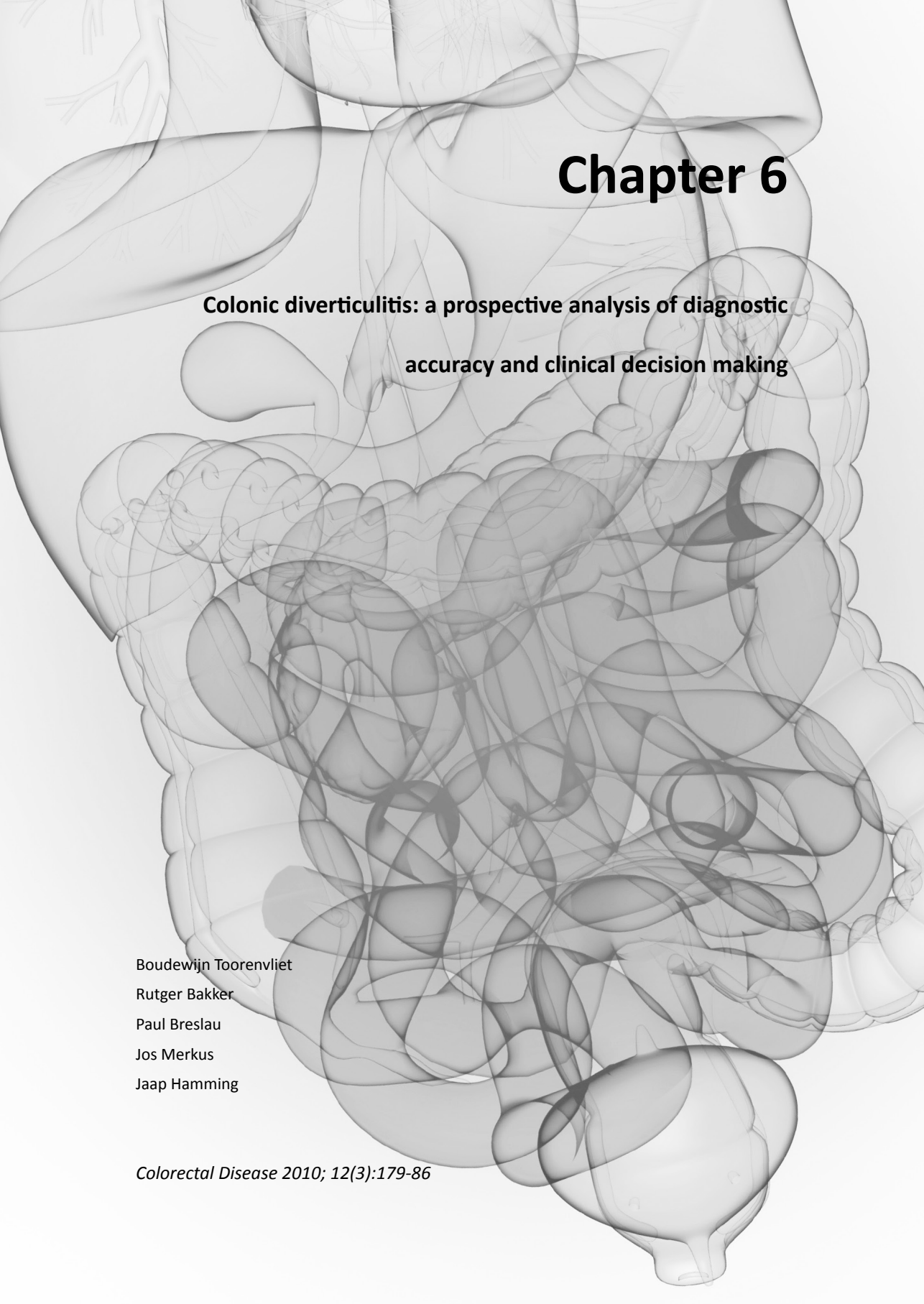
Acute abdominal pain : considerations on diagnosis and management

Toorenvliet, B.R.



Chapter 6

Colonic diverticulitis: a prospective analysis of diagnostic accuracy and clinical decision making

Boudewijn Toorenvliet
Rutger Bakker
Paul Breslau
Jos Merkus
Jaap Hamming

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Abstract

Objective: To evaluate the diagnostic accuracy of clinical evaluation and cross sectional imaging modalities such as ultrasound and computed tomography for patients with suspected colonic diverticulitis and to determine the value of these examinations in clinical decision making.

Methods: A prospective analysis was conducted of 802 consecutive patients that presented with abdominal pain at the emergency department. Initial clinical diagnoses and management proposals were compared to the final diagnoses and therapeutic strategies for all patients.

Results: Fifty-seven patients were identified with colonic diverticulitis as the final diagnosis. The positive and negative predictive values for the clinical diagnosis of colonic diverticulitis were 0.65 and 0.98 respectively. Additional cross sectional imaging had a positive and negative predictive value of respectively 0.95 and 0.99 or higher. These additional examinations led to a correct change of the initial clinical diagnosis in 37% of the patients, and a change in management in only 7%.

Conclusion: The accuracy of the clinical diagnosis for colonic diverticulitis is low. Ultrasound and computed tomography have superior diagnostic accuracy but these examinations rarely change the initial management proposal.

Introduction

Colonic diverticular disease is common in the Western and industrialized countries, accounting for approximately 130,000 hospitalizations yearly in the USA[1]. Diverticular disease affects 5-10% of people by the age of 45 years and as many as 80% of people by the age of 80 years[2]. Approximately 10-25% of patients with colonic diverticulosis develop diverticulitis[3].

Correctly identifying patients with colonic diverticulitis and initiating appropriate management can be challenging. Under- or overestimation of the patient's condition may result in unnecessary treatment delay or unwarranted surgical exploration, both of which can lead to extra morbidity and even mortality. Some authors stress the importance of clinical parameters for diagnosing diverticulitis[4], and suggest that the diagnosis can be made on the basis of clinical parameters alone[5]. Others state that clinical evaluation alone is inadequate, resulting in frequent misdiagnosis[6-8]. Consequently these authors appeal for the use of additional radiological imaging to confirm the diagnosis in patients with suspected diverticulitis. Abdominal computed tomography (CT) has replaced contrast enema as the imaging modality of choice, and is recommended as the initial radiological examination for patients with suspected diverticulitis by the American Society of Colon and Rectum Surgeons[9], the American College of Radiology[10], and in most review articles on colonic diverticulitis[11,12]. Contrary to this overwhelming support for abdominal CT are the results of a recent systematic review on the accuracy of radiological examination for diagnosing colonic diverticulitis[13]. Although only a few studies had acceptable methodological quality in this review, ultrasound was considered the method of choice for diagnosing diverticulitis.

The aim of this study is to evaluate the diagnostic accuracy of clinical evaluation, ultrasound and CT for patients with suspected colonic diverticulitis at the emergency department and to assess how these examinations aid us in clinical decision making.

Method

This study was performed in a mid-sized teaching hospital in the Netherlands with a catchment population of 200,000. All consecutive patients with acute abdominal pain evaluated at the emergency department by a surgeon between June 2005 and July 2006 were included in the study. Patients who were evaluated at another hospital for the same complaint, patients with abdominal pain caused by trauma and those that had undergone additional radiological examination (ultrasound or CT) prior to surgical consultation were excluded. First, a "clinical diagnosis" (D1) was made based on the patient's history, physical examination, and biochemical blood and urine analysis. Plain abdominal or chest x-rays were undertaken when indicated. An initial management proposal (S1) was then made based on the clinical diagnosis. The consultation of a specialist from another discipline, re-evaluation at the outpatient clinic, admission to the surgical ward and laparotomy were the most common management options. All clinical parameters, the clinical diagnosis (D1) and strategy (S1) were registered on a study form. Subsequently a decision was made whether or not to perform additional radiological examination. In that case, the radiologist was asked to confirm the clinical diagnosis or provide an alternative diagnosis. It was at the radiologist's discretion to decide whether ultrasound or CT was the most suitable examination taking the nature of the suspected condition and the patient characteristics into consideration. If an ultrasound was chosen initially but the result was inconclusive, a CT of the abdomen was subsequently made. After reviewing the radiological results (RD1), the initial clinical diagnosis and strategy were reassessed by the surgeon and consequently altered, if necessary (CD1 & CS1). Again all results and considerations were registered on the study form. All patients that were not directly operated or admitted to the surgical ward following surgical consultation at the emergency department were given appointments for re-evaluation at the out-patient clinic within 24 hours. The diagnosis and management strategy were then reassessed (D2 and S2) and additional radiological examinations were also undertaken if deemed necessary. Patients were discharged from follow-up when a diagnosis was made and the treatment successfully initiated or completed, or if the patient no longer had abdominal complaints (figure 1). The final diagnosis (FD) was

based on intraoperative findings or pathological examination of the resected organs. If patients were not operated on, the final diagnosis was made by the clinical and/or radiological diagnosis in combination with the clinical response to medical therapy at standard re-evaluation and follow-up as described above. All the patients who had colonic diverticulitis as a final diagnosis were classified according to a modified Hinchey score[14]. The scores were based on clinical, radiological and intraoperative findings. Patients with a first episode of diverticulitis that were successfully treated without surgery underwent a colonoscopy or barium enema for confirmation of diverticular disease after 6 weeks.

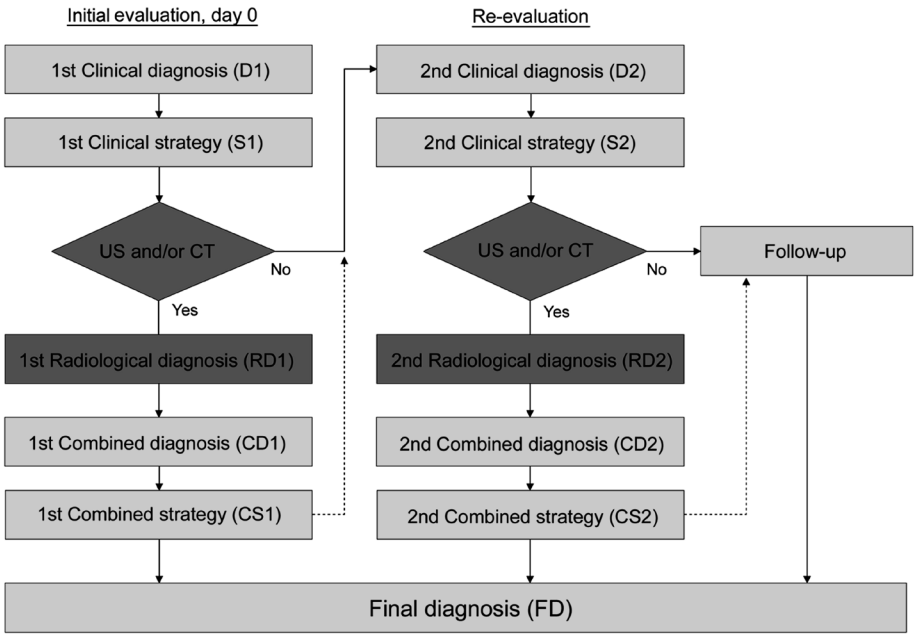

Figure 1. Prospective study design for patients presenting with abdominal pain at the emergency department for surgical consultation.

Results

In the period between June 2005 and July 2006, 802 consecutive patients with abdominal pain followed the protocol. The majority of patients (84%) were evaluated at the emergency department by surgical residents in their first 3 years of surgical training; all the other patients were evaluated by senior residents or surgeons. Sixty of the 802 patients were clinically suspected to have colonic diverticulitis at the initial consultation, and diverticulitis was confirmed as the final diagnosis in 57/802 patients (prevalence 7%). The demographics, clinical parameters, modified Hinchey classification and treatment data of patients with diverticulitis as a final diagnosis are presented in table 1. Of the 802 patients, 580 had ultrasound and/or CT examinations of the abdomen, all of which were performed by one of the five certified radiologists with similar levels of experience. All patients were re-evaluated according to the study protocol.

Suspected Colonic Diverticulitis

Of the 60 patients with colonic diverticulitis as a first clinical diagnosis (D1) at initial consultation, 57 (95%) underwent additional radiological examination. Thirty-five patients had ultrasound and/or CT examination on the day of presentation and 26 patients at re-evaluation the next day. Four patients underwent additional imaging on both days. The 3 patients that did not undergo additional imaging all had mild clinical diverticulitis (Hinchey 0) as a final diagnosis. These patients had left lower quadrant pain and infectious parameters upon presentation and colonic diverticular disease was confirmed in all 3 patients.

Table 1. Demographics, clinical parameters, modified Hinchey classification and treatment for patients with diverticulitis as a final diagnosis. (n = 57).

Age	60.4 years (SD = 12.3)
Female	31 (54.4%)
Referral	
Self	22 (38.6%)
General practitioner	29 (50.9%)
Specialist	6 (10.5%)
Duration of complaints	5.4 days (SD = 8.3)
Nausea	29 (50.9%)
Vomiting	14 (24.6%)
Anorexia	28 (49.1%)
Dysuria	3 (5.3%)
Diarrhea	8 (14.0%)
Rebound tenderness	23 (40.4%)
Abdominal guarding	5 (8.8%)
Right lower quadrant tenderness	20 (35.1%)
Suprapubic tenderness	13 (22.8%)
Left lower quadrant tenderness	45 (78.9%)
Heart rate	86.8 bpm (SD = 14.4)
Temperature	37.1 °C (SD = 0.8)
Leucocytes	11.4 $x10^9$/l (SD = 3.3)
C-reactive protein	72.4 mg/l (SD = 56.6)
Erythrocyte sedimentation rate	37.6 mm/hr (SD = 23.7)
Modified Hinchey Classification	
0	4 (7%)
Ia	41 (72%)
Ib	3 (5%)
II	3 (5%)
III	0 (0%)
IV	0 (0%)
Colovesical fistula	3 (5%)
Stenosis	3 (5%)
Treatment	
Conservative	49 (86.0%)
Hartmann's resection	1 (1.8%)
Sigmoid resection	1 (1.8%)
Sigmoid resection & colostomy	2 (3.5%)
Delayed Sigmoid resection	2 (3.5%)
Delayed Sigmoid resection & colostomy	1 (1.8%)
Delayed Hartmann's resection	1 (1.8%)

The numbers in parentheses are standard deviations (SD) for the given mean values, or percentages for the number of patients tallied.
Modified Hinchey classification. 0: Mild clinical diverticulitis, Ia: Confined pericolic inflammation – phlegmon, Ib: Confined pericolic abscess, II: Pelvic, distant intra-abdominal or retroperitoneal abscess, III: Purulent peritonitis, IV: Faecal peritonitis.

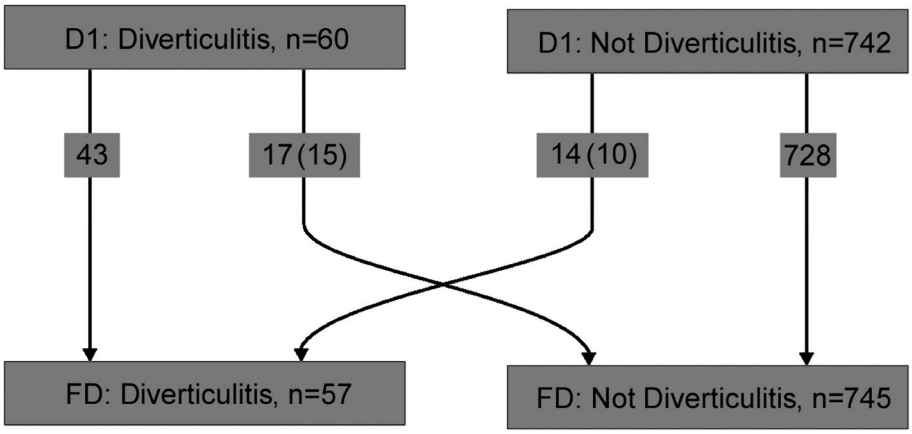

Figure 2. Diagnostic changes between the clinical diagnosis at initial evaluation (D1) and the final diagnosis (FD). Figures in parentheses are the number of diagnostic changes because of additional cross sectional imaging (ultrasound or CT).

Forty-three of the 60 patients (72%) suspected to have diverticulitis also had diverticulitis as the final diagnosis (figure 2). Of these 60 patients, 14 were known to have diverticulosis or previous episodes of diverticulitis and 13 of these patients had diverticulitis as a final diagnosis. The diagnostic accuracy of the clinical diagnosis was calculated excluding these 14 patients. The positive predictive value of the clinical diagnosis diverticulitis was 0.65, the negative predictive value is 0.98 (table 2).

Table 2. Diagnostic accuracies for the diagnosis diverticulitis.

	TP	FP	FN	TN	Sens	Spec	PPV	NPV	LR+	LR-
Clinical diagnosis	30	16	14	728	0.68	0.98	0.65	0.98	32	0.33
US only	20	0	2	383	0.91	1	1.00	0.99	Inf	0.09
CT only	20	1	1	71	0.95	0.99	0.95	0.99	69	0.05
US and CT	11	0	0	71	1	1	1.00	1.00	Inf	0.00
All CT	31	1	1	142	0.97	0.99	0.97	0.99	139	0.03
US and/or CT	51	1	3	525	0.94	1.00	0.98	0.99	497	0.06

TP, true positive; FP, false positive; FN, false negative; TN, true negative; Sens, sensitivity; Spec, specificity; PPV, positive predictive value; NPV, negative predictive value; LR+, positive likelihood ratio; LR-, negative likelihood ratio; US, ultrasound.

For patients that did not have diverticulitis as a final diagnosis, but were clinically suspected of having diverticulitis, the diagnosis was correctly adjusted by additional radiological examination in 15/57 patients (table 3). Two patients had false negative ultrasound results on the day of presentation as no abnormalities were seen apart from fat stranding in one patient. The next day diverticulitis was diagnosed by abdominal CT in both patients and diverticulosis was later confirmed by barium enemas.

Table 3. An overview of clinical diagnoses at initial evaluation, final diagnoses and diagnostic changes for patients with suspected or confirmed diverticulitis.

	D1	FD	FD[D1.Div]	D1[FD.Div]
Appendicitis	164	117		3 (3)
Abscess of the abdominal wall			1†	
Colonic diverticulitis	60	57	43	43
Calculus of kidney and ureter	32	27	1 (1)	
Cholecystitis	11	4		1(1)
Epiploic appendagitis		2	1(1)	
Infarction of the left kidney		1	1 (1)	
Myalgia of the abdominal wall	4	5		1 (1)
Necrosis of the falciform ligament		1	1 (1)	
Neoplasm of the bladder		2	1 (1)	
Neoplasm of the colon	3	7	1 (1)	1 (1)
Non specific abdominal pain	74	100	6 (6)	1*
Gynaecological pathology, unspec.	28	19		1 (1)
Ovarian torsion		1	1 (1)	
Pancreatitis	11	14	1 (1)	
Peptic/gastric ulcer	14	12	1††	
Unspecified ileus	35	10		4 (1)**
Urinary tract infection	37	37		1 (1)
Viral gastroenteritis	101	77	1 (1)	1 (1)
Other	228	309		
Total	802	802	60 (15)	57 (10)

Figures in parentheses are the number of diagnostic changes because of additional cross sectional imaging (ultrasound or CT).
† First presentation of Crohn's disease.
†† A gastric ulcer was diagnosed by gastroscopy because of hematemesis.
* Mild clinical diverticulitis (modified Hinchey 0). Diverticulosis was confirmed by barium enema.
** Twice a sigmoid stenosis was confirmed by gastrografin enema, once by CT without determining the underlying pathology (a false negative).
D1, clinical diagnosis at initial evaluation; FD, final diagnosis; FD[D1.Div], final diagnosis when diverticulitis was the initial clinical diagnosis; D1[FD.Div], clinical diagnosis at initial evaluation when the final diagnosis was diverticulitis.

Confirmed Colonic Diverticulitis

Of the 57 patients with colonic diverticulitis as a final diagnosis (FD), all but one had elevated infectious parameters (leucocytes > $12x10^9$/l, CRP > 8 mg/l or a sedimentation rate > 15mm/hr) or a temperature >38° Celsius. The presence of colonic diverticulosis was confirmed by colonoscopy or barium enema in 41 patients approximately 6 weeks after the episode of diverticulitis. In 8 patients that had immediate or delayed sigmoid resection the diagnosis was confirmed by pathological examination, and for one patient sigmoid diverticulosis had by chance been diagnosed during a laparotomy several months prior to his episode of diverticulitis. Seven patients only had an ultrasound and/or CT examination of the abdomen and follow-up. All 7 patients were contacted 2-2½ years after the first presentation at the emergency department. Two patients had mild intermittent abdominal complaints, possibly 'painful diverticulosis', but no recurrent episodes of diverticulitis or other intestinal disease. The other 5 patients had no complaints, no recurrent episodes of diverticulitis or other intestinal disease.

Fourteen of the 57 patients with diverticulitis as a final diagnosis were not suspected to have diverticulitis at initial evaluation (figure 2). The initial clinical diagnoses for these 14 patients are presented in table 3.

Additional radiological examination was performed in 51/57 (89%) patients that had diverticulitis as a final diagnosis. Thirty-four patients had ultrasound and/or CT examination on the day of presentation and 19 patients at re-evaluation. Two patients underwent additional imaging on both days. Six patients had no ultrasound or CT. Three of these patients are described earlier as having mild clinical diverticulitis. One other patient also had mild clinical diverticulitis (Hinchey 0) as a final diagnosis but was clinically not suspected to have diverticulitis at initial evaluation. This patient did have left lower quadrant pain and infectious parameters upon presentation and confirmed colonic diverticular disease later. Two other patients that had no ultrasound or CT were admitted to the surgical ward with bowel obstruction after initial evaluation. These 2 patients were operated the next day after gastrografin enema's diagnosed a sigmoid stenosis. Pathological examination revealed an active diverticulitis in both patients.

Ultrasound was the initial examination in 31/51 patients (61%), whereas 20 (39%) had a CT primarily. The diagnosis was correctly adjusted by additional radiological examination in 10/51 patients who were not suspected to have diverticulitis at initial consultation (table 3). One patient had a false negative result for diverticulitis because CT examination diagnosed a colonic obstruction without determining the underlying pathology. A sigmoid resection was performed and pathologic examination showed an active diverticulitis with obstruction. Of all the patients who were not clinically suspected of having diverticulitis and did not have diverticulitis as a final diagnosis (n = 728), one abdominal CT gave a false positive result. The CT diagnosed diverticulitis, but a neoplasm of the sigmoid colon was encountered at colonoscopy afterwards. Table 2 gives an overview of the diagnostic accuracy of ultrasound and CT for diverticulitis in this series.

For 6 of the 57 patients the episode of diverticulitis was complicated by a stenosis (3) or a colovesical fistula (3). Three patients had a confined pericolic abscess, while 3 other patients had a distant intra-abdominal or pelvis abscess. The majority of 41 patients (72%) however, only had pericolic inflammation without an abscess. Of the 8 patients with diverticulitis that were operated, 4 were operated shortly after admission while the operation was delayed in the other 4 patients (table 1). No percutaneous abscess drainage was performed in any of the patients, and all patients not operated were successfully treated with conservative management. The in-hospital mortality was 1.7%

Table 4. Clinical strategy changes after ultrasound and/or CT for patients with suspected or confirmed diverticulitis.

Sex/ Age	D1	S1	US/CT	CD1	CS1	FD
	Minor Strategy changes					
F/52	Diverticulitis	OPR	US & CT	Epiploic appendagitis	ADM	Epiploic appendagitis
F/82	Viral gastro-entritis	OPR	US & CT	Diverticulitis	ADM	Diverticulitis
F/62	Urinary tract infection	OPR	US	Diverticulitis	ADM	Diverticulitis
	Major strategy changes					
F/51	Diverticulitis	ADM	US & CT	Ovarian torsion	LAP	Ovarian torsion
F/46	Appendicitis	APP	US & CT	Diverticulitis	ADM	Diverticulitis

D1, clinical diagnosis at initial evaluation; S1, first clinical strategy; CD1, combined diagnosis after ultrasound/CT; CS1, combined clinical strategy; FD, final diagnosis; OPR, outpatient re-evaluation; ADM, admission; LAP, laparoscopy; APP, appendectomy; US, ultrasound.

In 5 cases the clinical strategy was altered after cross sectional imaging (table 4). Three patients that were planned for outpatient re-evaluation were admitted to the surgical ward for observation after additional radiological examination was undertaken. These strategy changes were considered to be 'minor' and all three patients were successfully managed with conservative treatment. Two patients had strategy changes after ultrasound and CT that were considered to be significant. One patient clinically suspected to have diverticulitis with an intended observation in the surgical ward had an ovarian torsion diagnosed by ultrasound and CT after which an emergency laparoscopy was performed by the gynecologist. Another patient with suspected appendicitis for whom appendectomy was the initial management proposal had diverticulitis diagnosed by ultrasound and CT. This patient was admitted to the surgical ward and treated conservatively with success.

Discussion

When a patient presents with suspected colonic diverticulitis, the diagnosis must be confirmed and appropriate therapeutic measures should be taken to manage the patient sufficiently. This prospective observational study was designed to assess the accuracy of clinical and radiological examinations for patients with suspected diverticulitis, and how these examinations influence management decisions. The referent standard for the final diagnosis was pathological examination for patients who were operated and clinical response to therapy with an adequate follow-up for those that were managed conservatively.

The clinical diagnosis of diverticulitis in this study had a high specificity of 98%, but a poor sensitivity of 68%. These results are similar to those published by Laurell et al., who report a sensitivity and specificity for the clinical diagnosis diverticulitis of 64% and 97% respectively[4]. In contrast to these authors, we do not conclude that these values confirm the importance of clinical parameters for diagnosing diverticulitis. With a sensitivity of 68% in our study, 32% of the patients with colonic diverticulitis will be missed with clinical evaluation alone, and even higher misdiagnosis rates (34-67%) have been reported[8,15].

Because of the high misdiagnosis rate in suspected diverticulitis, additional radiological imaging is recommended by most authors, and the majority considers abdominal CT to be the imaging modality of choice. CT has been shown to be superior to contrast enema[16,17], with a high sensitivity (93-97%) and specificity approaching 100%[7,18]. It allows for an accurate delineation of the disease process[14], can identify patients with a diverticular abscess enabling percutaneous drainage[19-21], and may help to differentiate diverticulitis from colon carcinoma[22,23]. A disadvantage of abdominal CT is that it requires ionizing radiation and there is direct evidence from epidemiological studies that the organ doses corresponding to a common CT study result in an increased risk of cancer. Although this is a small risk increase for the individual, because of the rapidly increasing use of CT it has been suggested that this may become a public health issue in the future[24]. Considering that patients with diverticulitis are prone to recurrence and thus multiple CT examinations, it seems sensible to replace CT, if feasible, with other diagnostic modalities that do not use ionizing radiation such as ultrasound or MRI.

Ultrasound has yielded similar results to those of CT for the evaluation of diverticulitis with a sensitivity between 77 and 98% and a specificity between 80 and 99%[25-29]. Ultrasound does not require ionizing radiation or the application of oral, rectal or intravenous contrast, and the examination can be repeated as often as needed. Furthermore, the costs are lower and the spatial resolution of a high-frequency ultrasound image is higher than that of a CT image providing more detailed information on the different bowel wall layers when a graded compression technique is used[30,31]. A disadvantage of ultrasound is that it is operator dependent and that good imaging is difficult in patients with increased levels of body fat. A recently published systematic review concluded that ultrasound should be the diagnostic modality of choice for acute diverticulitis, but that there are few studies of methodological quality concerning radiological imaging for diverticulitis[13].

In this study both ultrasound and CT had excellent sensitivity and specificity for diagnosing diverticulitis. Overall, in 25 out of 68 cases (37%), cross sectional imaging correctly adjusted the diagnosis in patients with suspected or confirmed diverticulitis. When additional radiological examination was considered necessary for patients with abdominal pain it was at the radiologist's discretion to decide the

imaging technique that was most suitable. Ultrasound was attempted as the initial examination in most cases and for 20 patients this sufficed to confirm the diagnosis diverticulitis. Hence an abdominal CT was not necessary in 39% of the patients, who were not exposed to ionizing radiation as a result. On the other hand, in 11 cases ultrasound alone was not sufficient, and a CT examination was nonetheless required in 22% of the patients with diverticulitis. When an abdominal CT was performed after an ultrasound, this was usually undertaken because the result was inconclusive, sometimes because of the fact that the patient characteristics (e.g. higher BMI) did not allow for an optimal ultrasonic examination. In these 11 cases there were no false negative or false positive results. CT was the initial radiological examination for 20 patients with confirmed diverticulitis.
In the light of our results and other publications[13,24,30,32] we believe that ultrasound can and should be the initial imaging modality for patients with suspected diverticulitis. Abdominal CT examination should be reserved for patients with generalized peritonitis, large abscesses requiring percutaneous drainage or in case of an inconclusive ultrasound examination[30,32].

Strategy changes brought about by additional ultrasound or CT occurred considerably less often than changes in the diagnosis. In only 5 cases (7%) the initial management proposal was altered after additional cross sectional imaging, and 3 of these were considered minor strategy changes (table 4). Ultrasound and/or CT thus led to a major change in management in only 3% of the patients. These percentages were compared to those for patients that underwent additional radiological imaging, but did not have suspected or confirmed diverticulitis (512). In this group 29% of the patients had a change in management, of which 16% were considered major. We found only one other study that prospectively evaluated the influence of radiological diagnoses on management strategies for patients with colonic diverticulitis[33]. These authors found that the initial treatment modality was modified in 21% of cases after CT or worsening of clinical signs. This is in contrast to the results of our analysis, in which ultrasound and CT seldom led to changes of the initial strategy proposal for patients with suspected diverticulitis after clinical evaluation. Apparently the clinical estimation for the appropriate management of the patient with abdominal pain or

suspected diverticulitis is substantially more accurate than the clinical diagnosis that the patient is given during that initial evaluation. Even so, all correct management changes are important from a patient's perspective.

We can conclude that clinical evaluation alone is inadequate for diagnosing colonic diverticulitis because of a poor positive predictive value. Both ultrasound and CT have excellent diagnostic accuracy for diagnosing diverticulitis, but rarely change the initial management proposal.

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