Original article

Comparative accuracy of unenhanced and IV-contrast enhanced MDCT in detection of acute appendicitis in adult patients

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Background: Computed tomography (CT) is the preferred imaging modality for suspected acute appendicitis. However, optimal CT technique remains controversial.

Objectives: To compare the diagnostic accuracy of unenhanced CT with standard IV-contrast enhanced CT in the diagnosis of acute appendicitis in adult patients and whether body mass index (BMI) affects the diagnosis.

Methods: A total of 209 patients (70 males and 139 females) with clinically suspected acute appendicitis underwent both unenhanced and IV-contrast enhanced CT with rectal contrast administration. We retrospectively reviewed radiographic findings of appendicitis, appendiceal visualization, likelihood of appendicitis and alternative diagnoses. Receiver operating characteristic (ROC) analysis, unpaired *t* - test and the Chi-square test were used.

Results: One hundred seventeen patients underwent appendectomy with definitely diagnosed appendicitis in 114 (54.5%) patients. Areas under the ROC curves were 0.88 (95% CI; 0.83 -0.92) for unenhanced and 0.92 (95% CI; 0.88 - 0.95) for enhanced CT without significant difference ($P = 0.07$). Sensitivity, specificity and diagnostic accuracy for unenhanced scan were about 86.7%, 88.5% and 87.6% compared with 93.9%, 89.5% and 91.9% for enhanced scan. Scores for visualization of the appendix were significantly higher in enhanced scan than in unenhanced scan of patients with normal BMI ($P = 0.0002$).

Conclusions: Unenhanced CT has comparable diagnostic performance with enhanced CT for diagnosing acute appendicitis, regarding of BMI. However, diagnostic confidence and visualization of the appendix in normal BMI patients and alternative diagnoses tend to be compromised on unenhanced CT. Therefore, IV-contrast enhanced CT may be considered for detection of appendicitis, especially in normal BMI patients.

Keywords: Appendicitis, appendix, computed tomography, unenhanced, Contrast Enhanced CT.

Acute appendicitis is one of the most common causes of acute abdominal pain and most common indications for emergency abdominal surgery in the United States (US), occurring 7.0 – 12.0% of the general population. [1] There are about 250,000 new cases per year in the US and 32 - 37 cases per 100,000 population in Thailand [2] with lifetime risk about 16.3%. [3] Up to 30.0 – 45.0% of patients of acute appendicitis have equivocal and atypical presentation [4] which can lead to inappropriate removal of a normal appendix about 8.0 – 30.0%. [5]

Computed tomography (CT) is becoming the preferred imaging modality for suspected acute appendicitis, particularly in adults due to its high sensitivity and specificity, and less operator dependent. [6 - 11] Many institutions perform various CT techniques for diagnosing appendicitis including single unenhanced CT, intravenous (IV)-contrast enhanced scan or combined two phases. Many retrospective and prospective studies have suggested that unenhanced CT is optimal and useful technique for diagnosis of acute appendicitis with high sensitivity, specificity and diagnostic accuracy. [12 - 15] A number of studies had compared the diagnostic accuracy between different protocols or contrast materials, however optimal CT technique for appendicitis remains controversial. One of the serious long-term side effect of CT scan is accumulative radiation exposure with increased risk of radiation-induced cancer. [16] As the result, appropriate use of CT scan should be considered. Unenhanced CT gains more attention for practical use due to no risk of allergic reaction of contrast medium, contrast-

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induced nephropathy and to minimize the radiation exposure. [12 - 14] Therefore, this study aimed to compare the diagnostic accuracy of standard dose unenhanced and standard IV-contrast enhanced multi-detector CT in patients suspected acute appendicitis and whether body mass index (BMI) affects the diagnosis.

Materials and methods

Patients

This retrospective Health Insurance Portability and Accountability Act (HIPAA)-complaint study was approved by our Institutional Review Board (approval No.299/60/ 575/2017). The requirement for informed consent was waived. We searched from our radiology database (Picture Archiving and Communication System (PACS), AGFA Impax; AGFA Technical Imaging Systems, Ridgefield Park, NJ, USA) for consecutive patients of clinically suspected acute appendicitis who performed emergency CT scan in our hospital between January 2016 and February 2017, accordingly we included 260 patients. The inclusion criteria were patients with age 15 years or older who presence of clinically suspected acute appendicitis and underwent abdominal CT examination in unenhanced and standard IV-contrast enhanced scans. Two hundred forty-seven patients met the inclusion criteria. Thirty-eight patients were excluded due to (a) incomplete data or loss follow up (n = 26), (b) no available unenhanced images (n = 2), (c) no available post contrast images (n = 2), (d) no rectal contrast administration (n = 2), and (e) patient information combined with other clinical sign and symptoms that suggested alternative diagnosis such as malignancy, gut obstruction or lower gastrointestinal bleeding (n = 6). A total of 209 patients were included in the analysis. The intra-operative findings and pathological report were used as the reference standard.

Image acquisition

CT examinations were performed using a 64-multidetector row MDCT scanner with collimation 64 x1 mm, 120 kVp, 95 - 200 mAs, pitch = 0.813 - 1.375 and 2-mm slice thickness (Philips Brilliance 64, Philips Medical Systems; Best, Netherland). The CT protocols were composed of unenhanced phase and portovenous phase after intravenous administration of nonionic contrast material with rectal contrast administration for each patient.

Image analysis

Unenhanced and standard IV-contrast enhanced studies of each patient were retrospectively reviewed by the abdominal radiologist (T.C.) in random order which blinded to clinical information, original CT report and definite diagnosis. Unenhanced studies were evaluated prior to the enhanced studies at least 4 weeks apart to prevent recall bias.

The reader evaluated visualization of an appendix by 3-point scale scores: 0, not identified; 1, unsure or partly visualized; 2, clearly visualized. The likelihood of appendicitis was reviewed by 5-point Likert scale: 1, definitely absent; 2, probably absent, 3; indeterminate; 4, probably present and 5, definitely present. Diagnostic criterion of acute appendicitis included appendiceal change, cecal change and inflammatory change in right lower abdomen. Appendiceal change referred to enlarged appendix (greater than 6 mm in outer-wall-to-outer wall transverse diameter), appendicolith, appendiceal wall thickening (appendiceal wall ≥ 3 mm), intramural gas, absence of intraluminal air and appendiceal wall hyperenhancement. [5, 11, 17]

The cecal changes included cecal apical thickening, arrow head sign and cecal bar sign. Inflammatory changes in right lower abdomen consisted of periappendiceal fat stranding, thickening of lateral conal fascia and mesoappendix, extraluminal fluid or air, phlegmon or abscess and ileocecal lymph node enlargement (≥ 1 cm in short axis). We determined positive for acute appendicitis in case which the Likert score for appendicitis score more than 3 to decrease negative appendectomy rate. In the cases that likelihood of appendicitis ≤ 3, alternative diagnosis was identified.

Definite diagnoses were made based on pathological findings, other diagnostic techniques and laboratory results, medical records in cases of improvement after receiving specific treatment or conservative treatment and follow-up data without surgery.

Statistical analysis

Statistical analysis was performed using Stata statistical software (Stata/IC 14.0; Stata Statistical Software, College Station, TX, USA). The data were expressed as mean ± standard deviation (SD). The Chi-square and unpaired Student's *t* - test were used to compare age, sex and body mass index (BMI) between patients with acute appendicitis and without

acute appendicitis. We used Receiver operating characteristic (ROC) analysis and created the areas under the ROC curves (AUCs) to compare between two scans. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy and visualization of appendix and alternative diagnosis were also obtained with *P*-value corresponds to unpaired *t* - test and Chi-square test. Inter-rater reliability was measured with Kappa statistics.[18] $P < 0.05$ was considered statistically significant.

Results

Two hundred and nine patients were included in the analysis, consisting of 70 male (33.5%) and 139 female patients (66.5%). The patient demographics are summarized in Table 1 and the representative CT images are shown in Figures 1 and 2. One hundred and seventeen patients undergone appendectomy with negative appendectomy rate about 2.6% (pathological reports of 3 out of 117 patients were mucosal lymphoid hyperplasia of appendix in 2 cases and low grade appendiceal mucinous neoplasm). Definite diagnosis of acute appendicitis was made in 114 (54.5%) out of 209 patients, classified as acute appendicitis without complication 79 cases (69.3%), abscess or phlegmon in 5 cases (4.4%) and ruptured appendicitis in 30 cases (26.3%). The rest of 95 patients were reported as no appendicitis with alternative diagnosis in 57 patients, predominantly diagnosed with urinary tract stone and urinary tract infection in male (5 cases) and gynecological conditions in female (14 cases). All alternative diagnoses are shown in Table 2 according to male and female patients. The other 38 patients (34 female and 4 male) were considered to have nonspecific abdominal symptoms and improving after conservative treatment. The group of acute appendicitis had statistically significant higher mean age than no appendicitis group ($P = 0.01$). There was significant higher percentage for diagnosed acute appendicitis than no appendicitis in male patients ($P = 0.001$). No significant difference of BMI between acute appendicitis and no appendicitis groups was observed ($P = 0.972$).

Sensitivity, specificity, PPV and NPV for diagnosing acute appendicitis were 86.7%, 88.5%, 89.9% and 85.0% for unenhanced scan and 93.9%, 89.5%, 91.5% and 92.4% for IV-contrast enhanced scan, respectively. Diagnostic accuracy of unenhanced and IV-contrast enhanced scans were 87.6% and 91.9%. False negative results in unenhanced scan are 16 cases compared to 7 cases in enhanced scan (Figure 3). The diagnostic performance in diagnosing acute appendicitis of unenhanced and IV-contrast enhanced scans was described in Table 3. The AUCs for unenhanced and IV-contrast enhanced scans were 0.88 (95% CI; 0.83 - 0.92) and 0.92 (95% CI; 0.88 - 0.95), respectively. No significant difference was observed between the AUCs of the two scans ($P = 0.07$, Figure 4). The inter-rater reliability of likelihood of diagnosing appendicitis between unenhanced and IV-contrast enhanced scans were considered substantial agreement ($k = 0.80$).

Appendices were not clearly identified in 38 cases (17.4%) of unenhanced scan and 5 cases (2.3%) of IV-contrast enhanced scan, defined as non-visualized appendix in 12 cases and partly visualized appendix in 26 cases of unenhanced scan compared to non-visualized appendix in 4 cases and only one partly visualized appendix in IV-contrast enhanced scan. Two cases of non-visualized appendix and 4 cases of partly visualized appendix in unenhanced scan were misdiagnosed appendicitis. Two cases of partly visualized appendix in unenhanced CT have false positive results. Thirty-four out of 38 cases that are not clearly identified appendix in unenhanced scan are recorded as clearly visualized appendix in IV-contrast enhanced scan. The other 3 cases are not clearly identified in both scans and another case is defined as partly visualized in enhanced scan. In both acute appendicitis and no appendicitis group, scores for visualization of the appendix were significantly higher in IV-contrast enhanced scan than unenhanced scan, especially in patients with normal BMI in subgroup analysis ($P = 0.0002$, Table 4). Nevertheless, there were no significant difference of visualization score between two scans in underweight, overweight and obese patients even though they were categorized by gender.

Frequency of findings detected by unenhanced and IV-contrast enhanced scans and overall diagnosis in patients with definite diagnosis of acute appendicitis and no appendicitis were listed in Table 5. There was significantly enlarged appendiceal diameter of acute appendicitis group, measuring about 11.2 ± 3.3 cm and 11.5 ± 3.2 cm on unenhanced and IV-contrast enhanced scan, compared with no appendicitis group which measured about 6.0 ± 1.8 cm and 5.8 ± 1.5 cm, respectively ($P < 0.001$). Findings that significantly suggested in diagnosing acute appendicitis on both unenhanced and IV-contrast enhanced scans were

appendiceal wall thickening, absence of intraluminal air, cecal change, periappendiceal fat stranding, thickened lateral conal fascia and mesoappendix, and extraluminal fluid or air (Figure 5) ($P < 0.05$). Presence of appendicolith in acute appendicitis was significantly higher than patient with no appendicitis in both scans ($P < 0.01$). However, size of appendicolith showed no significant difference on unenhanced scan ($P = 0.44$). Intramural gas and ileocecal lymph node enlargement showed no statistical difference in acute appendicitis and no appendicitis groups in both unenhanced and IV-contrast enhanced scans ($P = 0.09$ - 0.87).

Table 1. Patient demographics and definite diagnosis of acute appendicitis.

Characteristics (n = 209)	**Definite diagnosis**		***P*-value**
	Acute appendicitis (n = 114)	**No appendicitis (n = 95)**	
Age (years; mean ± SD)	47.7 ± 18.4	41.0 ± 18.5	0.01*
BMI (kg/m²; mean ± SD)	23.3 ± 4.3	23.3 ± 6.1	0.972
Gender			
Male	49 (43.0)	21 (22.1)	0.001*
Female	65 (57.0)	74 (77.9)	0.001*
Acute appendicitis and complications (n = 114)			
Acute appendicitis	79 (69.3)		
Abscess or phlegmon	5 (4.4)		
Ruptured appendicitis	30 (26.3)		

Note: Data are number of patients with percentages in parentheses.
*Statistically significant
BMI : Body mass index, SD: standard deviation

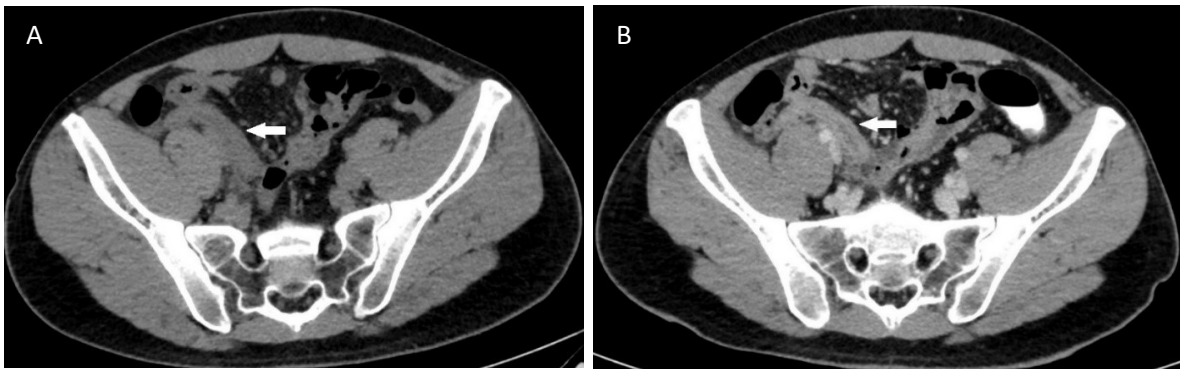

Figure 1. A case that diagnosed acute appendicitis in both unenhanced and IV-contrast enhanced scan in a 29-year-old man presented with migratory right lower quadrant pain. On axial CT image of unenhanced CT **(A)** showed enlarged fluid-filled appendix with thickened wall (arrow), measuring 1.2 cm in diameter. No intraluminal air is observed. On axial post contrast enhanced CT image **(B)** showed enlarged fluid-filled appendix with appendiceal wall hyperenhancement (arrow). Periappendiceal fluid and fat stranding are also observed (not shown).

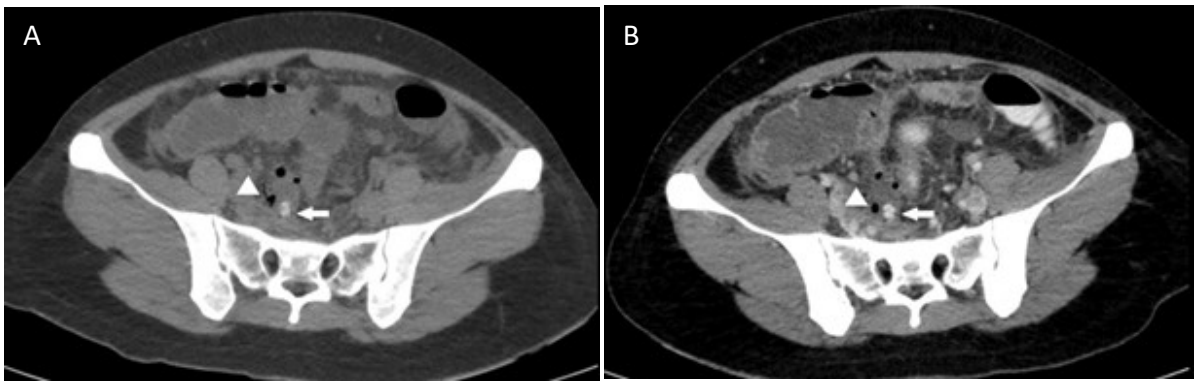

Figure 2. A case that diagnosed ruptured appendicitis in both unenhanced and IV-contrast enhanced scan in a 28-year-old woman with right lower quadrant pain. On axial CT images of unenhanced CT **(A)** and IV-contrast enhanced scans **(B)** show similar findings of enlarged fluid-filled appendix, measuring 1.2 cm in diameter with extraluminal air (arrowhead) and a 0.7-cm appendicolith (arrow).

Table 2. Alternative diagnoses in patients by definite diagnosis from other diagnostic techniques, unenhanced and IV-contrast enhanced CT.

	No. of patients (n = 17)		
Alternative diagnosis (Male patients)	**Definite diagnosis from other diagnostic techniques¶**	**Unenhanced CT**	**Standard IV-contrast enhanced CT**
Urinary tract stones and urinary tract infection	5	5	5
Acute diverticulitis	3	1	3
Enteritis, Ileitis, Colitis	3	0	1
Symptomatic gallstones and Acute cholecystitis	2	1	2
Acute pancreatitis	1	1	1
Bowel obstruction	1	1	1
Soft tissue infection	1	0	0
Low grade appendiceal mucinous neoplasm	1	0	0
	No. of patients (n = 40)		
Alternative diagnosis (Female patients)	**Definitive diagnosis from other diagnostic techniques¶**	**Unenhanced CT**	**Standard IV-contrast enhanced CT**
Gynecological condition‡‡	14	7	12
Enteritis, Ileitis, Colitis, Neutrophilic enterocolitis	10	2	6
Urinary tract stones and urinary tract infection	5	5	5
Acute diverticulitis	3	2	3
Symptomatic gallstones and Acute cholecystitis	2	1	1
Submucosal lymphoid hyperplasia of appendix	2	0	0
Bowel obstruction	1	1	1
Pancreatic cancer	1	0	1
Acute hepatitis	1	0	0
Lymphadenitis	1	0	0

¶Definite diagnosis was made by other techniques e.g. relief of pain, follow-up findings, surgery, biopsy, pelvic examination, and laboratory results

‡‡Gynecological condition – ovarian cyst, hydrosalpinx, tubo-ovarian abscess, pelvic inflammatory disease, and ovarian cancer

Figure 3. False negative case of unenhanced CT in an 18-year-old male with diagnosed appendicitis. On coronal and axial CT images of unenhanced CT **(A, B)** showed not clearly visualized appendix in right lower abdomen and defined the likelihood of appendicitis as 2 (probably absent). Whereas on coronal and axial CT images of enhanced CT **(C, D)** showed enlarged appendix with thickened, hyperenhanced wall (arrow), measuring about 1.0 cm in diameter and minimal periappendiceal fat stranding.

Table 3. Diagnostic performance in diagnosing acute appendicitis of unenhanced and IV-contrast enhanced scans.

Characteristics	Unenhanced scan	IV-contrast enhanced scan
Sensitivity (%)	86.7	93.9
Specificity (%)	88.5	89.5
Positive predictive value (%)	89.9	91.5
Negative predictive value (%)	85.0	92.4
Diagnostic accuracy (%)	87.6	91.9

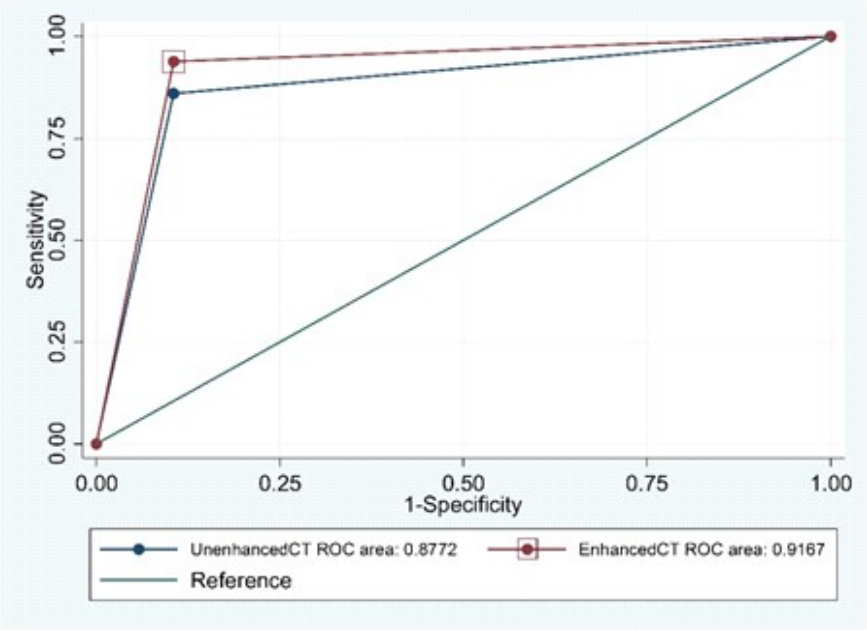

Figure 4. Area under the receiver operating characteristics curve (AUCs) for diagnosis of acute appendicitis in unenhanced and IV-contrast enhanced scans ($P = 0.07$).

Table 4. Scores of appendiceal visualization by 3-point scale scores in unenhanced and IV-contrast enhanced scans defined by BMI classification.

BMI (kg/m^2)	Acute appendicitis			No appendicitis		
	Unenhanced	IV-contrast	*P* - value	Unenhanced	IV-contrast	*P* - value
Overall	1.84 ± 0.41	1.99 ± 0.09	0.0002*	1.66 ± 0.66	1.92 ± 0.40	0.002*
Underweight (n = 16)	1.8 ± 0.2	1.8 ± 0.2	1.00	1.73 ± 0.65	2.0 ± 0.0	0.18
Normal (n = 143)	1.8 ± 0.45	2.0 ± 0	0.0002*	1.58 ± 0.72	1.9 ± 0.61	0.004*
Overweight (n = 33)	2.0 ± 0	2.0 ± 0	-	1.87 ± 0.35	1.87 ± 0.52	1.00
Obesity (n = 17)	1.88 ± 0.35	2.0 ± 0	0.33	1.78 ± 0.67	2.0 ± 0.0	0.33

Note: Value presented as mean ± SD, Dash (-) indicates the value cannot be calculated.
BMI classification defined < 18.5 as underweight, 18.5 - 24.9 as normal, 25.0 - 29.9 as overweight and ≥ 30 as obesity
*Statistically significant

Table 5. Frequency of imaging findings detected by unenhanced and IV-contrast enhanced scans in patients with definite diagnosis acute appendicitis and no acute appendicitis.

Variables	Unenhanced scan		*P* - value	IV-contrast enhanced scan		*P* - value
	Acute appendicitis (n = 114)	No appendicitis (n = 95)		Acute appendicitis (n = 114)	No appendicitis (n = 95)	
Diameter (Mean ± SD)	11.18 ± 3.34	5.96 ± 1.77	< 0.001*	11.51 ± 3.23	5.8 ± 1.47	< 0.001*
Appendiceal wall thickening	70 (62.5)	7 (8.2)	< 0.001*	88 (77.2)	7 (7.4)	< 0.001*
Appendicolith	52 (46.4)	17 (20)	< 0.001*	50 (43.9)	12 (12.6)	< 0.001*
Size of appendicolith (Mean ± SD)	6.89 ± 3.65	6.04 ± 4.78	0.437	7.84 ± 4.11	4.73 ± 1.4	< 0.001*
Intramural gas	2 (1.8)	0 (0)	0.216	1 (0.9)	1 (1.1)	0.873
Intraluminal air	18 (16.1)	58 (68.2)	< 0.001*	17 (14.9)	63 (66.3)	< 0.001*
Appendiceal wall hyperenhancement	-	-		78 (68.4)	15 (15.8)	< 0.001*
Cecal change	53 (46.5)	8 (8.4)	< 0.001*	81 (71.1)	8 (8.4)	< 0.001*
Periappendiceal fat tranding	96 (84.2)	15 (15.8)	< 0.001*	102 (89.5)	15 (15.8)	< 0.001*
Thickened lateral conal fascia and mesoappendix	75 (65.8)	26 (27.4)	< 0.001*	82 (71.9)	19 (20)	< 0.001*
Extraluminal fluid	43 (37.7)	6 (6.3)	< 0.001*	49 (43)	4 (4.2)	< 0.001*
Extraluminal air	8 (7)	1 (1.1)	0.034*	9 (7.9)	1 (1.1)	0.021*
Ileocecal lymph node enlargement	3 (2.6)	0 (0)	0.111	6 (5.3)	1 (1.1)	0.092

Note: Data are number of lesions with percentages in parentheses.
P - value corresponds to unpaired *t* - test and Chi-square test.
*Statistically significant

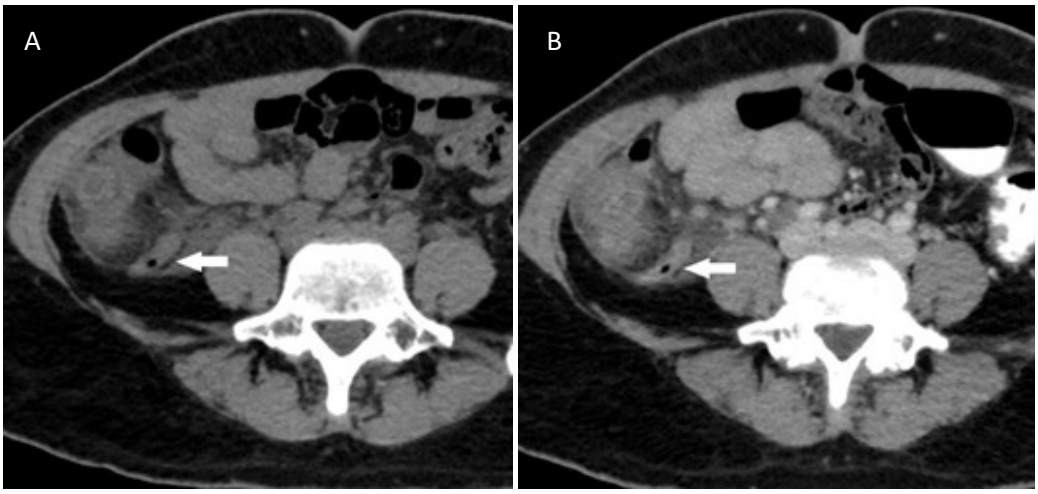

Figure 5. False positive case on both unenhanced and IV-contrast enhanced CT in a 47-year-old woman with acute RLQ pain. On axial CT image of unenhanced CT **(A)** showed mildly enlarged appendix (arrow), measuring 0.7 cm in diameter with periappendiceal fluid and fat stranding. On axial post contrast enhanced CT image **(B)** showed mildly enlarged fluid-filled appendix with appendiceal wall hyperenhancement, periappendiceal fluid and fat stranding. The pathological report was mucosal lymphoid hyperplasia of the appendix.

Discussion

Although utilization of CT scan for diagnosis of acute appendicitis tends to be increasing, instead of ultrasonography, the standard CT technique for appendicitis is still controversial. Sensitivity and specificity of unenhanced CT from two systematic reviews in which one review included only adult populations were about 90.0 - 92.7% and 94.0 - 96.1% [19, 20], respectively in comparison with 86.7% and 88.5% from our study. The use of IV-contrast administration has been debated due to risk of allergic reaction, contrast-induced nephropathy and delay scan time according to fasting (NPO) guidelines. The previous studies from Kitagawa M, *et al.*[21] and Kaiser S, *et al.* [22] suggested that enhanced CT was superior to unenhanced CT for the sensitivity and diagnosis of appendicitis. However, the population in their studies included pediatric patients and one did not include the patients who interpreted as negative for appendicitis. Therefore, different body habitat and intra-abdominal fat distribution might affect the result when applying to adult populations. No other study had compared diagnostic accuracy of standard-dose unenhanced and IV-contrast enhanced CT scans for appendicitis focused especially in adult population.

This retrospective study totally included 209 patients with clinically suspected acute appendicitis presented at Emergency department. Our study found that diagnostic performance of unenhanced scan for diagnosing acute appendicitis was comparable with standard IV-contrast enhanced scan in AUC analysis and yielding high sensitivity and specificity. However, visualization of an appendix tended to be compromised on unenhanced scan especially in normal BMI patients, which may lead to decreasing in diagnostic confidence and prolong time to interpret. In addition, we found 27.3% alternative diagnoses in our population, similar to the previous studies [11, 14, 17, 23] in which the correct diagnosis might be challenging on unenhanced scan particularly in gynecological conditions and other gastrointestinal tract pathology. For these reasons, we suggested the use of IV-contrast enhanced CT as the preferred imaging modality for diagnosing acute appendicitis especially in normal BMI patients. Benjaminov O, *et al*. reported that the paucity of intraperitoneal fat is one of the important factors resulting in non-visualization of an appendix. [24] However, in our study there was noticeably small numbers of underweight, overweight and obese patients (n = 16, 33, 17) compared with normal BMI patients (n = 143). This could be affected statistical calculations. Another retrospective study from Castro AA, *et al*. [25] performed contrast enhanced CT scan and used software to estimate body fat composition in acute appendicitis patients. They concluded that no significant difference between imaging findings of acute appendicitis detected in lean and normal BMI individuals compared to overweight or obesity patients such as intraluminal appendicolith, parietal thickening and parietal enhancement by contrast. But no available data about visualization of an appendix and visceral fat composition is gathered especially in unenhanced scan.

There are 3 false positive cases on both scans in our study whose pathological reports showed 2 cases of mucosal lymphoid hyperplasia (Figure 5) and 1 case of low graded appendiceal mucinous neoplasm. Lymphoid hyperplasia is common pathological findings in uninflamed appendix [11, 26], characterized by increased size of lymphoid tissue in response to gastrointestinal inflammatory disease such as viral infection which sometimes indistinguishable from acute appendicitis by imaging. [26]

Limitation of this study was retrospectively nonrandomized design in single tertiary care center. Therefore, a further prospective multicenter study might be valuable to detect statistical significance. Secondly, we have small numbers of underweight, overweight and obese patients compared with normal BMI patients, we should beware of making conclusions regarding the relationship between BMI and the diagnosis in these groups. Besides, we suggested that further evaluation of correlation between intraperitoneal fat and visualization of an appendix is considered especially in unenhanced study.

Conclusions

Our results concluded that unenhanced CT scan had similar diagnostic accuracy to IV-contrast enhanced scan for diagnosing acute appendicitis. However diagnostic confidence and visualization of an appendix in normal BMI patients and alternative diagnoses tended to be compromised on unenhanced scan. Therefore, IV-contrast enhanced CT may be considered as the preferred imaging modality for diagnosing appendicitis especially in normal BMI patients.

Conflicts of interest

The authors, hereby, declare no conflict of interest.

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