Review Article

Current Concepts

ACUTE DIVERTICULITIS

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THE acquired form of diverticular disease is extremely common in Western society, affecting approximately 5 to 10 percent of the population over 45 years old and almost 80 percent of those over 85.[1] It is estimated that symptomatic diverticulitis will develop in only 20 percent of patients with diverticula. The terms diverticulosis and diverticular disease usually refer simply to the presence of uninflamed diverticula. The scheme devised by Hinchey et al.[2] is a useful way to classify the varieties of inflammatory conditions encountered in patients with diverticular disease. Stage I encompasses patients with small confined pericolonic abscesses, whereas patients with stage II disease have larger collections. Stage III represents the patients with generalized suppurative peritonitis, and fecal peritonitis is categorized as stage IV. Since diverticulitis by definition means at least a microperforation in virtually all cases, confusion arises when the generic terms "complicated diverticulitis" and "perforated diverticulitis" are used. The term "perforated diverticulitis" should be reserved for cases in which a peridiverticular abscess has ruptured into the peritoneal cavity and caused a purulent peritonitis (Hinchey stage III). The less common rupture of an uninflamed and unobstructed diverticulum into the peritoneal cavity with gross fecal contamination (stage IV) should be referred to as a "free rupture" of a diverticulum and not as ruptured diverticulitis.

Up to 20 percent of patients with diverticulitis are less than 50 years old.[3] Diverticulitis is thought to be more severe in younger patients, but this may be a result of delayed diagnosis. Recent studies[4,5] indicate that up to two thirds of these younger patients will remain free of recurrence with nonoperative therapy for up to nine years. Parks[6] in 1969 reported that diverticulitis was more common in women, but more recent studies have noted a similar incidence in men and women.[7-9] The widespread success of organ transplantation, the epidemic of the acquired immunodeficiency syndrome, and the prolonged use of steroid therapy for a variety of medical conditions have produced a large population of immunocompromised persons in whom the consequences and sequelae of diverticulitis tend to be more severe, although the incidence is no greater. The initial signs and symptoms may be less pronounced,[10] medical therapy is less likely to be successful, free perforation is more frequent, and postoperative morbidity and mortality are greater.[11]

PATHOGENESIS

The cause of colonic diverticula is related primarily to two factors: increased intraluminal pressure and weakening of the bowel wall.[12] Diminished stool bulk, from insufficient dietary fiber, leads to alterations in gastrointestinal transit time and to elevated colonic pressure. Epidemiologic studies have demonstrated an association with Western diets high in refined carbohydrates and low in dietary fiber.[13] Supplementation of dietary fiber has been shown to increase stool weight, alter gastrointestinal transit time, and decrease intraluminal pressures. In addition, patients who receive fiber supplementation frequently note relief of pain, nausea, vomiting, and flatulence.[14,15]

Patients with diverticula have elevated resting colonic pressures and more frequent high-pressure waves.[16] Asymptomatic patients without overt diverticula but with features often found in diverticular disease, such as elevated intracolonic pressures, thickened, corrugated sigmoids, and luminal narrowing, are thought to be in a "prediverticular" state.[16]

Hypersegmentation and increased intracolonic pressure cause herniation of the colonic mucosa at areas of weakening adjacent to the points of penetration of the vasa recta through the bowel wall.[17] Diverticula, therefore, tend to be arranged in rows, situated between the mesenteric and lateral taeniae coli.[12] Once diverticula are present, particles of undigested food may become inspissated within them. Obstruction of the neck of a diverticulum then sets the stage for distention as a result of mucus secretion and overgrowth of normal colonic bacteria. The thin-walled diverticulum, consisting solely of mucosa, is thus highly susceptible to vascular compro-

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mise and subsequent perforation. Since many diverticula are adjacent to or within the mesocolon or appendices epiploicae, the walling off and localization of the perforation are common. Fleischner and Ming[18] emphasize that clinical diverticulitis virtually always represents a microperforation and further demonstrate that in acute diverticulitis, the colonic mucosa is grossly and microscopically normal, despite considerable inflammation of the pericolonic tissue.

The rupture of a localized peridiverticular abscess into the free peritoneal cavity (stage III) does not result in gross fecal peritonitis, presumably because the diverticular neck is obstructed by a fecalith. In the less common free perforation of the colon (stage IV), overt diverticulitis is usually absent, and an uninflamed rent in the diverticulum is the cause of this catastrophic event. In either case, perforation with either purulent or fecal peritonitis occurs more commonly in elderly and immunosuppressed populations and carries a high mortality rate.[19-21]

If nearby organs become involved or if an abscess ruptures into a nearby organ, a fistula may result. Colovesical fistulae are the most frequent and are more common in men than women, probably because of the interposition of the uterus between the sigmoid and the bladder. Colovaginal and colocutaneous fistulae are much less common.

DIAGNOSIS

Clinical Findings

The clinical diagnosis of diverticulitis is suggested in patients whose abdominal pain usually begins in the hypogastrium and then localizes to the left lower quadrant. There may be alterations in bowel habits (diarrhea occurring somewhat more frequently than constipation). Dysuria and urinary frequency and urgency may occur if the affected colonic segment lies close to the urinary bladder, and afferent visceral nerves from the inflamed colon, by way of the sacral plexus, may carry referred pain to the penis, scrotum, or suprapubic region.[22] If a colovesical fistula is present, pneumaturia, fecaluria, or recurrent urinary tract infection occurs.

On physical examination, tenderness is usually localized to the left lower quadrant. A lower abdominal or rectal mass may be present, and the possibility that this mass may represent a cancer should always be kept in mind. Trace blood in the stool may be present, but profuse lower gastrointestinal bleeding is very uncommon in the setting of acute diverticular inflammation and should lead the examiner to suspect alternative diagnoses. When generalized peritonitis is present, either rupture of a peridiverticular abscess or free rupture of an uninflamed diverticulum has occurred. Colonic obstruction, though relatively uncommon, may develop after repeated episodes of acute diverticulitis. A massively dilated (>10 cm) cecum, signs of cecal necrosis (i.e., air in the bowel wall) on abdominal radiography, or marked tenderness of the right lower quadrant in the setting of a moderately dilated cecum mandate immediate surgery. Small-bowel obstruction occurs somewhat more frequently, especially in the presence of a large peridiverticular abscess. Pylephlebitis is a rare but serious complication of diverticular disease and should be suspected in patients with diverticulitis in whom jaundice or hepatic abscesses develop.

Though 85 percent of cases of diverticulitis occur in the sigmoid and descending colon, diverticula may be found throughout the colon.[23,24] Right-sided diverticulitis occurs with greater frequency in Asians[25] and tends to follow a more benign course than that which occurs on the left. This condition is easily confused with appendicitis, since it occurs at a somewhat younger age than does left-sided diverticulitis. Sigmoid diverticulitis also may mimic acute appendicitis if a redundant colon is in the suprapubic region or right lower quadrant.

Imaging Studies

Diverticula are easily demonstrated by contrast enema, but their presence alone does not establish or negate the presence of diverticulitis. Multiple diverticula along with a segmental sigmoid narrowing or extravasation of contrast material suggest the presence of diverticulitis, although luminal narrowing and extravasation are also consistent with the diagnosis of Crohn's disease. The presence of a stricture or signs of extraluminal compression occasionally make differentiation from carcinoma difficult, but the clinical distinction between diverticulitis and nonperforating carcinoma is usually not subtle. In a retrospective study, Parks et al.[26] found not only great variability in the opinions of experienced radiologists about whether radiologic signs of inflammation were present but also a relatively poor correlation between the radiologic and subsequent pathological diagnosis of diverticulitis. Since the use of insufflation can actually dislodge an obstructing fecalith and result in a perforation, and given the limitations of diagnostic capabilities, the use of contrast studies in patients with presumed diverticulitis has been supplanted by computed tomography (CT) and ultrasonography. Sigmoidoscopy is of value in establishing the diagnosis of carcinoma or Crohn's colitis but is of limited use in ascertaining the presence of diverticulitis, since this disease is almost always extraluminal.

CT is the safest and most cost-effective diagnostic method, with additional potential for use in the treatment of abscesses.[27-34] Tomographic evidence of acute diverticulitis includes inflammation of the pericolic fat, the presence of a single diverticulum or multiple diverticula, thickening of the bowel wall to

more than 4 mm, or the finding of a peridiverticular abscess (Fig. 1).[35] Advantages of this imaging method include its relative noninvasiveness and the ability to visualize the bowel wall and pericolonic tissues (Fig. 2 and 3) as well as to exclude the possibility that other intraabdominal pathologic conditions are present. CT-guided percutaneous drainage can control systemic sepsis and eliminate or reduce the size of an abscess, allowing a single-stage resection and avoiding the more costly and complicated multistage procedure.[35]

False negative rates of 2 to 21 percent have been reported.[35,36] Several factors may contribute to the failure of CT to establish the diagnosis of diverticulitis definitively. These include the inability to exclude a diagnosis of carcinoma conclusively when there is a marked bowel-wall thickening and an insufficient sensitivity to detect small abscesses within the bowel wall or mesocolon.[37] Despite these shortcomings, CT remains the diagnostic method of choice in acute diverticulitis.

Several authors[38-40] advocate the use of ultrasonography in the diagnosis and treatment of acute diverticulitis. Positive findings include a hypoechoic, thickened colonic segment, the presence of diverticula, pain on compression of the affected region, and a zone of increased echogenicity surrounding the diseased colon.[39] This procedure is relatively inexpensive, noninvasive, and widely available and offers therapeutic options. The disadvantages are that ultrasonography is more operator-dependent than CT, abdominal tenderness may preclude the use of the requisite amount of external pressure to visualize the intraabdominal contents adequately, and the image quality is often poor in obese patients. As is true of CT, sonography fails to distinguish between inflammatory and neoplastic masses.[38]

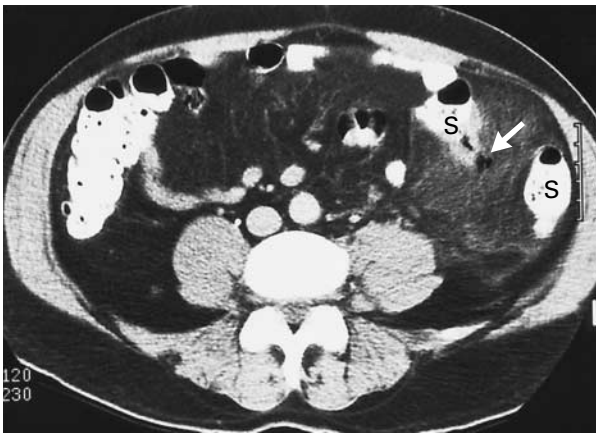


Figure 1. CT Scan of the Abdomen of a 67-Year-Old Man with Right-Sided Lower Abdominal Pain and Fever for Three Days.
The CT scan shows inflammation of the pericolic fat, manifested as increased attenuation and stranding occupying the sigmoid mesocolon between two sigmoid loops (S). Extraluminal gas (arrow) adjacent to a thick-walled diverticulum is suggestive of the site of perforation.

TREATMENT OF ACUTE DIVERTICULITIS

In patients for whom the diagnosis of diverticulitis can be made with confidence by clinical examination, it is reasonable to begin empirical treatment immediately. For a patient with a mild first attack, who is able to tolerate oral hydration, treatment may be initiated on an outpatient basis, consisting of a liquid diet and 7 to 10 days of oral broad-spectrum antimicrobial therapy, including coverage against anaerobic microorganisms (i.e., ciprofloxacin and metronidazole). Once the acute attack has resolved, the patient should be instructed to maintain a diet high in fiber,[14] and colonoscopy is advisable to exclude a diagnosis of cancer. After medical management of a first attack, about 5 percent of patients in one study had a second attack within the next two years[3]; others have noted higher rates of recurrence.[6,8]

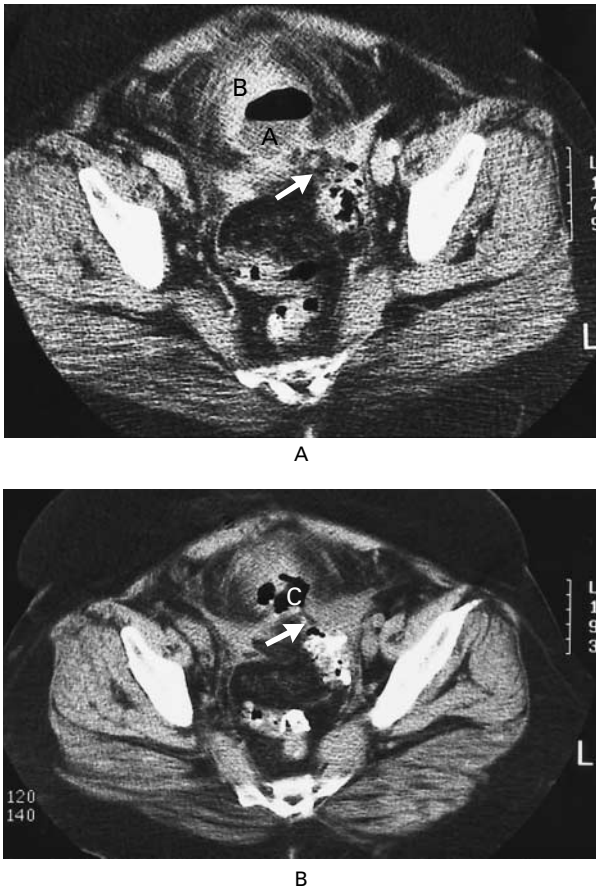
If the patient is unable to tolerate oral hydration, if pain is severe enough to require narcotic analgesia, or if the symptoms fail to improve despite adequate outpatient therapy, admission to the hospital is appropriate. Since feeding increases pressure in the colon,[16] the patient should be given nothing by mouth. Broad-spectrum antibiotic coverage is appropriate, and standard triple therapy consists of ampicillin, gentamicin, and metronidazole. Monotherapy with newer broad-spectrum antibiotics, such as piperacillin or tazobactam, has also been shown to be effective. Morphine sulfate should be avoided, since it causes colonic spasm and may accentuate hypersegmentation.[17] Meperidine is a more appropriate choice should narcotics be required. If the pain has not subsided in two to three days, if fever and leukocytosis do not resolve, or if serial physical examinations reveal new peritoneal signs, further imaging studies are appropriate.

Several recent reports[33,34,41] advocate the use of radiologically assisted percutaneous drainage as the initial therapeutic maneuver in patients with peridiverticular abscesses more than 5 cm in diameter. Smaller abscesses are not considered to require radiologic intervention, since most of these will regress with antibiotics sufficiently to allow for single-stage resection.[41] CT-guided drainage in conjunction with adequate antibiotic coverage usually leads to prompt (<72 hours) defervescence, diminution of pain, and resolution of leukocytosis,[41] and patients may remain symptom-free for as long as 29 months.[34] In patients whose abscess cavities contain gross fecal material, percutaneous drainage is unlikely to control sepsis, and early surgical intervention is essential.

Approximately 20 percent of patients with diverticulitis will require surgical treatment. Elective sig-

Figure 2. CT Scan Showing a Peridiverticular Abscess in a 74-Year-Old Man with Pelvic Pain and Fever.

The sigmoid colon in this CT scan has a thickened wall (S). A small fluid collection (arrow) indicates an intramural abscess extending to a contained extraluminal perforation and an organized inflammatory reaction posteriorly. Multiple diverticula are present.



A

B

Figure 3. Diverticulitis with Abscess in a 76-Year-Old Woman with Fever and Urinary Frequency.

Panel A shows a 5-cm abscess (A) with air–fluid level. The abscess is intimately related to the dome of the urinary bladder (B) and connected to the sigmoid colon through irregular fluid collection (arrow). Numerous diverticula are present. Panel B is a CT scan obtained six hours later, showing a smaller (4 cm) irregular cavity (C) and spontaneous drainage of the fluid, presumably through a fistula (arrow) into the sigmoid. These changes coincided with improvement of the patient's symptoms.

moid resection is usually undertaken in cases of fistula formation or recurrent episodes of diverticulitis. Some recommend that patients under the age of 35 undergo elective sigmoid resection,[42] although this recommendation has recently been challenged.[4,5] In patients who undergo operative therapy after successful medical management and in those in whom adequate control of diverticular abscesses can be obtained by means of percutaneous drainage, resection with primary anastomosis is the procedure of choice. Provided the patient's overall condition is stable, the bowel ends are healthy and nonedematous, and the proper preoperative or intraoperative bowel preparation has taken place, a single-stage procedure can be accomplished with minimal morbidity and less than 1 percent mortality.[7,8,43] In a recent retrospective case study of 227 patients who underwent surgery for diverticulitis, 88 percent had primary resection with immediate anastomosis.[43] Of this group, the patients with mild disease had no perioperative mortality and a 2 percent incidence of anastomotic leakage. The patients with pelvic abscesses or generalized peritonitis had an increased rate of complications and a mortality rate of 7.7 percent. Current trends in the surgical management of diverticular disease include the laparoscopic approach to sigmoid resection,[44-46] which has been used primarily in elective operations. Under these circumstances, laparoscopic resection can be as safe and effective as open operation and may result in faster recovery and shorter hospitalizations than the conventional laparotomy.[44-46]

The indications for emergency colonic resection include generalized peritonitis, uncontrolled sepsis, visceral perforation, and acute clinical deterioration. In addition, for those who are immunocompromised and those in whom the diagnosis of carcinoma cannot be definitively excluded, aggressive and urgent surgical management is warranted. Historically, a three-stage procedure was performed in all cases of diverticular abscess with rupture, in cases of gross fecal peritonitis, and in patients with colonic obstruction. In the initial operation, drainage and a transverse colostomy were established. In the second, the diseased segment of the colon was resected. Finally, bowel continuity was restored by colostomy closure. This series of operations proved to have unacceptably high morbidity and mortality, probably because of the number of operations and because

the diseased colon left in situ remained a source of persistent infection. By the early 1980s a two-stage procedure had become preferable for emergency indications. The diseased segment of the bowel is resected and an end colostomy is fashioned with oversewing of the distal colonic or rectal stump (Hartmann's procedure). In the second operation, colonic continuity is reestablished. Only 30 to 75 percent of the patients who undergo the first-stage resection go on to have colostomy closure,[7,9,43,47,48] probably because of either the morbidity of the additional operation or the debilitated condition of many of these patients. In addition, colostomy reversal after Hartmann's procedure tends to be technically demanding, with substantial morbidity, including a rate of anastomotic leakage of 16 percent and mortality of up to 4 percent.[43] A staged procedure is nevertheless virtually mandatory in the presence of generalized peritonitis.

In patients undergoing emergency operation for obstruction, perforation, or generalized peritonitis, inadequate colonic cleansing presents a serious problem. Intraoperative colonic lavage has recently been described as a safe and expedient method of providing bowel preparation adequate for single-stage resection and anastomosis,[49-51] but in our opinion this technique is most suitable for patients with obstruction. It remains safest, however, to carry out a two-stage procedure in the presence of peritonitis.

Unfortunately, 27 percent of patients who undergo surgical treatment will continue to have some symptoms with or without fiber supplementation.[8] Nevertheless, increasing dietary fiber intake is probably prudent in patients who have undergone sigmoid resection and in those who have recovered from acute attacks treated nonoperatively.

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