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FULL PAPER

Relative CT number of periappendiceal fat stranding may be an applicable index for estimating the severity of acute appendicitis

XINHONG SONG, MINGQI SHI, WEI LIU, YANSONG GE and PEIYUAN WANG, MD, PhD

Department of Radiology, Yantai Affiliated Hospital of Binzhou Medical University, No 717 Jinbu Road, Yantai, Shandong 264100, PR China

Address correspondence to: Mr Peiyuan Wang
E-mail: *wangpeiyuan1640@163.com*

The authors Xinhong Song and Mingqi Shi contributed equally to the work.

Objectives: To investigate the feasibility of relative CT numbers to periappendiceal fat attenuation as an applicable index for estimating the severity of acute appendicitis.
Methods: In total, 308 consecutive surgery-confirmed acute appendicitis patients and 243 controls with available preoperative CT were analyzed retrospectively. The radiological parameters were appendix diameter, length, and wall thickness as concurrent appendicitis signs. CT numbers of periappendiceal fat, mesenteric fat, subcutaneous fat in the anterior and posterior abdominal wall, retroperitoneal fat, gluteal subcutaneous fat and psoas major muscle were measured, as well as the relative CT numbers of periappendiceal fat compared with other locations.
Results: There were 287 suppurative acute appendicitis (SAA) and 21 gangrenous or perforated acute appendicitis (GPAA) cases confirmed by pathology. The CT number of periappendiceal fat was significantly higher in patients than in controls ($P < 0.01$) although there was a wide overlap (−72.33 HU–117.43 HU). Significant differences in relative CT numbers were observed between the groups in gluteal subcutaneous fat (R_{CTgl}) and psoas major muscle (R_{CTps}) ($P < 0.01$). The AUCs of R_{CTgl} and R_{CTps} showed high accuracy to discriminate acute appendicitis from controls (AUC = 0.803, 0.761; 0.854, 0.847) and GPAA from SAA (AUC = 0.905, 0.851).
Conclusions: Attenuation of periappendiceal fat on CT is related to the severity of appendicitis, and relative CT numbers (R_{CTgl} and R_{CTps}) could be an applicable index for severity determination.
Advances in knowledge: Periappendiceal fat infiltration is related to the severity of acute appendicitis (especially relative CT number). Other clinical and CT features also need to be considered in the evaluation of inflammation.

INTRODUCTION

Acute appendicitis, one of the most common acute abdominal conditions, is divided into uncomplicated (suppurative acute appendicitis, SAA) and complicated appendicitis (gangrenous or perforated appendicitis, GPAA) based on histopathology. Although antibiotics are effective for uncomplicated appendicitis, approximately 30% of patients require surgery because of treatment failure or recurrent appendicitis, and in approximately 17.6% of patients, surgical treatment is delayed because the disease is misdiagnosed as uncomplicated appendicitis.[1,2] Delayed diagnosis and treatment can lead to various complications, and surgery remains the gold standard for the treatment of acute appendicitis.[3] Approximately 20% of patients present with atypical symptoms that mimic gastrointestinal, urinary, and female reproductive system diseases.[4] Therefore, imaging examinations are necessary for differential diagnosis before clinical intervention.[5] CT is the most common and reliable imaging modality for appendicitis, showing diagnostic sensitivity and specificity >90%.[4] CT examination reduces the negative appendectomy rate from 20% to 2.5–5%.[6–8] Short- and long-term follow-up results support the feasibility of antibiotic treatment alone as an alternative to surgery for uncomplicated acute appendicitis confirmed by CT, and approximately 20% of appendicitis cases are cured without surgical treatment.[9,10] Therefore, less severe patients may delay or refuse surgery for a variety of reasons. Typical CT signs can facilitate the diagnosis of acute appendicitis,[11,12] the detection of perforation,[13,14]

and excluding the presence of gangrenous appendicitis with high sensitivity and specificity.[15] However, the technique is controversial and there are no unified diagnostic imaging criteria to distinguish uncomplicated from complicated appendicitis or for lesion severity estimation. In most cases, appendicitis is associated with peritonitis, which leads to changes in attenuation of periappendiceal fat stranding on CT(CT number, Hounsefield Unit, HU).[16] Periappendiceal fat infiltration is a common pathological manifestation of acute appendicitis, which is manifested by increased fat density around the appendix. Identifying periappendiceal fat infiltration in patients suspected of acute appendicitis is clinically significant and warrants further clinical research.[17,18] CT number of periappendiceal fat may be related to the severity of appendicitis, and the CT number or a related parameter (such as relative CT number) may be an applicable index to determine the severity of acute appendicitis. In this study, we examined the accuracy and feasibility of CT number of periappendiceal fat for the preoperative assessment of the severity of appendicitis to help decision-making regarding the need for surgical intervention.

METHODS

This retrospective study was reviewed and approved by the Institutional Review Board of our hospital. All procedures involving human participants were performed in accordance with the ethical standards of the institutional and/or national research committee and conformed to the 1964 Helsinki declaration and its later amendments or comparable ethical standards. For this type of study, formal consent was not required.

Patient characteristics

The 308 patients with acute appendicitis enrolled in this study were selected among 423 patients who met the inclusion and exclusion criteria (124 patients were excluded, including 19 who were under 18-years-old, 72 who received preoperative antibiotic treatment, 25 who had a history of abdominal or pelvic diseases, and eight clinically undiagnosed appendicitis patients who actively applied for appendectomy with pathology diagnosed as mucosal or intraluminal inflammation; all patients were diagnosed and treated at our hospital between January 1, 2016 and March 31, 2018. All patients had complete clinical and imaging data and underwent appendectomy with confirmation by histopathology. There were 150 females and 158 males, and the average age was 47.94 ± 16.14 years (18–91 years). The clinical data of the patients were collected and recorded, including age, sex, clinical manifestations and signs, laboratory examinations, and intervals between CT examination and surgery. The patients were divided into SAA and gangrenous or perforated acute appendicitis (GPAA) groups according to the pathology.

The inclusion criteria were as follows: (a) first time admission to the hospital with no previous treatments and suspected of acute appendicitis before CT examination; (b) underwent whole abdomen CT examination before surgery; (c) underwent appendectomy and pathology confirmation.

The exclusion criteria were as follows: (a) patients who were under 18-years-old; (b) lactating and pregnant females; (c) history of abdominal surgery or trauma, bleeding, or blood

Figure 1. Schematic diagram of CT number measurement. The axial segment (1a, (c) and multiple planar reformation images (1b) show the normal appendix (white arrow) clearly. 1c shows the CT number measurement locations of CTa (black arrow), CTm (white ▵), CTaw (black ▵), CTpw (star), and CTrp (hollow black arrow). Panel 1d shows the CT number measurement locations of CTgl (white circle) and CTps. (black circle)

Table 1. CT findings of the appendix and the concurrent signs

	SAA (n = 287)	GPAA (n = 21)	χ^2	P
Diameter >6 mm	252	21	2.89	0.09
Thickness >2 mm	140	15	4.02	0.045
Appendicolith	124	9	0.001	0.98
Periappendiceal fluid	38	9	4.74	0.03
Surrounding intestinal swelling	26	5	1.46	0.23
Pelvic C:\Users\Administrator\AppData\Local\youdao\dict\Application\7.5.2.0\resultui\dict\effusion	21	3	0.17	0.68
Extraluminal air	0/287	7/14	97.89	<0.01

GPAA, gangrenous or perforated acute appendicitis; SAA, suppurative acute appendicitis.

transfusions; (d) history of abdominal cancer, inflammatory, intestinal, or pelvic inflammatory diseases; (e) history of heart, liver, or renal insufficiencies; (f) with a history of immunodeficiency disorders; (g) lack of peritoneal fat; and (h) other surgical contraindications.

Control group

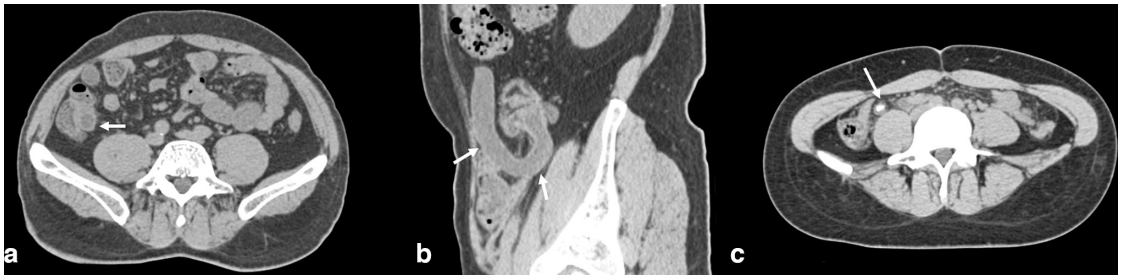
A total of 243 patients were randomly selected as the control group (CON) among 274 patients who met the inclusion and exclusion criteria (seven patients under 18-years-old and 24 patients who had incomplete clinical information were excluded).

Table 2. CT HU of different ROIs in patients and controls

	N	Maximum HU	Minimum HU	Mean ± SD (HU)	t	P
CTa	551			−83.12 ± 27.67	489.14	<0.01
controls	243	−72.33	−130.13	−104.54 ± 9.97		
patients	308	−8.27	−117.43	−66.29 ± 25.41		
CTm	551			−103.39 ± 11.32	20.49	<0.01
controls	243	−68.23	−126.23	−105.81 ± 8.59		
patients	308	−47.97	−128.33	−101.48 ± 12.76		
CTaw	551			−106.43 ± 9.40	9.10	<0.01
controls	243	−74.47	−144.23	−107.78 ± 9.03		
patients	308	−35.63	−132.03	−105.37 ± 9.56		
CTpw	551			−106.63 ± 9.75	18.93	<0.01
controls	243	−70.83	−133.67	−108.64 ± 9.37		
patients	308	−55.20	−125.57	−105.06 ± 9.78		
CTrp	551			−110.98 ± 8.08	15.24	<0.01
controls	243	−91.80	−144.20	−112.48 ± 8.07		
patients	308	−88.47	−133.06	−109.81 ± 7.95		
CTgl	551			−102.47 ± 8.45	0.92	0.34
controls	243	−75.97	−125.27	−102.86 ± 8.54		
patients	308	−69.30	−100.23	−102.16 ± 8.38		
CTps	551			50.35 ± 6.45	1.14	0.29
controls	243	71.73	33.53	50.02 ± 6.37		
patients	308	86.20	30.53	50.61 ± 6.51		

CTa, CT number of the periappendiceal fat; CTgl, CT number of gluteal subcutaneous fat; CTm, CT number of mesenteric fat gap; CTps, CT number of psoas major muscle; CTpw, CT number of abdominal posterior wall subcutaneous fat; CTrp, CT number of retroperitoneal fat; Ctaw, CT number of abdominal anterior wall subcutaneous fat.

Figure 2. A 41-year-old male patient with SAA at 6 h after onset (2a, (b). The appendix (white arrow) was 17.5 mm in diameter, 2.3 mm in wall thickness, and 158.3 mm in length. CTa = −86.72 HU, CTgl = −105.47 HU and CTps = 57.70 HU, and R_{CTgl} = 0.822, R_{CTps} = 1.503. A 35-year-old female patient at 5 h after onset (2c, (d). The appendix was 10.0 mm in diameter, 2.4 mm in wall thickness and 88.6 mm in length, and rounded high-density appendicolith could be seen at the initial section (white arrow). CTa = −62.31 HU, CTgl = −97.37 HU and CTps = 49.50 HU, and R_{CTgl} = 0.640, R_{CTps} = 1.259.



Patients had no abdominal pain (especially no appendix symptoms and signs), and whole-abdominal CT examinations showed no abnormalities in the appendix and surrounding areas. The control group included 130 females and 113 males, and the average age was 53.43 ± 15.58 years (18–92 years).

The inclusion criteria for the control group were as follows: (a) examined in the same study period as the patient group; (b) no signs or symptoms in the appendix area; (c) underwent whole abdomen CT examination and the appendix appeared clear and normal; and (d) final diagnosis was not appendicitis.

The exclusion criteria for the control group were the same as those for the appendicitis group.

CT imaging data acquisition

All patients underwent whole-abdomen plain CT examinations within 2 h after the onset of the emergency with a MDCT (SOMATOM definition flash CT, Siemens, Germany). No bowel cleansing, oral contrast administration, or antispasmodic agents were permitted in any patient before CT scanning to shorten patient preparation time and avoid possible interference. After breathhold training, the CT examination was performed in a supine position from the diaphragmatic dome to the symphysis pubis. The CT scan protocol was tube voltage of 120 kV and CARE Dose 4D automatic tube current modulation, reference mAs was 400, pitch was 0.6, and the original data were reconstructed with the filter backprojection algorithm with a convolution kernel of "B30f medium smooth" in1 mm slice thickness and slice space. For postprocessing, multiple planar reconstruction (MPR) and curved multiplanar reformation (CPR) were used to display the appendix and surrounding areas accurately on Syngo via a workstation.

Imaging observation and analysis

The CT findings from the patient and control groups were analyzed by two experts with 5 and 8 years of abdominal imaging experience. If there was disagreement regarding the concurrent appendicitis signs, agreement was reached based on discussion and a third expert. The main CT indicators were assessed as follows: (1) located the appendix and measured the largest diameter, longest length, and maximum appendiceal wall thickness; (2) collected the concurrent appendicitis signs, such as appendicolith, periappendiceal fluid collection, pelvic effusion, extraluminal air, and surrounding intestinal swelling; (3) Measured the CT number of the periappendiceal fat (CTa), mesenteric fat gap (CTm), abdominal anterior wall subcutaneous fat (CTaw), abdominal posterior wall subcutaneous fat (CTpw), retroperitoneal fat (CTrp), gluteal subcutaneous fat (CTgl), and psoas major muscle (CTps) (Figure 1). CT number was measured in a circle of area 10 mm^2–20 mm^2. CT number was measured three times at each location and the mean was used as the CT number of the site. CTa was measured within 5 mm from the appendix wall; measurements were obtained from multiple locations in

Figure 3. A 61-year-old female with GPAA at 5 h after onset. The appendix was 12.4 mm in diameter, 3.8 mm in wall thickness and 77.4 mm in length (3a, white arrow); the mesangial wall was rough and irregular, and periappendiceal fluid could be seen in the upper region (3b, white arrow). CTa = −46.33 HU, CTgl = −90.37 HU and CTps = 57.49 HU, and R_{CTgl} = 0.513 , R_{CTps} = 0.806.

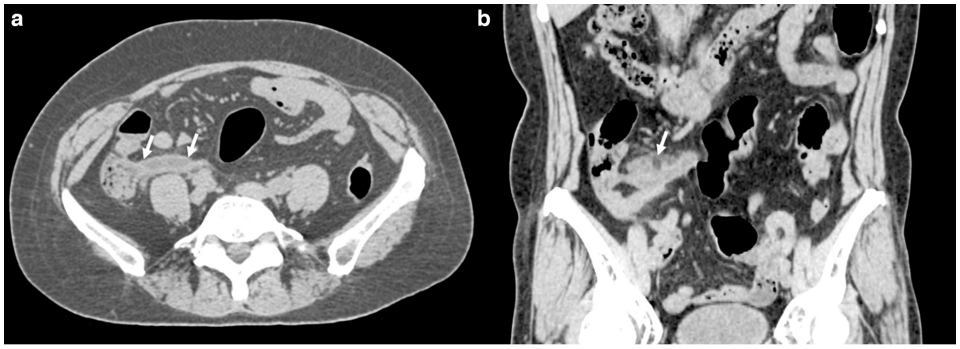


Table 3. Relative CT HU analysis of the patients and controls

Group	CON (n = 304)	SAA (n = 287)	GPAA (n = 21)	F	P
R_{CTgl}	1.02 ± 0.11	0.63 ± 0.26[a]	0.51 ± 0.24†‡	[a]70.725 [b]84.622 [c]44.792	<0.01 <0.01 <0.01
R_{CTps}	2.13 ± 0.34	1.33 ± 0.56[a]	1.13 ± 0.53†#	[a]65.223 [b]73.916 [c]43.209	<0.01 <0.01 <0.01

CON, control group; GPAA, gangrenous or perforated acute appendicitis; SAA, suppurative acute appendicitis.
[a]SAA compared with CON;
[b]GPAA compared with CON;
[c]GPAA compared with SAA

the highest density area avoiding mesangial vessels. In heterogeneous fat stranding, the measured area was determined by MPR imaging. If the exudate from appendicitis affected CTrp and CTps measurements, the measurement sites were placed symmetrically at the same CT section. CTgl was measured in the subcutaneous fat of the buttocks at the level of the acetabulum. The relative numbers were considered statistically relevant CT numbers. The ratio of CTa to the other six CT numbers was calculated and defined as the relative CT number (R_{CT}). The R_{CT} formulas in this study were as follows: R_{CTm} = CTa/CTm, R_{CTaw} = CTa/CTaw, R_{CTpw} = CTa/CTpw, R_{CTrp} = CTa/CTrp, and R_{CTgl} = CTa/CTgl. For the R_{CTps}, the absolute CT number was calculated using the formula R_{CTps}= | CTa / CTps |, which can better display the receiver operating characteristic (ROC) curves.

Pathology

All 243 appendectomy specimens were diagnosed in the pathology department of our hospital. Acute appendicitis cases were classified into SAA and GPAA according to the study by Carr et al.[18] Acute intraluminal inflammation, acute mucosal inflammation, and acute mucosal and submucosal inflammation were not considered true appendicitis.[19]

Statistical analysis

The clinical and imaging information of the patient and control groups was analyzed by independent sample t-tests and chi-square tests, and Fisher exact test was applied as appropriate. The measurement data were expressed as the mean ± SD. One-way ANOVA was used to analyze the differences in CT numbers between the seven measurement sites. The meaningful relative CT numbers of each group were analyzed using ROC curves, and area under the curve (AUC) and 95% confidence interval (95% CI) were obtained. The cutoff of each R_{CT} was determined, and the diagnostic accuracy, sensitivity, and specificity of R_{CT} in the contrast, SAA, and GPAA groups were calculated. All statistical analyses were performed using SPSS 21 for Windows (SPSS Inc., Chicago, IL, USA). Two-sided <i>p values < 0.05 were considered statistically significant, and a <i>p value < 0.10 was considered marginally significant.

RESULTS

Clinical characteristics of the patient group

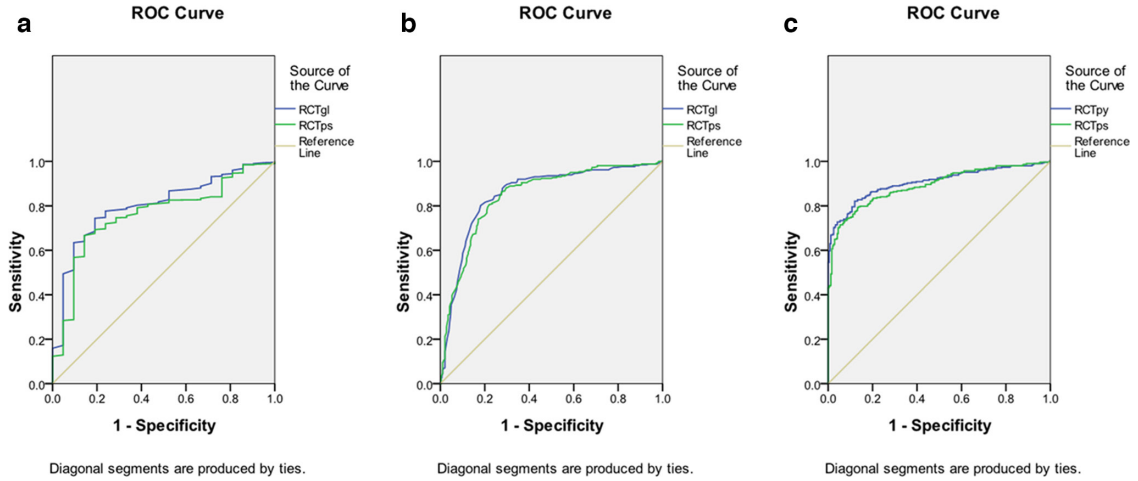
In the patient group, there were 287 SAA and 21 GPAA cases. All patients received timely surgical treatment after CT

Table 4. ROC of relative CT HU analysis for patients and controls

	SAA/CON	GPAA/CON	GPAA/SAA
AUC (95% CI)R_{CTgl}	0.803 (0.719–0.886)	0.854 (0.821–0.888)	0.905 (0.718–0.931)
R_{CTps}	0.761 (0.668–0.855)	0.847 (0.814–0.880)	0.891 (0.864–0.918)
Std. Error[a]R_{CTgl}	0.042	0.017	0.013
R_{CTps}	0.047	0.017	0.014
Asymptotic Sig.[b]R_{CTgl}	0.000	0.000	0.000
R_{CTps}	0.000	0.000	0.000
Cutoff R_{CTgl}	0.655	0.905	0.898
R_{CTps}	1.455	1.655	1.654
Sensitivity R_{CTgl}	0.744	0.802	0.821
R_{CTps}	0.667	0.863	0.734
Specificity R_{CTgl}	0.810	0.819	0.880
R_{CTps}	0.857	0.725	0.926

CON, control group; GPAA, gangrenous or perforated acute appendicitis; R_{CTgl}, relative CT number of CTgl; R_{CTps}, relative CT number of CTps; SAA, suppurative acute appendicitis.

Figure 4. ROC curves of R_{CTgl} and R_{CTps}. In the differentiation of SAA (4a) and GPAA (4b) from control group, the ROC curves showed that R_{CTgl} and R_{CTps} both had high sensitivity and specificity. The same result was obtained for the differentiation of GPAA from SAA (4c). The diagnostic efficacy of R_{CTgl} was higher than that of R_{CTps}.



examination and were confirmed by postoperative pathology. Regarding the clinical characteristics, there were significant differences in fever, nausea, and emesis ($P < 0.05$) between the SAA and GPAA groups, with no significant differences in other characteristics ($P > 0.05$).

CT findings of the patient and control groups

On the CT images, the appendix diameter (12.43 ± 3.99 mm), length (69.01 ± 18.50 mm) and wall thickness (2.01 ± 0.84 mm) were greater in the patient group than in the control group (6.76 ± 1.55 mm, 56.11 ± 13.79 mm, 0.92 ± 0.23 mm, respectively), and the differences between the three groups were significant ($p < 0.01$). In the patient group, the appendix diameter and wall thickness increased in correlation with the severity of appendicitis, and significant differences were found between the SAA and GPAA groups ($p < 0.05$) (Table 1).

Assessment of the concurrent appendicitis signs (Table 1) showed that periappendiceal fluid, surrounding intestinal swelling, and pelvic effusion were more common in GPAA than in SAA, whereas extraluminal air was only observed in patients with GPAA (7/21). The differences in periappendiceal fluid and extraluminal air between the two groups were statistically significant ($p < 0.05$).

CT number differences between the patient and control groups

Regarding changes in fat density, the CTa of appendicitis (−66.29 ± 25.41 HU) increased greatly compared with that of controls (−104.54 ± 9.97 HU) ($p < 0.01$), although there was a wide overlap range (-72.33−−117.43 HU). One-way ANOVA showed no significant differences in CTgl and CTps between patients and controls (Table 2). These two CT numbers could be selected as a reference for further relative CT number evaluations of appendicitis CTa (Figures 2 and 3).

Correlation between relative CT number (R_{CT}) and appendicitis severity

The relative CT numbers based on R_{CTgl} and $R_{CTps}$and the corresponding ROC curves were further analyzed. The R_{CTgl} and R_{CTps} were higher in the CON group than in the SAA and GPAA groups, and significant differences were observed between the three groups ($P < 0.01$, Table 3). The AUCs (95% CIs) of R_{CTgl} and R_{CTps} could both distinguish appendicitis from the normal appendix with high sensitivity and specificity, and the diagnostic efficacy of R_{CTgl} was better than that of R_{CTps} (Table 4, Figure 4), especially in the comparison between GPAA and SAA (Table 4, Figure 4). The differences in AUCs (95%CIs) of relative CT numbers between the CON, SAA, and GPAA groups indicated that periappendiceal fat infiltration was aggravated in correlation with lesion severity, and the relative CT number was an accurate indicator of the severity of appendicitis.

DISCUSSION

Acute appendicitis is one of the most common acute abdominal disorders. Typical clinical manifestations include migrated abdominal pain, tenderness over Mc Burney's point, rebound pain, muscle tension, and an elevated leukocyte count in laboratory tests.[4,20,21] The selection of treatment between antibiotics and appendectomy remains controversial,[22–24] especially in cases of uncomplicated appendicitis.[22] However, delayed surgery in cases of complicated appendicitis may lead to severe complications such as diffuse peritonitis, systemic infection, and even multiple organ failure or death.[9,25,26] The incidence of gangrene and perforation is higher in cases of appendicitis with antibiotic treatment failure.[27] Therefore, a precise diagnosis and evaluation of the severity of appendicitis are crucial for the timely implementation of effective treatments. Certain characteristic clinical manifestations such as age ≥52 years, body temperature ≥37.5°C, duration of symptoms ≥ 48 h,[20] and C-reactive protein ≥4.7 mg dl^{-1}[21] could be used as predictive factors for complicated appendicitis, although their diagnostic accuracy is low. The

results of the analysis of clinical factors in this study supported this hypothesis.

Preoperative MDCT can accurately show appendix lesions and the accompanying changes, and MDCT has been the clinically preferred technique for the prognostic evaluation of appendicitis,[12] which can lower the negative appendectomy rate.[8,28] In addition to establishing diagnostic standards for appendicitis such as appendix diameter and wall thickness, MDCT studies focus on assessing the severity of appendicitis.[6,20,21]

Avanesov[20] reported that the appendicitis severity index (APSI) determined by CT showed a positive predictive value of 92% and a negative predictive value of 83% in cases of complicated appendicitis. Indicators of perforated appendix include defects in the appendiceal wall, or periappendiceal phlegmon combined with periappendiceal abscess, extraluminal air, and an extraluminal appendicolith.[29] In this study, the signs detected in cases of suppurative and gangrenous appendicitis supported the results of previous studies.

The CT manifestations of periappendiceal fat infiltration include increased fat density around the appendix or ileocecal region in strips or plaques, and an increase in the amount of exudate in correlation with the severity of inflammation. This finding needs to be distinguished from periappendicitis caused by pelvic inflammatory disease, ovarian neoplasia, or chronic inflammatory bowel disease.[18] CT is the most accurate imaging method for measuring abdominal fat,[30] which can be evaluated by direct measurement or with the pixel method.[31] In this study, direct measurement was used to evaluate periappendiceal fat density changes. Previous studies demonstrated that positive fatty infiltration around the appendix is a possible indicator of appendicitis[11] with a high sensitivity for perforating appendicitis,[32,33] and similar results were obtained in this study. However, quantitative evaluation of the severity of appendicitis is difficult because of the overlap in periappendicular fat CT numbers between the controls and the patients. This may be the reason for the lack of studies on CT number in the literature. Referring to the relative CT numbers of previous reports,[34,35] the correlation between the relative CT number of periappendiceal fat and the severity of appendicitis was quantitatively analyzed in this study. According to the anatomical distribution,[36] six reference measurement sites were selected, which contained the psoas major muscle and five fat-rich areas that are easily measured and are not affected by appendicitis. The results of the relative CT number analysis demonstrated the feasibility of applying CTgl and CTps as indicators, and the difference in R_{CTgl} and R_{CTps} could be regarded as a qualitative indicator of the severity of appendicitis.

In this study, the overlap in CT number between the appendicitis and control patients may affect the reliability of the assessment of the severity of appendicitis based on CT number alone. In the assessment of the relative CT number, individual factors were excluded. One-way ANOVA of CT numbers from six sites except periappendiceal fat detected significant differences in CTm, Ctaw, CTpw, and CTrp, and further study was not feasible for these data. One possible explanation for this result is that these sites are susceptible to multiple factors, such as inflammatory infiltration caused by pelvic or other abdominal diseases, or abdominal wall edema. Intergroup comparisons of the CT numbers of R_{CTgl} and R_{CTps} suggested that periappendiceal fat infiltration became worse in correlation with the severity of appendicitis, which confirmed the hypothesis that the CT number of periappendiceal fat is related to the severity of appendicitis. The AUCs (95% CIs) of R_{CTgl} and R_{CTps} confirmed that R_{CTgl} and R_{CTps} could be used to distinguish complicated appendicitis from uncomplicated appendicitis. The ROC curves of the relative CT numbers suggested that R_{CTgl} and R_{CTps} can be used to determine the severity of appendicitis with high diagnostic accuracy, which may helpful for clinical decisions regarding surgery. In clinical practice, determination of the severity of appendicitis must be based on other direct CT findings and clinical factors, rather than on AUCs (95%CIs) alone. For example, gangrenous appendicitis can be diagnosed based on factors such as age (≥60 years), temperature (>39.0°C), high CPR, APSI score, and the presence of extramural gas, extramural appendicolith, and focal defects in the appendix wall.[20,37]

This study had several limitations related to its retrospective nature such as the lack of independent readings and determination of interobserver variability. In addition, the effect of intra-abdominal fat quantity (and/or BMI) on periappendiceal fat CT attenuation was not evaluated. The sample size of GPAA was small, and additional studies are necessary.

In conclusion, periappendiceal fat stranding is a sign of appendicitis but it is not a specific indicator. When combined with other severity indexes, relative CT numbers may be useful for the differential diagnosis of uncomplicated and complicated appendicitis and may improve the accuracy of the assessment of appendicitis severity, which is important to direct the clinical treatment.

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CONFLICTS OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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