

CT Optimization for Diagnosis of Some Acute Abdomen Cases

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Abstract

The acute abdomen is one of the most frequent causes for presentation to the emergency department. Imaging plays an important role for an accurate diagnosis, which in turn diminishes morbidity and mortality. The aim of this study was to demonstrate optimum CT aspects and emphasize on the important features of CT for those patients presenting with an acute abdominal pain at the Emergency Department both in general and in a number of selected conditions (appendicitis, small-bowel obstruction, acute pancreatitis, and diverticulitis). The reported data by this study are based on the author working experience, which forms a continuous protocol adjustment process. The present study provides evidence that CT would result in definite diagnosis of patients with abdominal pain in terms of the detection of some urgent conditions.

Keywords

CT, Acute Abdominal Pain, Appendicitis, Small-Bowel Obstruction

1. Introduction

The acute abdomen may be defined generally as an intra-abdominal process causing severe pain and often requiring medical or surgical intervention. The acute abdomen is a frequent entity at the Emergency Department, the acute abdomen may be life threatening and so rapid diagnosis of patients presenting with acute abdominal

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pain is required [1].

Diagnostic work-up with imaging can consist of plain X-ray, ultrasonography (US), computed tomography (CT) and even diagnostic laparoscopy. During the last decade, a trend towards increased use of computed tomography in patients with abdominal pain can be seen [2] [3]. In general, acute abdominal pain is responsible for about 10% of total number of patients visiting the emergency. Quick and precise diagnosis for the urgent cases is usually vital for treatment [4].

Medical imaging is commonly used for the diagnosis of most acute abdomen pain [5]. Abdomen and pelvis are reviewed by CT scan. Specifically, in cases of acute abdomen complain [6].

The sensitivity, specificity, and accuracy of unenhanced helical CT are 96.0%, 95.1%, and 95.6%, respectively. But, radiograph series of acute abdominal was reported to have an overall sensitivity, specificity, and accuracy of 30.0%, 87.8%, and 56%, respectively [7].

The aim of this study was to demonstrate optimum CT aspects and emphasize on the important features of CT for those patients presenting with an acute abdominal pain at the Emergency Department both in general and in a number of selected cases as described in the results section. Similar studies by the authors were previously reported [8].

2. Materials and Methods

After the approval of Human Ethics of King Abdulaziz University, this study retrospectively reviewed electronically available records for patients admitted to the Emergency Department. All patients examined on a multi-slice CT scanner (64 slice Siemens somatom definition dual source), and the contrast administered using automatic power injector, there is no inclusion criteria for the selection of patients, but all patient who came to examine CT abdomen with acute abdominal pain has been included. Different patient preparation and different CT protocols were conducted in order to know the nature of diseases that may lead to acute abdomen pain. Imaging protocols are dependent on the possible diagnosis, clinical adjustment, and radiographer's experience. Factors that should be adjusted to each patient includes: slice collimation and pitch; the use of oral or IV material; and limited-focus scan versus a complete abdominal examination. Summarized clinical findings, as in routine practice, will be provided. The CT scan was evaluates and records data in a similar way. The CT protocols used are described below.

2.1. Pancreatitis Protocol

The patient is prepared, he/she was asked to fast for several hours (NPO 4-6 hours), fresh serum creatinine and GFR are required, if IV contrast will be used during an examination. Water or low-attenuation oral contrast agents are preferred because dense contrast may obscure small stones, also to delineate the duodenal wall with possibility to perform CT angiography without beam hardening artifacts caused by bowel contrast. The protocol is described in **Table 1**.

2.2. Abdomen and Pelvis/Small Bowel Obstruction

The patient is prepared by fasting for several hours (NPO 4-6 hours), fresh serum creatinine and GFR are required, if the patient candidate for IV contrast. The protocol is listed in **Table 2**.

2.3. Abdomen and Pelvic: Urolithiasis

In **Table 3**, Urolithiasis (a renal stone) scanning protocol is described. There are some important points regarding abdomen and pelvic exam. If patient is able, scan the patient in the prone position. This is useful for differentiating between an ureterovesical junction (UVJ) stone and a passed stone. No patient preparation is required because of this is a non-contrast study, however, better patient hydration through the ingestion of water before the study can help to eliminate small hyper densities of the renal pyramids that can mimic stones. Thin slices allow identification of small stones that may be overlooked with thicker slices. The radiation dose should be kept minimum particularly to the gonads. It is important because many patients who have stone are young and may have repeated stone formation. Therefore, might undergo CT again several times in the future. Lower dose techniques can reduce the exposure but exposure can still be high if multiple examinations are obtained.

Table 1. Pancreatitis protocol.

Indications	Pancreatitis
Patient position	Supine arms elevated above head
To program	From above diaphragm to pubic symphysis
Breathing breath	hold in inspiration (single breath hold)
Contrast	Oral: 1000 ml water over 30 min, I.V: 110 ml at 3 ml/s
Timing for	Pancreatitis/arterial follow up 65 s and 120 delay
Technical parameters	Pitch: 1 Suggested collimation 64 × 0.6 mm, Slice thickness: axial 5 mm, oblique 1 mm and coronal + sagittal 2 mm
Comments	Water as oral contrast is preferred (pancreatitis)

Table 2. Abdomen and pelvis/small bowel obstruction.

Contrast protocol	Parameters
Oral contrast	Positive, if possible/tolerable
Rectal contrast	Usually not necessary
IV contrast-iodine conc. (mgI/mL)	300
Volume (mL)	100 - 115
Iodine dose (gI)	46
Flow rate (mL/s)	2.8 - 3.0
Iodine dose rate (gI/s)	1.2
Saline flush-volume (mL)	50
Saline flush-flow rate (mL/s)	3
Scan delay (s)	70 or care bolus
Delayed scans	Not necessary
Scanning Protocol	Parameters
Scout (to program)	Anterior-posterior
Patient position	Supine
Scan range	Diaphragm to symphysis
Scan direction	Cephalocaudal
Tube voltage (KVp)	120
Effective mAs	170 to 200; use CARE Dose 4D
Gantry rotation time (s)	0.5
Slice collimation (mm)	64 × 0.6
Pitch	0.9
Table feed (mm/rotation)	17.28
Reconstruction parameters	
Slice width (mm)	5
Axial slice width for 3D/MPR (mm)	2
Recon. increment (mm)	5
Axial recon. increment for 3D/MPR (mm)	1
Special views	Coronal
Recon. kernel	B20f/B30f
Recon. field of view	Fit to patient

Positive oral contrast is given to patient if they can tolerate but usually not necessary: *Obstructive patient have excessive of enteric fluid. *Surgeon may not prefer oral contrast prior surgery. -IV contrast portal venous phase occasionally dual phase of concern for closed lobe or ischemia-MPR is useful to identify the site, level and cause of obstruction, when axial is indeterminate.

Table 3. Abdomen and pelvic: urolithiasis.

Scanning protocol	Acquisition parameters
Scout (topogram)	A-P
Patient position	Prone
Scan range	Top of kidneys to symphysis
Scan direction	Cephalocaudal
Tube voltage (kVp)	100 or less
Effective mAs	50 use CARE Dose 4D
Gantry rotation time (s)	0.5
Slice collimation (mm)	64 × 0.6
Pitch	0.9
Table feed (mm/rotation)	17.28
Reconstruction Parameters	
Slice width (mm)	2
Axial slice width for 3D/MPR (mm)	2
Recon. Increment (mm)	2
Axial recon. increment for 3D/MPR (mm)	2
Special views	Coronal
Recon. field of view	Fit to patient

3. Results

3.1. Acute Pancreatitis

Edema of the pancreas and surrounding fat is clearly demonstrated in the CT findings of acute pancreatitis. The whole gland could be enlarged. By enhancement to the islands of viable tissue could become scattered throughout the gland as demonstrated in [Figure 1](#).

3.2. Diverticulitis

Fever, pain, and leukocytosis are associated with Patients that have diverticulosis usually happening with left lower quadrant. Inflammation and abnormality in the pericolic fat is observed in the CT of diverticulitis. Phlegmon formation can occur in severe cases. The CT images of the inflamed diverticulum shown as a rounded paracolic outpouching in the center of parabolic inflammation [Figure 2](#).

3.3. Small Bowel Obstruction (SBO)

CT findings of bowel obstruction are normally the delineation of a transition zone appearing between decompressed bowels and dilated as demonstrated in [Figure 3](#). If there is no hernia, mass, or inflammatory thickening; adhesion is clearly the right diagnosis.

3.4. Urolithiasis

Non-contrasted CT calcified and non-calcified urinary stones were identified, along with the location and size of the stone from kidney to bladder. Secondary signs of obstructive uropathy, including hydronephrosis and ureteral ectasies were noticed. On non-contrast CT, calcified urinary stones appear as opaque densities within the urinary tract to differentiate calcified and non-calcified urinary stones according to their appearance are not



Figure 1. Acute pancreatitis.



Figure 2. Diverticulosis showing abnormality.

possible. Degree of accuracy in interpreting a non-contrast CT in a case with urinary stone increases in accordance with the severity of urinary obstruction.

4. Discussion

Different patient preparation and different CT protocols were conducted in order to know the nature of diseases that may lead to acute abdomen pain. Imaging protocols are dependent on the possible diagnosis, clinical adjustment, and radiographer's experience [8] [9].

Both CT and ultrasound plays important roles in acute appendicitis diagnosis. CT is found to be more accurate thus was the preferred imaging modality [10] [11].

Small-bowel obstruction (SBO) is a common cause of acute abdomen. Scanning was performed from the diaphragm to the pubic symphysis with a CT scanner. The transverse plus coronal scans were more confident and diagnostic for the presence of SBO than for the transverse scans alone [12].

When the transition zone of the luminal contents is carefully inspected this will usually tell the obstruction reason [13] [14]. [15] proved that sub millimeter coronal reformations add to the confidence level of readers for the diagnosis of acute appendicitis.

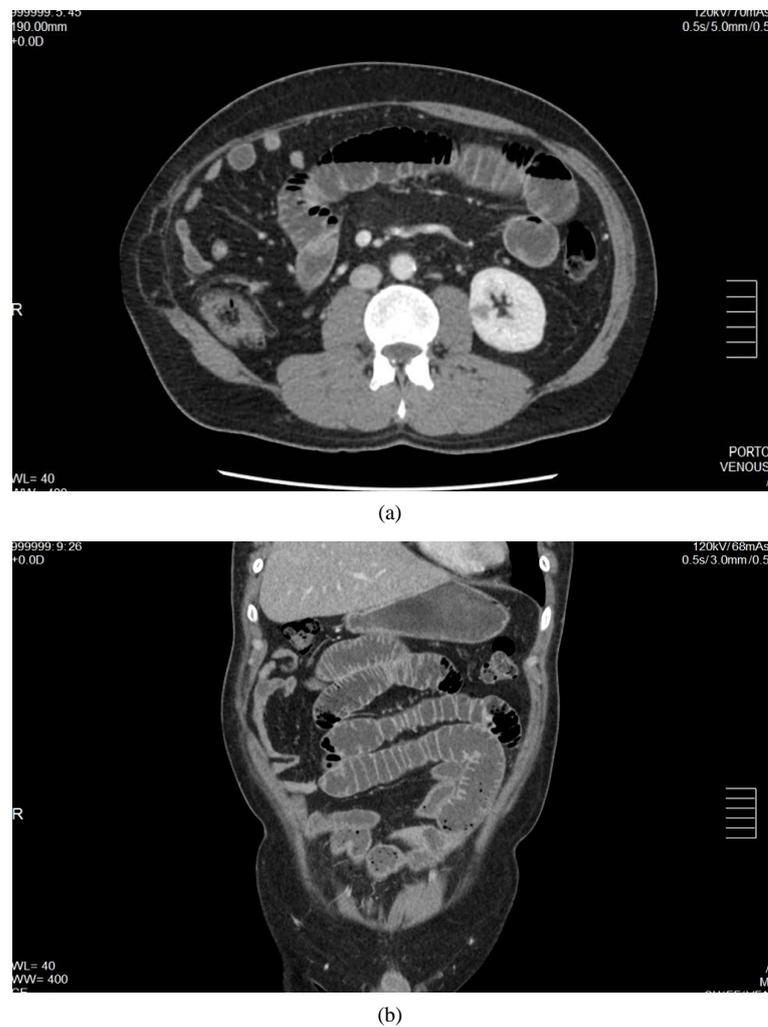


Figure 3. (a) Small bowel obstruction; axial cut; (b) Small bowel obstruction; coronal cut.

Acute colonic diverticulitis normally do not show any typical image features. Therefore, CT is will ensure suspected diagnosis by detecting any complication that might be present [16]. It has been suggested that the use of plain imaging should be excluded from the initial assessment of these patients [17].

Previous studies demonstrated that CT allowed diagnosis and determining the size, composition, and location of stones [18]. This was done by analyzing the correlation between dimensions of stone using CT scan assessment and plain X-ray of the kidneys, bladder and ureter. Other studies [19] [20] to evaluate calculi, it was possible to demonstrate a sensitivity of 97%, specificity of 96%, and accuracy of 97% in 60 patients. Identification of the number, size, and location of urinary stones and detection of hydronephrosis are easily made with CT.

SBO is a relatively common cause of acute abdominal pain. Combination of vomiting, increased bowel sounds, and a distended abdomen has a positive predictive value for SBO of 64% [21]. The exact location or cause of SBO may not be diagnosed via plain abdominal imaging [22]. Instead, CT is capable to obtain obstruction causes. [23] [24] suggested that multiplanar reformations are helpful for the evaluation of SBO.

In our study, SBO was compared to the previously identified CT scout scans [25] [26]. These results corroborate recent reports [12]. Our results suggest that the coronal plane serves as a useful addition to the transverse plane in patients suspected of having SBO.

From radiation protection point of view, lower dose techniques can reduce the exposure but exposure can still be high if multiple examinations are obtained this can be Some sort of limitations for optimizing protocols implemented in CT investigations.

5. Conclusion

The present study provides evidence that CT would result in definite diagnosis for detecting urgent conditions in patients with abdominal pain. Proper technique and protocol are essential for optimizing the CT examination and maximizing diagnostic accuracy. CT scanning has gained acceptance as the primary imaging techniques for the SBO, Urolithiasis and acute appendicitis.

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