Acute Colonic Diverticulitis

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Jan Ulrych

11.1 Introduction

Acute colonic diverticulitis is defined as an inflammation of one or more diverticula located in the large bowel. The diverticula can develop anywhere in the large intestine. The colon may be affected by a single diverticulum or by diverticulosis. Diverticulosis is a condition characterized by the presence of numerous diverticula in the colon. Symptomatic diverticulosis is called diverticular disease, and the most common symptom is pain. Diverticula are characterized by herniation of the colonic mucosa and submucosa through the colonic wall. Diverticula are classified as true or false depending upon the layers involved. True diverticula involve all layers of the colon, including muscular layer and peritoneum. False diverticula (also known as "pseudodiverticula") do not involve muscular layer or peritoneum. Left-sided colonic diverticula and right-sided colonic diverticula are usually regarded as two units with different etiology and pathology. Similarly, acute left colonic diverticulitis and acute right colonic diverticulitis are different forms of this disease, and they will be described separately.

11.2 Acute Left Colonic Diverticulitis

11.2.1 Epidemiology

The incidence of diverticulosis has increased dramatically throughout the world over the last period. Recent data show that 50% of individuals older than 60 years of age and approximately 70% of people aged at least 80 years have colonic

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diverticula in the United States [1]. The same trend including an increase in the incidence of diverticulosis is observed in Europe. Diverticular disease has been believed to be a disease affecting the elderly people; however, more recent data have reported a dramatic increase in the incidence of left-sided colonic diverticulosis among younger persons in Western countries [2]. Diverticula in Western population are seen predominantly (90–99%) in the sigmoid colon and the distal descending colon. Golder et al. [3] reported 447 patients with barium enema verified diverticulosis including 72% of patients who had solely left-sided diverticulosis and about 22% of patients who had pan-diverticulosis or both-sided diverticula. On the other hand, left-sided colonic diverticulosis is uncommon in Asia and Africa, only 10.9% of all diverticulosis in China [4]. Nevertheless, an increase of the left colon diverticulosis is reported in Asian elderly population caused by the shift to a westernized lifestyle [5].

Acute left colonic diverticulitis (ALCD) is an inflammatory complication of diverticular disease in descending or sigmoid colon. The lifetime risk of developing acute left colonic diverticulitis is traditionally cited 10–25% in those patients harboring diverticulosis. Recent evidence suggests that real lifetime risk of developing ALCD is only about 4% among patients with diverticulosis. Patients who are diagnosed with diverticulosis at younger age may incur more risk of developing acute diverticulitis [6]. In line with the increase in the incidence of diverticulosis, incidence rates of ALCD as well as emergency department visits for acute diverticulitis have increased significantly. More than a half of all patients presenting to the emergency department with a primary diagnosis of acute diverticulitis were admitted to inpatient care in the United States [7]. However, new trends in hospital admission and surgery rate for ALCD have been observed. Decrease in the rates of hospital admission and surgery for ALCD, despite increasing emergency department visits, is associated with safe outpatient management of uncomplicated acute diverticulitis and changes to the surgical guidelines. The surgical rate ranges from 4.7% to 6.0% of emergency department visit patients [7, 8].

11.2.2 Classification

Acute left colonic diverticulitis encompasses a variety of conditions ranging from localized inflammation of the diverticula without colon wall perforation to severe diffuse fecal peritonitis caused by diverticula perforation and inflammation affecting the extensive colon segment. For the last period, the Hinchey classification has been the most commonly used classification especially among surgeons [9]. This classification is based on the surgical intraoperative findings of abdominal abscess or diffuse peritonitis. Nowadays, many patients are treated by antimicrobial therapy or percutaneous drainage only, and surgery is not necessary. Common nonsurgical treatment enforced new classification of ALCD. Several modified classifications were introduced within the last two decades, principally proposed according to the computed tomography (CT) findings [10–13] or combination of clinical, radiologic, and physiologic parameters [14]. Finally, a proposal for a CT-guided classification

Table 11.1 WSES classification of acute diverticulitis [16]

Classification (stage)	CT findings
Uncomplicated acute diverticulitis	
• Stage 0	Diverticula, thickening of the colonic wall or increased density of the pericolic fat
Complicated acute diverticulitis	
• Stage 1A	Pericolic air bubbles or little pericolic fluid without abscess (within 5 cm from inflamed bowel segment)
• Stage 1B	Abscess ≤ 4 cm
• Stage 2A	Abscess > 4 cm
• Stage 2B	Distant air (>5 cm from inflamed bowel segment)
• Stage 3	Diffuse fluid without distant free air (no hole in the colon)
• Stage 4	Diffuse fluid with distant free air (persistent hole in the colon)

of acute left colonic diverticulitis was published by the World Society of Emergency Surgery (WSES) working group in 2015 [15]. It is a simple classification system of ALCD based on CT scan findings. The WSES classification divides ALCD into two groups: uncomplicated and complicated acute diverticulitis. In the event of uncomplicated acute diverticulitis, the inflammation does not extend to the peritoneum. In the event of complicated acute diverticulitis, the inflammatory process proceeds beyond the colon throughout the peritoneal cavity. Complicated acute diverticulitis is divided into four stages based on the extension of the inflammatory process (Table 11.1). The WSES classification may guide clinicians in the management of acute diverticulitis and may be universally accepted for day-to-day practice.

11.2.3 Pathogenesis

It has been suggested that the development of inflammation in the diverticula may be caused by fecal material trapped in the diverticula. Inflammation develops due to abrasion of the mucosa allowing access of fecal bacteria to the deeper layer of the mucosa and submucosa. This can be associated with an acute inflammation of the mesenteric and pericolic fat with formation of an abscess. Another postulated mechanism for the development of acute diverticulitis is a micro-perforation at the fundus of the diverticulum leading to inflammation. However, the mechanism by which asymptomatic diverticula become inflamed and perforate is still under investigation and is probably associated with altered gut motility and increased pressure combined with a deranged colonic microenvironment [17]. The microbial load in the colon is high, with 10^{10}–10^{11} bacteria present per gram of stool. The major pathogens involved in ALCD are likely to be due to a patient's own flora. Therefore, they are predictable and include *Enterobacteriaceae* (predominantly *E. coli* and *Klebsiella* species), viridans group *streptococci*, *enterococci*, and anaerobes (especially *B. fragilis*). The main resistance threat in ALCD is posed by extended-spectrum beta-lactamase (ESBL)-producing *Enterobacteriaceae* which are becoming increasingly common in community-acquired intra-abdominal

infections worldwide. The most significant risk factors for ESBL-producing infection include prior exposure to antibiotics and comorbidities requiring concurrent antibiotic therapy.

11.2.4 Clinical Manifestation

History and physical examination are the cornerstones of ALCD diagnosis. The clinical presentation of acute diverticulitis depends on the severity and localization of the underlying inflammatory process. Patients often present with acute constant abdominal pain in the left lower quadrant due to involvement of the sigmoid colon. Sometimes patients may complain about suprapubic pain due to the presence of a redundant inflamed sigmoid colon. ALCD may be associated with nausea and vomiting or change in bowel habits (constipation and diarrhea). Patients may have localized peritoneal signs with localized tenderness, rigidity, and rebound tenderness, or they may have signs of diffuse peritonitis. Extensive perforated ALCD with diffuse peritonitis may result in hemodynamic instability and septic shock. However, the majority of patients are misdiagnosed on the basis of clinical decision-making alone. Clinical diagnosis of ALCD is not sufficiently accurate, and misdiagnosis rates vary between 32% and 57% [18]. In addition, the interpreting of clinical findings and diagnostic accuracy depends on the surgeon's previous experience. To improve diagnostic reliability, a clinical decision rule and a clinical scoring system for diagnosing ALCD using logistic regression have been published [18, 19]. For example, Lameris et al. [19] developed a clinical decision rule for the diagnosis of acute diverticulitis, based on three criteria: (1) direct tenderness in the left lower quadrant, (2) CRP > 50 mg/l, and (3) absence of vomiting. If all three criteria were met, 97% of the patients had ALCD.

11.2.5 Laboratory Tests

Serological inflammatory markers are used to support the clinical diagnosis of acute diverticulitis. White blood cell (WBC) count and C-reactive protein (CRP) are commonly determined when acute diverticulitis is suspected. The primary role of inflammatory markers is to verify the inflammatory complication of diverticulosis. However, the diagnostic value of serological inflammatory markers in discriminating complicated from uncomplicated acute diverticulitis was studied. WBC count may show leukocytosis and a left shift, nevertheless, may be normal in immunocompromised persons or elderly patients. Unfortunately, WBC count is of no value in discriminating complicated from uncomplicated acute diverticulitis. CRP has been identified as a useful biomarker of inflammation, and CRP may be helpful in the prediction of the clinical severity of acute diverticulitis. A CRP cutoff value of 150–175 mg/l significantly discriminates complicated from uncomplicated acute diverticulitis [20–22]. CRP may be used as diagnostic tool for identifying patients with increased risk of complicated acute diverticulitis who should always undergo a CT examination.

11.2.6 Imaging

Radiological imaging techniques that are used for ALCD diagnosis in the emergency department are computed tomography and ultrasound (US). CT imaging is the gold standard in the diagnosis of ALCD. The sensitivity and specificity of abdominal CT for the diagnosis of ALCD are 94% and 99%, respectively [23]. CT scan may be also used to determine the grade of severity and may drive treatment planning of patients. According to WSES guidelines, abdominal CT scan is indicated for all patients with suspected ALCD [16]. Ultrasound may be a useful alternative in the initial evaluation of patients with suspected ALCD, since US has wide availability and easy accessibility. In addition, US avoids radiation exposure. However, ultrasound limitations include operator dependency, poor assessment in obese patients, and difficulty in the detection of free air or deeply located abscesses. A step-up approach with CT performed after an inconclusive or negative US may be a safe approach for patients suspected of having ALCD.

11.2.7 Diagnosis and Differential Diagnosis

The diagnosis of ALCD should be suspected in a patient with left lower abdominal pain, abdominal tenderness on physical examination, and laboratory findings of increased inflammatory markers. Imaging, preferably CT scan, is required to establish the diagnosis of ALCD. The differential diagnosis of ALCD includes other etiologies of left lower abdominal pain — colorectal cancer, inflammatory bowel disease, infectious colitis, ischemic colitis, urological disease, gynecological disease, etc.

11.2.8 Treatment

11.2.8.1 Principles of Acute Left Colonic Diverticulitis Treatment

Treatment of ALCD is determined by severity of acute diverticulitis and patient's clinical condition. Patients with ALCD may be treated in outpatient setting or inpatient setting. Outpatient management should be considered in patients with uncomplicated ALCD without significant comorbidities, immunosuppression, and signs of sepsis. Patient's compliance with recommended therapy and reliability for return visits are obvious conditions for outpatient management. Patients should be reassessed clinically two or three days after the initiation of antibiotic therapy. If antimicrobial therapy is necessary, oral administration of antibiotics is acceptable. Clear liquid diet is usually recommended; however, no studies have examined the value of dietary restriction or bed rest [21, 22]. Repeat imaging study is not indicated unless the patient fails to improve clinically. Patients who have persistent abdominal pain and fever and who relapse after initial improvement should be admitted for inpatient treatment. Inpatient management is established for risk patients with uncomplicated ALCD (comorbidities, immunosuppression, advanced age, uncompliance) or patients with complicated ALCD. Patients with complicated diverticulitis must undergo treatment specific to

Table 11.2 Recommendations for antimicrobial therapy for ALCD [24]

Patient	Antibiotics
Stable (non-critically ill) patients	
• No risk factors for ESBL	Amoxicillin/clavulanic acid or ciprofloxacin + metronidazole
• ESBL-associated risk factors	Ertapenem or tigecycline
Critically ill patients	
• No risk factors for ESBL	Piperacillin/tazobactam
• ESBL-associated risk factors	Meropenem or imipenem + echinocandin

their complications. However, in inpatient setting, all patients are treated with intravenous antibiotics, fluids, and pain medications. Antimicrobial therapy plays an important role in the management of complicated ALCD. Antibiotics should be administered as soon as possible. Initial antimicrobial therapy for patients with ALCD is empiric in nature as these patients need immediate treatment and microbiological data (culture and susceptibility results) usually require ≥48 h for the identification of pathogens and antibiotic susceptibility pattern. Most of the complicated ALCD is community-acquired infection with predictable bacterial pathogens. Considering intestinal microbiota of the large bowel, ALCD requires antimicrobial coverage for gram-positive and gram-negative bacteria, as well as for anaerobes. Knowledge of local epidemiological data and regional resistance profiles is essential for antibiotic selection. For stable (non-critically ill) patients with ALCD, antibiotics with a narrower spectrum of activity are preferred. Anti-ESBL-producer coverage should be warranted for patients with prior exposure to antibiotics and comorbidities requiring concurrent antibiotic therapy. By contrast, for critically ill patients with ALCD, antimicrobial regimens with broad spectrum of activity are recommended (Table 11.2). Although discontinuation of antimicrobial treatment should be based on clinical and laboratory criteria, a 4–6-day period of postoperative antimicrobial therapy in complicated ALCD is suggested if source control has been adequate [16]. Disease progression should be suspected in patients with clinical deterioration and those who fail to improve after two to three days of intravenous antibiotic therapy. Repeat imaging is required in such patients. The purpose of repeat imaging is to look for new complications that may require further intervention (percutaneous drainage or surgery). Surgery for ALCD is indicated for patients who present with sepsis and diffuse peritonitis and for patients whose condition did not improve with medical therapy, percutaneous drainage, or both. Surgical options include simple colostomy formation, traditional sigmoid resection with colostomy (Hartmann procedure), and sigmoid resection with a primary colocolonic or colorectal anastomosis with or without a diverting loop ileostomy. Traditionally, surgery for acute diverticulitis encompasses one-stage procedures and two-stage procedures. Colon resection can be performed open or laparoscopically.

11.2.8.2 Treatment of Uncomplicated ALCD

The current consensus is that uncomplicated diverticulitis is a self-limiting condition in which local host defense can manage the bacterial inflammation without antibiotics in immunocompetent patients. Antimicrobial therapy can be avoided in

immunocompetent patients with uncomplicated diverticulitis without systemic manifestations of infection. This recommendation is supported by results of multicenter randomized trial that recruited 623 patients with acute uncomplicated left-sided diverticulitis. This trial reported no difference in recovery, complication, and recurrence in patients with (314 patients) or without (309 patients) antibiotics [25]. However, antimicrobial therapy is recommended in patients with uncomplicated acute diverticulitis associated with systemic manifestations of infection. Oral administration of antibiotics may be equally effective as intravenous administration [26]. Oral antibiotics are prescribed for 7–10 days. Outpatient management is suggested for patients with uncomplicated acute diverticulitis with no comorbidities, whereas patients with significant comorbidities and unable to take fluids orally should be treated in the hospital with intravenous fluid and intravenous antibiotics. In patients with CT-proven uncomplicated acute diverticulitis treated conservatively, a routine colonoscopy is not required. The risk of malignancy is really low. A systematic review investigating the rate of colorectal cancer found by colonoscopy after an episode of uncomplicated diverticulitis was published in 2014. Of the total number of 1468 patients with uncomplicated diverticulitis who underwent colonoscopy, 17 patients were diagnosed with colorectal cancer. The prevalence of colorectal cancer detected by colonoscopy was 1.16% [27]. However, patients aged 50 years or older should participate in colorectal cancer screening program including fecal occult blood test or colonoscopy.

11.2.8.3 Treatment of Complicated ALCD

Localized complicated ALCD encompasses acute diverticulitis with CT findings of pericolic air bubbles or little pericolic fluid and diverticular abscess. CT finding of pericolic air or little pericolic fluid without abscess (stage 1A—WSES classification) is associated with diverticulum perforation, and antimicrobial therapy should be always recommended. Surgery is not usually necessary in these cases. Therapy of diverticular abscess is based on the size of the abscess and patient clinical condition. Patients with small diverticular abscesses (<4–5 cm, stage 1B) may be treated by antibiotics alone, whereas patients with large abscesses (>4–5 cm, stage 2A) should be treated by percutaneous drainage combined with antibiotic treatment [16]. If the percutaneous drainage is not feasible in patients with large abscesses, the initial antibiotic therapy alone is justified; however, patient clinical condition monitoring is mandatory. Drainage catheter can be removed when the output has ceased. Routine fistulogram via the percutaneous drainage is not recommended; it should be performed in doubtful cases only. In patients with diverticular abscesses treated conservatively, early colonoscopy should be planned. In a retrospective study of 633 patients with acute diverticulitis including 145 patients with diverticular abscesses, 11.4% of the patients with abscess had colorectal cancer [28, 29]. Colonoscopy is generally performed 4–6 weeks after an attack of acute diverticulitis.

Generalized complicated ALCD encompasses acute diverticulitis with CT findings of solely distant free air (stage 2B), diffuse fluid without distant free air (stage 3), and diffuse fluid with distant free air (stage 4). These patients with diffuse peritonitis are typically critically ill and require prompt fluid resuscitation, immediate

intravenous antibiotic therapy (Table 11.2), and surgery without delay. Although the absolute prevalence of perforated acute diverticulitis complicated by diffuse peritonitis is low and most patients hospitalized for acute diverticulitis can be managed by nonoperative treatment, approximately 10–25% of all admitted patients may require an urgent operative intervention [30, 31]. Distant pneumoperitoneum is pathognomonic for sigmoid perforation in patients with diffuse peritonitis; nevertheless, a successful nonoperative management in patients with ALCD and a pneumoperitoneum was described [32]. Sallinen et al. reported results of conservative treatment in patients with distant air without diffuse intraperitoneal fluid. Nonoperative treatment was a feasible therapy for hemodynamic stable patients with pericolic extraluminal air or with small amount of distant intraperitoneal air in the absence of clinical diffuse peritonitis or fluid in the pouch of Douglas. Occurrence of large amount of distant intraperitoneal air or distant retroperitoneal air even in the absence of clinical diffuse peritonitis was associated with high failure rate (57–60%) of nonoperative management [28, 29]. It was suggested that only highly selected group of patients with distant pneumoperitoneum without intraperitoneal fluid may be treated by conservative treatment [16]. However, generally recommended treatment for patients at this stage should be surgical resection. Open surgery with colon resection is a commonly accepted treatment for patients with diffuse peritonitis due to ALCD. The principle of surgical treatment of ALCD with diffuse peritonitis is surgical source control and treatment of diffuse peritonitis. Surgical source control encompasses the elimination of the infection source by colon resection and correction of anatomic derangements as well as restoration of normal physiologic function. The aim of surgical treatment of diffuse peritonitis is the elimination of bacterial contamination and inflammatory substances. Hartmann resection (sigmoid resection with primary colostomy) has been considered the procedure of choice in patients with diffuse purulent or fecal peritonitis due to ALCD and remains a safe technique for emergency surgery. Hartmann procedure is still the most commonly performed emergency operation accounting for 64–72% of surgery for ALCD [31, 33]. However, restoration of bowel continuity after a Hartmann procedure has been associated with significant morbidity. Many patients (31–46%) cannot undergo reversal surgery due to comorbidities; therefore, they remain with a permanent stoma [34, 35]. In recent years, some authors have reported the role of colon resection and primary anastomosis with or without diverting stoma in the treatment of acute diverticulitis with diffuse peritonitis. Favorable rates of mortality and morbidity were observed in patients with diffuse peritonitis who undergo colon resection with primary anastomosis [36]. Moreover, greater stoma reversal rates in the primary anastomosis group with diverting stoma compared to Hartmann procedure were proved [37]. However, future randomized controlled trials are needed to evaluate different surgical treatments (Hartmann procedure versus colon resection with primary anastomosis). Hartmann resection is still advised for managing diffuse peritonitis in critically ill patients and in patients with multiple comorbidities. However, in clinically stable patients with no comorbidities, primary resection with anastomosis with or without a diverting stoma may be performed [16]. Emergency laparoscopic sigmoidectomy for the treatment of ALCD with diffuse peritonitis is feasible in selected patients and may be performed

only by a dedicated laparoscopic team. Furthermore, laparoscopic peritoneal lavage and drainage has been debated in recent years as an alternative to colonic resection in patients with diffuse peritonitis. It consists of the laparoscopic aspiration of pus followed by abdominal lavage and the placement of abdominal drains, which remain for many days after the procedure. Based on the disappointing results of the latest prospective trials such as SCANDIV, Ladies, and DILALA trials [38–40], laparoscopic peritoneal lavage and drainage should not be considered the treatment of choice in patients with diffuse peritonitis.

Damage control surgery with lavage, limited bowel resection, laparostomy, and scheduled second-look operation is feasible in critically ill unstable patients with diffuse peritonitis and septic shock.

11.2.9 Prognosis and Elective Surgery

Recurrence of ALCD is lower than previously thought. Recurrence after an uncomplicated ALCD has recently been shown to be less than 5% [41]. The indication for elective colon resection based on the age at onset younger than 50 years and two or more episodes of acute diverticulitis is no longer accepted. After a conservatively treated episode of ALCD, an elective sigmoid resection should be planned only in high-risk patients, such as immunocompromised patients [16]. Recommendations for elective sigmoid colectomy following recovery from ALCD should be made on a case-by-case basis. Elective surgery is recommended for patients with large abscesses treated by percutaneous drainage as well.

11.3 Acute Right Colonic Diverticulitis

11.3.1 Epidemiology

The incidence of right-sided diverticulosis is estimated approximately 1–2% of colonic diverticular disease in the Western world. However, recent results suggest that right colonic diverticular disease is more common and has higher density scores in the West population than previously reported [3, 42]. Diverticular disease of the cecum and the ascending colon is more common than the left-sided form of diverticulosis in Asian population [43]. Wide range in incidence of diverticulosis is reported throughout the Asian countries. Observed incidence of diverticular disease is 1.97% in China [4], 12.1% in Korea [44], and 23.9% in Japan [45]. This difference may be attributed to different race, genetic predisposition, dietary habits, and lifestyle. Diverse trends in the prevalence of diverticulosis were also reported throughout Asia. The prevalence of diverticulosis has been increasing up to about 24% in Japan [45]; in contrast, overall prevalence does not change significantly in China over the time [4]. The diverticula are predominantly (78–85%) located in the right side of the colon in Asian population [4, 45]. Asian patients with right-sided diverticular disease are younger compared to those ones with left-sided localization.

The prevalence of right-sided diverticulosis reaches a peak in patients at 51–60 years of age in Asian population [4, 45]. Considering gender right-sided diverticular disease is found more frequently in males.

The incidence of acute right colonic diverticulitis is increasing, and this diagnosis should be particularly considered in Asian and African population. Acute right colonic diverticulitis (ARCD) typically arises in younger people. Jun-Ho et al. reported that 84.8% of the patients with ARCD were from 20 to 40 years old. It was found that for those patients between 20 and 40 years of age, the incidence of ARCD expressed as a percentage of appendicitis was 8.9% [46].

11.3.2 Pathogenesis

Right-sided diverticula may be solitary or numerous and can be found in the appendix, cecum, or ascending colon. When right-sided diverticula are solitary, they are usually congenital and true diverticula. Most of the congenital diverticula are found between 1 cm proximal to and 2 cm distal from the ileocecal junction. When diverticula are multiple, they are typically acquired and false diverticula. For acquired diverticula, increased intraluminal pressure and abnormal ascending colon motility play an important role in disease pathogenesis. Solitary cecal diverticulum is rare. In Thai adults, the occurrence of solitary cecal diverticulum was only 1.5%, whereas right-sided diverticulosis was reported in 22.3% of individuals [47]. The mechanism by which asymptomatic diverticula become inflamed and perforated is probably the same as in the event of acute left colonic diverticulitis.

11.3.3 Clinical Manifestation

It is difficult to distinguish acute right colonic diverticulitis from acute appendicitis according to symptoms and clinical characteristics. However, the clinical manifestation of ARCD seems to be a little different from those of acute appendicitis. Relatively long-lasting right lower abdominal pain, lateralized right abdominal pain, less nausea and vomiting, and ache starting from the right lower abdomen have been reported to be more specific for ARCD [48]. Also pain migration from the upper abdomen to the right lower abdomen is more characteristic for acute appendicitis than for ARCD. Clinical diagnostic criteria and scoring model for better preoperative diagnosis of ARCD were proposed. Patients are scored upon clinical presentation based on major diagnostic criteria (two points for each symptom) and minor diagnostic criteria (one point for each symptom). Major diagnostic criteria include no pain migration to the right lower abdomen, a leukocyte count of $<10{,}000\ mm^{-3}$, lateralized abdominal pain, and a history of right colonic diverticulum. Minor diagnostic criteria include a history of right lower abdominal pain, no symptoms of nausea or vomiting, symptoms of constipation or diarrhea, and abdominal pain for at least seven days. Score ≥ 3 points is associated with high sensitivity

(85%) but low positive predictive value (28%) [49]. These clinical criteria and scoring model should help to distinguish patients with right lower abdominal pain and high suspicion for ARCD. CT scan should be considered in the event of high clinical suspicion for diverticulitis.

11.3.4 Laboratory Test

WBC count and CRP are generally used for diagnosis of inflammatory complication of the diverticula. In the event of right lower abdominal pain, WBC count has been identified as a useful biomarker discriminating ARCD and acute appendicitis. It was reported that leukocytosis with a left shift is associated more frequently with acute appendicitis than ARCD [46]. It was mentioned above that a leukocyte count of <10,000 mm^{-3} is used as major diagnostic criterion.

11.3.5 Imaging

Computed tomography scan, ultrasound, and magnetic resonance imaging have all been described as effective modalities to differentiate acute right colonic diverticulitis from other intra-abdominal pathology. CT scan has a documented diagnostic accuracy rate of 90% to 95% [50]. However, routine computed tomography in all patients with right lower abdominal pain is not cost-effective. CT scan should be recommended in patients with clinical findings of increased risk of ARCD. CT findings of ARCD are similar to those of acute left-sided diverticulitis, which include thickening of fascial planes, pericolic fat stranding, colonic wall thickening, the presence of an extraluminal mass, and the presence of an extraluminal free air and intraperitoneal fluid. Ultrasound is another widely used modality for assessing right lower abdominal pain. US has 91.3% sensitivity and 99.8% specificity for correct diagnosis of ARCD, but ultrasound examination has to be performed by an experienced operator. Similarly, a step-up diagnostic approach may be recommended. CT should be considered in patients with US findings or clinical findings of suspected acute diverticulitis [50].

11.3.6 Diagnosis and Differential Diagnosis

Historically, the preoperative diagnosis rate of ARCD is extremely low, accounting for 4–16% [50], since there are no clinical signs of symptoms that are truly specific for acute diverticulitis. Moreover, the differential diagnosis of acute diverticulitis includes other etiologies of right lower abdominal pain—acute appendicitis, Crohn's disease, perforation by a foreign body, tumors of the appendix, gastroenteritis, urological disease and gynecological disease, etc. ARCD can be accurately diagnosed and distinguished from most other causes of lower abdominal pain by imaging (CT) only.

11.3.7 Treatment

The correct pretreatment diagnosis of ARCD allows clinicians to determine optimal management according to the severity of the diverticulitis. Patient may avoid unnecessary surgery because ARCD without complications can be treated medically. However, in many cases the correct diagnosis is made intraoperatively.

If a preoperative diagnosis of uncomplicated ARCD is made, patient management should consist of bowel rest and intravenous antibiotics. Reported recurrence rate after first attack of uncomplicated acute diverticulitis ranges 9.9–12.6% [51, 52]. Most of the recurrent attacks of ARCD have indolent course and may be successfully managed with medical therapy. Elective surgery should be considered in cases of frequent recurrence that interfere with activities of daily living. Patients who present with abscess, but nevertheless are hemodynamically stable, should be treated with percutaneous drainage, bowel rest, and intravenous antibiotics. Patients with perforation and diffuse peritonitis or who are clinically unstable should be taken for immediate operative intervention.

If the correct diagnosis is made intraoperatively, the surgical management of the disease is controversial. With the exception of isolated cecal diverticulitis, no consensus currently exists on optimal treatment of patients with ARCD found incidentally at time of operation. Less extensive management with prophylactic appendectomy and postoperative antibiotics has been suggested for the uncomplicated ARCD diagnosed intraoperatively. Prophylactic appendectomy is justified to avoid misdiagnosis in case of future episodes of acute diverticulitis. On the other hand, some surgeons advocate surgical therapy ranging from diverticulectomy and ileocecal resection to right hemicolectomy and depending on the extent of inflammation. Resection of all diverticula is usually suggested because surgery prevents the recurrence of acute diverticulitis. However, it is impossible to determine all the locations of the diverticula without inflammation during surgery. Immediate right hemicolectomy should be considered in cases of extensive inflammatory changes, multiple diverticula, and cecal phlegmon. When malignant disease is suspected, the right hemicolectomy is recommended as well. Surgical resection can be safely performed even in an unprepared colon with few postoperative complications. In cases of isolated cecal diverticulitis, resection is strongly recommended.

11.3.8 Prognosis

ARCD has usually an indolent course and low rate of complicated diverticulitis at first attack. Conservative management and surgery treatment are safe and effective in most patients. Therefore, the therapy outcomes are far more favorable compared to ALCD.

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