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A retrospective study of CT findings in cases undergoing appendectomy at a single hospital

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Abstract

The purpose of this study was to determine which clinical information or computed tomography (CT) features can distinguish perforated from nonperforated appendicitis. We collected data from 102 patients (62 men, 40 women; mean age, 49.6 years; age range, 16–85 years) who presented to the emergency department with acute abdominal pain or suspicion of acute appendicitis and underwent appendectomy. In the clinical information, there was no significant factor to predict appendiceal perforation. As for CT features, significant imaging factors for predicting appendiceal perforation included abscess, phlegmon, and thickening of lateroconal fascia. The treatment strategy of acute appendicitis varies according to the integrity of the appendiceal wall. Besides clinical findings, CT features can distinguish perforated from nonperforated appendicitis, facilitating proper decision making in ER.

Keywords: Computed tomography; Appendicitis; Appendiceal perforation

1. Introduction

Acute appendicitis is a common cause of acute abdomen encountered in the emergency department, and appendectomy is the most common emergent surgical operation done worldwide. Prompt and accurate diagnosis is essential to minimize morbidity, which remains substantial if perforation occurs. Atypical presentations may result in delayed treatment and complications. The management of appendicitis traditionally involved a purely surgical approach. However, in the setting of perforated appendicitis presenting with abscess or phlegmon, initial nonoperative management by conservative treatment or percutaneous drainage has been proved to be safe and effective [1,2]. During the past decade, computed tomography (CT) has been shown to be a quick and accurate imaging method for the evaluation of patients with suspected appendicitis in the emergency room (ER) [3–7]. Therefore, our retrospective study aimed to find the determinants of clinical information or CT features to distinguish nonperforated from perforated appendicitis.

2. Materials and methods

2.1. Patients

Between May 2003 and April 2005, 120 patients received abdominal and pelvis CT scans with acute abdominal pain or preoperative diagnosis of acute appendicitis at our ER. One hundred and two of them (62 men, 40 women; mean age, 49.6 years; age range, 16–85 years) were treated with appendectomy and proved to have acute appendicitis pathologically. Eighteen of 120 patients did not receive operation due to unstable conditions or patients' refusal. Thirty-seven patients had perforated appendicitis and 65 patients had nonperforated appendicitis.

The clinical information of these patients, including abdominal pain (diffuse or right lower quadrant), tenderness, fever, signs of peritonitis, laboratory tests of white blood cell and differential count, surgical records, and pathologic results, was collected according to their medical

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records. Our institutional review board does not require its approval or patient informed consent for retrospective study of case records and CT studies.

2.2. Computed tomography scanning

All patients received oral and intravenous ionic contrast medium unless there was a contraindication. Bowel opacification was achieved by orally administrating 600–900 ml contrast medium (2% meglumine iosthalamate solution) 1 h before scanning. All CT studies were performed with a four-detector row multislice CT scanner (LightSpeed QXi; GE Medical Systems, Milwaukee, WI, USA) with 5 mm collimation and a pitch of 3, with 60 mm table travel per gantry rotation from the lung bases to the pubic symphysis. The contrast agent was injected at a rate of 2.5–3 ml/s for a total volume of 100 ml iothalamate (Conray 240 mg/ml, Mallinckrodt) through an 18- to 20-gauge needle inserted in the antecubital vein by a power injector. Bolus tracking software was used to detect contrast bolus with a region of interest situated at the distal abdominal aorta. The exposure parameters were based on patient size. All CT images were reviewed in hardcopy or on a picture archiving and communication system (Centricity; GE Medical Systems, Milwaukee, WI, USA).

2.3. Computed tomography scan evaluation

Two reviewers (K.E.L., who had more than 10 years of experience in abdominal CT interpretation, and C.T.W.) retrospectively reviewed the abdominal CT scans in one image interpretation section.

They interpreted the CT scans without knowledge of surgical and pathologic data. Decisions regarding the CT findings were determined in consensus. Specific CT findings of nonperforated and perforated appendicitis were recorded and included enlarged appendix (transverse diameter, anywhere along its length, is greater than 6 mm), enhancement of thickened appendiceal wall, appendicolith, periappendiceal inflammatory fat stranding, enlarged lymph nodes, arrowhead sign, cecal bar sign, intraluminal air, retrocecal appendix, abscess, extraluminal air, phlegmon, extraluminal appendicolith, a focal defect in the enhancing appendiceal wall [8], intramural or periappendiceal air, lateroconal fascial thickening, enhancement of the peritoneum, and ascites (around the cecum or appendix, in the pelvis, mesentery, right flank, and perihepatic space). The arrowhead sign occurs when cecal contrast material funnels symmetrically at the cecal apex to the point of appendiceal occlusion [9]. The cecal bar sign occurs when a proximally embedded calcified appendolith incites surrounding inflammation of the cecal apex.

Table 1
Sex and age characteristics of the study population

Patient characteristics	Nonperforated appendix	Perforated appendix	Overall
Sex			
Male	37	25	62
Female	28	12	40
Age (years)			
Mean[a]	47.4±18.5	53.3±19.6	49.6±19.0
Median	46	49	47
Range	16–85	17–84	16–85

[a] Values are shown as mean±S.D.

Table 2
Association of CT findings in our review with appendiceal perforation

	Perforated appendicitis	Nonperforated appendicitis	*P* value
Age (years)	53.27±19.57	47.43±18.47	.166
Abdominal pain			.382
Negative	1 (2.7%)	0 (0%)	
Diffuse	3 (8.1%)	7 (1.8%)	
RLQ	33 (89.2%)	58 (89.2%)	
Tenderness	31 (83.8%)	59 (90.8%)	.292
Fever	26 (70.3%)	25 (38.5%)	.002*
Peritonitis	10 (27%)	10 (15.4%)	.154
Leukocytosis (WBC >11,000/μl)	22 (59.5%)	38 (58.5%)	.922
Neutrocytosis (band form >7500/μl)	25 (67.6%)	43 (66.2%)	.884
Appendiceal diameter (mm)	12.7±4.6	11.7±3.9	.265
Dilated appendix	36 (97.3%)	64 (98.5%)	.683
Appendiceal wall enhancement	34 (91.9%)	57 (87.7%)	.511
Appendicolith	15 (40.5%)	20 (30.8%)	.318
Fat stranding	36 (97.3%)	54 (83.1%)	.032*
Enlarged lymph node	14 (37.8%)	16 (24.6%)	.159
Arrowhead sign	7 (18.9%)	7 (10.8%)	.250
Cecal bar sign	5 (13.5%)	9 (13.8%)	.963
Intraluminal air	9 (24.3%)	11 (16.9%)	.365
Retrocecal appendix	9 (24.3%)	14 (21.5%)	.746
Abscess	7 (18.9%)	1 (1.5%)	.002*
Extraluminal air	7 (18.9%)	3 (4.6%)	.020*
Phlegmon	12 (32.4%)	3 (4.6%)	.00*
Extraluminal appendicolith	0 (0%)	0 (0%)	
A defect in the enhancing appendiceal wall	8 (21.6%)	3 (4.6%)	.008*
Intramural or periappendiceal air	3 (8.1%)	2 (3.1%)	.258
Degree of adjacent inflammation	20 (54.1%)	12 (18.5%)	.000*
Lateroconal fascia thickening	18 (48.6%)	15 (23.1%)	.008*
Bowel wall thickening	33 (89.2%)	51 (78.5%)	.172
Peritoneal enhancement	21 (56.8%)	21 (32.3%)	.016*
Fluid collection			.683
Around cecum and appendix	18 (48.6%)	17 (26.2%)	.021*
In the pelvis	16 (43.2%)	15 (23%)	.033*
In the mesentery	4 (10.8%)	3 (4.6%)	.234
In the right flank	4 (10.8%)	4 (6.2%)	.400
Perihepatic space	4 (10.8%)	2 (3.1%)	.110

* $P<.05$.

2.4. Statistical analysis

Statistical analyses were performed by using a commercially available statistical software program (SPSS, version 11.0.1; SPSS, Inc.). Descriptive statistics were reported as means and standard deviations, and continuous variables were reported as medians and ranges. Categorical variables were reported as frequencies and percentages.

The association between each CT feature and perforated appendicitis was assessed by using chi-square tests. For these analyses, the response was perforation (yes or no), as