



Diverticulosis and Diverticulitis

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Abstract

Diverticular disease is a common condition that is associated with variable presentations. For this review article, we performed a review of articles in PubMed through February 1, 2016, by using the following MeSH terms: *colon diverticula*, *colonic diverticulitis*, *colonic diverticulosis*, *colonic diverticulum*, *colonic diverticula*, and *diverticula*. *Diverticula* are structural alterations within the colonic wall that classically form “pockets” referred to as *diverticula*. Diverticula form from herniation of the colonic mucosa and submucosa through defects in the circular muscle layers within the colonic wall. Often this is at the sites of penetrating blood vessels in the colon. Diverticular disease is extremely common, which resulted in 2,682,168 outpatient visits and 283,355 hospitalization discharges for diverticulitis or diverticulosis in 2009. Diverticulosis is one of the most common detected conditions found incidentally on colonoscopy. Risk factors for the development of diverticulitis include obesity, smoking, nonsteroidal anti-inflammatory drugs, corticosteroids, and opiates. In contrast, fiber may be protective, but recent studies have questioned the role of fiber in developing diverticular disease. Most patients with diverticulosis will be asymptomatic, but a subset of patients may develop nonspecific abdominal pain (isolated or recurrent), diverticulitis, or segmental colitis associated with diverticulosis. Classically, the treatment of diverticulitis has included antibiotics for all patients. More recent evidence indicates that in mild to even moderate uncomplicated diverticulitis, antibiotics may not be as necessary as initially believed. In more complicated diverticulitis, intravenous antibiotics and surgery may be necessary. Once a patient has had an attack of diverticulitis, increasing fiber may help prevent future attacks. Other modalities such as 5-aminosalicylate products, antibiotics, and probiotics are still of unclear benefit in preventing future episodes of diverticulitis. Similarly, even when patients develop recurrent episodes of diverticulitis, surgery may not be necessary as a prophylactic treatment.

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Diverticula are structural alterations within the colonic wall that classically form “pockets” referred to as *diverticula*. Diverticula form from herniation of the colonic mucosa and submucosa through defects in the circular muscle layers within the colonic wall. Often this is at the sites of penetrating blood vessels in the colon.¹ Diverticular disease is a common condition affecting many patients, with an estimated 2,682,168 outpatient clinic visits in 2009.² It was the most common gastrointestinal-related hospitalization discharge code in 2009, accounting for 219,133 persons discharged for diverticulitis and another 64,222 discharged for diverticulosis.² Likewise, diverticulosis is the most frequently detected anomaly on colonoscopy.³ The disease can be asymptomatic, with diverticulosis noted on colonoscopy, or it can present with bleeding (ie, diverticular bleeding) or inflammation (ie, diverticulitis). The overall rates of complications of bleeding are quite

low, and most cases will resolve spontaneously. In contrast, diverticulitis can be associated with infection, sepsis, and perforation. Often antibiotics are used and surgery may be warranted in certain cases. In this article, we review the current literature because it relates to asymptomatic diverticulosis and diverticulitis. For this review, we performed a review of articles in PubMed through February 1, 2016, by using the following MeSH terms: *colon diverticula*, *colonic diverticulitis*, *colonic diverticulosis*, *colonic diverticulum*, *colonic diverticula*, and *diverticula*.

EPIDEMIOLOGY

The overall prevalence of diverticulosis increases with age. Approximately 50% of individuals aged 60 years and older will have diverticulosis and by the age of 80, approximately 70% of patients will have diverticulosis.^{4,5} Western and industrialized countries (eg, United States, Europe, and Australia)

have a higher prevalence of diverticular disease than do countries such as Africa and Asia, which have prevalence rates of less than 0.5%.⁵ The theory behind this finding is the low fiber content in Western diets compared with that in Asian and African diets, which results in the formation of diverticula. Burkitt et al⁶ compared fiber in diets in the United Kingdom with that in Uganda. Patients in the United Kingdom had low fiber intake, with a transit time of 80 hours and a mean stool weight of 110 g/d. In contrast, patients in Uganda had increased fiber intake, with a transit time of only 34 hours and a higher mean stool weight of 450 g/d.⁶ Similarly, Painter et al⁷ performed motility studies in patients with diverticulosis and noted higher colonic pressures in these patients than in controls. The assumption was that longer stool transit time resulted in the development of diverticular disease from increased wall pressure. As diets change to be more Westernized, this geographic difference has become less evident.^{8,9} Nonetheless, the actual cause and effect relationship between low fiber and colonic transit time in the development of diverticular disease remains unclear.^{10,11}

There also appears to be sex-related differences in the development of diverticular disease. Using data from the National Inpatient Sample from 2000 to 2010, Wheat and Strate¹² found that hospitalization for diverticulitis is more common in white women. Most patients are in the age group of 40 to 80 years.

The location of diverticula differs geographically as well. In Western countries, most diverticular disease is in the sigmoid colon.¹³⁻¹⁵ In contrast, in Asia, right-sided diverticular disease is the predominant.¹⁶⁻¹⁸ The cause for this geographic variability is unclear. Previous theories about left-sided diverticula being acquired and right-sided diverticula being more congenital have not been substantiated in studies. In addition, despite the Westernization of diets, this difference in geographic location of diverticula remains.¹⁶

The risk of being hospitalized for diverticulitis is 3 times higher than that associated with diverticular bleeding.¹² Historically, individuals with diverticulosis have been counseled that 15% to 25% will develop diverticulitis in their lifetime; however, this is not based on population studies and is likely

ARTICLE HIGHLIGHTS

- Diverticular disease is a common condition that is found in approximately 50% of individuals older than 60 years.
- Diverticular disease is increasingly common in younger patients who often present with a more virulent form and develop more substantial complications.
- Risk factors for diverticulitis include obesity, smoking, and medications (eg, nonsteroidal anti-inflammatory drugs, corticosteroids, and opiates).
- Routine use of antibiotics may not be necessary in cases of mild diverticulitis.
- The optimal timing and need for surgery is unclear and is no longer considered necessary after 2 episodes of diverticulitis.
- The role of fiber in preventing formation of diverticulitis and preventing further complications of diverticulitis is unclear.
- Diverticular disease can be associated with more chronic forms of abdominal pain and inflammation even after the acute episode.

an overestimate of the true risk.¹⁹ More recent studies¹⁹⁻²² speculate that the true risk is less than 5%, with 1 study indicating that it may be as low as 1% over an 11-year follow-up period. Diverticulitis is more common in patients aged 18 to 80 years than is diverticular bleeding, and it is more prevalent in women than in men (98.6 per 100,000 persons vs 76.3 per 100,000 persons).¹² However, among patients younger than 50 years, diverticulitis occurs more often in men than in women. Using the data from the National Inpatient Sample, whites were found to have the highest prevalence rate of diverticulitis (61.8±9.0 per 100,000 persons).¹² The overall prevalence of hospitalization increased from 74.1 per 100,000 persons in 2000 to 91.9 per 100,000 persons in 2010.¹² This increase is noted in the age group of 17 to 70 years.¹²

PATHOPHYSIOLOGY

Currently, the exact pathological mechanisms by which diverticula occur in the colon are unknown. There are multiple theories including those related to genetics, diet, motility, microbiome, and inflammation.

One of the leading theories is the development of diverticula from increased pressure in areas of weakened walls. With age, there is

degeneration of the mucosal wall as well as increase in the colonic pressure that bulges in areas of insertion of the vasa recta that results in the development of diverticulosis.¹⁹ Older theories about the development of diverticulitis stressed food and/or stool lodging in diverticula, which then caused trauma, ischemia, necrosis, and focal perforation. More recent theories have called this into question and instead focus on changes in the microbiome, inflammation, motility, and genetics.¹⁹

Genetics

Genetics play a significant role in the development of diverticular disease. A Swedish Twin Registry comprising 104,452 twins noted diverticular disease in 2296 twins.²³ The odd ratios for developing diverticular disease was 7.15 (95% CI, 4.82-10.61) when 1 twin was affected and 3.20 (95% CI, 2.21-4.63) for dizygotic twins. The heritability effect is estimated to be 40% and the nonshared environmental effect as 60%.²³ Specific genes, such as the *TNFSF15* SNP rs7848647, have also been implicated in the development of diverticulitis and complications of the disease.²⁴

Motility

The motility theory hinges on the neural degradation that occurs with age in the myenteric plexus and in the myenteric glial cells and interstitial cells of cajal.^{25,26} The loss of neurons results in uncoordinated contractions, and subsequent increased pressure may result in the development of diverticular disease.

Microbiome

Recently, the changes in the microbiome have been implicated in the development of diverticulitis. Long-standing stasis of feces may result in a chronic microbiome dysbiosis, which may then result in a chronic inflammatory state.¹⁹ When comparing patients with diverticulitis with patients without diverticulitis, there was an increase in the Firmicutes/Bacteroidetes ratios as well as overall levels of Proteobacteria.²⁷

Inflammation

Inflammation is associated with both symptomatic diverticular disease and complications of diverticular disease. In diverticular disease, there is an increase in microscopic inflammation from chronic lymphocytic infiltration

and active neutrophilic infiltrate as well as an enhanced expression of tumor necrosis factor α .²⁸⁻³⁰ Interestingly, ongoing histological inflammation is associated with an increased risk of recurrent diverticulitis.³¹ A more recently subclassified disorder of diverticulitis is segmental colitis associated with diverticulosis (SCAD), which is associated with the macroscopic finding of chronic inflammation in diverticula on colonoscopy.^{32,33}

TERMINOLOGY

There are many different terms used to describe diverticulosis and its complications.^{19,34,35}

Diverticulosis: Presence of diverticula.

Diverticular disease: Clinically significant and symptomatic diverticulosis.

Acute diverticulitis: Active inflammation in diverticula. This can be isolated or recurrent as well as uncomplicated or complicated.

Asymptomatic uncomplicated diverticular disease: This refers to the presence of diverticulosis without any symptoms or complications of the disease. Most often this is noted incidentally on colonoscopy or on radiological imaging.

Symptomatic uncomplicated diverticular disease (SUDD): Symptoms attributed to diverticulosis in the absence of any visible inflammation or diverticulitis. This refers to episodes of abdominal pain without evidence of inflammation. Classically, the pain will come and go but can also be constant in nature. Symptoms may be relieved with flatus or bowel movements. Associated symptoms include abdominal pain, bloating, constipation, and diarrhea. Importantly, this condition does not include a history of acute diverticulitis.

Recurrent symptomatic uncomplicated diverticular disease: This refers to the above-mentioned symptoms of SUDD occurring multiple times during the year.

Segmental colitis associated with diverticulosis (SCAD): A chronic form of diverticulitis that can mimic inflammatory bowel disease (IBD) and has evidence of macroscopic inflammation in diverticula on colonoscopy. Symptoms are

often similar to IBD and include abdominal pain, diarrhea, and bleeding.

RISK FACTORS

Classically, a diet low in fiber has been viewed as a risk factor for the development of diverticular disease. Dietary fiber intake has been shown to be inversely associated with the risk of developing diverticular disease (relative risk [RR], 0.58; 95% CI, 0.41-0.83; $P=.01$).³⁶ However, more recently, a large cross-sectional study³⁷ of dietary risk factors for the development of diverticulosis failed to identify low fiber diets as a risk factor for diverticulosis. The study followed 2014 patients who underwent screening colonoscopy and then had a telephone interview about food frequency, bowel frequency, and physical activity. This study³⁷ found that dose-dependent higher fiber diets were actually associated with a higher prevalence of diverticulosis.

Although fiber does not appear to prevent the formation of diverticulosis, it may have a role in preventing diverticular disease. Crowe et al³⁸ studied 47,033 patients and found that adherence to a vegetarian diet reduced the risk of hospitalization and death from diverticular disease. In this study,³⁸ those with higher fiber intake were less likely to have complications of diverticular disease. For many years, it was believed that consumption of nuts and seeds may lead to obstruction of diverticula opening, resulting in the development of diverticulitis.^{39,40} However, a large study by Strate et al⁴¹ found that nuts, corn, and seeds were not associated with any increase in diverticulitis or diverticular bleeding.

Other reported risk factors for diverticulosis include diets high in red meat and fat.³⁶ Medications have been associated with a risk of both diverticulitis and diverticular bleeding, including nonsteroidal anti-inflammatory drugs, corticosteroids, and opiates.⁴²⁻⁴⁵ Obesity is associated with a risk of diverticulitis (RR, 1.57; 95% CI, 1.18-2.07),⁴⁶ and relative to nonsmokers, smokers have an increased risk as well (odds ratio, 1.89; 95% CI, 1.15-3.10).⁴⁷

In contrast, vegetarian diets and increased physical activity appear to be protective of diverticular disease.^{48,49} Medications that may have a protective effect are calcium channel blockers and statins. Also, higher vitamin D

levels reduce the risk of hospitalization for diverticulitis (RR, 0.49; 95% CI, 0.38-0.62).¹⁹

SIGNS AND SYMPTOMS

Diverticular disease can present in many different ways including asymptomatic disease, infectious complications, and gastrointestinal bleeding.

Acute diverticulitis can present as mild intermittent pain or as chronic severe unremitting abdominal pain. Systemic symptoms of fever and a change in bowel habits are common. Constipation is reported in approximately 50% of patients and diarrhea in 25% to 35%.⁵⁰ Other symptoms include nausea, vomiting, and urinary symptoms. In cases of overt peritonitis, abdominal examination may be notable for rigidity, rebound tenderness, and guarding. Laboratory testing is often notable for a leukocytosis and elevated inflammatory markers.

DIAGNOSIS

Diverticular disease can be diagnosed clinically with classic presenting symptoms or more frequently with a confirmatory test done radiologically or via colonoscopy.

Radiological Diagnosis

Classically, barium enema was used for the diagnosis of diverticular disease.⁵¹ However, currently, computed tomography (CT) has become the standard for diagnosing diverticular disease (Figure 1).⁵² Both CT of the abdomen and pelvis and CT colonography are effective in diagnosing the disease, extent of disease, and complications of disease.^{51,53} In the

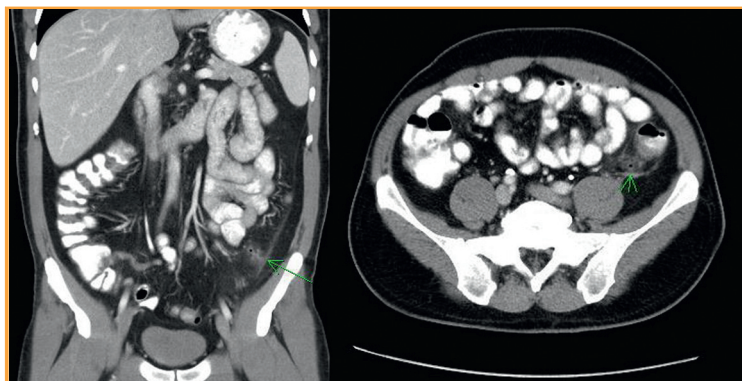


FIGURE 1. Sigmoid diverticulitis on computed tomography.

Class	Computed tomographic findings
Mild disease	Bowel wall thickening Fat stranding
Moderate disease	Bowel wall thickening >3 mm Phlegmon/small abscess
Severe disease	Bowel wall thickening >5 mm Perforation with subdiaphragmatic free air Abscess >5 mm

more emergent setting, CT of the abdomen and pelvis is more commonly used. The sensitivity for acute diverticulitis is 94%, with a specificity of 99%.⁵⁴ When CT of the abdomen and pelvis is used, the Buckley or Hinchey classification system can be used to assess the severity of diverticulitis (Tables 1 and 2).^{55,56}

Endoscopic Diagnosis

Colonoscopy is the main diagnostic tool for diagnosing diverticular disease. Asymptomatic diverticular disease is a frequent incidental finding on screening colonoscopy (Figure 2).³ However, colonoscopy is not used in the setting of acute diverticulitis. In this setting, there is a concern for possible perforation related to air insufflation. Although diverticulitis can be identified on colonoscopy and is seen in up to 2% of screening colonoscopy,⁵⁷ it cannot identify certain disease complications such as abscess.

DIFFERENTIAL DIAGNOSIS

A number of conditions may mimic acute diverticulitis. Both ulcerative colitis and Crohn disease may present with similar findings of abdominal pain and changes in bowel habits. In cases of severe inflammation, both conditions may also present with systemic findings of fever. Ischemic colitis may also present similar to acute diverticulitis. This typically presents in patients who develop transient episodes of hypotension, resulting in decreased

Class	Computed tomographic findings
Stage I	Pericolic abscess/phlegmon
Stage II	Pelvic, intra-abdominal, or retroperitoneal abscess
Stage III	Purulent peritonitis
Stage IV	Fecal peritonitis

blood flow to the colon. This can result in diffuse abdominal pain or localized abdominal pain to the areas of ischemia as well as change in bowel habits and low-grade fever. A key difference, however, is that ischemic colitis is often associated with bloody diarrhea, which is not typically present in cases of diverticulitis. Similarly, both infectious gastroenteritis and acute appendicitis need to be ruled out.

DIVERTICULITIS

Diverticulitis can be uncomplicated or complicated.

MANAGEMENT OF UNCOMPLICATED DIVERTICULITIS

In uncomplicated diverticulitis, patients are typically treated with antibiotics and bowel rest. When there are no signs of systemic toxicity, patients can be safely treated with oral antibiotics in an outpatient setting whereas those with more moderate to severe disease should be hospitalized and treated with intravenous antibiotics and bowel rest.⁵⁸ Overall, uncomplicated diverticulitis is associated with few complications and rarely necessitates emergent surgery.⁵⁹ Antibiotics should be geared toward treating aerobic and anaerobic gram-negative bacteria. Recent European studies⁶⁰⁻⁶² have suggested that antibiotics may not even be necessary in cases of mild to even moderate uncomplicated disease. A randomized trial⁶³ in cases of uncomplicated diverticulitis found no change in complications, hospital stay, or recurrent diverticulitis after 12 months of follow-up. An important goal of antibiotic therapy is the reduction in diverticular complications and risk of recurrence.⁶³ Given that these risks are quite low in uncomplicated diverticulitis, the most recent American Gastroenterological Association (AGA) guidelines⁶⁴ now recommend that antibiotics should be used selectively as opposed to routinely in patients with uncomplicated diverticulitis.

MANAGEMENT OF COMPLICATED DIVERTICULITIS

In complicated cases, patients may present with a phlegmon, abscess, peritonitis, fistula formation, or obstruction. Typically, the infection spreads locally involving structures adjacent to the area of inflammation (eg, bladder

and hip joint) or via the portal circulation that may result in the development of hepatic abscesses. In cases of complicated disease as evident on CT, patients should be hospitalized, treated with intravenous antibiotics, bowel rest, and surgical consultation.

Diverticular abscess may develop in up to 16% of patients with acute diverticulitis.⁶⁵ When an abscess is present, definitive therapy with surgery or percutaneous drainage is often necessary. In a systematic review⁶⁶ of patients with diverticulitis and abscess formation, abscesses that were of Hinchey stages IB and II were successfully drained by radiology in approximately 50% of cases. Patients who do not improve with conservative therapy may require urgent surgical resection during hospitalization. Given the ongoing inflammation, most patients will necessitate a 2- to 3-staged surgical procedure with a resection of the diseased area, temporary diverting colostomy, and Hartmann pouch formation. More recent studies,⁵³ however, have questioned the need for this diversion in patients without overt fecal peritonitis. Oberkofler et al⁶⁷ reported on 62 patients with diverticulitis from 4 centers who were randomized to a Hartmann pouch or to a diverting ileostomy. The diverting ileostomy was associated with reduced rates of complications, operating time, hospital stay, and lower in-hospital costs.⁶⁷ A previous study³³ had shown safe and positive results in a single-stage procedure in carefully selected individuals.

Perforation with peritonitis from diverticulitis with rupture into the peritoneal cavity is rare, occurring only 1% to 2% of the time. However, in these situations, mortality rates approach 20%.^{68,69} Fistulous tracts form in up to 12% of patients with diverticulitis. Most fistula will form to adjacent organs, most often involving the bladder followed by vaginal, cutaneous, and enterocolic fistulas.^{48,70} In both situations, broad-spectrum antibiotics and surgery are necessary.

Overall, the risk of readmission and need for emergent surgery after the nonoperative management of diverticulitis is low.⁷¹ However, those presenting with complicated disease are at high risk of readmission (12% vs 8.2%; $P < .001$) and need for emergent surgery (4.3% vs 1.4%; $P < .001$) as compared with those with uncomplicated disease.⁷¹

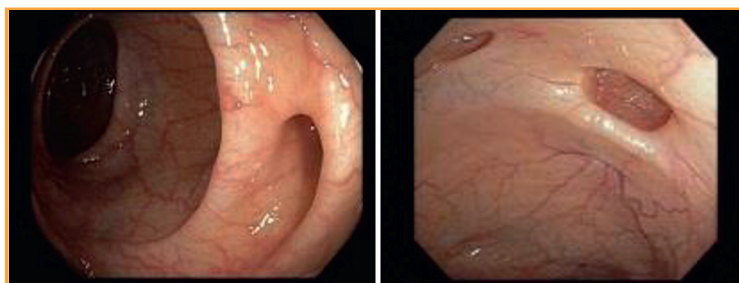


FIGURE 2. Diverticulosis on colonoscopy.

MANAGEMENT OF DIVERTICULAR-ASSOCIATED COLITIS

Segmental colitis associated with diverticulosis is an infrequently seen form of chronic colitis involving areas of diverticula (Figure 3).^{72,73} The condition can often be mistaken for IBD, especially Crohn colitis. Typically, diverticula will have erythematous and friable mucosa with exudate. The surrounding mucosa around diverticula may also be involved. Aphthous ulcers are not usually seen, and if found, these should be suggestive of Crohn disease. On histology, the inflammatory reaction shows chronic colitis without granuloma formation and typically the rectum should be spared of any disease as diverticula do not involve the rectum.³² Patients who have persistent symptoms of abdominal pain, rectal bleeding, or diarrhea may be treated similarly to those with IBD, and often 5-aminosalicylate (5-ASA) compounds are used.⁷⁴ If symptoms persist, then limited surgical resection of the involved area may be warranted. However, surgery should be done cautiously as there are some



FIGURE 3. Segmental colitis associated with diverticulosis on colonoscopy.

data to suggest that SCAD may be a precursor of IBD, and in cases of Crohn disease, surgery is not curative.⁷⁵

COMPLICATIONS OF DIVERTICULAR DISEASE

The effect of diverticular disease on patients' quality of life is still being elucidated. Even when asymptomatic, patients with a history of symptomatic diverticular disease experience lower health-related quality of life than did controls in areas related to bowel symptoms and overall emotional function.⁵⁷ Although an exact causal relationship has yet to be established, epidemiological studies^{76,77} implicate diverticular disease with the development of irritable bowel syndrome. Other delayed long-term complications include depression, anxiety, and chronic abdominal pain.⁷⁶ Given the association of long-term bowel symptoms after attacks of diverticular disease, Spiegel et al⁷⁸ developed and validated a quality-of-life instrument for chronic diverticular disease. Their study found that diverticular disease has a significant impact on patients' quality of life both during and after diverticular attacks. Patients reported negative psychosocial, social, and physical symptoms attributed to diverticular disease. The emotional consequences attributed to diverticular disease included anticipation anxiety, anger, depression, devitalization, frustration, and social ostracism. Interestingly, these symptoms were present even without active diverticular symptoms, but patients specifically attributed these emotional changes to their diverticular disease.⁷⁸

PREVENTION OF DIVERTICULAR DISEASE

Unfortunately, aside from surgical resection, there are no ideal methods to prevent the recurrence of diverticular disease. Multiple treatments have been studied, including fiber, anti-inflammatory drugs, and antibiotics.

Classically, the risk of recurrent diverticulitis ranged from 7% to 62%.⁴⁰ More recent studies,^{79,80} however, have reported lower risks of 13% over 9 years and 19% over 16 years of follow-up. In a large study⁸¹ of patients in the Kaiser Permanente system, after an initial bout of diverticulitis, 86% remained symptom free over nearly 9 years of follow-up. A single clinical recurrence occurred in 13.3% of patients and only 3.9% had a second recurrence.

Only 4.7% have multiple recurrences beyond 2 episodes of diverticulitis.⁸¹ The risk of developing complicated disease after an initial uncomplicated episode of diverticulitis was only 5% over 8 years of follow-up.⁸¹ The risks of recurrent complicated disease after an initial complicated episode are similar to those of uncomplicated disease.⁸²

Surgery

Classically, surgery was recommended after 2 uncomplicated attacks of diverticulitis. Parks⁸³ in 1969 reported that patients who had recurrent diverticulitis had more severe episodes and were more likely to require emergent surgery. More recently, this has been questioned on the basis of evidence showing a low risk of recurrent disease, and so long as patients have not had complicated diverticulitis, many will defer surgical management to patient preference for risks of recurrent episodes vs surgery.⁸² Andeweg et al⁸⁴ further supported this notion of delaying surgery on the basis of a Markov decision model used to evaluate the optimal timing for surgery in diverticulitis vs conservative management on quality-adjusted life years. Only after the third episode of diverticulitis, surgical and conservative management provided similar quality-adjusted life years. Importantly, however, abdominal symptoms were less frequent in those managed medically.⁸⁴ Similarly, a study⁸⁵ of patients with complicated diverticulitis had no difference in quality of life when comparing the surgically and medically managed groups. In contrast, a recent meta-analysis⁸⁶ indicated that surgery may provide an overall improvement in quality of life and reduction in overall gastrointestinal symptoms. Importantly, though, the authors⁸⁶ noted that the studies included in the analysis were of low quality. Although the timing of surgical management of older patients with diverticulitis is less clear, younger patients appear to be at a high risk of recurrent diverticulitis and more virulent forms with a 5-fold higher risk of complications and requiring more surgical interventions than do older patients.⁸⁷ Therefore, prophylactic surgery may be reasonable to consider in younger patients.^{40,82}

Surgery, however, is not without risk of complications. A meta-analysis⁸⁸ reported a mortality point estimate of 10.64% (95% CI, 1.73%-5.32%; $P < .001$) for emergent surgery

compared with only 0.50% (95% CI, 0.46%-0.54%; $P < .001$) for elective surgery. Similarly, mortality was less when using a laparoscopic approach and when a primary anastomosis was performed than that when open surgery and a Hartmann procedure were performed.⁸⁸ The increased morbidity and mortality related to emergent surgery may be more related to patient comorbidities and age.⁸⁹ Also, complicated diverticulitis had higher rates of postoperative complications than did uncomplicated diverticulitis (19.6% vs 10%).⁹⁰ Overall, laparoscopic elective surgery with primary anastomosis appears to be associated with the fewest complications of wound infection, ileus, and need for blood transfusion.⁹¹

Fiber

The evidence supporting low fiber as a cause for diverticular disease is equivocal.^{36,38} Similarly, the ability to prevent further diverticular disease from increasing fiber supplementation is unclear. The recent AGA guidelines⁹² recommend increasing fiber supplementation after an attack of diverticulitis, but note that the recommendation is a conditional recommendation based on weak evidence.

Anti-Inflammatory Medications

Given the finding of chronic inflammation in cases of SCAD as well as histological evidence of inflammation on biopsy, studies have evaluated the use of 5-ASA derivatives as a preventive treatment. In an open-label study⁹³ of 166 patients with acute diverticulitis randomized to placebo or mesalamine, patients had symptomatic relapse 15% of the time when receiving mesalamine for 8 weeks as compared with 46% in those who received placebo. A similar study⁹⁴ noted that the continuous dose of mesalamine was superior in preventing relapse as compared with the cyclical dose of mesalamine for just 10 d/mo. The current AGA guidelines⁹² indicate that there is no adequate evidence at this time to recommend the use of 5-ASA products after a flare of diverticulitis.

Antibiotics

Antibiotics have been evaluated as a preventive measure on the basis of the theory that altered intestinal microbiota may be the trigger for inflammation and resultant symptoms. Rifaximin use has been associated with a reduction

in recurrent diverticulitis in patients with SUDD and appears to be more effective when combined with a 5-ASA product.^{95,96} A meta-analysis⁹⁷ of rifaximin in diverticular disease found a number needed to treat of only 3 to achieve symptom relief and a number needed to treat of 59 to avoid a diverticular complication. Nonetheless, the AGA guidelines⁹² do not recommend using rifaximin as a preventive drug at this time.

Probiotics

Similar to antibiotics, probiotics work to alter the intestinal flora. Studies⁹⁸ have indicated a possible role of probiotics in preventing recurrence of SUDD. Tursi et al⁹⁴ evaluated combining VSL#3 with balsalazide (5-ASA) as compared with VSL#3 alone. In this study, there was no difference in remission rates between the groups, but the combination group had better symptom control related to constipation, bloating, and pain.

Miscellaneous

Current societal guidelines^{92,99} recommend colonoscopy 4 to 8 weeks after an episode of diverticulitis. In the first year after diagnosis of diverticular disease, there is an increased risk of colon cancer. One study¹⁰⁰ reported an increased odds ratio of 25 (95% CI, 17-38) for a diagnosis of colon cancer within 6 months of admission for diverticular disease. In a systematic review of imaging confirmed cases of diverticulitis from 2000 to 2010, the rates of missed colon cancer were substantial, with an estimated 1/67 patients with confirmed diverticulitis would have a misdiagnosed colon cancer identified on colonoscopy.¹⁰¹ However, if adequate screening colonoscopy was performed recently, then routinely repeating it after an episode of diverticulitis is not necessary.⁹²

CONCLUSION

Diverticular disease is a common condition. It affects individuals in many different ways. The current recommendations for the management and prevention of diverticulitis is evolving as newer evidence debunks classic beliefs and treatment paradigms. Further studies are still needed to better identify who is at highest risk of future complications and who will benefit most from early antibiotics and prophylactic surgery.

Abbreviations and Acronyms: **AGA** = American Gastroenterological Association; **5-ASA** = 5-aminosalicylate; **CT** = computed tomography; **IBD** = inflammatory bowel disease; **RR** = relative risk; **SCAD** = segmental colitis associated with diverticulosis; **SUDD** = symptomatic uncomplicated diverticular disease

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