Unenhanced Ultrafast Computerized Tomography for the Evaluation of Patients with Acute Flank Pain

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Abstract

Objective : To determine the value of unenhanced ultrafast computerized tomography (CT) in the diagnosis of acute flank pain in 43 patients evaluated for suspected stone disease.

Material and Method : Noncontrasted ultrafast CT was performed in 43 consecutive patients seen in the emergency department to evaluate acute flank pain. All CT studies were reviewed for the presence of ureteral and renal calculi, perinephric and periureteral stranding, presence and degree of pelvicalicectasis or other radiological findings. If necessary, an excretory urogram was performed to confirm the presence or absence of urinary stone. Patients were followed to determine clinical outcome including the need for urological intervention.

Results : Of the 28 patients determined to have stones 16 (57.14%) had spontaneous stone passage, 7 (25%) had improved symptoms without documented stone passage and 4 (14.29%) required surgical intervention. In 6 of 14 patients (42.86%) with negative CT readings for stone disease a diagnosis was established by other intra-abdominal findings. In 7 patients (50%) no clinical diagnosis could be established, and 1 scan in a patient with a ureteral calculus was interpreted as falsely negative. These findings yielded a sensitivity of 96.63 per cent, Specificity 92.85 per cent and overall accuracy 95.24 per cent for diagnosing ureteral stones.

Conclusions : Unenhanced ultrafast CT is an accurate, safe and rapid imaging modality for the detection of urinary tract calculi and obstruction. The majority of patients required no further imaging to determine the need for urological intervention. Ultrafast CT could be used as the standard method to evaluate patients with acute flank pain.

Key word : Computerized Tomography, Acute Flank Pain, Calculi

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Intravenous pyelography (IVP) is generally accepted as the gold standard test for evaluation of acute flank pain. It provides physiological information used to define the degree of obstruction, and evaluates the need for and plans the timing of stone management. However, the administration of intravenous contrast material is associated with potential nephrotoxicity (5-10%) and occasional life threatening anaphylactoid reactions[1]. Unenhanced ultrafast computerized tomography (CT) was introduced as the first line investigation for this group of patients. Due to the rapid evaluation and no contrast media used, it has become generally accepted in the emergency departments of Western contries. To our knowledge, there has been no prospective study on the successful use of unenhanced ultrafast CT for detection of urinary calculi in Thailand. The authors present experience with 43 patients with acute flank pain evaluated by unenhanced ultrafast CT for suspected stone disease during a 6-month period.

PATIENTS AND METHOD

From October 2000 to March 2001, 43 consecutive patients seen in the emergency department of Ramathibodi Hospital for suspected renal colic underwent imaging with unenhanced ultrafast CT. After informed consent was obtained, all the study patients were enrolled in the standardized prospective protocol in the emergency department, which included history, physical examination, evaluation of blood and urine parameters, and diagnostic imaging with unenhanced ultrafast CT. Axial images included sections from the renal upper pole to the bladder base. Scans were obtained in 7 mm thick sections with an incremental table speed equal to 7 mm per second.

Noncontrast CT was reviewed by an experienced genitourinary radiologist (B.W.) and a single urologist (W.K.). CT was evaluated for the presence and size of renal and ureteral calculi, perinephric or periureteral stranding, the degree of pelvicalicectasis and the presence of other intra-abdominal or pelvic pathology. CT diagnosis of renal and/or ureteral calculi was established by visualization of a high attenuation area (greater than 100 Housefield units) within the ureteral lumen with or without ureteral dilatation above the level of the suspected stone. The presence or absence of secondary signs of ureteral obstruction on noncontrast CT (that is perinephric or periureteral stranding) was also considered in establishing the diagnosis[2,3].

CT findings were classified into three categories of positive for calculus, negative for calculus and indeterminate. Criteria for the indeterminate category were defined as the presence of multiple pelvic phleboliths making differentiation from a distal ureteral calculus impossible. This indeterminate group was excluded from analysis and, therefore, had no impact on the specificity, sensitivity and accuracy calculation. In 8 cases IVP was performed to confirm the presence of urinary calculi.

All patients were followed to determine clinical outcome, including the need for urological intervention. Follow-up was performed either by visit to the office of the treating physician (15 cases) or by telephone interview (28 cases). Patients were asked for direct or indirect signs or symptoms of stone passage or other established diagnoses. Surgical procedures were performed by one member of staff at our institution.

RESULTS

The study included 25 men and 18 women, 18 to 70 years old (mean age 40.3), seen in the emergency room from October 2000 to March 2001 for suspected renal colic. All patients underwent unenhanced ultrafast CT according to the aforementioned standardized evaluation protocol. In 28 of the 43 patients (65.12%) ultrafast CT was positive for upper tract urinary calculi, including ureteral in 23, renal in 1, and renal and ureteral calculi in 4. In 14 patients (32.56%) no urinary concrements were identified on CT and in 1 (2.32%) CT diagnosis were indeterminate (Table 1). Of the 28 patients with positive CT 16 (57.14%) had stone passage with retrieval of the concrements in a urinary strainer and 7 (25%) had spontaneous passage with resolution of symptoms but were unable to recover urinary calculi (Table 1). All 7 of these patients had a positive stone history with prior episodes of renal colic and each symptom experienced during the study was described as similar to prior colic episodes. Therefore, the authors believe that these scans most likely presented true positive findings.

Surgical intervention was performed in 4 (14.29%) due to refractory pain and/or significant

stone burden unlikely to pass spontaneously. Ureterorenoscopy with pneumatic lithotripsy was performed in all 4 cases.

One patient (3.57%) with stone was lost to follow-up. Since the authors could not exclude the possibility of a false-positive CT, this case was considered as false-positive in the analysis.

Of the 14 patients with negative CT, 6 (42.86%) were identified with unexpected intra-abdominal disease processes, including chronic pancreatitis with pseudocyst, liver cirrhosis, myoma uteri, pelvic inflammatory disease and retroperitoneal lymph nodes which required further therapy (Table 1). In 7 patients (50%) with negative CT no intra-abdominal disease process could be identified and the cause of flank pain remained undetermined. Among these 7 patients no passage of a calculus was observed or reported during follow-up. One case (7.14%), in which the ultrafast CT was interpreted as negative, ultimately proved to be positive from spontaneous stone passage.

In one patient with indeterminate CT finding, no stone passage or other intra-abdominal pathology was documented during follow-up. Of the 28 patients with positive and 14 with negative readings, CT findings were interpreted as falsely negative for urinary calculi in1 and falsely positive in 1 lost to follow-up (Table 2). These findings yield a sensitivity of 96.42 per cent, specificity 92.85 per cent and overall accuracy of 95.23 per cent for diagnosis of upper tract calculi.

Table 1. Unenhanced CT readings of 43 patients evaluated for suspected renal colic.

	No. patients	%
CT positive	28	65.12
Ureteral calculi	23	
Renal calculi	1	
Renal and ureteral calculi	4	
Spontaneous passage	16	57.14
Improved symptoms	7	25
Required intervention	4	14.29
Lost to follow-up	1	3.57
CT negative	14	32.56
Renal stone (undocumented passage)	1	7.14
No clinical diagnosis	7	50
Established clinical diagnosis	6	42.86
CT indeterminate	1	2.32

Table 2. Cross tabulation of actual diagnosis to CT diagnosis for detection of upper tract urinary calculi.

Actual diagnosis	No. positive reading	No. negative reading
Stone positive	28	1
Stone negative (lost to follow-up)	1	14
Total	29	15

DISCUSSION

Renal colic is a common urological problem in the emergency department. The correct clinical diagnosis is sometimes difficult because the pain of renal colic may be atypical, and flank pain and other associated symptoms (hematuria, nausea, vomiting) are also seen with other conditions. Therefore, radiological imaging is essential in patients with acute flank pain. At most centers, IVP remains the study of choice for the emergency diagnosis of renal colic, primarily when hospitalization is considered or surgical intervention is contemplated. IVP provides precise information on upper tract morphology and accurately addresses the presence or severity of ureteral obstruction. However, IVP can be time-consuming especially when high grade obstruction is present, requires the presence of a physician to administer intravenous contrast material and exposes the patient to possible adverse reactions including anaphylaxis and nephrotoxicity. Furthermore, IVP imaging is of decreased value in the presence of obscuring bowel gas and fecal debris in an unprepared patient, and in the detection of radiolucent stones.

Diagnostic imaging in the emergency department provides important information for the treating physician as well as the consulting urologist to plan further triage and facilitate management decisions. Clinically important parameters detected by radiographic imaging are calculi greater than 5 mm, which have a reduced chance of spontaneous passage, persistence of ureteral calculi of any size with associated discomfort and/or obstruction, and ureteral obstruction in the presence of a single functioning renal unit, which may prompt more immediate intervention. All of these features can be safely assessed with ultrafast CT.

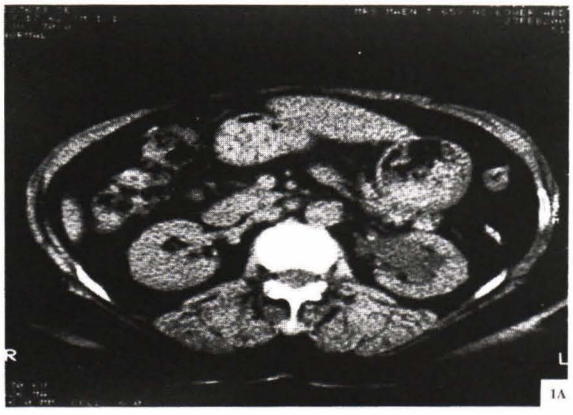

Fig. 1A. Shows dilatation of left renal collecting system.

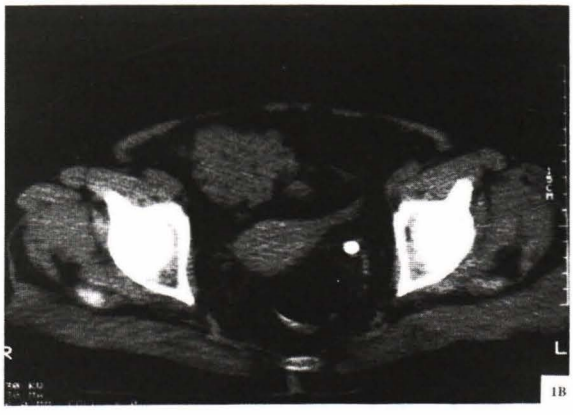

Fig. 1B. Shows a calculus in distal ureter.

Therefore, the authors believe that noncontrast ultrafast CT is adequate to establish the diagnosis of upper tract urinary calculi, facilitate correct triage in the emergency department and guide the urologist to the appropriate treatment decision.

The clinical diagnosis was accurate in 28 of 43 patients (65.12%) with positive CT for ureteral/renal stones. Similarly, Smith et al reported 109 of 312 patients (35%) positive noncontrast CTs [4], and Preminger et al reported that 49 of 105 patients (49%) evaluated with spiral CT presented with ureteral/renal stones[5]. Therefore, acute flank pain is associated with but not pathognomonic for the presence of upper tract urinary calculi. Most patients with a positive diagnosis of urinary calculi present with stones allowing spontaneous passage of concrement and complete recovery within 3 to 4 days. Accordingly, in the present series the vast majority of patients with a positive stone diagnosis reported spontaneous passage of stones and complete resolution of symptoms, whereas only 4 (14.29%) required surgical intervention.

Early in the present study IVP was used in 8 cases to confirm positive CT results. As the authors became more confident in the interpretation of the ultrafast CT the process of confirming stones with IVP was discontinued. Results yielded a sensitivity of 96.42 per cent, specificity 92.85 per cent and overall accuracy 95.23 per cent for diagnosing upper tract urinary calculi, comparable to the pilot study of Smith et al[6]. Current experience with unenhanced ultrafast CT was further demonstrated in one patient with renal colic. In this case a 8 mm distal ureteral calculi leading to severe hydronephrosis was demonstrated (Fig. 1).

Other imaging modalities have been suggested as a replacement for IVP in the evaluation of renal colic (Table 3). Plain abdominal roentgenograms have yielded poor sensitivity (58%) and specificity (60%) compared to IVP[7]. Others have emphasized plain abdominal roentgenogram in combination with renal ultrasound yielding predictive values similar to IVP in detecting hydronephrosis but this approach has been shown to be of limited value in detecting obstructing ureteral calculi[7-10]. As pioneered by Smith et al, unenhanced helical CT is superior to IVP in detecting ureteral stones and is equally effective in determining the presence of ureteral obstruction. Sommer et al reported that helical CT yielded a higher sensitivity in detecting urinary calculi compared to imaging using plain abdominal roentgenogram or ultrasound, the latter of which is known to be strongly operator dependent[11].

In the authors' institution unenhanced ultrafast CT has just completed a research study for the initial screening test for acute flank pain. Exceptions are pediatric and obstetric patients who are better imaged with renal ultrasound because exposure to ionizing radiation is hazardous.

Table 3. Value in detecting upper tract calculi by imaging modalities suggested as alternative to IVP.

Reference	Modality	No. Pts.	% Sensitivity (No./Total/No.)	% Specificity	% Accuracy
Mutgi et al[7]	Plain abdominal roentgenogram alone	85	58	60	-
Erwin et al[8]	Plain abdominal roentgenogram/ U/S	21	70 (11/15)**	-	-
Laing et al[9]	Plain abdominal roentgenogram/ U/S	20	14 (2/14)**	-	-
Haddad et al[10]	Plain abdominal roentgenogram/ U/S	101	10 (7/69)**	-	-
Smith et al[6]	Helical CT	292	97	96	97
Dalrymple et al[13],*	Helical CT	417	95	98	97
Fielding et al[12]	Helical CT	100	98	100	-
Preminger et al[5]	Helical CT	105	98	98	96
Present study	Ultrafast CT	43	96.42	92.85	95.23

* Include the 292 patients reported by Smith et al.
** Sensitivity in detecting obstructing ureteral calculi only.

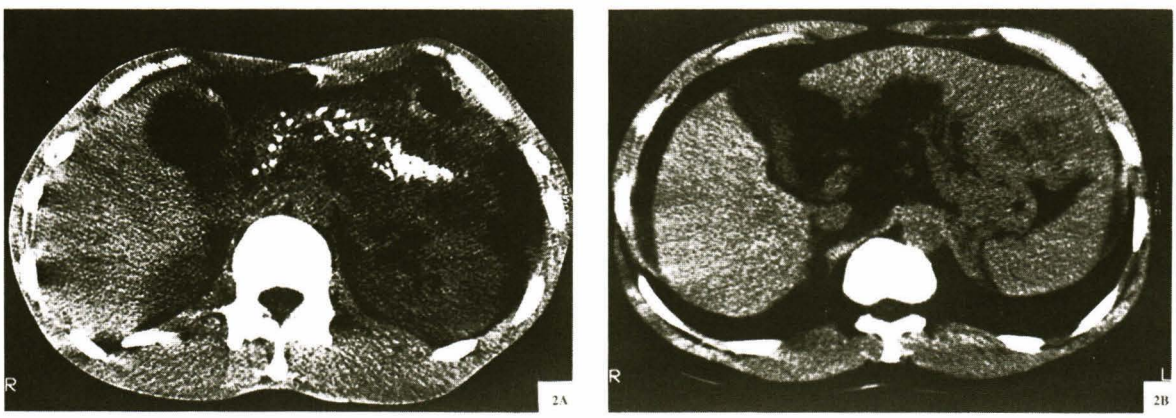

Fig. 2. Shows chonic pancreatitis with pseudocyst.

The increased use of ultrafast CT in the diagnosis of renal colic is not only dependent on its clinical or diagnostic usefulness, but also on economic consideration. But in Thailand, the per patient average charges are 4,000 Baht to 5,000 Baht for ultrafast CT compared to 800 Baht to 1,000 Baht for IVP. In this study, the per patient average charge was reduced to 1,000 Baht which is the same for IVP. However, charges depend on radiology department policies and do not necessarily reflect actual cost. Actual cost is greatly reduced by eliminating the need for an intravenous line, contrast media, physician personnel, diminished film used and time requirement to perform the study. Moreover, the current results clearly demonstrate that 40 to 50 per cent of patients evaluated for suspected stone disease, in fact, have other intra-abdominal pathology (Fig. 2). In these cases a correct diagnosis may be established solely with unenhanced CT, thus eliminating the need for an unnecessary and time-consuming IVP.

SUMMARY

Unenhanced ultrafast CT appears to be a sensitive imaging modality for the detection of urinary tract calculi, stone size and location, and obstruction in patients with acute flank pain. When

stone disease is absent other incidental intra-abdominal processes can be identified. The majority of patients require no further imaging to determine the need for urological intervention. Ultrafast CT could be used as the standard imaging modality for evaluating patients with acute flank pain.

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การประเมินผู้ป่วยที่มาด้วยอาการปวดเอวเฉียบพลันโดยการตรวจด้วยอัลตราฟาสต์ คอมพิวเตอร์ไรซ์ โทโมกราฟี แบบไม่ใช้สารทึบรังสี

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วัตถุประสงค์ : เพื่อศึกษาถึงค่าความไว ความจำเพาะและความแม่นยำของ ultrafast computerized tomography (CT) แบบไม่ใช้สารทึบรังสีในการประเมินผู้ป่วยจำนวน 43 รายที่มาด้วยอาการปวดเอวเฉียบพลันและสงสัยว่าเป็นนิ่วในระบบทางเดินปัสสาวะ

วัสดุและวิธีการ : เป็นการศึกษาแบบไปข้างหน้า โดยผู้ป่วยจำนวน 43 รายที่มาที่ห้องฉุกเฉินของโรงพยาบาลรามาธิบดีด้วยอาการปวดเอวเฉียบพลันและสงสัยว่าเป็นนิ่วในระบบทางเดินปัสสาวะจะได้รับการตรวจด้วย ultrsfast CT แบบไม่ใช้สารทึบรังสี ในการแปลผลการตรวจจะดูในเรื่องของ การพบนิ่วที่ท่อไตและ/หรือไต, perinephric และ periureteric stranding, การพบและดีกรีของ pelvicalicectasis และการพบพยาธิสภาพอื่น ๆ ในกรณีที่จำเป็นจะทำการตรวจด้วย excretory urogram เพื่อการวินิจฉัยที่แน่นอน การติดตามการรักษากระทำโดยดูจากอาการของผู้ป่วย การที่ผู้ป่วยปัสสาวะออกมาเป็นนิ่วได้เองและในบางรายที่จำเป็นที่จะต้องได้รับการผ่าตัดเอานิ่วออก

ผลของการศึกษา : ในจำนวนผู้ป่วยทั้งสิ้น 43 รายมี 28 รายที่ตรวจพบนิ่ว ในจำนวนนี้มี 16 ราย (57.14%) ที่ปัสสาวะออกมาเป็นนิ่วได้เอง, 7 (25%) รายที่มีอาการดีขึ้นโดยผู้ป่วยไม่พบนิ่วและ 4 ราย (14.29%) ที่จำเป็นต้องได้รับการผ่าตัดเอานิ่วออกสำหรับในรายที่ตรวจไม่พบนิ่วมีจำนวน 14 ราย ในจำนวนนี้มี 6 ราย (42.86%) ที่ตรวจพบพยาธิสภาพอื่น ๆ ในช่องท้องและอุ้งเชิงกราน, 7 ราย (50%) ที่ไม่สามารถวินิจฉัยอาการปวดเอวเฉียบพลันได้ และมี 1 ราย (7.14%) จากการตรวจไม่พบนิ่ว แต่หลังจากติดตามการรักษาพบว่าผู้ป่วยปัสสาวะออกมาเป็นนิ่วได้เอง จากผลของการศึกษาทั้งหมดนี้สามารถสรุปได้ว่า ultrafast CT แบบไม่ใช้สารทึบรังสีมีค่าความไวเท่ากับ 96.63% ค่าความจำเพาะเท่ากับ 92.85% และค่าความแม่นยำเท่ากับ 95.24% สำหรับการวินิจฉัยโรคนิ่วในระบบทางเดินปัสสาวะ

สรุป : การตรวจด้วย ultrafast CT แบบไม่ใช้สารทึบรังสีเป็นวิธีการที่ให้ความแม่นยำสูง รวดเร็วและปลอดภัยสำหรับใช้ในการวินิจฉัยโรคนิ่วและภาวะอุดตันในระบบทางเดินปัสสาวะ นอกจากนี้ยังสามารถใช้ในการวินิจฉัยพยาธิสภาพอื่น ๆ ในช่องท้องและอุ้งเชิงกรานได้ด้วย ผู้ป่วยส่วนใหญ่ไม่จำเป็นต้องได้รับการตรวจด้วยวิธีการอื่น ๆ เพิ่มเติมก่อนการผ่าตัดเอานิ่วออก การตรวจด้วย ultrafast CT แบบไม่ใช้สารทึบรังสีเป็นวิธีการที่มีมาตรฐานวิธีหนึ่งในการประเมินผู้ป่วยที่มาด้วยอาการปวดเอวเฉียบพลัน

คำสำคัญ : คอมพิวเตอร์ไรซ์ โทโมกราฟี, อาการปวดเอวเฉียบพลัน, นิ่ว

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