Whether Intravenous Contrast is Necessary for CT Diagnosis of Acute Appendicitis in Adult ED Patients?

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Rationale and Objectives: To assess the necessity of intravenous contrast medium for abdominopelvic computed tomography (CT) diagnosis of acute appendicitis (APP) among adult patients with right lower quadrant (RLQ) abdominal pain at emergency department (ED).

Materials and Methods: ED patients with clinical suspicion of APP from RLQ pain for a period of 8 months were enrolled retrospectively. Both pre- and postintravenous contrast-enhanced CT scans were performed for these patients. The visibility of vermiform appendix and specific CT findings of APP were recorded separately for noncontrast CT (NCT) and contrast-enhanced CT (CCT) images without knowledge of the patient's identity and final diagnosis. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of CT diagnosis for APP were compared between the two groups. The ease of identifying appendix was also compared.

Results: Forty-two (42.0%) of the 100 patients (55 males, 45 females; age range, 16–90 years; mean age, 49.3 years) were APP. There was no significant difference for the visibility of appendix (94% vs. 91%; $P = .589$) and radiological characters between the CCT and NCT groups. There were significant differences between the two groups for sensitivity (100% vs. 90.5%; $P = .036$), specificity (94.8% vs. 100%; $P = .038$), PPV (93.3% vs. 100%; $P = .021$), NPV (100% vs. 93.5%; $P = .021$), but no significant difference for accuracy (97% vs. 96%; $P = 1$). The appendix was easier to detect on CCT than NCT images ($P = .013$).

Conclusion: The diagnostic sensitivity of CCT was significantly better than that of NCT. Intravenous contrast administration could also make doctors easier in indentifying appendixes.

Key Words: Acute appendicitis; computed tomography; contrast medium; length of stay.

Acute appendicitis (APP) remains one of the leading causes of acute abdominal pain requiring surgical treatment in patients presenting to the emergency department (ED), occurring in 27.5% of surgical abdominal emergencies (1–3). Unfortunately, timely diagnosis remains clinically challenging, and the correct diagnosis is not made in at least 20% of patients with APP (4–8). Delays increase the risk of appendiceal perforation, postoperative complications and medical expenses (8,9).

As helical abdominopelvic computed tomography (CT) performed in patients with clinically suspected APP has shown high diagnostic accuracy (93% to 98%) and reduction of hospital resource utilization in many previous reports, the use of this imaging modality in diagnosing APP has increased steadily (5–8,10–13). Various methods to enhance the visibility of CT have been studied, and the protocol with intravenous contrast administration has proven to be an effective technique, which also reduced the negative appendectomy rate (1,11). However, with the increasing emphasis on the dose of radiation exposure and the risk of contrast-induced nephropathy or allergic reaction, noncontrast CT is particularly appealing in nowadays' choice of diagnostic tests. The aim of this study was to assess the necessity of intravenous contrast medium for CT diagnosis of APP among adult patients at ED.

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MATERIALS AND METHODS

Study Population

This retrospective, noninterventional study was conducted in the ED of a 2700-bed tertiary care medical center located in Taipei, Taiwan, with an ED annual census of approximately 80,000. The institutional review board approved the study. One hundred seventy-three patients (age ≥18 years) who presented to our ED with right lower quadrant abdominal pain,

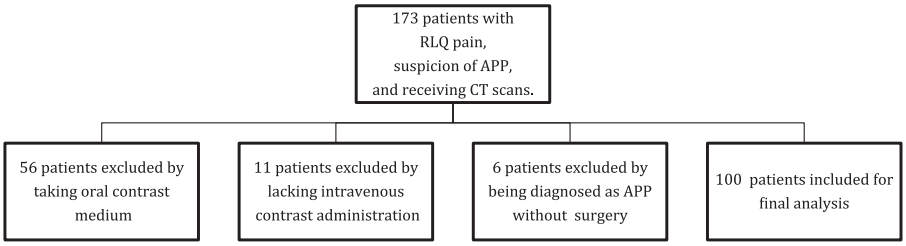

Figure 1. A flow chart of enrolling patients. APP, acute appendicitis; CT, computed tomography; RLQ, right lower quadrant.

clinical suspicion of APP, and subsequently received helical abdominopelvic CT scans between July 2008 and February 2009 were retrospectively included. Both pre- and postintravenous contrast-enhanced CT scans were performed according to this institution's protocol unless contraindicated. Excluded were those patients who took oral contrast medium (n = 56), lacked intravenous contrast administration (n = 11), or were diagnosed as APP but unproven surgically (n = 6) (Fig 1). The negative appendectomy rate at this institution was 15.8% (14).

All patients were followed for more than 6 months. According to the clinical, radiological, surgical, and pathologic results, the diagnosis of each patient was retrospectively classified as either APP or not. All the cases of APP were surgically proven (n = 42). Those without APP were proven either by surgery (n = 9) or by clinical course and radiological findings (n = 41). Uneventful clinical follow-up for minimum of 2 weeks was considered as an acceptable reference standard for the exclusion of APP. The 9 patients with negative CT findings and without specific clinical diagnoses, received no antibiotics and no appendectomy in 6-month follow-ups, and they were excluded from the diagnosis of APP. The main CT features of APP included an abnormal appendix, periappendiceal inflammation, and changes in the cecal apex (5,15–19).

TABLE 1. Etiologic Factors (n = 100)

Etiology	n (%)
Patients with acute appendicitis	42 (42.0%)
Unruptured appendix	30 (71.4%)
Ruptured appendix	12 (28.6%)
Patients with non-acute appendicitis	58 (58.0%)
Obstetric and gynecologic diseases	12 (20.7%)
Pelvic inflammatory disease	7 (12.1%)
Tuboovarian abscess	3 (5.2%)
Ovarian cyst rupture	1 (1.7%)
Ovarian tumor	1 (1.7%)
Diverticulitis	9 (15.5%)
Negative findings	9 (15.5%)
Enterocolitis	8 (13.8%)
Acute cholecystitis	4 (6.9%)
Mesenteric adenitis	4 (6.9%)
Ureteral stone	4 (6.9%)
Intestinal obstruction	3 (5.2%)
Others	5 (8.6%)
Colon carcinoma	1 (1.7%)
Hollow organ perforation	1 (1.7%)
Pancreatitis	1 (1.7%)
Pelvic spindle cell sarcoma	1 (1.7%)
Retroperitoneal abscess	1 (1.7%)

Data Collation and CT Analysis

Chart review was performed for the following items of each patient: age, gender, routine blood test values, surgical records, and pathological findings. All these patients received CT scans by a multidetector CT scanner (Philips Brilliance 40, Israel, Tel Aviv) with collimation 32 × 1.25 mm, rotation time 0.75 seconds, pitch 0.906, matrix: 512 × 512, KV 120, and mA 250 to 300 depending on the patient's body size under the use of tube current modulation software (D-DOM, Philips). The noncontrast CT for lower abdomen and postcontrast CT for whole abdomen were performed for all these patients. All the images were reconstructed with slice thickness 5 mm and reconstruction interval 5 mm for axial and coronal display. The visibility of vermiform appendix and specific CT findings of APP, including maximum outer appendiceal diameter, appendiceal wall thickening, appendiceal wall enhancement after intravenous contrast medium, appendicolith, periappendiceal inflammation, and cecal wall thickening, these findings were recorded separately for noncontrast CT (NCT) images and contrast-enhanced CT (CCT) images by two experienced radiologists (J.D.C., C.M.T.) who did not know the initial CT reports or final diagnoses during imaging review. We also classified the ease of identifying appendix into score 1 (the vermiform appendix could be indentified within 1 minute), and score 2 (longer than 1 minute).

Statistical Analysis

Descriptive results were reported as number and percentage for categorical data and mean value ± standard deviation (SD) for continuous data when appropriate. The statistic characters, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of CT diagnosis for APP, were compared between NCT and CCT groups by two-sample Z test for proportions. The radiological characters, appendiceal diameter (>8 mm), appendiceal wall thickening, presenting appendicolith, periappendiceal