestinal radiologists (E.J.B., B.C.Y.) reaching consensus agreement. The following were assessed: the location and length of the involved colonic segment; the appearance and degree of wall thickening; the presence of a double-halo or target configuration (two or three concentric rings); pericolic streakiness; peritoneal fluid or blood; presence of intramural, mesenteric, or portal venous gas; and free intraperitoneal air or other relevant abdominal findings.

The bowel wall was considered thickened if it measured more than 3 mm in diameter with the lumen partially distended. Pericolic streakiness and ascites were recorded. Right colonic involvement was defined as abnormalities affecting a segment or the entire ascending colon including the hepatic flexure. Left-sided involvement was defined as abnormalities starting at or distal to the splenic flexure.

For statistical analysis, the Wilcoxon Mann-Whitney U test and the Kolmogorov-Smirnov z test were used. Statistical significance was defined as $P < .05$.

RESULTS

Among the 54 patients, 48 (89%) exhibited a segmental involvement of the colon (Fig 1), and six patients (11%) had the entire colon involved. The length of involvement in the patients with a segmental distribution ranged from 5 to 38 cm, with a mean length of 19 cm. This measurement is an approximate measurement obtained by counting the number of sections involved in the ascending and descending colon and by measuring the length of CT abnormalities in the transverse and sigmoid colon. The thickness of the wall of the colon in the affected segments varied from 2 to 20 mm, with a mean bowel wall thickness of 8 mm.

Right-sided ischemic colitis (Fig 1) was detected in 16 patients (30%), left-sided colitis (Fig 2) in 25 patients (46%), ischemic colitis of the transverse colon and splenic flexure (Fig 3) in five patients (9%), ischemic colitis of the sigmoid colon only (Fig 4) in two patients (4%), and ischemic colitis of the entire colon (Fig 5) in six patients (11%). In the six patients with ischemic pancolitis, the diagnosis

was confirmed at colonoscopy in five patients and at total colectomy in one patient.

The gross appearance of the affected colonic wall at CT could be divided into three morphologic groups: (*a*) In the first group, wall thickening with heterogeneous enhancement and zones of low attenuation compatible with severe colonic edema (Figs 1, 3, 5) were present in 33 patients (61%); there was enhancement of the mucosa consistent with an acute process, a shaggy contour, and loss of colonic haustra, with varying degrees of pericolic streakiness (Figs 1, 3, 5). (*b*) In the second group, which consisted of 18 patients (33%), the CT appearance showed concentric and symmetric mild mural thickening and homogeneous attenuation of the wall of the colon with a sharply defined contour and without or with only minimal pericolic streakiness (Figs 2, 4). (*c*) In the third group, which consisted of three patients (6%), there was circumferential intramural air consistent with pneumatosis coli (Fig 6).

Concentric rings (the double-halo sign or the target sign) were detected in the affected colonic wall (Fig 3) in 13 patients (24%), all of whom were patients who had colons with a shaggy contour and pericolic streakiness. The double-halo sign and the target sign were detected only among the 44 patients who received intravenous contrast material.

Mild to moderate amounts of free fluid were present in the peritoneal cavity (Figs 1, 6) in 20 patients (37%) with pericolic streakiness or intramural air. The ascites was located mainly in the paracolic gutters and adjacent to the liver (Fig 1), with only a small amount of fluid in the pelvis. High-attenuation fluid consistent with blood was present in only two of the patients with ascites (4%). Two patients who had ascites had a history of pancreatic or ovarian carcinoma, which may explain the presence of intraperitoneal fluid.

Other pertinent abdominal CT findings were detected in two patients. In the portal vein of one patient, there was air associated with pneumatosis coli affecting an infarcted right colon (Fig 6). In the other patient, who had sepsis, a hepatic abscess was seen with ischemic sigmoiditis (Fig 4).

On the basis of the results of the initial CT examination, endoscopic findings, and clinical evaluation, laparotomy was performed in 12 patients (22%), and colonic resection was performed in 11 patients (20%). In one patient with right-sided ischemia, the colon, although
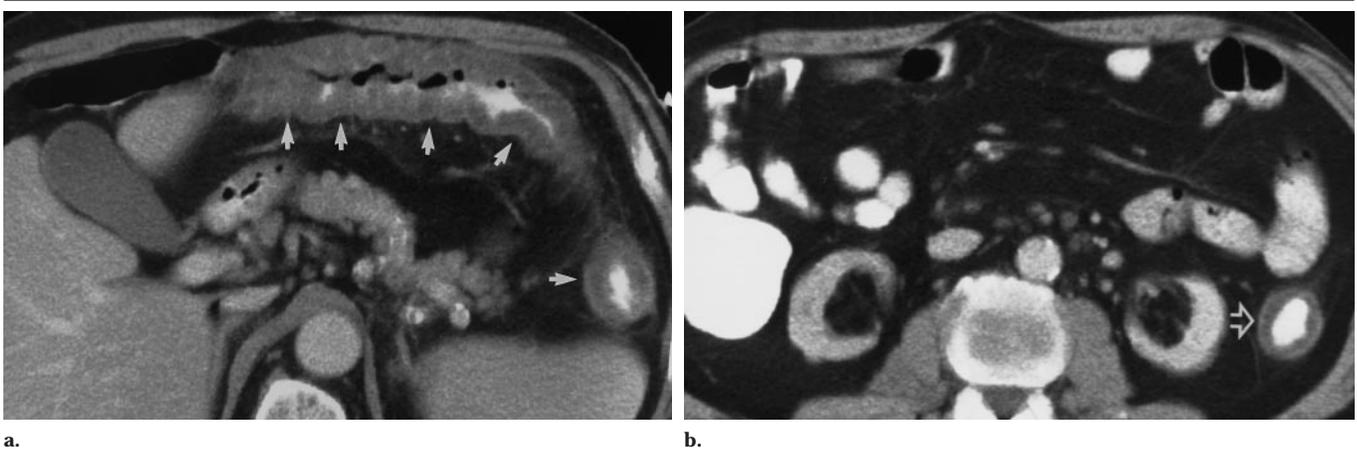
a. **b.**

Figure 3. Ischemic colitis in a 47-year-old man with vasculitis, who presented with abdominal pain and bloody diarrhea. **(a)** Contrast-enhanced CT scan reveals involvement of the distal transverse colon and splenic flexure (arrows), with marked wall thickening and pericolic streakiness. **(b)** CT scan shows proximal descending colon with concentric layers of low and high attenuation (double-halo sign) (arrow), consistent with colonic edema. Diagnosis was confirmed at colonoscopy and biopsy. The ischemic process resolved; however, the patient returned 2 months later and died of extensive bowel infarction.
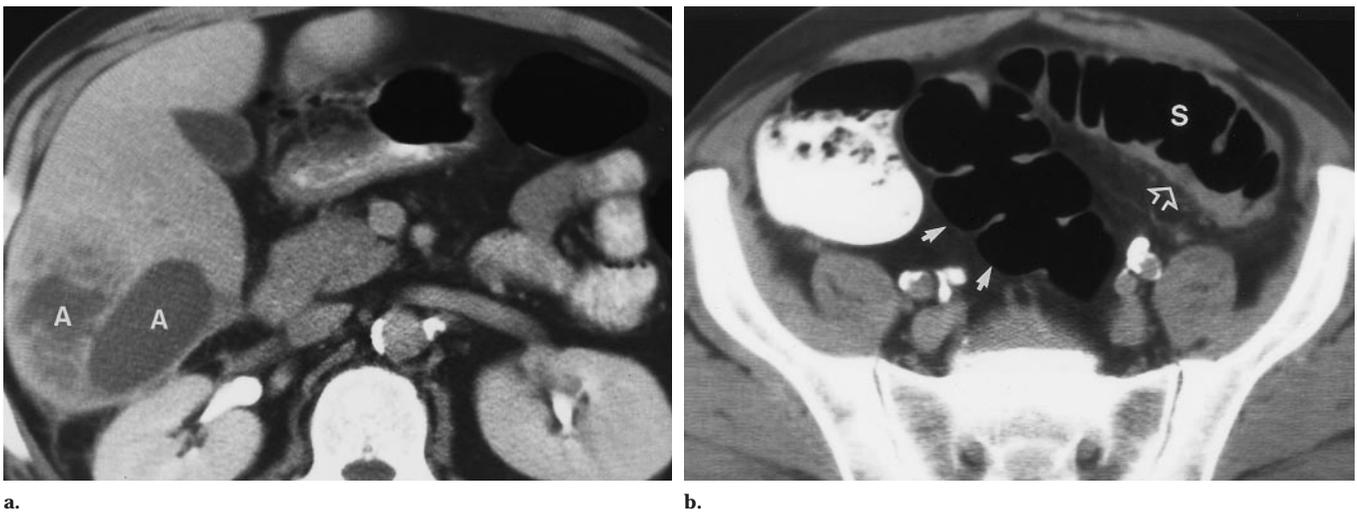

a. **b.**

Figure 4. Ischemic sigmoiditis in a 57-year-old man who presented with fever and had an elevated WBC count and guaiac-positive stools. **(a)** Contrast-enhanced CT scan reveals a multilocular abscess (*A*) in the right lobe of the liver. **(b)** CT scan shows that proximal sigmoid colon (*S*) has a circumferential thickened wall (open arrow), which contrasts with the normal-appearing distal sigmoid colon (solid arrows). Sigmoidoscopy with biopsy showed erythematous mucosa, moderate inflammation, and marked hemosiderin deposits consistent with ischemic colitis.

affected, was considered viable at gross inspection and was not resected. In one patient, surgery was performed 3 weeks after the initial episode because of the development of a stricture and a sealed-off perforation of the transverse colon (Fig 7). In three patients, segmental resection was performed for colon carcinoma associated with ischemic colitis (Fig 8). In the remaining seven patients, partial resection (six patients) or a total colectomy (one patient) was performed for acute colonic infarction.

A retrospective attempt was made to correlate the CT findings (morphologic appearance, degree of thickening, length of involvement) with the presence or development (or both) of infarction. In this group of seven patients with surgically proved infarcted colons, three had pneumatosis coli, one with air in the portal system (Fig 6). Among the 33 patients with a shaggy, wet CT appearance of the colonic wall, two developed colonic infarction. Two other patients among the 18 patients with a dry homogeneous wall thickening had infarction at the time of surgery.

The degree of thickening of the infarcted colons varied between 5 and 10 mm, with a mean of 8 mm. This compares with the range of 2–20 mm and a mean of 8 mm for the entire group of 54 patients. Similarly, the length of involvement in six patients with an infarcted segmental distribution ranged from 7 to 30 cm, with a mean of 20 cm. This compares with a range of 5–38 cm and a mean of 19 cm for the 48 patients who had a segmental distribution. The entire colon was infarcted in one patient among the six patients who had ischemic pancolitis.

Nonparametric analysis was used because the data were not normally distrib-
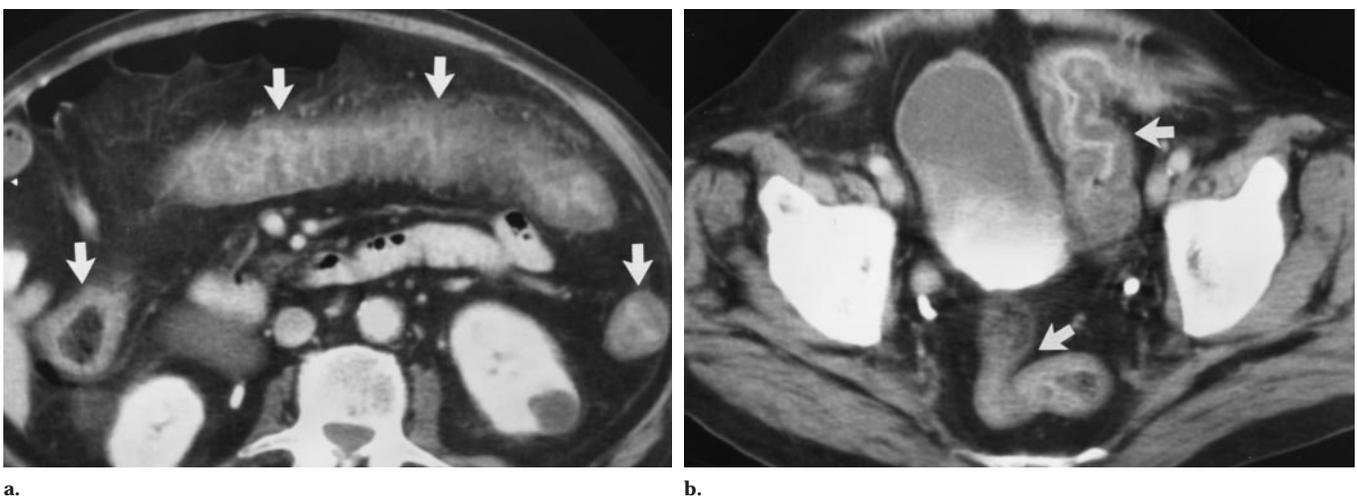
a.   b.

Figure 5. Ischemia involving the entire colon in a 77-year-old man with relapsing polychondritis, arteriosclerotic heart disease, and myocardial infarction, who had previously undergone coronary artery bypass surgery. Abdominal pain and rectal bleeding were present. **(a)** Contrast-enhanced CT scan shows heterogeneous enhancement and wall thickening of the transverse colon, as well as the right and left colon (arrows), with loss of haustral markings. **(b)** CT scan shows sigmoid colon and rectum (arrows) with alternate layers of high and low attenuation consistent with edema. Findings mimic an acute inflammatory colitis. Diagnosis was confirmed at colonoscopy. A benign cyst is present in the left kidney.
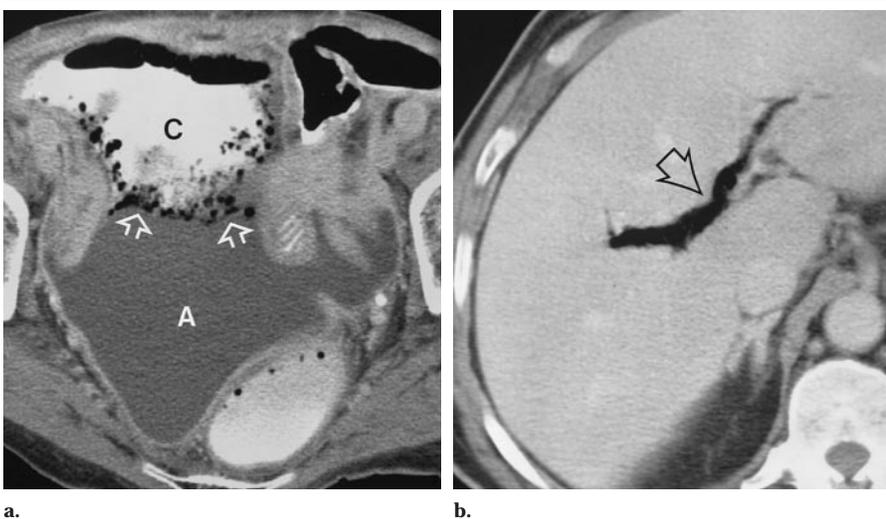

a.   b.

Figure 6. Infarcted right colon in a 72-year-old man with atrial fibrillation who presented with abdominal pain and fever and had an elevated WBC count. **(a)** Contrast-enhanced CT scan shows pneumatosis affecting the cecum (*C*) and ascending colon (arrows) and ascites (*A*) in the pelvis. **(b)** CT scan shows air in the intrahepatic branches of the portal vein (arrow). At surgery, the right colon was infarcted, and the pelvic fluid was infected.

uted. The Wilcoxon Mann-Whitney *U* test and the Kolmogorov-Smirnov *z* test failed to demonstrate a significant difference ($P > .05$) in either the degree of wall thickening or the length of involvement between the groups of patients with and without infarction. Except for the three patients with intramural air (Fig 6), there were no specific CT findings to allow differentiation of reversible ischemic changes from transmural infarction in this series.

With exclusion of the patients who had carcinoma of the colon and the patient who underwent delayed (3 weeks) resection of the stricture in the transverse colon, the time between the CT examination and surgery ranged between 6 and 18 hours (Fig 9). In the entire series of 54 patients, six patients (11%) died; the deaths of four (7%) of the patients were considered related to ischemic colitis, while the deaths of two patients (4%) were unrelated and were attributed to renal insufficiency and heart failure.

DISCUSSION

Ischemic colitis is considered a form of nonocclusive ischemic disease usually seen in older patients, without a marked sex predilection. A number of predisposing or precipitating factors, such as arteriosclerotic heart disease, hypotensive episodes, cardiac and aortic surgery, myocardial infarction, digitalis treatment, arrhythmias, vasculitis, and colonic obstruction, have been incriminated (4–6,19).

In one series (7), circulatory abnormalities were reported in 25% of the patients. In most cases, however, there is no evidence of obstruction of a major artery or vein. A decrease in blood flow to 20% of the normal flow, associated with small-vessel disease (hypoxia), and reperfusion injury when the blood flow is reestablished are the responsible factors (4,20). Consequently, any part of the colon can be involved, with no correlation established between the length and site of involvement and the distribution of the superior mesenteric or inferior mesenteric artery or vein (4,8,10).

Segments commonly affected by ischemic colitis are the junction between the distribution of the superior and inferior mesenteric arteries near the splenic flexure (Griffith point) and the anastomotic plexus between the inferior mesenteric artery distribution and the hypogastric vascular supply (point of Sudeck) at the rectosigmoid junction (21). In patients with colonic obstruction, the proximal dilatation with increased intraluminal
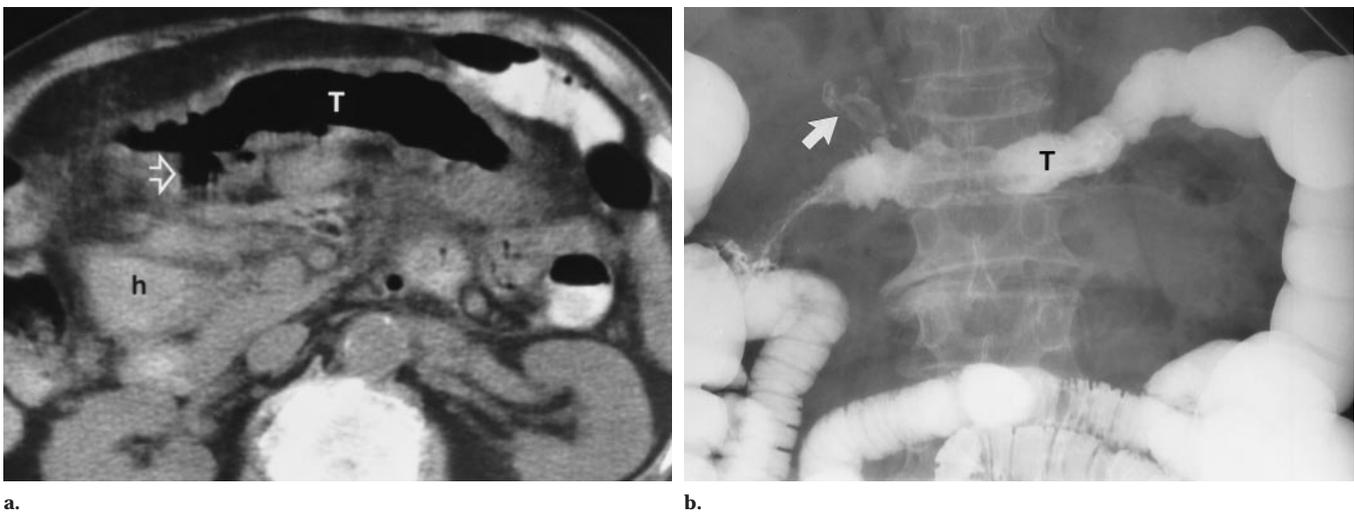
a.   **b.**

Figure 7. Ischemia of transverse colon in an 81-year-old man with arteriosclerosis, a recent syncopal episode, abdominal tenderness, fever, an elevated WBC count, and a decrease in the hematocrit. **(a)** CT scan obtained without intravenous contrast material shows high-attenuation fluid consistent with abdominal hemorrhage (*h*) that is associated with an ahaustral transverse colon (*T*) with a thickened wall. Small collection of air (arrow) was present adjacent to the proximal transverse colon. **(b)** Radiograph obtained after administration of diatrizoate meglumine (Hypaque Meglumine; Sterling Winthrop, New York, NY) enema shows narrowing of transverse colon (*T*) with small extravasation (arrow) consistent with sealed-off perforation. Findings obtained at surgery performed 3 weeks after the initial episode confirmed these findings.

pressure and reduced mucosal blood flow may be responsible for the development of anoxia (22). The ischemic process, which leads to mucosal congestion, hemorrhage and edema, patchy areas of mucosal necrosis, and ulcerations, tends to initially affect the mucosa and, only when severe and prolonged, the muscularis propria (Fig 9c). Mucosal damage is reversible, occurring as a self-limiting condition, whereas necrosis of the muscle layer can lead to the development of a fibrotic stricture (Fig 7) or to necrosis (Fig 9) with severe sepsis and perforation (4,6–8,12).

CT scans obtained during intravenous administration of a bolus of contrast material in 44 of the patients showed no evidence of embolization or thrombosis of a major mesenteric artery or vein. In 57% (31 patients) of the 54 patients, no definite precipitating cause was recognized, while a predisposing condition was probably responsible for the development of ischemia in 43% (23 patients) of the 54 patients. Documented hypotensive episodes were present in 17% (nine of 54 patients), vasculitis in 11% (six of 54 patients), and colonic obstruction in 7% (four of 54 patients) in this series.

A segmental distribution was apparent in 89% (48 patients) of the 54 patients, with the right colon affected in 30% (16 of 54 patients), transverse colon in 9% (five of 54 patients), left colon in 46% (25 of 54 patients), sigmoid colon in 4% (two of 54 patients), and the entire colon in 11% (six of 54 patients). The mean length
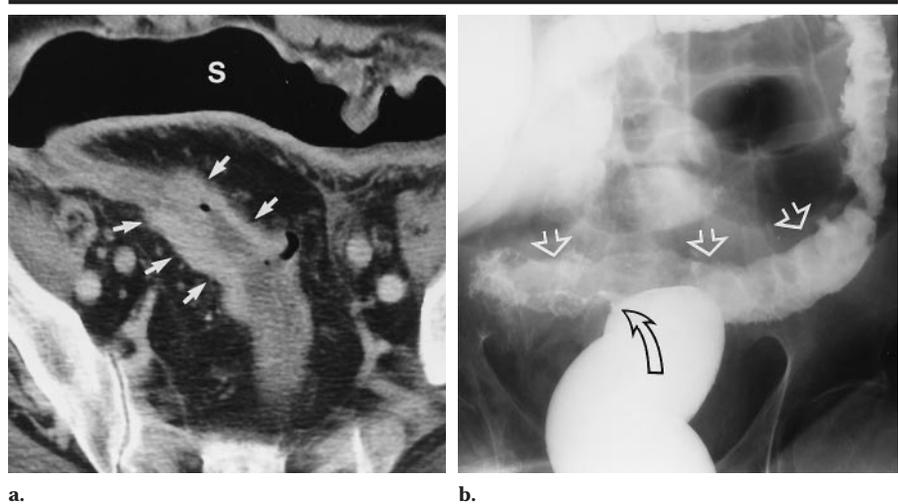

a.   **b.**

Figure 8. Ischemic colitis associated with carcinoma of the colon in a 92-year-old man who presented with abdominal pain and rectal bleeding. **(a)** Contrast-enhanced CT scan shows a circumferentially thickened wall of the proximal sigmoid colon (*S*) and a circumferential infiltrating lesion consistent with carcinoma in the distal sigmoid (arrows). **(b)** Radiograph obtained after administration of diatrizoate meglumine (Hypaque Meglumine; Sterling Winthrop) enema shows the obstructing carcinoma (curved arrow) and the associated proximal ischemic colitis (straight arrows). Findings were confirmed at surgery and histopathologic examination.

of involvement in patients with segmental involvement as detected at CT was 19 cm, and circumferential bowel wall thickness varied greatly from 2 to 20 mm, with a mean thickness of 8 mm.

The striking differences in the gross morphology of the ischemic segments as detected at CT probably relate to the timing of the examination and to the pathophysiology of the developing anoxic

process. In the initial phases of anoxia, mucosal damage occurs first; with more severe and prolonged forms of anoxia, submucosal hemorrhage, edema, and pericolic congestive and edematous changes develop later (Fig 9c).

The results of the experimental study by Boley et al (1) have shown that the pericolic fat changes and the development of thumbprinting were most severe
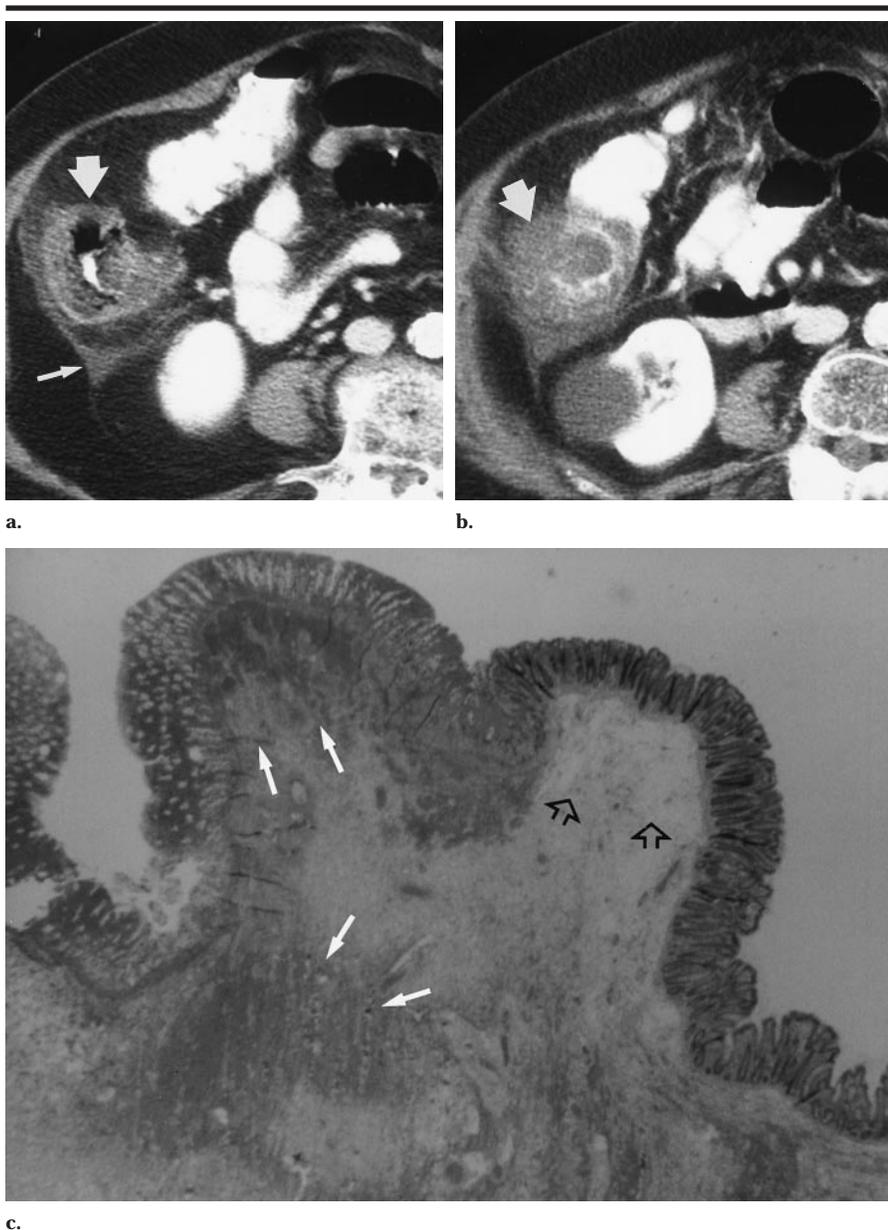
a.

b.

c.

Figure 9. Colonic infarction of mid–ascending colon in a 99-year-old woman who presented with acute right lower quadrant pain of unknown cause. **(a, b)** Contrast-enhanced CT scans obtained at adjacent levels show a segmental area of heterogeneous wall thickening of the right colon (thick arrow in **a** and **b**) with pericolic streakiness and a small pericolic fluid collection (thin arrow in **a**). A large cyst is present in the right kidney. Right colectomy performed 6 hours later revealed infarcted bowel. **(c)** Photomicrograph from histopathologic examination shows mucosal necrosis with transmural hemorrhage (solid arrows) and submucosal edema (open arrows). (Hematoxylin-eosin stain; original magnification, ×40.)

in the dogs that had obstructions of the terminal vascular branches, rather than obstructions of the more proximal mesenteric arcade. However, there were no noticeable histopathologic differences between ischemic injuries produced by arterial versus venous occlusions.

In our series, intramural bubbles of air were present in the colonic wall in three patients (Fig 6), and in one-third of the patients, there was a dry appearance with a sharply defined homogeneously enhancing wall and only mild mural thickening (Figs 2, 4). In the remaining 61% (33 patients) of the 54 patients, however, the ischemic process appeared wet or edematous, with a shaggy configuration, layers of low attenuation, and marked pericolic streakiness (Figs 1, 3, 5, 9).

No correlation was established be-

tween the degree of wall thickening, the length of involvement, or the gross CT appearance and the presence or development of colonic infarction except for the three patients with pneumatosis coli (Fig 6). Among the other four patients who had colonic infarctions, an initial wet, edematous CT appearance was present in two patients (Fig 9), and a dry appearance was present in two patients (Fig 2).

It should be emphasized that except for the presence of portal air or intraperitoneal air in symptomatic individuals, the development of complications (stricture, infarction, perforation) cannot be predicted from the findings from the initial clinical or CT examination. A period of close clinical observation, conservative therapy, and treatment with antibiotics to avoid secondary infections has been recommended (4–8).

In this series of 54 patients, on the basis of the clinical follow-up course, the ischemic process resolved in 41 patients (76%), and complications occurred in 13 patients (24%). Eleven patients (20%) had infarction; seven (13%) underwent resection and survived, and four patients (7%) did not undergo surgery and died. Two more deaths (4%) that were apparently not related to the development of colonic ischemia were recorded, for an overall mortality rate of 11% (six of 54 patients).

In addition, one patient had stricture formation and a sealed-off perforation (Fig 7), and one patient had a hepatic abscess associated with ischemic sigmoiditis (Fig 4). One of the patients whose condition initially responded to conservative treatment and who was discharged returned to the hospital 2 months later with a second episode of colonic ischemia; the patient developed transmural infarction and died (Fig 3).

Because most of the 54 patients did not undergo follow-up roentgenologic examinations (radiographs or CT scans), the number of patients that might have developed asymptomatic colonic strictures is not known. The overall 11% mortality rate in this series or the 7% mortality rate directly related to colonic ischemia is markedly lower than the 36% mortality rate reported by Wittenberg et al in 1975 (8). The discrepancy is probably related to the patient selection bias and to the close monitoring and improved surgical and postsurgical care that have occurred in the past 2 decades.

Our patient selection process and the retrospective nature of this study do not allow for an evaluation of the sensitivity or specificity of CT for the diagnosis or detection of ischemia. Substantial limita-

tions in making a specific CT diagnosis of bowel ischemia have been reported. A CT detection rate of only 26% was reported by Alpern et al (16) and 39% by Smerud et al (17). Although technical advances have improved image resolution in the past 10 years, there is little doubt that cases of colonic ischemia can be missed with CT.

One potential pitfall is the assessment of the presence and degree of bowel wall thickening in the absence of colonic cleansing or colonic distention in this group of elderly sick patients. Although slight variations (3–4 mm) in the apparent degree of colonic wall thickening can be misleading, marked thickening (>1 cm) is a reliable abnormality when encountered even in partially collapsed segments of bowel.

Furthermore, in our series, the findings seen in one segment of colon have been compared with other segments similarly distended. Additional abnormalities such as the degree of enhancement, heterogeneous attenuation, loss of haustra, and pericolic streakiness have all played a role in identifying segments of colon that were clearly abnormal.

The other major limitation of CT imaging in the diagnosis of colonic ischemia is the lack of specificity. The gross morphologic features overlap with those of inflammatory colitis, although the segmental distribution is more often seen in ischemia (23). The differential diagnosis includes a variety of specific and nonspecific inflammatory conditions, ranging from ulcerative or granulomatous colitis for the dry appearance to pseudomembranous colitis or cytomegaloviral colitis for the wet, shaggy, and edematous CT appearance (23).

In spite of these limitations, the presence of ischemic colitis can be strongly suspected when the following combination of CT and clinical findings is present. First, with regard to the CT findings, the segmental colonic involvement seen in 89% (48 patients) of the 54 patients is a finding that is unusual for infectious colitis. Either the right or left colon can be affected, and the appearance can be shaggy and edematous (33 of 54 patients [61%]) (Figs 1, 5, 9) or dry and sharply defined (18 of 54 patients [33%]) (Figs 2, 4). Intramural air, which was seen in 6% (three patients) of the 54 patients, is a helpful CT sign in the proper clinical setting and has been correlated with the presence of colonic infarction (Fig 6). Although pneumatosis coli can be seen in benign conditions (24–26) or in milder forms of colonic ischemia, its detection should be considered suggestive of bowel infarction, and its importance must be correlated with the clinical evaluation.

Second, the helpful clinical features are the sudden onset of abdominal pain, lack of sepsis, negative stool culture results, blood in the stool, and resolution of the process at clinical follow-up without specific treatment. These findings associated with segmental colonic abnormalities are seen particularly in elderly patients with documented precipitating factors (hypotensive episodes, cardiac or aortic surgery, vasculitis) and should be considered highly suggestive of colonic ischemia.

CT can be used to detect abnormalities and to suggest the diagnosis of ischemic colitis in the proper clinical setting, particularly when a segmental distribution is evident. In addition, CT is useful in the depiction of other abnormal conditions that may be seen in patients suspected of having ischemic colitis.

Initial CT abnormalities, however, cannot be used as a prognostic indicator for the presence of infarction or for the later development of infarction. Most patients with ischemic colitis will have an uneventful clinical course, with resolution of the clinical findings within a few days. In patients with nonspecific clinical findings and lack of a well-documented etiologic factor, confirmation of the CT findings by means of clinical assessment, endoscopy, barium enema examination, and close follow-up clinical assessment is recommended.

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