Non-Enhanced Spiral CT Versus Excretory Urography in Acute Renal Colic

Uraiqat A., Al Khateeb M., Al Shishani J.
Department of General Surgery, Royal Medical Services
Amman, Jordan

Abstract:
Objective: To evaluate the usefulness of non-enhanced spiral CT (NECT) and compare it with that of excretory urography (EU) in patients with acute flank pain.

Methods: Ninety five patients presenting with acute flank pain underwent both NECT and EU. Both techniques were used to determine the presence, size, and location of urinary stone, and the presence or absence of secondary signs was also evaluated. The existence of ureteral stone was confirmed by its removal or spontaneous passage during follow-up. The absence of a stone was determined on the basis of the clinical and radiological evidence.

Result: Seventy eight of the 95 patients had one or more ureteral stones and 17 had no stones. CT depicted 79 of 83 calculi in the 78 patients with a stone and no calculus in all seventeen without a stone. The sensitivity and specificity of NECT were 95% and 100%, respectively. EU disclosed 73 calculi in the 78 patients with a stone and no calculus in fifteen of the seventeen without a stone, with sensitivity and specificity 89% and 88% respectively.

Conclusion: For the evaluation of patients with acute flank pain, NECT is an excellent modality with high sensitivity and specificity. In near future it may replace EU.

Keywords: Non-enhanced CT, excretory urography, ureter, stone.

Introduction:
In the fields of emergency medicine and urology, acute flank pain is a common clinical problem. Urolithiasis, for example, is reported to affect up to 12% of the population during their lifetime(1). Intravenous urography has been the procedure of choice for evaluation of renal colic since it was first performed in 1923(2). It provides structural as well as functional information of the urinary tract. In addition it gives us information regarding the site, degree, and the nature of obstruction. There are a few disadvantages with intravenous urography. The incidence of contrast induced allergic reactions is 5%-10%(3,4). There is 25% risk of contrast induced nephrotoxicity in people with pre-existing renal failure and diabetes mellitus(5). Intravenous urography is more time consuming. On the other hand spiral computed tomography has several advantages. As the imaging with spiral computed tomography is performed without contrast medium, the stones are not masked by the presence of radio-opaque contrast. Total time taken to perform a spiral computed tomography is less than a minute. Like an intravenous urogram, but unlike an ultrasound scan, a spiral computed tomogram gives good imaging of the ureter and has the same advantage as an intravenous urogram to be able to delineate the level of obstruction. The sensitivity and specificity of unenhanced spiral computed tomography in the diagnosis of renal colic is reported to be more than 95%(6,7,8). Evaluation of spiral computed tomography and intravenous urography revealed comparable radiation dosages and with a lower gonadal dose provided by the spiral computed tomography(9). The main disadvantage of unenhanced spiral computed tomography compared with intravenous urography is the absence of evaluation of renal function and the lining epithelium of the urinary tract. Rarely phleboliths in the pelvis could be confused with ureteral stones on spiral computed tomography.

Secondary signs of urinary tract obstruction and other signs such as the soft-tissue rim sign have been described that aid in interpretation of the CT examination. However, most studies have described the presence or absence of signs such as perinephric stranding without providing methods for identifying them.

For patients with suspected acute ureteral colic, non-enhanced spiral CT (NECT) is an attractive alternative. The procedure lasts only a very short time and causes no discomfort. In addition, it can be used for patients who are allergic to contrast media or who suffer renal insufficiency. The purpose of this
study was to evaluate the usefulness of NECT in patients with acute flank pain by prospectively comparing NECT with EU, and to determine whether NECT can replace EU in the diagnosis of kidney stones.

Methods:

Between 1st July 2004 and 30th November 2004, ninety five patients presented to Prince Hashem Hospital in Zarqa with acute flank pain and in whom ureterolithiasis was suspected, participated in this study. The presence or absence of ureteral stone was confirmed by the passage of stones, either spontaneously or following extracorporeal shock wave lithotripsy (ESWL), by ureteroscopic stone removal, and/or by follow-up imaging studies. After informed consent, the 95 enrolled subjects successively underwent NECT and EU. For NECT, a High-Speed Advantage CT scanner (General Electric) was used to obtain transverse scans from the top of the kidneys to the symphysis pubis. The settings were 5 mm collimation, 1.5:1 pitch, 120 kVp, and 220 - 260 mA. EU images were obtained 5, 15 and 25 minutes after the administration of 30 cc of non-ionic contrast medium. If the renal pelvocalyceal system or ureter was not observed during routine EU examination, delayed radiographs were obtained after an appropriate interval. NECT was performed within 24 hours of the onset of symptoms, and EU within six hours of NECT. For image analysis, one radiologist interpreted the NECT and EU findings for the presence or absence of ureteral stones. NECT and EU imaging findings of urolithiasis, including size and location, were analyzed. The presence or absence of secondary signs of ureterolithiasis and associated findings outside the urinary tract were also analyzed. Secondary signs included the presence of delayed nephrogram, or ureteral or pelvocalyceal dilatation in comparison with the contralateral side, as seen on EU, and ureteral dilatation, soft tissue rim sign, or perinephric or periureteral stranding, as seen on NECT. The sensitivity, specificity of both NECT and EU were calculated.

Results:

Of the 95 patients, 78 were confirmed as having one or more ureteral stones, while seventeen had no stone. Seventy of the 78 underwent subsequent intervention such as extracorporeal shock wave lithotripsy (ESWL) or ureteroscopic stone removal, while in eight, stones passed spontaneously. NECT depicted 79 of 83 calculi in the 78 patients with a stone (Figure 1), with five patients had more than one stone and no calculus in the seventeen without a stone. The sensitivity and specificity of NECT were 95% and 100%, respectively. EU disclosed 73 of 83 calculi among the group of 78, and no calculus in fifteen of the seventeen without a stone. The remaining two patients were falsely diagnosed on EU as having a radiolucent stone, while NECT correctly diagnosed the absence of a calculus in the ureter. The sensitivity and specificity of EU were 89% and 88%, respectively.

NECT and EU demonstrated secondary signs of ureterolithiasis in 59 (77%) and 65 (84%) patients, respectively. While dilatation of the ureter and pelvocalyceal system was revealed by both modalities, functional assessment such as delayed ureteral opacification and dense persistent nephrogram were demonstrated only by EU.

In the 78 patients with 83 ureteral calculi, the calculus was located at the ureteropelvic junction in four patients, in the proximal, mid (Figure 2) and distal ureter in twenty six, nine and thirty one patients, respectively, and at the ureterovesical junction in thirteen. The size of the stones ranged from 2 mm to 15 mm (average, 5.3 mm).
The stone that was missed on EU was located in the proximal ureter in four patients, the distal ureter in three, and at the ureterovesical junction in the other three. The size of these stones ranged from 2 mm to 7 mm (average, 3.6 mm). Among these ten patients, secondary signs were disclosed by EU in six. In four patients, NECT failed to demonstrate two consecutive ureteral stones whereas EU accurately depicted two separate stones. On NECT they were seen as one elongated stone. Conversely, in another patient, EU missed one of two distal ureter stones, both of which were clearly depicted by NECT.

In three patients renal stones were also seen on NECT. Incidental findings outside the urinary tract included a calcified renal pelvic tumor in one patient and a gallstone in another.

**Discussion:**

In the evaluation of patients with acute flank pain the diagnosis is often suggested by clinical history, physical examination, and laboratory findings. For the diagnosis of urolithiasis, imaging studies such as plain radiography (KUB) or EU are essential. The sensitivity of KUB, however, is known to be low, only about 45 to 60%\(^{(10,11,12)}\) and due to overlying fecal materials or bowel gas it is sometimes difficult to diagnose ureteral stones and to differentiate them from mesenteric or vascular calcifications. Although EU has been used as a standard method for the diagnosis of ureteral stones, it uses iodinated contrast medium and this may cause life-threatening side effects. In addition, the time required is often relatively long (greater than 30 minutes), particularly in cases of obstruction, and this will increase both patient discomfort and exposure to radiation. The sensitivity of EU, however, has been reported as 84-95%\(^{(13)}\).

Since 1995, NECT has been used for the evaluation of patients with acute flank pain, and has been reported to be more effective than EU, with a sensitivity of about 96-100%\(^{(14)}\).

The treatment of patients with ureteral calculi revealed on unenhanced helical CT depends on many factors. Two factors include stone size and location. Previous studies have shown that calculi are more likely to spontaneously pass if they are located in the distal ureters and if they are smaller than 4 mm\(^{(15,16)}\).

Using spiral CT, the whole study can be completed within one breath hold. NECT can visualize all calcium-containing stones, including uric acid or cystine calculi, and some indinavir stones in HIV patients, all of which plain radiography or EU reveals only with difficulty\(^{(17)}\). Interpretation of the CT scans begins with inspection for secondary signs of urinary tract obstruction. The secondary signs of obstruction first described include asymmetric stranding of the perinephric fat (Figure 3), dilatation of the intrarenal collecting system, hydronephrosis, and unilateral renal enlargement\(^{(18)}\). Subsequently, unilateral absence of the white pyramid was described as an additional secondary sign. Stranding of the perinephric fat is a common finding, particularly among older patients. The stranding likely represents fluid that collects within the bridging septa of the perinephric fat as a result of increased lymphatic pressure. Fluid collections may become asymmetric in the presence of unilateral obstruction or pyelonephritis. More focal, nonlinear perinephric fluid collections associated with obstruction likely represent extravasated urine as a result of fornicesal rupture and should be reported, since many clinicians treat such patients with prophylactic antibiotics.

In this study, NECT depicted all ureter stones except four that were located immediately next to a larger stone in the left upper ureter, left lower ureter and right lower ureter, a detection rate much higher than that of EU (89%). These results are comparable to those of recently published studies which reported the sensitivity of NECT as 67-97% and its specificity as 90-93%\(^{(18,19)}\).

The presence of the tissue rim sign has been reported in 50-77% of patients with ureteral stones\(^{(20,21)}\). In our study it was present in 40/78 such patients (51%). Ureteral and calyceal dilatation were seen in 52% and 48% of our patients, respectively, figures which are also comparable to those of earlier studies\(^{(20,21)}\). Other signs such as nephromegaly and perinephric or periureteral stranding were less frequent in our study than in previous ones\(^{(22)}\).

One of the most important advantages of NECT is its short scan time and the fact that there is thus less patient discomfort. In our study, scanning took only 50 seconds to one minute and no additional scan was needed. The room time for NECT has been reported to be one-third to one-quarter of that required for EU.

**Figure 3:** A 42-year-old male patient with acute flank pain. Unenhanced CT scan reveals severe perinephric stranding on left side. Note normal perinephric fat on right side.
for routine EU\textsuperscript{(23,24)}. The reformatted image can be helpful for communication with the clinician but further increases in sensitivity or specificity have not been reported.

\textbf{Conclusion:}

The use of nonenhanced helical CT offers the radiologist and clinician a rapid method for evaluating patients presenting with acute flank pain without the risks associated with the use of intravenously administered contrast media. Although the findings may be readily apparent in many cases, a methodical approach to the interpretation of the CT scans can help the radiologist identify subtle signs of urinary tract obstruction and to resolve confusion between ureteral stones and phleboliths. It is highly sensitive and specific in the depiction of ureteral stones, and it may replace EU in the evaluation of patients with acute flank pain in the near future.

\textbf{References:}