22 Acute Diverticulitis: Imaging and Percutaneous Drainage

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Introduction

Diverticular disease is an increasingly common condition, particularly in the western hemisphere responsible for over 300,000 hospital admissions and $2.5 billion in healthcare costs annually. While diverticular disease alone is not necessarily symptomatic, acute diverticulitis frequently results in patients seeking medical attention, and from 1998 to 2005, there was a 26% increase in acute diverticulitis cases seen in the United States [1]. Acute diverticular disease presentations vary from mild colonic inflammation to complicated cases with phlegmon, abscess formation, fistulas, bowel perforation, and generalized peritonitis [2, 3]. Mild forms of disease are typically treated effectively as outpatients, while more severe forms may require IV antibiotics, intensive care unit (ICU) admission, and surgery for definitive management [4]. The majority of diverticular disease involves the descending and sigmoid colon; however 5% of cases will involve the right colon and cecum [5]. Complicated forms of disease are seen in 15–30% of cases [4, 6–9], most commonly in the setting of pericolonic abscess formation [10, 11]. Studies have shown that there has been an increase in diverticular abscesses from 1991 to 2005 from 5.9% to 9.6%, respectively, and patients who present with complicated forms of disease will do so on their initial presentation [2, 12].

Treatment strategies of acute diverticulitis depend on the stage of the disease at presentation, patient comorbidities, and general clinical condition (Fig. 22.1). There is much discussion in the literature with regard to which acute therapies if any may reduce chronic disease complications and need for surgery. Historically uncomplicated acute diverticulitis was treated with antibiotics, and the treatment for acute complicated diverticular disease involved a three-stage surgical approach to include a diverting proximal colostomy, sigmoid colectomy and anastomosis, and colostomy takedown [13]. Modern advances in medicine and surgical procedures have evolved these treatment strategies so that now uncomplicated diverticulitis can be managed with supportive care on an outpatient basis, and complicated cases can be treated with a one-stage elective surgery in most patients after the acute complication has been controlled. The purpose of this chapter is to discuss the role of radiology in diagnosing and treating acute diverticulitis. Chronic forms of diverticular disease and the management of such are a separate issue and beyond the scope of this chapter.

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R. Lim (ed.), *Multidisciplinary Approaches to Common Surgical Problems*,
https://doi.org/10.1007/978-3-030-12823-4_22

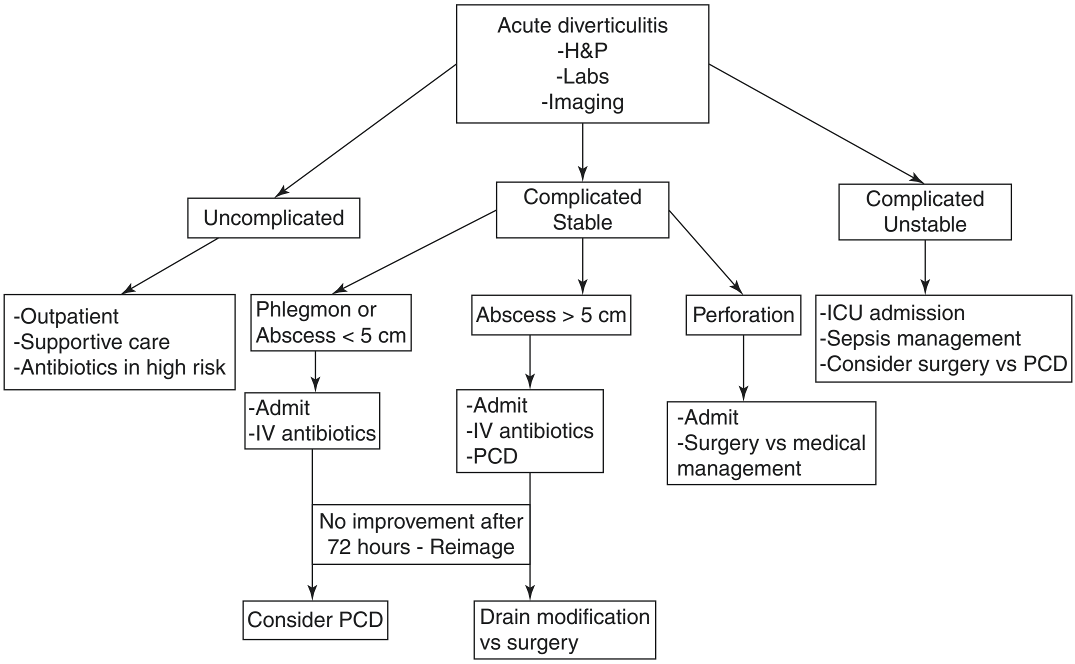

Fig. 22.1 Treatment algorithm for acute diverticulitis

Clinical Presentation and Evaluation

Patients with acute diverticular disease classically present with symptoms of left lower quadrant or lower abdomen/pelvis pain and tenderness, fever, and inability to tolerate oral intake. Patients who may be immunocompromised due to underlying malignancy, corticosteroid use, transplant patients, chronic kidney disease, and others are considered at high risk for complicated disease, and a high index of suspicion should be maintained [2, 9]. Laboratory studies should include a complete blood count, basic metabolic panel, urinalysis, and pregnancy test in females of childbearing age [4]. A basic metabolic panel to include serum creatinine and estimated glomerular filtration rate (eGFR) is obtained as a routine lab as many radiology departments require this prior to administering intravenous (IV) contrast as part of their contrast administration policies.

Imaging

Radiological studies play a vital role in diagnosing acute diverticular disease, providing information on severity and extent of disease, and sometimes provide alternative diagnoses giving healthcare providers the information they need to choose the most appropriate course of action for treatment. The American College of Radiology (ACR) has published a collection of Appropriateness Criteria ® to serve as guidelines generated from expert panels on recommended imaging studies for a variety of clinical conditions. In the setting of left lower quadrant pain, suspected to be the result of diverticular disease, computed tomography (CT) has been recognized as the gold standard imaging modality (Fig. 22.2). CT has proven to be nearly 100% sensitive and specific, with an overall accuracy of 99% in the diagnosis of diverticular disease, giving detailed

American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Left lower quadrant pain — suspected diverticulitis**

Variant 1: **Typical clinical presentation for diverticulitis, suspected complications or atypical presentations.**

Radiologic procedure	Rating	Comments	RRL*
CT abdomen and pelvis with IV contrast	9	For this procedure oral and/or colonic contrast may be helpful for bowel luminal visualization.	☢☢☢☢
CT abdomen and pelvis without IV contrast	6		☢☢☢☢
CT abdomen and pelvis without and with IV contrast	5		☢☢☢☢
MRI abdomen and pelvis without IV contrast	5		○
MRI abdomen and pelvis without and with IV contrast	5		○
X-ray contrast enema	4		☢☢☢
US abdomen transabdominal graded compression	4		○
X-ray abdomen and pelvis	4		☢☢☢
US pelvis transvaginal	2		○
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative radiation level**

Fig. 22.2 ACR appropriateness criteria for radiologic evaluation of left lower quadrant pain

information on the severity and extent of disease to include small perforations, distant abscesses, and providing alternative diagnoses [5, 14–16]. Intravenous (IV) contrast is encouraged and should be given in all cases unless there is a contraindication such as severe allergy to iodinated contrast or impaired renal function. Luminal contrast (oral, rectal) administration practices vary among institutions, and many facilities do not routinely administer these. Although it has been shown that the absence of luminal contrast does not significantly limit the ability to correctly diagnose an episode of acute diverticulitis, oral contrast can be extremely helpful in thin patients and for procedural planning (i.e., percutaneous drainage) to distinguish between an abscess cavity and normal fluid-filled intestine [15].

In the setting of acute diverticulitis, CT will demonstrate colonic diverticula associated with segmental bowel wall thickening (>3 mm) within the involved portion of colon and fat stranding in the adjacent mesentery and peritoneal fat. Diverticulosis and bowel wall thickening can also be seen in chronic diverticular disease due to muscular hypertrophy; however inflammatory fat stranding would not be present in this case. Complicated features of diverticulitis include:

1. Phlegmon: Heterogeneously enhancing soft tissue mass near the inflamed colon
2. Abscess: Rim-enhancing fluid collection with or without internal air. May be pericolonic or at distant sites such as the liver, lung, or adnexa
3. Perforation: May be contained pockets of air or gross pneumoperitoneum detected as extraluminal collections of air within the peritoneal cavity or retroperitoneum

CT can also reveal fistulas, obstructions, alternative diagnoses, and other ancillary findings such as appendicitis, epiploic appendagitis, malignancy, inflammatory bowel disease, infectious/ischemic/pseudomembranous colitis, tubo-ovarian abscess, and pylephlebitis (septic thrombophlebitis) within the mesenteric and portal venous systems [5, 9, 10].

Abdominal radiographs are commonly ordered in the acute setting; however their utility in diagnosing diverticular disease is limited. When bowel perforation is present, radiographs may detect free air as pneumoperitoneum; however small and contained perforations and retroperitoneal air may not be visible [5]. Radiographs may reveal other information such as the presence of pathological calcifications in the abdomen, ileus, and bowel obstructions; however this often leads to advanced imaging to further evaluate the underlying etiology.

Abdominal ultrasound (US) and magnetic resonance imaging (MRI) can be used in select cases where there is intent to avoid ionizing radiation to the patient, such as females during pregnancy. US has a reported sensitivity of 77–98% and specificity of 80–99% but is operator dependent and not as reliable as CT in providing alternative diagnoses. The colon can be evaluated adequately in thin patients, demonstrating noncompressible diverticula with thickened hypoechoic walls and hyperechoic mesenteric fat; however, visualization is limited in overweight patients and in the presence of bowel gas. MRI has a reported sensitivity and specificity of 88–92% and 80–99%, respectively but has its own limitations in availability, increased time to acquire images, bowel motion and bowel gas artifact, and reduced resolution compared to CT. Other modalities such as CT colonography, single- and double- contrast barium, should not be a part of the imaging workup in acute diverticular disease [5, 9, 14, 15].

Classification

Since the late 1970s, there have been numerous classification systems developed with regard to the surgical, radiologic, and clinical features of acute diverticular disease, originating with the *Hinchey Classification* in 1978 based on the extent of disease at the time of surgery [2, 3, 17]. Following the increased use of CT in the 1980s and 1990s, Kaiser et al. published the *Modified Hinchey Classification* (Table 22.1) incorporating CT findings with the original Hinchey system based on findings of *Wasvery* et al. More recently the World Society of Emergency Surgery (WSES)

Table 22.1 Comparison of original Hinchey classification from 1978 with modified Hinchey classification taking CT findings into account in 1999

Stage	Original Hinchey classification (1978)	Stage	Modified Hinchey classification (1999)	Comments
		0	Mild clinical diverticulitis	LLQ pain, elevated WBC, fever, no confirmation by imaging or surgery
I	Pericolic abscess or phlegmon	**Ia**	Confined pericolic inflammation – phlegmon	
II	Pelvic, intraabdominal, or retroperitoneal abscess	**Ib**	Confined pericolic abscess	
		II	Pelvic, distant intraabdominal, or retroperitoneal abscess	
III	Generalized purulent peritonitis	**III**	Generalized purulent peritonitis	No open communication with bowel lumen
IV	Generalized fecal peritonitis	**IV**	Fecal peritonitis	Free perforation, open communication with bowel lumen
		Fistula	Colovesical/colovaginal/coloenteric/colocutaneous	
		Obstruction	Large and/or small bowel obstruction	

proposed an updated classification also based on imaging findings, separating the system into uncomplicated and complicated forms of disease. Each system is intended to better stratify the disease presentation, guide therapy, and predict outcomes [3, 18].

WSES CT-Guided Classification System of Left Colon Acute Diverticulitis (2015)

- Stage 0: Uncomplicated

Complicated

- Stage 1a: Pericolonic air bubbles or little pericolic fluid without abscess (within 5 cm from inflamed bowel segment)
- Stage 1b: Abscess ≤ 4 cm
- Stage 2: Abscess ≥ 4 cm
- Stage 2b: Distant air (>5 cm from inflamed bowel segment)
- Stage 3: Diffuse fluid
- Stage 4: Diffuse fluid with distant free air

Sallinen et al. has produced the only classification system to date that may be used to predict mortality rate, need for surgery, and ICU level of care based on retrospective clinical, radiologic, and physiologic data of 631 patients (Table 22.2). Independent risk factors associated with poor patient outcome were organ dysfunction, abscess size >6 cm, and peritonitis [19].

Percutaneous Drainage of Abscess

The initial treatment of acute diverticulitis and complications may require a multidisciplinary approach with a general surgeon, an endoscopist, and an interventional radiologist. The medical management is discussed in another chapter. Most cases of complicated diverticulitis present with an abscess formation. Abscesses have been shown to be associated with a 25.7% chance of needing an urgent operation, which may carry significant morbidity [27]. With the development and increased use of CT during the 1980s and 1990s, percutaneous drainage procedures have become a mainstay of treatment for *Modified Hinchey Ib and II* disease [2, 28, 29]. The rate of percutaneous drainage (PCD), typically performed by interventional radiologists, nearly doubled from 1998 to 2005, while the rate of surgery during that same time declined from 17.4% to 14.4% suggesting a paradigm shift in the management of diverticular abscess [1]. Although PCD is now frequently considered the first-line treatment for diverticular abscess, it should be noted that there is no clear consensus as to which patients should undergo this procedure, who can be medically managed, and who requires surgery. The patient's overall condition plays an important role in treatment decisions and the timeliness as to when they should occur.

Patient selection can be challenging when deciding who should and should not be a considered for PCD. It has been shown that although PCD is successful 71–100% of the time resolving

Table 22.2 Classification proposed by *Sallinen* et al [19]

Classification of acute diverticulitis based on radiologic, clinical, and physiologic parameters – *Sallinen* et al. [19]							
Stage	Complicated	Abscess > 6 cm or distant air	Generalized peritonitis	Organ dysfunction	ICU admission	Operative treatment	30-Day mortality
1	N	–	–	–	0%	1%	0%
2	Y	N	N	–	0%	7%	1%
3	Y	Y	N	–	8%	54%	3%
4	Y	Y	Y	N	12%	98%	5%
5	Y	Y	Y	Y	58%	100%	37%

Distant air defined as >5 cm from affected bowel segment
Organ dysfunction defined as:
MAP <70 mmHg
GCS < 15
PaO_2/FIO_2 (P/F) ratio < 400 – corresponds well with O_2 saturation < 90%
Y = yes or present, N = no or absent

acute episodes of diverticular abscess [7, 8, 18, 27, 30–32], recurrence rates for diverticulitis following PCD remain high at 42–68% [7, 8, 27, 33, 34]. For this reason PCD is indicated as a temporizing measure to achieve source control and stabilize the patient in order to avoid emergent surgery, increasing chances of a one-stage elective surgery for definitive management typically 4-6 weeks following an acute attack [1, 2, 7, 18, 27–29, 35, 36]. In the cases where PCD is unsuccessful, there can be up to 75% mortality and 80% rate of colostomy [37].

Factors to consider when deciding on PCD include clinical stability, patient comorbidities, abscess size, and abscess location. Throughout the literature, it has been shown that abscesses up to 5 cm and sometimes even larger can be effectively treated with antibiotics alone [7, 10, 29, 33, 35]. Studies have also shown that medical management is more likely to be unsuccessful for patients with an *American Society of Anesthesiologists* (ASA) score ≥ 3, hemoglobin level ≤ 11.2 mg/dL, abscess size ≥6.5 cm, and temperature of ≥101.2 °F on initial presentation [26, 38]. A prospective study by *Ambrosetti* et al. that is cited regularly in the literature showed that mesocolic abscesses are more likely to respond to antibiotic therapy when compared to pelvic abscesses, but the rate of PCD was increased for abscesses >5 cm [11]. When clinical signs of SIRS or sepsis are present in the setting of abscess, source control is paramount. A universal standard on the timing of source control is a topic of debate [25, 28, 35, 36]; however the *Surgical Infection* Society recommends source control within 24 hours of establishing a diagnosis, but states exceptions can be made for more stable patients on a case-by-case basis. Septic patients, conversely, are more likely to require urgent interventions, while otherwise clinically stable patients can be drained within the 24-hour window [25].

The *Society for Interventional Radiology* (SIR) practice parameters for image-guided percutaneous drainage of abscesses and fluid collections provide indications and contraindications for percutaneous abscess drainage and fluid aspiration and are listed in Table 22.3. With regard to coagulation status, the SIR guidelines classify percutaneous abscess drainage as having a moderate risk of bleeding with the following parameters before performing a percutaneous drainage procedure [39]. Newer anticoagulants such as apixaban, a direct factor Xa inhibitor, are not included in the SIR anticoagulant guidelines. This drug has a 12 h half life, and should generally be held for 2–3 days in most patients, but should be held up to 5 days in patients with poor renal function defined as a creatinine clearance of < 30 mL/min [47, 48].

- INR < 1.5
- Platelets > 50,000/mL
- aPTT: no consensus but trend toward correcting values >1.5× control
- Clopidogrel: hold for 5 days
- Low molecular weight heparin: hold one dose prior to procedure
- Aspirin: does not need to be withheld

The size of an abscess that requires drainage has yet to be studied on a large-scale prospective

Table 22.3 Indications and contraindication for percutaneous abscess drainage from the SIR

Indications and contraindications for percutaneous abscess drainage
Indications
Suspected infected fluid collection or fluid collection related to a fistula
Aspiration of fluid is needed for diagnostic purposes
Suspicion that abscess/fluid is causing adverse physiologic effects such as sepsis or organ dysfunction
Absolute contraindications
None
Relative contraindications
Uncorrectable coagulopathy
Severely compromised cardiopulmonary function or hemodynamic instability
Lack of a safe access route into the abscess
Uncooperative patient or inability to position the patient appropriately

basis; however there are several reports suggesting that abscesses ranging from ≤3 to 5 cm can be effectively treated with antibiotics alone [3, 4, 26–28, 38]. Risks of PCD include rigors, injury to adjacent organs, bleeding, bacteremia, worsening sepsis, and failure to resolve abscess [26, 36, 40]. PCD has also been shown to increase the length of hospital stay compared to antibiotics alone by nearly double [26]. For patients who are not high risk and don't have clinical signs of sepsis, initial treatment with antibiotics alone seems rational for abscesses ≤5 cm [3, 18, 26]. Antibiotics may have reduced uptake in some abscess cavities; so if fever, leukocytosis, abdominal pain/tenderness, and inability to tolerate oral intake fail to resolve within 48–72 hours, the patient should be reimaged and considered for PCD [26]. Patients who present with an abscess >5 cm, but are unsuitable for PCD due to any of the aforementioned contraindications, may be considered for antibiotic therapy alone on a case-by-case basis or proceed to surgery as necessary [3, 38].

Techniques for PCD have been well described since the 1980s, and approaches including anterior, transgluteal, transrectal, and transvaginal have been well described using CT and US guidance [28–30, 36, 41–45]. The most direct path is typically chosen as site of drainage unless there is an interposing structure such as bowel. These procedures should take place in a hospital setting where ancillary support such as anesthesia and surgical services are available [32]. Most procedures can be performed with IV sedation, and some using only local anesthetic [32, 40]. Periprocedural antibiotics in the form of second- or third-generation cephalosporins are recommended within 1 hour of the procedure start, with antibiotic coverage for at least 48 hours afterward [23]. If there is no clinical improvement after 72 hours of PCD, patients should be considered for reimaging to assess the need for additional drainage catheters, or modification/repositioning of existing drains [13].

The specifics of each procedure may vary with respect of imaging modality, trocar vs. Seldinger technique, and patient positioning, and these are usually based on the preference of the interventional radiologist. There are multiple types and sizes of drains available for drainage. Most drains are sized between 8 to 16 French depending on the operator with larger drains typically required for more viscous fluid collections. Once the drain is placed, abscess fluid is aspirated until no further return, and the drain is attached to either gravity drainage or to bulb suction. Samples of aspirated fluid should be sent for culture and sensitivities. Most IR references cite gravity drainage; however bulb suction is commonly seen in post-op surgical patients. There are no studies to determine if one is superior to the other.

Drain management should focus on monitoring of output and maintaining patency of the drain. Drains should be flushed about three times daily with 5–10 cc of normal saline, subtracting any flush volume from daily output totals [13, 31, 41]. If drains are not flushed regularly, output may cease misleading one to think that the abscess has resolved [40]. Continued high output from the drain suggests the presence of a fistula, which occurs in ~14% of cases. Small fistulas will usually resolve by leaving the drain in place; however a persistent fistula may require continued drainage and can be removed during surgical resection of the diseased bowel [9]. Feculent output is suspicious and should elicit surgical evaluation as this may indicate a large fistula or bowel perforation [13]. A large amount of blood seen in the drain could indicate puncture or erosion into a blood vessel; if this occurs, the tube should be clamped, and interventional radiology should be contacted immediately [40].

Drain removal criteria vary from institution to institution; however a few main principles should be met [6, 31, 36, 38, 41]. Most importantly, it is imperative to not remove the drain prematurely, or this could lead to re-accumulation of the abscess possibly requiring a second percutaneous drain or other invasive procedure [36]. First, the patient's clinical symptoms such as fever, leukocytosis, and abdominal pain should be resolved. When drain output drops to less than 10–20 cc/day, the tube should be flushed to ensure that it is not clogged. If the drain is patent, repeat imaging should be performed to ensure satisfactory drainage. Persistence of the abscess may indicate the presence of a fistula or viscous fluid that is inherently difficult to drain [31]. If this is the case, the patient should be re-evaluated by the IR team to determine if there is need for drain modification or placement of a new drain. Drain modification entails injecting the drain with iodinated contrast under fluoroscopy in order to identify undrained areas or fistulous connections with the bowel, bladder, vagina, or skin [9]. Modifications such as drain upsizing, repositioning, or placing a catheter with additional side holes such as a biliary drain as an alternative [31]. For collections with thick fluid, serial injections of tPA into the cavity over a few days can be performed to promote drainage. This can also be done at the time of initial drainage if necessary [46]. Following any drain modification, the same process of flushing and monitoring output should take place. Once output ceases, and imaging does not reveal any further fluid, the drain can be safely removed.

Conclusion

Acute diverticulitis can present with a variety of symptoms and imaging findings. Treatment strategies can guide therapy based on the clinical presentation and whether the patient has uncomplicated or complicated disease. Percutaneous abscess drainage has become a frontline therapy for patients with abscess formation, the most common presentation of complicated disease. This minimally invasive procedure allows patients to recover from an acute infection and avoid a multistage surgical repair and associated operative morbidity.

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