Changing paradigms in the management of acute uncomplicated diverticulitis

A. Chabok1,2, A Thorisson2,3, M. Nikberg1,2, J. K. Schultz4 and V Sallinen5,6

Abstract
Left-sided colonic diverticulitis is a common condition with significant morbidity and health care costs in Western countries. Acute uncomplicated diverticulitis which is characterized by the absence of organ dysfunction, abscesses, fistula, or perforations accounts for around 80% of the cases. In the last decades, several traditional paradigms in the management of acute uncomplicated diverticulitis have been replaced by evidence-based routines. This review provides a comprehensive evidence-based and clinical-oriented overview of up-to-date diagnostics with computer tomography, non-antibiotic treatment, outpatient treatment, and surgical strategies as well as follow-up of patients with acute uncomplicated diverticulitis.

Keywords
Colonic diverticulitis, acute uncomplicated diverticulitis, antibiotics, surgery, cancer

Introduction
Diverticular disease was first described during the 19th century by anatomists who described the development of the disease with inflammation and its complications including the formation of abscesses and fistulae (1–3). The disease was described as a surgical rarity during the 19th century. At the beginning of the 20th century, Bland-Sutton noted that the incidence had risen dramatically between 1910 and 1920 (4). In 1916, Telling and Gruner published a comprehensive description of diverticulosis and diverticulitis (5). Burkitt and Painter drew attention to the rate of diverticulitis during the 1960s and 1970s and reported the dependence of environmental factors and that differences in incidence between countries were associated with their level of economic development (6).

Colonic diverticulosis is a common condition affecting up to 70% of the population in Western countries by the age of 80 (7–9). However only 4%–5% of patients will develop symptomatic disease, most commonly acute diverticulitis, and about 20% of these patients will have complicated diverticulitis (10–14). Thus, acute diverticulitis usually has an uncomplicated course, which is characterized by the absence of organ dysfunction, abscesses, fistula, or perforations. This review provides a comprehensive evidence-based and clinical oriented overview of up to date diagnostics, medical, and surgical treatment as well as follow-up of patients with acute uncomplicated diverticulitis.

Diagnostics
Clinical diagnosis
The most common presentation of patients with diverticulitis is pain in the left lower abdominal quadrant and changes
in bowel habits (constipation or diarrhea) with or without fever. These symptoms are non-specific, and the clinical diagnosis of diverticulitis has a sensitivity of only 45%–72% (15–20); however, the diagnostic accuracy of acute diverticulitis may be increased to 86% with a combination of direct left-sided tenderness, absence of vomiting, and a C-reactive protein (CRP) > 50 mg/L (21,22). Common differential diagnoses for acute diverticulitis include appendicitis, colitis, epiploic appendagitis, and cancer.

**Radiology**

To confirm the diagnosis and to differentiate uncomplicated from complicated disease, radiological examination is needed. Since the introduction of computed tomography (CT) during the latter part of the 20th century, this modality has taken over as the primary examination method as it has excellent sensitivity for acute diverticulitis, and is rapid and relatively inexpensive to carry out (18,19,23). However, both ultrasonography (US) and magnetic resonance imaging (MRI) are viable alternatives. US is inexpensive and has high spatial resolution and is as sensitive as CT in the hands of an experienced radiologist, with the advantage of delivering no ionic radiation to the patient (24,25). However, the specificity of CT compared to US is higher (96% vs 90%), and US is highly operator-dependent and time-consuming (26). MRI is sensitive to the presence of diverticulitis; however, it is time-consuming, expensive, and susceptible to motion artifacts from the large bowel that can reduce image quality (27). MRI can be used in pregnant patients and has advantages in fistula diagnostics (28).

Even though CT is the most common examination tool used for suspected diverticulitis, CT examination protocols (exposure and choice of contrast) differ between countries and hospitals. In most Nordic countries, full-dose CT with intravenous contrast is used (Fig. 1). The use of rectal contrast medium, which is invasive and uncomfortable for the patient, is considered to add limited information in the acute setting. However, it can be advantageous in patients with chronic diverticulitis, especially for visualizing a fistula tract (29). Although low radiation-dose CT without intravenous contrast has a high sensitivity for diverticulitis, smaller perforations and small pericolic or intramural abscesses can be missed using this technique (30). Therefore, a full-dose CT protocol with intravenous contrast is recommended for patients with suspected acute diverticulitis.

**Changes in treatment regimens**

In the pre-antibiotic era, treatment of diverticulitis consisted of bed rest and no or low residual diet. These treatments had a rather high symptomatic success rate (31). Despite the lack of controlled studies, antibiotics have been used to treat uncomplicated diverticulitis for many years. The reason for this recommendation was the belief that acute diverticulitis is caused by the translocation of intestinal bacteria through the mucosa, resulting in bacterial infection. However, the observation that many patients already showed improvements after one dose of antibiotics and sometimes even before receiving antibiotics raised the question as to whether the improvement was actually in response to antibiotics. This was the background for the first and largest to date randomized controlled trial (RCT; the AVOD study) to evaluate the effect of antibiotics on recovery from acute uncomplicated diverticulitis (32). That study showed that antibiotic treatment neither prevents complications and recurrences nor does it reduce symptoms or length of hospital stay. The findings were confirmed in two other RTCs with patient cohorts from Netherlands and New Zealand/Australia (33,34). In addition, several prospective cohort studies with similar findings, from different countries have been published (Table 1) (20,36,38,39).

A long-term follow-up of the AVOD trail with data on 556 patients of the 623 originally included with a mean follow-up time of 11 years showed that antibiotics omission was safe in the long-term (36). The long-term safety of a non-antibiotic treatment protocol was further confirmed by van Dijk et al. (35) with an analysis of long-term data for patients included in the DIABOLO trial.

Strict patient selection in randomized studies is a drawback, and further studies in a population-based setting are necessary for external validity. Following the findings from RCTs, several retrospective population-based observational studies have shown the implementation and the safety of a non-antibiotics policy for AUD (12,40,41). In the light of this new evidence, several international surgical and gastroenterological organizations and have adopted the non-antibiotic policy for AUD (11,42–46). However, gastroenterological organizations in the United State have been more conservative in changing their recommendations (47,48). Interestingly, in a collaboration project between the European and American societies of endoscopic surgery (EAES and SAGES)
non-antibiotic policy in AUD was an area of disagreement. Only 26% of the members agreed on the consensus policy and as many as 50% disagreed that the available evidence would change their practice (49). This illustrates that strong evidence alone may not be enough to change traditional treatment habits. Further efforts are needed to convince colleagues around the world that in the absence of septicemia, antibiotics have no place in the management of immunocompetent patients with AUD.

**Inpatient versus outpatient treatments**

In recent years, outpatient treatment has gained much attention. In a systematic review, outpatient treatment in selected groups was shown to be safe, reduced healthcare costs considerably, and did not increase the risk of complications, revealing a pooled readmission rate of 7% and very low rates of surgical intervention (50,51). The concept of outpatient treatment without antibiotics was studied for the first time in a prospective cohort study (the PVOD trial) including 155 patients with CT-verified AUD (37). Only four patients (2.6%) were readmitted to hospital because of treatment failure, with none of them requiring surgical intervention. In 2018, Isacson et al. (52) showed that the outpatient regimen for uncomplicated diverticulitis halved the healthcare costs for this patient group with no increased risk of complications. Similarly, in another prospective trial, 140 patients with uncomplicated diverticulitis were treated as outpatients without antibiotics and only four (3%) needed to be admitted to the hospital during follow-up (38). The presented treatment failure rates in the literature vary between 3% and 11% for outpatient treatment (Table 2) (53,54). The first randomized trial on non-antibiotic outpatient treatment of uncomplicated diverticulitis (DINAMO study) presented at the virtual ESCP meeting in 2020 showed similar results to the PVOD trial. However, an outpatient regimen should only be considered in patients with low comorbidity, proven immunocompetence, and the ability to tolerate oral intake.

**Surgery—is it necessary?**

In 1916, Telling stated in the British Journal of Surgery that the treatment of diverticula and diverticulitis “comprised in one word—Surgery” (5). Much has changed since then, and there is now a broad consensus that acute surgery is not indicated in patients with AUD. Even minor complications like small abscesses or covered perforations with extra luminal air can normally be handled conservatively, whereas emergency surgery is mainly reserved to severe complications (bowel obstruction or free perforation with peritonitis) (55,56). Elective sigmoid resection after one or more episodes of uncomplicated diverticulitis has been advocated after two episodes of uncomplicated diverticulitis (57–59). The rational was to prevent complications. However, several studies have shown that the risk of severe complications decreases with the number of diverticulitis episodes (14,60–63). Consequently, international guidelines have been revised, and there is a consensus that the decision for elective resection should be individualized and not based on the number of previous episodes (49,64). The only
legitimate goal of sigmoid resection in an elective setting is to improve the patient’s quality of life. Generally, there are two categories of patients: those with frequent recurrences of AUD and those with ongoing symptoms after an episode of uncomplicated diverticulitis.

There is a variety of mainly retrospective cohort studies investigating elective surgery after uncomplicated diverticulitis, all of which were hampered by a high risk of selection bias (65–69). Fortunately, two RCTs comparing conservative treatment to elective sigmoid resection for recurrent or persistent painful diverticulitis have been published: DIRECT and LASER trials (70,71). The trials’ design was highly similar, but DIRECT trial has published results of 5-year follow-up, while LASER trial has only results for 6-month follow-up. A significant difference in health-related quality of life (HRQoL) favoring surgery was observed after 6 months in both trials, but also at 1 year and 5 years in DIRECT trial (70,72). However, premature abortion of both trials (DIRECT trial due to low recruitment and LASER trial due to benefit in interim analysis) may have led to an overestimation of the effect size (73). Although both trials favor elective sigmoid resection for patients with three or more episodes of diverticulitis within 2-year period, the risks of surgery must be born in mind. Risk for stoma was 5%–21%, and severe complication requiring reoperation occurred in 10%–28% patients randomized to surgery arm (70,71). From an economical point of view and based on DIRECT trial data, elective sigmoid resection was also found to be cost-effective (74). Both trials were open-labeled, and a placebo effect in HRQoL results is likely. Although there was minimal (4%) cross-over from conservative treatment to surgery in LASER trial during the first 6 months, significant amount of patients crossed over to surgery in DIRECT trial (23% within 6 months, 46% at 5 years), which means that the results must be interpreted with caution. Key studies on elective sigmoid resection after uncomplicated diverticulitis are summarized in Table 3 (65–72).

Any decision on sigmoid resection in patients with AUD should be individualized, and the advantages of elective sigmoid resection, namely superior HRQoL, lower pain, and fewer recurrences, need to be balanced against the significant risk of major complications of surgery.

Surgical techniques

Although evidence is limited, currently elective sigmoid resection with primary anastomoses is usually performed with minimal invasive techniques (75). Hartmann’s procedure or temporary diversion of colonic anastomoses is preserved in patients with severe comorbidity or in cases with anastomotic complications. The main advantages of the laparoscopic approach are faster recovery, reduced wound infection rates and a reduced frequency of hernias; however, the conversion rates to open surgery is around 13% (76,77). Robotic sigmoid resection compared to laparoscopic resection might result in lower conversion rates of around 8% (77). More controversial is the extent of colonic resection and whether a central vessel ligation should be performed. Based on retrospective cohort studies, it is widely recommended that the lower resection margin should be at the colorectal junction and that all macroscopically inflamed bowel should be removed (78,79). However, there is no evidence for the removal of all diverticula-bearing proximal colon. Furthermore, there is no rationale for central vessel ligation in diverticular disease when malignancy has been ruled out. As central vessel ligation bears a theoretical risk of impaired perfusion of the colorectal anastomosis and a risk of nerve damage, it is not generally recommended. However, the evidence for this recommendation is sparse (80).
Follow-up

There is no consensus in the literature with regards to the need for a routine colonic examination after an episode of AUD. Meta-analyses of studies on cancer prevalence after an episode of acute diverticulitis have shown varying results with a prevalence of malignancy of 0.5%–2% for uncomplicated diverticulitis and 7.9%–10.8% for complicated diverticulitis (81,82). Given the high rate of carcinoma in patients diagnosed with complicated diverticulitis, all patients treated non-surgically for complicated diverticulitis should undergo a colonic examination to rule out malignancy. In patients with CT-verified uncomplicated diverticulitis, the prevalence for colorectal cancer is similar to predicted prevalence in screening populations of similar age in the majority of studies (32,83–88). However, some studies have found higher cancer prevalence in patients with diverticulitis, making omission of routine follow-up colonoscopy difficult (20,89).

In our opinion, omission of a routine follow-up colonoscopy could be considered in patients with CT-verified uncomplicated diverticulitis, where the CT scans have been re-evaluated by a gastrointestinal radiologist, the patient has no sign of colorectal cancer such as anemia, haematochezia, or change in bowel habit and where the symptoms of diverticulitis have diminished at a 4-week follow-up.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Supported by research grants from the County of Västmanland Sweden.

ORCID iDs

A. Chabok https://orcid.org/0000-0001-9662-5045
J. K. Schultz https://orcid.org/0000-0002-9427-2087

References

1. Voigtel. Verdauungsorgane. Vom Darmkanal überhaupt. Handbuch Der Pathologischen Anatomie Vol 2. Magdeburg: Hemmerde Und Schwetschke, 1804, pp. 573–577.
2. Cruveilhier J: Traité d’Anatomie Pathologique Généralé. Paris: Bailliere, 1849.
3. Graser E: Das falsche Darmdivertikel. Arch Klin Chir 1899;59:638–647.
4. Bland-Sutton J: Proceedings of the Royal Society of Medicine, section of surgery. 1920;13(64).
5. Telling W: Acquired diverticula, diverticulitis and peridiverticulitis of the large intestine. Br J Surg 1917;4:468–530.
6. PainterNS,BurkittDP:Diverticulardiseaseofthecolon:DeficiencydiseaseofWesterncivilization. BrMedJ1971;2(5759):450–454.
7. Jacobs DO: Clinical practice. Diverticulitis. N Engl J Med 2007;357(20):2057–2066.
8. Peery AF, Keku TO, Martin CF et al: Distribution and characteristics of colonic diverticula in a United States screening population. Clin Gastroenterol Hepatol 2016;14(7):980–985.
9. Shahbazadeh DM Wille-Jorgensen P: Antibiotics for uncomplicated diverticulitis. Cochrane Database Syst Rev 2012;11:CD009092.
10. Shahedi K, Fuller G, Bolus R et al: Long-term risk of acute diverticulitis among patients with incidental diverticulosis found during colonoscopy. Clin Gastroenterol Hepatol 2013;11(12):1609–1613.
11. Andersen JC, Bundgaard L, Elbrond H et al: Danish national guidelines for treatment of diverticular disease. Dan Med J 2012;59(5):C4453.
12. Chabok A, Andreasson K, Nikberg M: Low risk of complications in patients with first-time acute uncomplicated diverticulitis. Int J Colorectal Dis 2017;32(12):1699–1702.
13. Biondo S, Lopez Borao J, Millan M et al: Current status of the treatment of acute colonic diverticulitis: A systematic review. Colorectal Dis 2012;14(1):e1–e11.
14. Alexandersson BT, Stefansson T: Incidence and recurrence rate of sigmoid diverticulitis in patients requiring admission to hospital in Iceland from 1985 to 2014: Nationwide population-based register study. BJIS Open 2020;4:1217–1226.
15. Goh H, Bourne R: Non-steroidal anti-inflammatory drugs and perforated diverticular disease: A case-control study. Ann R Coll Surg Engl 2002;84(2):93–96.
16. Wilson RG, Smith AN, Macintyre IM: Complications of diverticular disease and non-steroidal anti-inflammatory drugs: A prospective study. Br J Surg 1990;77(10):1103–1104.
17. Hiltunen KM, Kolehmainen H, Vuorinen T et al: Early water-soluble contrast enema in the diagnosis of acute colonic diverticulitis. Int J Colorectal Dis 1991;6(4):190–192.
18. Rao PM, Rhea JT, Novelline RA et al: Helical CT with only colonic contrast material for diagnosing diverticulitis: Prospective evaluation of 150 patients. AJR Am J Roentgenol 1998;170(6):1445–1449.
19. Werner A, Diehl SJ, Farag-Soliman M et al: Multi-slice spiral CT in routine diagnosis of suspected acute left-sided colonic diverticulitis: A prospective study of 120 patients. Eur Radiol 2003;13(12):2596–2603.
20. Azhar N, Buchwald P, Ansari HZ et al: Risk of colorectal cancer following CT-verified acute diverticulitis: A nationwide population-based cohort study. Colorectal Dis 2020;22(10):1406–1414.
21. Andeweg CS, Knoblen B, Hendriks JC et al: How to diagnose acute left-sided colonic diverticulitis: Proposal for a clinical scoring system. Ann Surg 2011;253(5):940–946.
22. Lameris W, van Randen A, van Gulik TM et al. A clinical decision rule to establish the diagnosis of acute diverticulitis at the emergency department. Dis Colon Rectum 2010;53(6):896–904.
23. Rotter H, Noldge G, Encke J et al: [The value of CT for the diagnosis of acute diverticulitis]. Radiologe 2003;43(1):51–58.
24. Liljegren G, Chabok A, Wickbom M et al: Acute colonic diverticulitis: A systematic review of diagnostic accuracy. Colorectal Dis 2007;9(6):480–488.
25. Lembcke B: Diagnosis, differential diagnoses, and classification of diverticular disease. Viszeralmedizin 2015;31(12):95–102.
26. Andeweg CS, Wegdam JA, Groenewoud J et al: Toward an evidence-based step-up approach in diagnosing diverticulitis. Scand J Gastroenterol 2014;49(7):775–784.
27. Severhan J, Sitter H, Zielke A et al: Prospective evaluation of the value of magnetic resonance imaging in sus-
pected acute sigmoid diverticulitis. Dis Colon Rectum 2008;51(12):1810–1815.
28. VanBuren WM, Lightner AL, Kim ST et al: Imaging and surgical management of anorectal vaginal fistulas. Radiographics 2018;38(5):1385–1401.
29. Sugi MD, Sun DC, Menias CO et al: Acute diverticulitis: Key features for guiding clinical management. Eur J Radiol 2020;128:109026.
30. Thorisson A, Nikberg M, Torkzad MR et al: Diagnostic accuracy of acute diverticulitis with unenhanced low-dose CT. BJNS Open 2020;4(4):659–665.
31. Rankin F: Diverticulitis of the colon. Surg Gynecol Obstet 1930;50:836–847.
32. Chabok A, Pahlman L, Hjern F et al: Randomized clinical trial of antibiotics in acute uncomplicated diverticulitis. Br J Surg 2012;99(4):532–539.
33. Daniels L, Ünlü Ç, de Korte N et al: Randomized clinical trial of observational versus antibiotic treatment for a first episode of CT-proven uncomplicated acute diverticulitis. Br J Surg 2017;104(1):52–61.
34. Jaung R, Nisbet S, Gosselink MP et al: Antibiotics do not reduce length of hospital stay for uncomplicated diverticulitis in a pragmatic double-blind randomized trial. Clin Gastroenterol Hepatol 2020;19:503–510.e1.
35. van Dijk ST, Daniels L, Ünlü Ç et al: Long-term effects of omitting antibiotics in uncomplicated acute diverticulitis. Am J Gastroenterol 2018;113(7):1045–1052.
36. Isacson D, Smedh K, Nikberg M et al: Long-term follow-up of the AVOD randomized trial of antibiotic avoidance in uncomplicated diverticulitis. Br J Surg 2019;106(11):1542–1548.
37. Isacson D, Thorisson A, Andreasson K et al: Outpatient, non-antibiotic management in acute uncomplicated diverticulitis: A prospective study. Int J Colorectal Dis 2015;30(9):1229–1234.
38. Mali JP, Mentula PJ, Leppaniemi AK et al: Symptomatic treatment for uncomplicated acute diverticulitis: A prospective cohort study. Dis Colon Rectum 2016;59(6):529–534.
39. Estrada Ferrer O, Ruiz Edo N, Hidalgo Grau LA et al: Selective non-antibiotic treatment in sigmoid diverticulitis: Is it time to change the traditional approach. Tech Coloproctol 2016;20(5):309–315.
40. Brochmann ND, Schultz JK, Jakobsen GS et al: Management of acute uncomplicated diverticulitis without antibiotics: A single-centre cohort study. Colorectal Dis 2016;18(11):1101–1107.
41. Isacson D, Andreasson K, Nikberg M et al: No antibiotics in acute uncomplicated diverticulitis: Does it work. Scand J Gastroenterol 2014;49(12):1441–1446.
42. Andeweg CS, Mulder IM, Felt-Bersma RJ et al: Guidelines of diagnostics and treatment of acute left-sided colonic diverticulitis. Dig Surg 2013;30(4-6):278–292.
43. Binda GA, Cuomo R, Laghi A et al: Practice parameters for the treatment of colonic diverticular disease: Italian society of colon and rectal surgery (SICCR) guidelines. Tech Coloproctol 2015;19(10):615–626.
44. Lefeldt L, Germer CT, Bohm S et al: [S2k guidelines diverticular disease/diverticulitis]. Z Gastroenterol 2014;52(7):663–710.
45. Pietrzak A, Bartnik W, Szczepkowski M et al: Polish interdisciplinary consensus on diagnostics and treatment of colonic diverticulosis (2015). Pol Przegl Chir 2015;87(4):203–220.
46. Sartelli M, Catena F, Ansaloni L et al: WSES Guidelines for the management of acute left sided colonic diverticulitis in the emergency setting. World J Emerg Surg 2016;11:37.
47. Feingold D, Steele SR, Lee S et al: Practice parameters for the treatment of sigmoid diverticulitis. Dis Colon Rectum 2014;57(3):284–294.
48. Stollman N, Smalley W, Hirano I et al: American gastroenterological association institute guideline on the management of acute diverticulitis. Gastroenterology 2015;149(7):1944–1949.
49. Francis NK, Sylla P, Abou-Khalil M et al: EAES and SAGES 2018 consensus conference on acute diverticulitis management: Evidence-based recommendations for clinical practice. Surg Endosc 2019;33(9):2726–2741.
50. van Dijk ST, Bos K, de Boer MGJ et al: A systematic review and meta-analysis of outpatient treatment for acute diverticulitis. Int J Colorectal Dis 2018;33(5):505–512.
51. Cirocchi R, Randolph JJ, Binda GA et al: Is the outpatient management of acute diverticulitis safe and effective? A systematic review and meta-analysis. Tech Coloproctol 2019;23(2):87–100.
52. Isacson D, Andreasson K, Nikberg M et al: Outpatient management of acute uncomplicated diverticulitis results in health-care cost savings. Scand J Gastroenterol 2018;53(4):449–452.
53. Moya P, Arroyo A, Pérez-Legaz J et al: Applicability, safety and efficiency of outpatient treatment in uncomplicated diverticulitis. Tech Coloproctol 2012;16(4):301–307.
54. Biondo S, Golda T, Kreisler E et al: Outpatient versus hospitalization management for uncomplicated diverticulitis: A prospective, multicenter randomized clinical trial (DIVER Trial). Ann Surg 2014;259(1):38–44.
55. Gregersen R, Mortensen LQ, Burchardt J et al: Treatment of patients with acute colonic diverticulitis complicated by abscess formation: A systematic review. Int J Surg 2016;35:201–208.
56. Mali J, Mentula P, Leppaniemi A et al: Determinants of treatment and outcomes of diverticular abscesses. World J Emerg Surg 2019;14:31.
57. Roberts P, Abel M, Rosen L et al: Practice parameters for sigmoid diverticulitis. The standards task force american society of colon and rectal surgeons. Dis Colon Rectum 1995;38(2):125–132.
58. Kohler L, Sauerland S, Neugebauer E: Diagnosis and treatment of diverticulitis: Results of a consensus development conference. Surg Endosc 1999;13(4):430–436.
59. Wong WD, Wexner SD, Lowry A et al: Practice parameters for the treatment of sigmoid diverticulitis—Supporting documentation. Dis Colon Rectum 2000;43(3):290–297.
60. Haglund U, Hellberg R, Johnsen C et al: Complicated diverticular disease of the sigmoid colon. An analysis of short and long term outcome in 392 patients. Ann Chir Gynaecol 1979;68(2):41–46.
61. Ritz JP, Lehmann KS, Frericks B et al: Outcome of patients with acute sigmoid diverticulitis: Multivariate analysis of risk factors for free perforation. Surgery 2011;149(5):606–613.
62. Janes S, Meagher A, Frizelle FA: Elective surgery after acute diverticulitis. Br J Surg 2005;92(2):133–142.
63. Buchs NC, Konrad-Mugnier B, Jannot AS et al: Assessment of recurrence and complications following uncomplicated diverticulitis. Br J Surg 2013;100(7):976–979; discussion979.
64. Hall J, Hardiman K, Lee S et al: The American society of colon and rectal surgeons clinical practice guidelines for the treatment of left-sided colonic diverticulitis. Dis Colon Rectum 2020;63(6):728–747.

65. Boostrom SY, Wolff BG, Cima RR et al: Uncomplicated diverticulitis, more complicated than we thought. J Gastrointest Surg 2012;16(9):1744–1749.

66. Brandlhuber M, Genzinger C, Brandlhuber B et al: Long-term quality of life after conservative treatment versus surgery for different stages of acute sigmoid diverticulitis. Int J Colorectal Dis 2018;33(3):317–326.

67. Santos A, Mentula P, Pinta T et al: Comparing laparoscopic sigmoid resection in diverticular disease. Ann Surg 2010;251(4):670–674.

68. Polese L, Bressan A, Savarino E et al: Quality of life after laparoscopic sigmoid resection for uncomplicated diverticulitis. Int J Colorectal Dis 2018;33(5):513–523.

69. von Strauss Und Torney M, Thommen S, Dell-Kuster S et al: Surgical treatment of uncomplicated diverticulitis in Switzerland: Comparison of population-based data over two time periods. Colorectal Dis 2017;19(9):840–850.

70. van de Wall BJM, Stam MAW, Draaisma WA et al: Surgery versus conservative management for recurrent and ongoing left-sided diverticulitis (DIRECT trial): An open-label, multicentre, randomised controlled trial. Lancet Gastroenterol Hepatol 2017;2(1):13–22.

71. Santos A, Mentula P, Pinta T et al: Comparing laparoscopic elective sigmoid resection with conservative treatment in improving quality of life of patients with diverticulitis: The laparoscopic elective sigmoid resection following diverticulitis (LASER) randomized clinical trial. JAMA Surg 2020;156:129–136.

72. Bolkenstein HE, Consten ECJ, van der Palen J et al: Long-term outcome of surgery versus conservative management for recurrent and ongoing complaints after an episode of diverticulitis: 5-year follow-up results of a multicenter randomized controlled trial (DIRECT-Trial). Ann Surg 2019;269(4):612–620.

73. Bassler D, Briel M, Montori VM et al: Stopping randomized trials early for benefit and estimation of treatment effects: Systematic review and meta-regression analysis. JAMA 2010;303(12):1180–1187.

74. Bolkenstein HE, de Wit GA, Consten ECJ et al: Cost-effectiveness analysis of a multicentre randomized clinical trial comparing surgery with conservative management for recurrent and ongoing diverticulitis (DIRECT trial). Br J Surg 2019;106(4):488–497.

75. Abrahá I, Binda GA, Montedori A et al: Laparoscopic versus open resection for sigmoid diverticulitis. Cochrane Database Syst Rev 2017;11: CD009277.