Diverticulitis

Abstract

Diverticulitis occurs when the inner layer of the colon protrudes through the muscle layer and forms a pocket that becomes inflamed and infected. No one is sure of the cause of diverticulitis, but it may be related to diet. There are many risk factors including age, sex, lifestyle, heredity and geographic location. Common symptoms include left side pain, leukocytosis and fever. Diverticulitis can be diagnosed by a general physician, emergency room doctor, or gastroenterologist. It is necessary to confirm suspected cases with lab work, x-ray, CT, MRI, ultrasound, or a colonoscopy. Diverticulitis can be life-threatening when complications such an abscess, perforation, peritonitis, rectal bleeding, fistula or intestinal obstruction occur. Treatment options are rapidly evolving, can be outpatient or inpatient, and usually includes antibiotics. Surgery may be necessary in rare cases to remove diseased portions of the colon and reconnect healthy portions. A case report of a 77-year-old woman with diverticulitis in the duodenum demonstrates the use of medical imaging, complications that can occur, and treatments available to diverticulitis patients.

Introduction

The western world is a common place to find diverticulitis. It is most predominant in middle-age and elderly people.[1-8] According to the International Foundation for Functional Gastrointestinal Disorders,[8] half of the western population will have at least one, and commonly a few dozen, diverticula by the age of 60. Over the last 7 years, there has been a 26% increase in hospital admissions for diverticular disease.[9] Bontrager et al[10] defines a diverticulum as an "out-pouching of the mucosal wall that may result from herniation of the inner wall of the colon." (p.500) Each pouch is called a diverticulum. Many pouches are called diverticula. Diverticulosis refers to the presence of many diverticula. Diverticulitis begins when diverticula become inflamed, irritated, swollen and infected.[1,8] Diverticula may form in any sac like organ of the body, but are most common in the intestines. Diverticula of the intestines may be divided into two categories: true and false. The wall of a true diverticulum includes the entire thickness of the wall of the intestine. False diverticulum are a herniation of the mucosa and submucosa layers, protrude through the muscular coat of the intestine, and are covered by serosa.[2,8,11] False diverticula are also known as pseudodiverticulum or pulsion diverticulum.[2] Diverticula may also be classified as congenital or acquired. Congenital diverticula can be true or false and are present from birth. Acquired diverticula are mostly false diverticula and develop later in life.[11]

Causes of Diverticulitis

No one is sure what causes diverticulitis, but for the last 50 years, it has been widely accepted that a low-fiber diet is the cause.[1,2,8] Records of diverticulitis begin in the early 1900s in the United States, which is about the time processed foods became available. Process foods have less fiber than fresh foods. Fiber in foods comes from plants. Fiber softens stool, making it easier for stool to move through the colon. Fiber found in beans, fruits, and oats is considered soluble fiber. Soluble fiber can dissolve in water. Insoluble fiber is contained in vegetables and whole-grain products. It is very slow to dissolve, or does not dissolve at all. Both kinds of fiber are helpful in preventing constipation.[1] In addition, diverticulitis is less common in vegetarians.[2,8]

Many other ideas of what causes diverticulitis have recently surfaced.[1,4,5,9] How a diverticulum becomes infected and inflamed likely involves a deranged micro environment.[4] Inflammation in the colon can be caused by a change in bacteria, more specifically a decrease in healthy bacteria and increase of disease-causing bacteria.[1] Just like appendicitis can be caused by an obstruction of fecal matter, a diverticula with fecal matter trapped in it can develop a low grade inflammation due to abrasion of the mucosa. This fecal microbia could then infect the lamina propria, which would lead to inflammation of the mucosa, and would be the beginning of an apex of the diverticular sac. It could also create inflammation of the mesenteric and pericolic fat.[9]

According to Manwaring and Champagne[5], 40% of cases could be contributed to heredity. They studied a family of 9 siblings, 7 of which had diverticular disease between 49 and 70 years of age. In this study they determined that "genetic predispositions to diverticular disease can be broken into in three conditions: colon wall integrity conditions, visceral neurological dysfunction conditions, and conditions that result in change of stool consistency."[5(p.149)] Humes and Spiller[9] report that the causes of diverticulitis are multifactorial, including diet, microbioa, enetic factors, colonic motility, heritability, and structure. Morris et al[4] adds increased luminal pressure to the list of potential causes. Another new indication is that a decreased level of serotonin causes decreased relaxation and increased spasms of muscles in the colon.[1]

Regardless of these causes, diverticulitis may also be influenced by lack of exercise and smoking as well as taking certain drugs, such as anti-inflammatory drugs like aspirin and drugs containing steroids.[1,9] People who smoke increase their risk of diverticular complications by three times, and people who participate in regular physical activity decrease their risk of developing diverticulitis by 25%.[9] Diverticulitis is not, however, more common in patients who drink alcohol or caffeinated drinks.[2] Obesity has a significant association with diverticulosis, especially in younger

patients.[1,2,4,9] One study suggested patients who take calcium blockers, which reduce smooth muscle contractions, have a lower risk of diverticulitis compared to patients who do not.[4] Most research indicates the cause of diverticulitis is very hard to identify.[1,4,5,7-9]

Diverticulitis Risk Factors

Diverticulitis is more frequent in older people.[1-8] According to the World Gastroenterology Organisation Practice Guidelines,[2] only 5% of diverticulitis cases occur in patients age 40 years and older, 30% occur in patients aged 60 years and older, and 65% occur patients aged 80 year and older. Both the World Gastroenterology Organisation[2] and the National Institute of Diabetes and Digestive and Kidney Diseases[1] notes that diverticular disease is becoming more common in younger people, and mostly common in males. Diverticulitis has a long-term recurrence rate of 20%.[3] Humes and Spiller[9] report on several studies about recurrence, one followed 221 patients, of which 20.8% had recurrent diverticulitis. Patients under the age of 50 are more likely to have recurring diverticulitis and the need for resection than patients over 50 years of age.[9]

Another risk factor unique to diverticulitis is the part of the world that one lives in.[5,6,9] Diverticulitis is most common in the western world. Diverticulitis is rare in developing countries, but its occurrence is beginning to increase, as people in other countries change their lifestyles to be more like the western world.[9] Manwaring and Champagne[5] reported on a study in Nigeria that showed 1.8% of barium enemas revealed diverticular disease. A study in the Southern Islamic Republic of Iran reported 1.2% incidence of diverticulitis. This is a lot smaller rate of occurrence than that of diverticulitis in western populations.[5] Even within the United States, the area one lives in may affect one's risk of getting diverticulitis. Within the United States, the Northeast has the largest percent of hospital admissions for diverticulitis verses the West having the lowest.[9]

Signs and Symptoms of Diverticulitis

People with diverticulitis have a variety of symptoms, making it hard to diagnose.[1-3,9] Many people with diverticulitis remain symptom free.[2] The most common symptom is lower left side pain. The pain is commonly intense and sudden, although it can be constant or intermittent and can worsen over days or weeks.[1,9] The amount of pain can change from mild to severe and back again.[1] Right sided pain may indicate diverticulitis in the sigmoid colon. Diffuse abdominal pain may indicate a perforation.[9] Other common diverticulitis symptoms are:

- Fever and chills
- Nausea and vomiting

- Constipation or diarrhea
- Blood in stool
- Weakness, dizziness or light-headedness
- Abdominal cramping.[1,9]

Diverticulitis Diagnosis and Detection

People can be diagnosed by emergency room doctors, a primary care physician, or a gastroenterologist.[1] The three main suspicious indicators of diverticulitis are left lower quadrant pain, fever, and a high white blood cell count.[1,9,12] A diagnosis made solely on clinical observations will be incorrect 33% of the time. If diverticulitis is suspected, the physician will likely order one or more procedures to confirm the diagnosis.[2] An x-ray is often one of the first tests ordered to diagnosing diverticulitis, as it one of the least expensive and least evasive tests. An abdomen x-ray is determined to be abnormal in 30 to 50% of patients with acute diverticulitis. What a radiologist may find in an abdomen x-ray that suggests diverticulitis is a small or large bowel dilation, a bowel obstruction, or a soft tissue density that suggests an abscess.[2] Lab tests are very helpful in diagnosing diverticulitis, and should be done before antibiotics are started. A urinalysis can be completed to rule out urinary tract infection or pregnancy in women. A blood test should be performed to check for blood count and electrolytes along with C-reactive protein and amylase.[6] A blood test revealing a high white blood cell count indicates an infection. The blood test can also reveal the presence of inflammation or anemia.[1]

Computer Tomography (CT) is the most common method used to diagnose diverticulitis.[1,2] The World Gastroenterology Organisation[2] reports that "CT offers the benefit of evaluating both the bowel and the mesentery with a sensitivity of 69% to 98% and a specificity of 75% to 100%."[(p.5)] CT findings usually show pericolonic fat stranding, bowel wall thickening, an abscess, free fluid, or free air. Additionally, an inflamed diverticulum can show an arrowhead sign in which the iodinated contrast shows an arrowhead configuration at the base of an inflamed diverticulum (see **Figure 1**).[9] The reason a CT will show a thick bowel wall is because when inflammation occurs, free air and an abscess formation are often present.[6] Correct CT diagnosis of diverticulitis ranges from 60% to 97%, depending on the facility evaluated.[9] Most physicians now order a CT instead of a barium enema. Barium enemas are usually ordered if the diagnosis from a CT is not conclusive.[12]

Diverticulitis is also commonly diagnosed with ultrasound.[2,7,9] The advantages of ultrasound over CT is lower costs, no radiation or contrast material is used, and is generally available. Many physicians prefer to first check for diverticulitis with ultrasound, then only order a CT, which gives significant radiation, if the ultrasound is inconclusive.[7] Ultrasound appearance of diverticulitis presents

as a "thickened loop of bowel with a target-like appearance."[9(p.363)] or thickening of the colonic wall and cystic masses.[2] Ultrasound success rates in correctly detecting diverticulitis range from 84% to 99%. Therefore, the best modality for diagnosing diverticulitis may be ultrasound.[9]

Magnetic Resonance Imaging (MRI) can also be used to diagnose diverticulitis. This modality may be better at differentiating between colon cancer and diverticulitis. Diffusion-weighted MRI (DWI) is an MRI where image contrast is increased by microscopic motion of water protons (see **Figure 2**).[6] Oistamo et al[6] noted a study of 30 patients in which CT was able to correctly diagnose cancer 66.7% and diverticulitis 93.3% of the time. However, T2 weighted and MRI DWI imaging was able to correctly diagnose cancer and diverticulitis 100% of the time. Therefore, MRI may be the modality of choice for diverticulitis verses colon cancer patients.[6]

A colonoscopy can also be performed to determine if colorectal cancer (CRC) is present in patients diagnosed with acute diverticulitis.[1] Colorectal cancer may present clinically with symptoms very much like diverticulitis.[4] A colonoscopy can be performed in a hospital or outpatient center, and light anesthesia is necessary because a flexible tube is inserted into the anus. A small camera sends video images to a computer screen.[1] The American College of Gastroenterology, the American Society of Colon and Rectal Surgeons, the European Association for Endoscopic Surgery, and the Association of Coloproctology of Great Britain and Ireland all recommend a colonoscopy for patients diagnosed with acute diverticulitis.[12] However, a review by de Vries et al[12] reports that "there is no indication for routine endoscopic evaluation after an episode of acute uncomplicated diverticulitis, unless the patient has persistent complaints or alarming symptoms for CRC" [(p.2045-6)] and that there is no higher occurrence of CRC in diverticulitis patients than in the national average.[12]

Complications of Diverticulitis

Complications of diverticulitis include an abscess, perforation, peritonitis, rectal bleeding, fistula, or intestinal obstruction.[1,2,8,12] An abscess is a swollen and painful area, often puss-filled just outside of the colon wall. An abscess is usually treated with antibiotics. If the abscess is too large or does not improve, it may need to be drained. To drain an abscess, a radiologist will insert a needle through the skin and into the abscess with the guidance or ultrasound or CT, then drain the fluid through a catheter.[1]

A perforation is when a small hole forms in the wall of the colon, allowing fluids to leak into the abdominal cavity.[1] A perforation has a high mortality rate of about 35%. Fortunately, perforations are uncommon.[2] A patient with a perforation will need emergency surgery to repair the hole. If the perforation cannot be repaired, a resection is performed. A resection is when a damaged part of the

colon is removed, and two healthy sections are stitched together.[1]

Peritonitis is inflammation of the tissues inside the abdomen caused by pus and or stool that leaked out of a perforation.[1,2,8] A patient with peritonitis commonly has intense abdominal pain, nausea, vomiting and fever. Peritonitis also requires immediate surgery. It is necessary to clean up the abdominal cavity before more complications occur. A resection may also be necessary. The patient will be treated with antibiotics following the surgery. Peritonitis can be fatal without proper medical intervention.[1]

Any rectal bleeding is a serious concern.[2,8] A CT scan can be ordered to find the location of bleeding. Diverticular disease is the most common cause of massive lower gastrointestinal bleeding, occurring during 30% to 50% of cases. The World Gastroenterology Organisation Practice Guidelines[2] estimates that 15% of patients with diverticulosis will experience bleeding at some time. This is because diverticulum can herniate the blood vessels, which often then become looped over the top of the diverticulum. Because of this, the vessel can be injured by the contents of the lumen as time goes by.[2,8] Bleeding stops by itself in 70% to 80% of cases.[2] A colon resection can be deemed necessary if abdominal bleeding does not stop. [1]

A fistula is an irregular passage formed between two organs or between an organ and the outside of the body.[1,2] Fistulas can be caused by diverticular related infections. The most common fistulas occur between the colon and the bladder.[1] Fistulas occur in 2% of patients with diverticulitis, and are more common in men than in women.[2] The National Digestive Diseases Information Clearinghouse[1] reports that fistulas are most often corrected with a colon resection and removal of the fistula as well.

An intestinal obstruction is a blockage of the movement of material through the intestine. It can be partial or total. If the intestine is completely blocked, surgery may be necessary.[1] Complete obstruction is rare and accounts for only10% of large bowel obstructions. Partial obstructions are more common and are caused by bowel spasm or chronic inflammatory changes. Acute diverticulitis can lead to obstruction due to edema or compression from an abscess.[2]

Case Report

A 77 year old woman was checked into an emergency department with nausea and vomiting extending over a period of two weeks and complainting of right upper quadrant pain. She recently had an abdominal ultrasound, and her gallbladder was determined to be normal. A CT scan was ordered and showed three duodenal diverticula. The colon is the most common site for diverticulitis, and the duodenum is the second most common site. Two false diverticula were in the second portion and one in

the fourth portion of the duodenum. These diverticula arose from the medial wall, which is common. Only 5% of diverticula arise from the lateral wall. Within the duodenum, the periampullary region is the most common site for diverticula, with the second through fourth portions a less common place. The periampullary region is the region within 2 cm of the where the pancreatic duct and common bile duct join. Also discovered was an enterolith in a large diverticulum in the second portion of the duodenum, which displaced the head of the pancreas (see **Figure 3).**[13] "Enterolith formation is thought to be caused by stasis within diverticula either *de novo* or around a nidus composed of food particles, stool content, and physical or chemical foreign material. Enterolith growth and distal propagation results in small bowel obstruction." [14(p.356)] The walls of the diverticulum were unusually thick. The pancreatic duct was thickened to 6 mm and the common bile duct was dilated to 10 mm. Other small diverticula were observed in the small bowel.[13]

This patient was treated with ciprofloxacin, metronidaole, and analgesics. She improved rapidly. An upper gastrointestinal endoscopy was performed and found complex diverticulum that contained food and debris. The debris was removed. A MRI was performed that included magnetic resonance cholangiopancreatogaphy (MRCP) and an enhanced T1-weighted 3D gradient echo. This showed 3.7 cm and 5 cm diverticula that held air in the descending and transverse duodenum. There was a small amount of free fluid with air pockets in the second and third portions of the duodenum. The pancreas was unremarkable. The patient was discharged and was instructed to take oral antibiotics. The patient came back to the emergency room, however, in 10 days. A CT with oral and intravenous contrast was performed and showed a decrease in inflammation around the diverticula. This time there was no enterolith in the duodenal diverticulum. However, a small bowel obstruction by a 3.8 cm enterolith was seen. It was believed that this is the same enterolith on the prior CT scan. A surgical procedure by laparotomy was performed, and the enterolith was found to be stuck in the distal jejunum. The enterolith was removed. It was also noted that there were many diverticula along the mesenteric border in both the jejunum and the ileum. A complete resection was not performed because of the patient's cardiac status. After the surgery, the patient improved quickly and she was discharged from the hospital.[13]

Treatments

Diverticulitis was a devastating disease with high morbidity and mortality before broad spectrum antibiotics were available.[2,4] There are several stages of treatment for diverticulitis,[2,3] and treatments are rapidly evolving.[4] Treatments depend upon the age of the patient, the severity of the attack, and the medical fitness of the patient.[1,2,4] In fact, patients without signs of sepsis may resolve

without any treatment.[1,2,9]

Treatments are classified as outpatient, inpatient, and surgical.[1-4] Outpatient treatment is for patients with mild pain and tenderness.[1-3] According to Tursi[3] "outpatient treatment seems to be safe and effective, allowing important cost-savings to health care systems." (p35) Patients are also treated with a broad spectrum of antibiotics to ensure coverage against Gram-positive, Gram-negative, and aerobic-anaerobic bacterial strains for 7 to 10 days. The medication mesalazine (Asacol) has been shown to improve diverticulitis. Also, the antibiotic rifaximin (Xifaxan) can improve diverticulitis symptoms.[4] Other common outpatient treatments include diet modification, fiber supplements, and probiotics.[1] Diet modifications can range from bowel rest to eating high fiber foods and can even include avoiding seeds, popcorn, and nuts,[1,9] Fiber supplements are available as powders, pills, or wafers. They can contain 0.5 to 3.5 grams of fiber, and should be taken with water. Citrucel and Metamucil are common band names of fiber supplements. The National Institute of Diabetes and Digestive and Kidney Diseases[1] recommends that Americans have 14 grams of fibers per 1,000 calories.[1] Probiotics is the newest idea in treating diverticulitis, and more research is needed.[1-4] Probiotics can be found in some foods such as yogurt and in capsules or tablets. Probiotics are live bacteria like those found in a healthy gastrointestinal tract.[1,4] Improvement should be seen as a result of outpatient treatment within 48 to 72 hours. If not, there may be further complications.[1-4] Outpatient treatments have been found to be very effective, with 94% are patients are successfully treated as outpatients.[3,4]

If a patient fails to show improvement after receiving outpatient treatments, the patient would be treated in the hospital with intravenous antibiotics, which occurs in about 1 to 2% of cases.[2,3] Improvement will ideally be seen in 3 to 4 days. A 7 to 10 day course of oral treatment will continue to be used after discharge.[3] To prevent recurrent of diverticulitis, 5-aminosalicylic acid (or mesalamine) is prescribed.[3,9] Also, probiotics is increasing in popularity to reduce the chance of recurrent attacks.[9] For pain, an Analgesia (meperidine) is preferred over morphine because morphine may create an increase intracolonic pressure.[2]

Seventy to eighty percent of patients can be treated without surgery,[9] however surgery is necessary if complications occur.[1-4],[9] Tursi et al[3] reports that "Current guidelines advise elective resection after two well documented attacks of diverticulitis." (p.33) Morris et al[4] similarly recommends surgical intervention for patients who do not improve with medical therapy or percutaneous drainage. This is due to concern that a perforation will occur, which can lead to many serious health complications.[4,9] However, Tursi[3] recommends a case-by-case approach, taking into effect the impact on quality of life and the severity of attacks. Elective surgery is a more common than emergency surgery and is recommended after obstructive symptoms or any evidence of contrast leakage. Elective

surgery often involves resection of the colon. Bowel preparation such as mechanical preparation or laxative preparation is necessary before surgery. Surgery can be done in a single procedure or through multiple procedures, called a staged procedure. Staged procedures are sometimes necessary, as sometimes it is not safe to try to rejoin the colon right away.[2] According to Humes and Spiller,[9] the possible options are "a Hartmann's procedure, primary anastomosis with or without intra-operative colonic lavage or resection and anastomosis with a diverting stoma."[(p.366)] Hartmann's procedure, which is a staged procedure, is a traditional sigmoid resection with colostomy. A stoma, or opening, in the colon is created. The stoma is connected to a pouch to allow for normal eating while the colon is healing. Stool is then collected in the pouch, called a colostomy bag. Later, a second surgery will remove the pouch, rejoin the now healthy sections of colon, and the stoma will be closed. This is the preferred procedure if there is time for bowel preparation.[1] A transverse colostomy and drainage is another staged procedure where a colostomy is created, later to be followed by a resection of diseased segment and closure of colostomy. Surgery can be done as an open procedure or as a laparoscopic procedure.[9]

Conclusion

While having a diverticulum is not a big concern, the complications arising from diverticulitis can be life threatening. Diverticulitis is an infection or inflammation of a herniated out-pouching in the wall of the colon. Diverticulitis is increasingly costly and common disease in industrialized nations. Scientists are not sure what causes diverticular disease, but is probably related to diet and lifestyle. Diverticulitis is most common in people over age 50, but is becoming more common in younger people, most of whom are male. To confirm a suspected diagnosis of diverticulitis, a doctor may order an x-ray, lab tests, CT, MRI, ultrasound, or colonoscopy. Complications of diverticulitis include abscess, perforation, peritonitis, fistula or obstruction. Treatments and understanding of diverticulitis are rapidly evolving, but commonly include diet modifications and antibiotics. Surgery can be necessary depending on the complications that may occur. With correct diagnosis and treatments, diverticulitis is a highly survivable disease.

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F**igures and Captions**

Figure 1. *CT scan of acute sigmoid diverticulitis with associated abscess formation (white arrow), which required surgical resection. Image courtesy of:* R. Humes D, Spiller R. Review article: the pathogenesis and management of acute colonic diverticulitis. *Aliment Pharmacol Ther.* 2014; 30: 359-370. doi:10.1111/apt.12596.

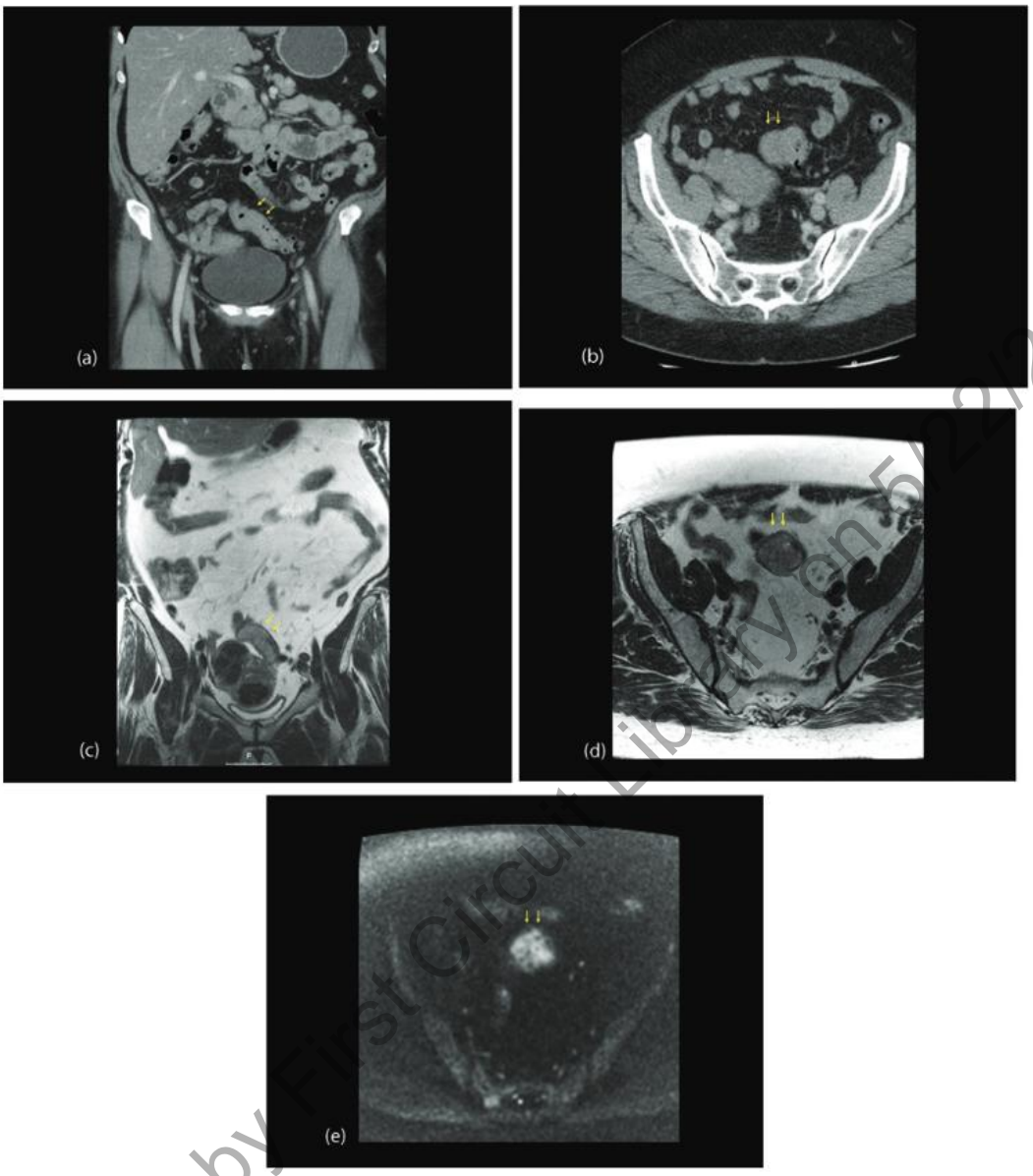

Figure 2. *A 64-year-old woman. Coronal and transaxial CT (a, b) and MR images (c–e). At blinded retrospective assessment of the CT examination, the diagnosis on CT was diverticulitis influenced by the presence of diverticular in the sigmoid colon. When independently assessing MR images, the tumor could be identified due to the difference in signal intensity between the propria muscle layer of the bowel and the lesion on coronal (c) and transaxial (d) T2-weighted images as well as focal increase in signal intensity on diffusion-weighted MR images with high b-value (e). Image courtesy of:* Oistamo E, Hjern F, Blomqvist L, Von Heijne A, Abraham-Nordling M. Cancer and diverticulitis of the sigmoid colon. differentiation with computer tomography versus magnetic resonance imaging: preliminary experiences. *Acta Radiologica*. April 2013;54(3):237-241. doi:10.1258/ar.2012.120543.

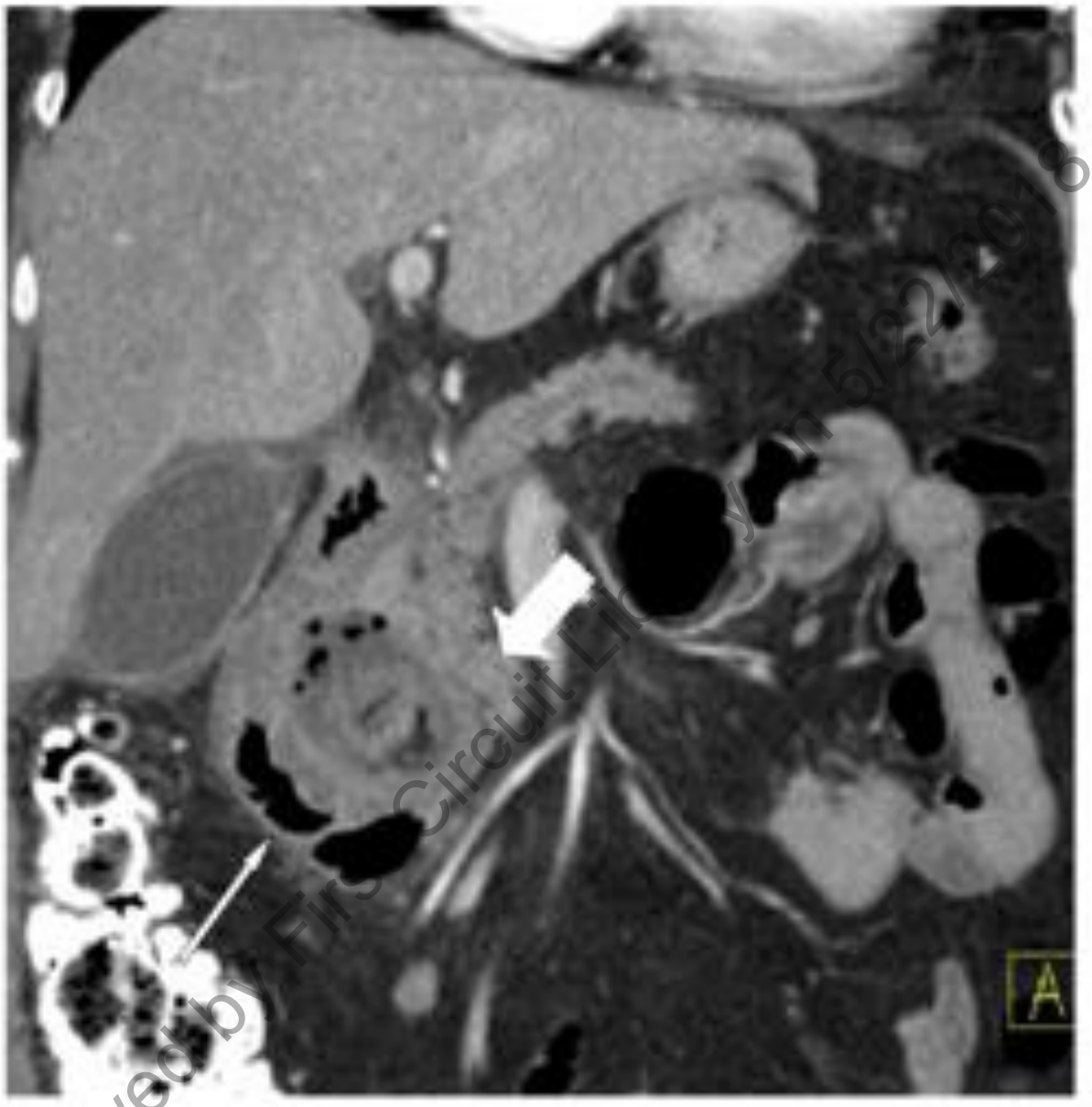

Figure 3. *Contrast-enhanced CT coronal multiplanar reformation shows a complex mass containing gas in the pancreaticoduodenal groove between the duodenum (arrow) and pancreatic head (thick arrow). Image courtesy of:* Medsinge A, Remer EM, Winans CG. Duodenal diverticulitis followed by enterolith-associated small bowel obstruction. *Emerg Radiol.* 2012;19;261-264. doi 10.1007/s10140-012-1019-2.