Published in final edited form as:

Abdom Radiol (NY). 2018 August ; 43(8): 2060–2065. doi:10.1007/s00261-017-1422-y.

Surgical management in acute diverticulitis and its association with multi-detector CT, modified Hinchey classification, and clinical parameters

David D. B. Bates^{1,5}, Marina Bernal Fernandez¹, Cecilia Ponchiardi², Michael von Plato³, Joshua P. Teich³, Chaitan Narsule⁴, Stephan W. Anderson¹, Avneesh Gupta¹, Christina A. LeBedis¹

¹Department of Radiology, Boston University Medical Center, Boston, MA, USA

²Department of Pathology, Boston University Medical Center, Boston, MA, USA

³Boston University School of Medicine, Boston, MA, USA

⁴Department of Surgery, Boston University Medical Center, Boston, MA, USA

⁵Department of Radiology, Memorial Sloan Kettering Cancer Center, 1275 York Ave, New York, NY 10065, USA

Abstract

Purpose: To assess whether CT findings, clinical parameters, and modified Hinchey classification are predictive of management outcomes of patients with acute diverticulitis.

Materials and methods: Data were accrued between January 2014 and December 2015. A total of 301 adult subjects were identified from radiology reports, of which six who did not meet the inclusion criteria were excluded, thus yielding 295 subjects. Subjects were 43.1% ($n = 127$) male and 56.9% female ($n = 168$), with mean age 51.9 years (range 18–90). Two independent abdominal radiologists reviewed all scans; imaging features and a modified Hinchey classification were scored. Descriptive statistics compared the relationships between imaging findings, clinical parameters obtained from medical record review, and modified Hinchey classification with management outcomes.

Results: CT findings associated with surgical management include the presence of a pericolic fluid collection (36.8% vs. 8.2%, $P = 0.0001$), colonic fistula (13.2% vs. 0.4%, $P = 0.0002$), extraluminal air (26.4% vs. 9.3%, $P = 0.0052$), bowel obstruction (5.2% vs. 0.0%, $P = 0.0162$),

Correspondence to: David D. B. Bates; batesd@mskcc.org.

Compliance with ethical standards

Conflict of interest Dr. Bates declares that he has no conflict of interest. Dr. Bernal Fernandez declares that she has no conflict of interest. Dr. Ponchiardi declares that she has no conflict of interest. Dr. von Plato declares that he has no conflict of interest. Dr. Teich declares that he has no conflict of interest. Dr. Narsule declares that he has no conflict of interest. Dr. Anderson declares that he has no conflict of interest. Dr. Gupta declares that he has no conflict of interest. Dr. LeBedis declares that she has no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was waived by the institutional review board.

and a modified Hinchey score of Ib or higher (55.3% vs. 11.7%, $P=0.0001$). Slightly lower systolic blood pressure was also associated with operative management (137.2 mmHg vs. 128.2 mmHg, $P=0.0220$).

Conclusion: Specific CT imaging features and modified Hinchey classification are associated with subsequent surgical management in patients with acute diverticulitis.

Keywords

Diverticulitis; Hinchey; Abscess; Management; Colon; Computed tomography

It is estimated that as much as half of the adult population in the United States has colonic diverticulosis, and 10–25% may go on to develop acute diverticulitis [1]. An analysis of recent annual discharge data found that acute diverticulitis was responsible for over 300,000 hospitalizations annually in America [2]. It is reasonable to conclude that acute diverticulitis is a considerable public health problem.

The management of patients with acute diverticulitis has evolved in recent years. In 2000, the American Society of Colon and Rectal Surgeons stated that an elective colectomy should be considered following an episode of complicated acute diverticulitis [3]. Acute diverticulitis is considered complicated when there is an associated abscess, bowel perforation, bowel obstruction, fistula, or stricture. For cases of uncomplicated acute diverticulitis, i.e., those that lack the above-mentioned features, the decision to pursue an elective colectomy should be determined on an individual basis [3]. Cases requiring emergent colectomy include patients who fail conservative management or who have peritonitis, and an emergent colectomy is considered appropriate when purulent or feculent peritonitis is present [3]. However, some surgeons have begun to explore the role of laparoscopic lavage and drainage for patients with purulent peritonitis (Hinchey III), though this approach remains controversial [4, 5]. In fact, recent evidence suggests that there is much controversy around the management of acute diverticulitis, even within the same geographic region [6, 7].

In recent years, a trend has emerged in the surgical literature moving toward non-operative management of patients with acute diverticulitis. Several studies have shown non-operative management to be a safe alternative to colectomy in cases of uncomplicated diverticulitis [8–10]. Although the rates of recurrent episodes of acute diverticulitis in patients managed conservatively were not insignificant, the overall risk of mortality was low [8, 9].

Several studies have explored the relationship between specific CT findings of acute diverticulitis and subsequent clinical outcomes, with mixed results [11–16]. To our knowledge, no studies have compared the relationship of modified Hinchey classification on CT with subsequent surgical management outcomes. Briefly, the Hinchey Classification was first described in 1978 [17] and was used a decade later to compare surgical outcomes by Wasvary et al. [18]. Originally a surgical classification system, the criteria were summarized and adapted by Kaiser et al. for use in CT interpretation [19]. Although multiple authors have put forth additional proposals for classification systems since then [20], the Hinchey classification is the most widely known and accepted among surgeons at this time.

The purpose of this study is to assess whether CT findings, clinical parameters, and modified Hinchey classification are associated with the need for subsequent surgical management of patients presenting to the emergency department with acute diverticulitis.

Materials and methods

This retrospective study was performed at a single urban academic medical center and was in compliance with the Health Insurance Portability and Accountability Act. Prior to beginning the study, approval was obtained from the institutional review board. Informed consent was waived.

Adult patients (mean age 51.9 years, range 18–90) were included if they were diagnosed with acute diverticulitis in the Emergency Department (ED) by a CT scan of the abdomen and pelvis performed with intravenous contrast. All reports from contrast-enhanced abdominopelvic CT scans performed in the Emergency Department over a 2-year period (January 1, 2014–December 31, 2015) were used to identify 301 potential subjects. Two fellowship-trained abdominal imaging radiologists C.L. and A.G. with, respectively, 8 and 12 years of experience independently reviewed the CT scans for these patients. Scans were evaluated for the presence of specific imaging features, including bowel wall thickening (≥ 5 mm), diverticulosis, an inflamed diverticulum, pericolic inflammation, a pericolic fluid collection, bowel obstruction, free fluid, extraluminal air (local or diffuse), bowel wall abscess, and colonic fistula. Readers were also asked to provide a modified Hinchey score for each case. Examples of the modified Hinchey classification are shown in Fig. 1. In cases of disagreement, the study radiologists reviewed the images and consensus was reached.

In addition, a review of the medical charts was performed with attention to certain clinical parameters at the time of presentation, including the number of previous episodes of diverticulitis, temperature, serum white blood cell count, systolic blood pressure, and serum lactate levels. Patients were included in the surgical cohort if they underwent surgery at any time since the presentation of acute diverticulitis included in the study period.

Patients were included if both interpreting radiologists agreed that with the diagnosis of acute diverticulitis after interpreting the CT scan. Following review of the CT images and medical records, six patients were excluded from the cohort, including three due to imaging findings (two epiploic appendagitis, one colitis), two due to incomplete medical charts, and one patient who was scanned twice during the same ED visit. Thus, the final cohort consisted of 295 patients, of which 43.1% (127) were male and 56.9% (168) were female, with a mean age of 51.9 years (range 18–90).

Fisher's exact test and Student's *t* test were performed to compare data from the two groups, with $P < 0.05$ being considered statistically significant.

Results

There was no significant difference between the age of the surgical and non-surgical subjects ($P = 0.909$), 50.0 years (range 26–86 years) and 54.0 years (range 18–90 years), respectively. The surgical group comprised 31.6% male and 68.4% female, as opposed to 45.8% male and

54.2% female in the non-surgical group, which was also not significantly different ($P=0.160$).

Regarding the clinical parameters, a slightly lower systolic blood pressure was seen in the cohort treated surgically, 128.2 mmHG vs. 137.2 mmHG ($P=0.022$). There was no difference in the number of previous episodes of acute diverticulitis, with an average of 1.5 previous episodes for the surgical group vs. 1.6 for the non-surgical group ($P=0.349$). There was also no statistically significant difference in the temperature (98.6 F vs. 98.4 F, $P=0.2270$), white blood cell count (11.3 k/mL vs. 11.9 k/mL, $P=0.4285$), or serum lactate levels (1.5 mg/dL vs. 1.9 mg/dL, $P=0.353$). The mean and median time to surgery for the operative group were 71.6 days (range 0–418, standard deviation 93.1) and 31.5 days, respectively.

Regarding the specific imaging features on CT, findings associated with surgical management included the presence of a pericolic fluid collection (36.8% vs. 8.2%, $P=0.0001$), free intraperitoneal air ($P=26.3\%$ vs. 9.3%, $P=0.0052$), small or large bowel obstruction (5.2% vs. 0%, $P=0.0162$), and colonic fistula (13.2% vs. 0.4%, $P=0.0002$). The presence of free air was more likely to be associated with surgery when it was diffuse rather than local, as 70.0% of patients with diffuse free air underwent surgery, whereas just 16.7% of patients with localized free air underwent surgery ($P=0.0147$). Additionally, a Hinchey classification score of Ib or higher was more significantly associated with surgery than Hinchey scores of Ia (55.3% vs. 11.7%, $P=0.0001$). Specific CT findings that were not significantly different between the surgical and non-surgical groups include bowel wall thickening (98.8% vs. 97.4%, $P=1.000$), diverticulosis (99.6% vs. 100%, $P=1.000$), an inflamed diverticulum (95.7% vs. 94.7%, $P=0.6675$), pericolic inflammation ($P=0.2414$), diffuse free fluid (1.6% vs. 2.6%, $P=0.5007$), and the presence of a bowel wall abscess smaller than 4 cm (2.3% vs. 5.3%, $P=0.2751$) (Figs. 2, 3).

The clinical parameters and imaging features, including modified Hinchey classification scores, are summarized in Tables 1 and 2, respectively. Interobserver agreement is summarized in Table 3.

Discussion

As surgeons gravitate toward conservative management of acute diverticulitis when possible, information regarding clinical and imaging features associated with management outcomes is useful in guiding patient management. Several conclusions can be drawn from this study.

First, the clinical parameters examined generally do not predict which patients will subsequently go on to surgical management. The only significant finding in this area was a slightly lower systolic blood pressure in the group that went on to surgery. This finding is likely of limited significance, since the mean systolic blood pressure in both groups was not hypotensive, and was normal in the surgical cohort. Since the differences in gender were not significantly different, that alone cannot explain the discrepancy in systolic blood pressure. The number of previous episodes of acute diverticulitis, temperature, white blood cell count, and serum lactate levels were not predictive of management outcomes.

Second, we demonstrate that certain specific CT findings are associated with the need for subsequent surgical management, including the presence of a pericolic fluid collection, free intraperitoneal air, bowel obstruction, and colonic fistula. Interestingly, free intraperitoneal air was not an absolute determinant of subsequent surgical management. A total of 9.3% of patients in the non-surgical group had free intraperitoneal air, though in 83% of those cases it was local rather than diffuse. Another imaging finding which was not significant in differentiating the two groups was the presence of a bowel wall abscess under 4 cm. Familiarity with the imaging features and their implications may be useful in communication with surgeons.

Lastly, we found that subjects with a Hinchey classification of Ib or higher were more likely to require surgery. In fact, 88.3% of patients who did not undergo surgery were classified as Hinchey Ia.

Acute diverticulitis is one of the most common conditions encountered in the setting of acute abdominal pain. As the management for this condition evolves over time, a familiarity with the modified Hinchey classification is useful to the practicing radiologist in order to communicate clearly with their surgical colleagues.

Limitations

This study has several limitations. First, it was a retrospective study that is inherently limited in its scope. Due to the retrospective nature, some of the data may have elements of uncertainty. For example, patients who report prior a specific number of episodes of diverticulitis in the past but we cannot confirm by reviewing CT scans from other hospitals. Second, it was performed at a single academic urban medical center, and practice patterns may vary widely. Third, as with any retrospective study, it is difficult to know whether patients subsequently received care elsewhere for future bouts of diverticulitis. In theory, this risk would evenly be distributed between the two cohorts, but it does provide an element of uncertainty.

Acknowledgement

Special thanks to the Susanne Loomis and the REMS Media Services at Massachusetts General Hospital for assistance with the diagrams in this article.

References

1. Weizman AV, Nguyen GC (2011) Diverticular disease: epidemiology and management. *Can J Gastroenterol* 25(7):385–389 [PubMed: 21876861]
2. Kozak LJ, DeFrances CJ, Hall MJ (2006) National hospital discharge survey: 2004 annual summary with detailed diagnosis and procedure data. *Vital Health Stat* 13 162:1–209
3. Wong WD, Wexner SD, Lowry A, et al. (2000) Practice parameters for the treatment of sigmoid diverticulitis-supporting documentation. The standards task force. The American society of colon and rectal surgeons. *Dis Colon Rectum* 43(3):290–297 [PubMed: 10733108]
4. Gervaz P, Ambrosetti P (2016) Critical appraisal of laparoscopic lavage for Hinchey III diverticulitis. *World J Gastrointest Surg* 8(5):371–375 [PubMed: 27231515]

5. Marshall JR, Buchwald PL, Gandhi J, et al. (2017) Laparoscopic lavage in the management of Hinchey grade III diverticulitis: a systematic review. *Ann Surg* 265(4):670–676 [PubMed: 27631772]
6. O’Leary DP, Lynch N, Clancy C, Winter DC, Myers E (2015) International, expert-based, consensus statement regarding the management of acute diverticulitis. *JAMA Surg* 150(9):899–904 [PubMed: 26176318]
7. Regenbogen SE, Hardiman KM, Hendren S, Morris AM (2014) Surgery for diverticulitis in the 21st century: a systematic review. *JAMA Surg* 149(3):292–303 [PubMed: 24430164]
8. Holmer C, Lehmann KS, Engelmann S, et al. (2011) Long-term outcome after conservative and surgical treatment of acute sigmoid diverticulitis. *Langenbecks Arch Surg* 396(6):825–832 [PubMed: 21688045]
9. Mueller MH, Glatzle J, Kasperek MS, et al. (2005) Long-term outcome of conservative treatment in patients with diverticulitis of the sigmoid colon. *Eur J Gastroenterol Hepatol* 17(6):649–654 [PubMed: 15879727]
10. Shaikh S, Krukowski ZH (2007) Outcome of a conservative policy for managing acute sigmoid diverticulitis. *Br J Surg* 94(7):876–879 [PubMed: 17380481]
11. Ambrosetti P (2008) Acute diverticulitis of the left colon: value of the initial CT and timing of elective colectomy. *J Gastrointest Surg* 12(8):1318–1320 [PubMed: 18443885]
12. Ambrosetti P (2012) Value of CT for acute left-colonic diverticulitis: the surgeon’s view. *Dig Dis* 30(1):51–55 [PubMed: 22572685]
13. Ambrosetti P, Robert J, Witzig JA, et al. (1992) Prognostic factors from computed tomography in acute left colonic diverticulitis. *Br J Surg* 79(2):117–119 [PubMed: 1555056]
14. Poletti PA, Platon A, Rutschmann O, et al. (2004) Acute left colonic diverticulitis: can CT findings be used to predict recurrence? *AJR Am J Roentgenol* 182(5):1159–1165 [PubMed: 15100111]
15. Sartelli M, Moore FA, Ansaloni L, et al. (2015) A proposal for a CT driven classification of left colon acute diverticulitis. *World J Emerg Surg* 10:3 [PubMed: 25972914]
16. Thorisson A, Smedh K, Torkzad MR, Pahlman L, Chabok A (2016) CT imaging for prediction of complications and recurrence in acute uncomplicated diverticulitis. *Int J Colorectal Dis* 31(2):451–457 [PubMed: 26490053]
17. Hinchey EJ, Schaal PG, Richards GK (1978) Treatment of perforated diverticular disease of the colon. *Adv Surg* 12:85–109 [PubMed: 735943]
18. Wasvary H, Turfah F, Kadro O, Beauregard W (1999) Same hospitalization resection for acute diverticulitis. *Am Surg* 65(7):632–635; discussion 636. [PubMed: 10399971]
19. Kaiser AM, Jiang JK, Lake JP, et al. (2005) The management of complicated diverticulitis and the role of computed tomography. *Am J Gastroenterol* 100(4):910–917 [PubMed: 15784040]
20. Klarenbeek BR, de Korte N, van der Peet DL, Cuesta MA (2012) Review of current classifications for diverticular disease and a translation into clinical practice. *Int J Colorectal Dis* 27(2):207–214 [PubMed: 21928041]

Fig. 1.

A Hinchey Ia diverticulitis is characterized by a pericolic phlegmon and associated inflammation is present, without an organized fluid collection. **B** Hinchey Ib diverticulitis is characterized by the additional finding of a pericolic abscess less than 4 cm in size, adjacent to the area of diverticulitis. **C** Hinchey II diverticulitis is characterized by the presence of a pelvic or inter-loop abscess, or by the presence of an abscess that is larger than 4 cm. **D** Hinchey III and **E** Hinchey IV diverticulitis are characterized by the presence of purulent peritonitis and feculent peritonitis, respectively.

Fig. 2. Representative images demonstrating common types of colonic fistulae seen as complications of diverticulitis. Included are sagittal images of a colocolonic fistula (A, arrows), colovesicular fistula (B, arrow), and colovaginal fistula (C, arrow).

Fig. 3.

A 75-year-old woman with a history of diverticulitis who presented with lower abdominal pain. Contrast-enhanced axial(A) and coronal (C) CT images of the abdomen and pelvis demonstrated acute diverticulitis with pericolic fat stranding, engorgement of vasa recta, and mesenteric lymphadenopathy. She also had that near-circumferential intramural abscess of the sigmoid colon (A and B, arrows).

Table 1.
Clinical parameters in acute diverticulitis surgery vs. non-surgical management from the ED in 2014 and 2015

	Mean		P value
	No surgery	Surgery	
# Episode diverticulitis	1.5 (1–6)	1.6 (1–8)	0.3490
Temperature (F)	98.6 (97.5–103)	98.4 (97.4–103)	0.2270
WBC (k mL)	11.3 (8.8–24.0)	11.9 (3.1–25.2)	0.4285
Systolic BP (mmHg)	137.2 (110–237)	128.2 (85–186)	0.0220
Lactic acid (mg/dL)	1.5 (0.8–5.6)	1.9 (0.8–4.2)	0.353

Table 2.

MDCT findings in surgery vs. non-surgical management

	No surgery	Surgery	P value
Bowel wall thickening	98.8% (254/257)	97.40% (37/38)	1.000
Diverticulosis	99.60% (256/257)	100.00% (38/38)	1.000
Inflamed diverticulum	95.70% (246/257)	94.70% (36/38)	0.6675
Pericolonic inflammation	99.60% (256/257)	97.40% (37/38)	0.2414
Pericolonic fluid collection	8.20% (21/257)	36.80% (14/38)	0.0001
Diffuse free fluid	1.60% (4/253)	2.60% (1/38)	0.5007
Extraluminal air	9.30% (24/257)	26.30% (10/38)	0.0052
Free air is local	83.30% (20/24)	30.00% (3/10)	0.0147
Free air is diffuse	16.70% (4/24)	70.00% (7/10)	
SBO/LBO	0% (0/257)	5.20% (2/38)	0.0162
Fistula	0.40% (1/257)	13.20% (5/38)	0.0002
Bowel wall abscess	2.30% (6/257)	5.30% (2/38)	0.2751
Hinchey			
Ia	88.30% (227/257)	44.70% (17/38)	0.0001
Ib or higher	11.70% (30/257)	55.30% (21/38)	

Table 3.

Interobserver agreement for CT findings

Bowel wall thickening	96.3% (284/295)	Free air	96.3% (284/295)
Diverticulosis	99.7% (294/295)	Local vs. diffuse free air	95.9% (283/295)
Inflamed diverticulum	95.9% (283/295)	Bowel wall abscess	98.3% (287/295)
Pericolonic inflammation	96.9% (286/295)	Hinchey classification	89.2% (263/295)
Pericolonic fluid collection	96.6% (285/295)	SBO/LBO	95.9% (283/295)
Diffuse free fluid	99.7% (294/295)	Fistula	95.9% (283/295)