EVALUATION OF ACUTE FLANK PAIN WITH NON-CONTRAST SPIRAL CT AND ITS PREDICTIVE ROLE ON CLINICAL OUTCOME

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ABSTRACT

Objective: The advantages of non-contrast spiral computerized tomography (CT) were its accuracy and speed, no need for intravenously or orally administered contrast material and ability to detect extra-urinary system in the evaluation of acute flank pain. We assessed the use of spiral CT in-patients with acute flank pain and in patients with ureterolithiasis for prediction of a favorable clinical outcome.

Methods: One hundred and eighty five patients having acute flank pain were evaluated with physical examination, urinalysis and hemogram, and non-contrast spiral CT. Stone size (greatest width-mm.), its localization, perinephritic fat stranding, the degree of hydronephrosis, tissue rim sign and perinephritic fluid were assessed on spiral CT. Extracorporeal shock wave lithotripsy (ESWL), surgical approaches, ureteroscopic stone extraction and conservative treatment were performed as therapeutic alternatives in urinary tract stone disease.

Results: Urinary stone disease was determined in 173 patients (93.5%) out of 185 (mean age: 41.1 years) by non-contrast spiral CT. Stone localizations were kidney in 77 patients (59 unilateral, 18 bilateral) and ureter in 96 patients (94 unilateral, 2 bilateral). Spontaneous passage was assumed in 79 patients with ureterolithiasis. Only 38 patients spontaneously passed ureteral stones that were less than 7.4 mm. diameters. The greatest width difference was statistically significant between passed and unpassed group [(2.0-7.4 mm; mean 4.37±1.63) vs. (4.0-10.0 mm; mean 7.35±1.81), $p<0.05$].

Conclusion: Spiral CT seems to be a sensitive imaging modality for the detection of urinary tract calculi, stone size and location as well as prediction of spontaneous passage in patients with acute flank pain due to urinary tract stone disease.

Key Words: Computed tomography, urinary calculi, colic, ureter

INTRODUCTION

The value of unenhanced helicial CT in the demonstration of urinary tract stones has been well established since first reported by Smith et al. (1-4). In spite of the valuable results, obtained using unenhanced CT in the evaluation of patients with acute renal colic, the use of non-contrast CT has not been accepted fully by clinicians accustomed to findings shown on intravenous urography (IVU).

(Accepted 27 July, 2000)

In the evaluation of renal colic IVU has an important role to delineate the urinary structures, its functional features along with localization and degree of any obstruction. In spite of its advantages, use of contrast material, difficulty to perform the test properly in acute pain and the time needed for completion are limiting factors. The incidence of nausea, skin rash and more severe contrast reactions like bronchospasm and anaphylaxis have been reported in about 5-10% of cases in the past. Although utilization of more costly low osmolar, non-ionic contrast agents decreases the incidence of contrast reactions, it does not totally eliminate them (5). In some cases, procedure times up to 2 hours after contrast injection are necessary to obtain the radiological findings, which becomes a major disadvantage considering the need for early analgesia treatment based on rapid diagnosis, especially in patients with severe renal colic. On the other hand, the main reason conventional excretory urography performs poorly is due to the confusion of ureteral pleboliths. Radiolucent stones, lack of bowel preparation or tiny stones superimposed over bony pelvis are also problems.

On therapeutic approach, smaller stone size, location of the stone, especially in the distal ureteral part and presence or perinephritic fluid extravasation might be correlated with spontaneous stone passage (6,7). Based on these facts related to IVU and the literature on the application of spiral CT in recent years, we studied in our series of renal colic the diagnosis role of non-contrast spiral CT scanning and discussed its other features such as the procedure time and cost in the case management compared to intravenous urography. In addition, we assessed using spiral CT in patients with ureterolithiasis for prediction of a favorable clinical outcome and impact of stone diameter and localization.

MATERIAL AND METHODS

One hundred and eighty five patients presented with acute, severe flank pain to the emergency room and urology outpatient clinic were included in the study. Patients with fever or other features suggestive of septicemia and those likely or known pregnant, were excluded from the study group. All patients initially evaluated in emergency and out-patient settings by history, physical examination and laboratory tests (white blood cell level and urinanalysis) had subsequently spiral CT scan without contrast material.

Imaging was performed with a CT scanner (Siemens Somatom Plus 40) utilizing spiral technique with table speed of 7 mm/sec., 5 mm. collimation (pitch 1.2) and 5 mm. reconstruction interval covering the urinary tract without contrast application. Areas with small opaque calculi or undetermined findings were additionally reviewed at 3 mm. intervals. The scan time was between 40 and 50 sec. with suspended respiration in insprium. All patients were able to hold their breath for at least the first half of the scan sequence. The greatest width was measured in all patients having ureterolithiasis (Figs. 1a, 1b, 1c).

All CT images were jointly reviewed by a radiologist and two urologists for presence of opaque calculi, tissue rim sign, hydronephrosis or hydroureter, perirenal fluid and perinephritic fat stranding as well as for significant findings in the other organs within field of view (Figs. 1b, 1c).

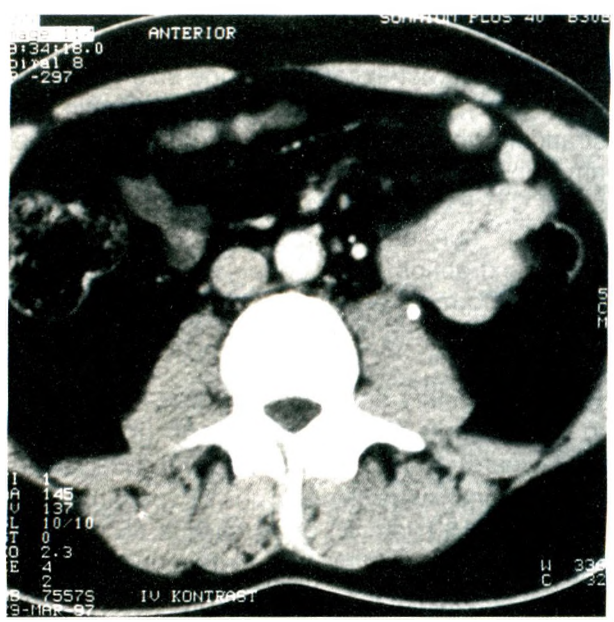

Fig. 1a.: Left ureteral calculi surrounded by tissue rim sign.

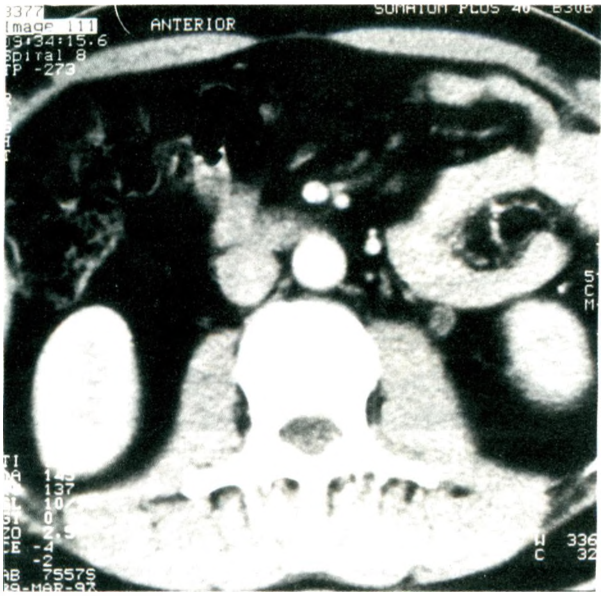

Fig. 1b.: Perirenal fat stranding around the lower pole of left kidney and dilated proximal ureter

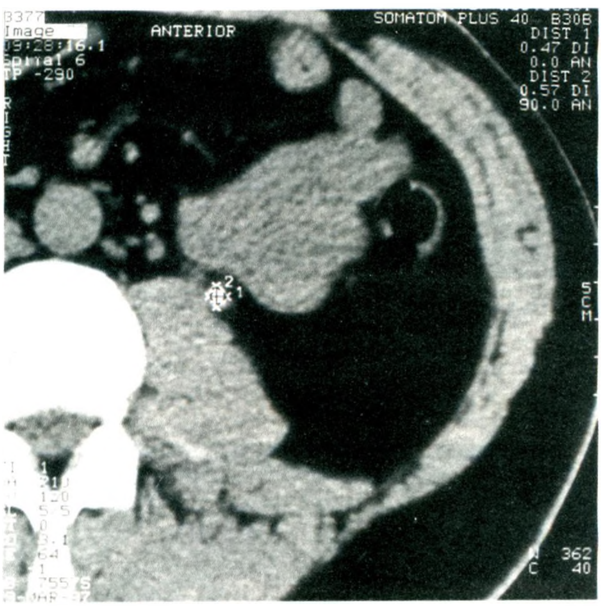

Fig. 1c.: Greatest width of the ureteral stone was measured (5.7 mm.)

In patients found to have urolithiasis by this method, spontaneous passage of stone, its eradication by retrograde ureteroscopy or surgery, or resolution of the findings at the follow-ups after ESWL were considered as proof of definite diagnosis. The follow-up of all positive cases for non-obstructive or obstructive stones was done by two authors. The CT findings of patients negative for urinary calculi were further evaluated by multidisciplinary approach and the diagnosis documented.

The patients with ureterolithiasis were separated into 2 groups as less and more than 7 mm. stone diameter according to Takahashi (7) to determine a cut-off value in the spontaneous passage of the stones. All patients were followed utmost 3 weeks for spontaneous stone passage determined depend on patients report and control X-ray examinations.

"Mann-Withney U" test was used for statistical analysis for stone diameter differentiation between spontaneous stone passage group and conservative therapy failed group.

RESULTS

Urinary stones were found in 173 (93.5%) out of 185 patients (average age: 41.1±15.1 years) evaluated by non-contrast spiral CT for acute flank pain.

In 173 patients (51 females, 122 males) there were 59 with unilateral (40 on the right, 19 on the left) and 18 with bilateral renal stones. Ninety-four patients had unilateral ureter stone (48 on the right, 51 on the left) and 2 bilateral ureter stones.

Six unilateral stones were found in the proximal ureter, 14 in the mid and remaining 74 in the distal portion. In 2 patients with bilateral ureter stones one had stones in both distal ureters, whereas in the other case the stones were in the distal ureter and in the mid-portion on the contralateral side.

Cure was achieved with ESWL in 53 out of 59 patients with renal stones (89.8%), whereas 6 patients underwent pyelolithotomy (12.5%). All patients with bilateral renal stone disease were treated with ESWL. In patients with ureter stones, spontaneous passage occurred in 38 (40.0%) cases, ESWL therapy was performed in 16 (16.8%) cases. Retrograde ureteroscopic stone extraction was successful in the remaining 41 cases including one patient with bilateral stones (43.2%). Considering the high mortality risk no intervention was possible in one patient with bilateral ureter stones, anuria and multiorgan failure in the intensive care unit, who expired during hemodialysis. In 3 patients with ureter stones, spontaneous passage of stone into the bladder was detected during spiral CT scanning with dramatic decrease in pain (Figs.-2a, -2b).

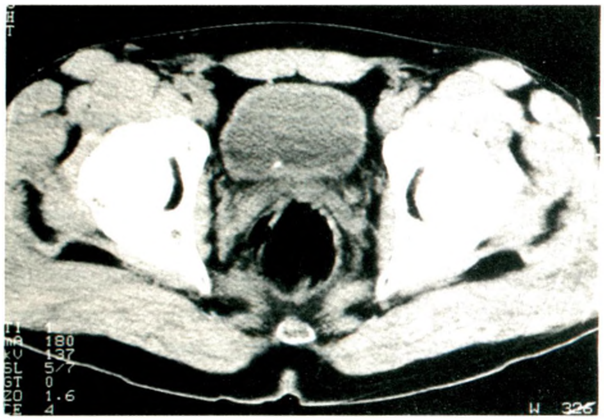

Fig.2a.: Spontaneous passage of the right ureteral calculi was observed during non-contrast spiral CT scanning with dramatic improvement in pain

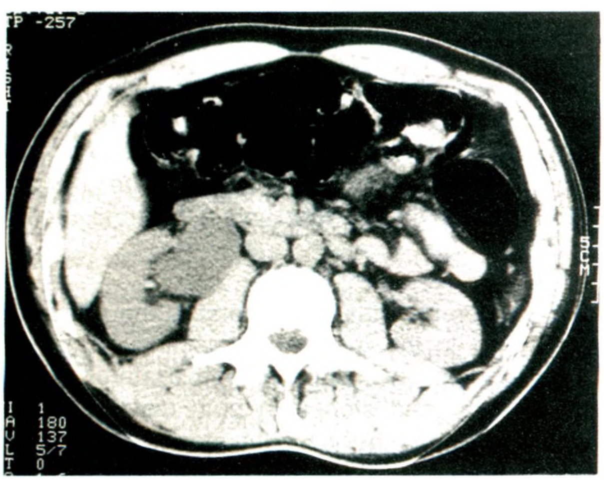

Fig.2b.: Right upper urinary tract with evident hydronephrosis

In 33 cases with ureter stones there was no obstruction on spiral CT images. The other 63 patients showed obstructive signs -hydroureter, hydronephrosis, perinephritic fluid or fat stranding (Figs. 3a, 3b, 3c).

Spontaneous passage of the ureteral stone was assumed in 79 patients with ureterolithiasis. These patients were divided into 2 subgroups according to the stone diameter as less than 7.0 mm. diameter and more than 7.0 mm. diameter (7). In 32 patients (66.7%), spontaneous stone

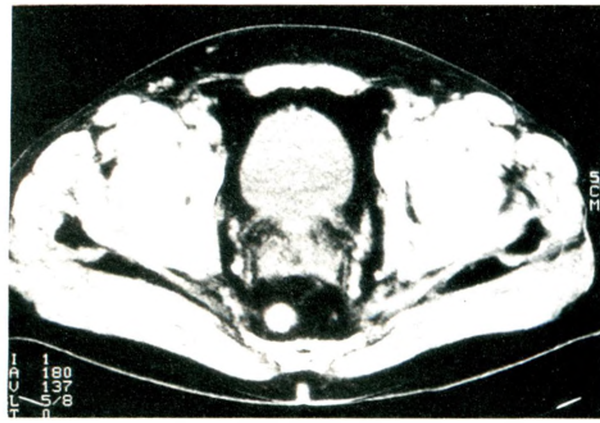

Fig.3a.: Left distal ureteral calculi

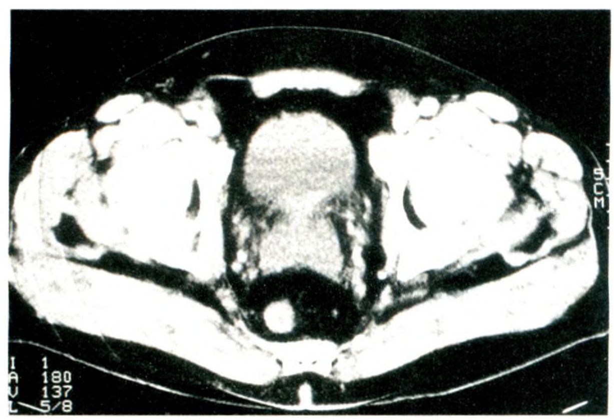

Fig.3b.: Ipsilateral vascular phlebolith without tissue rim sign having similar density and its localization is outside of the left ureteral line

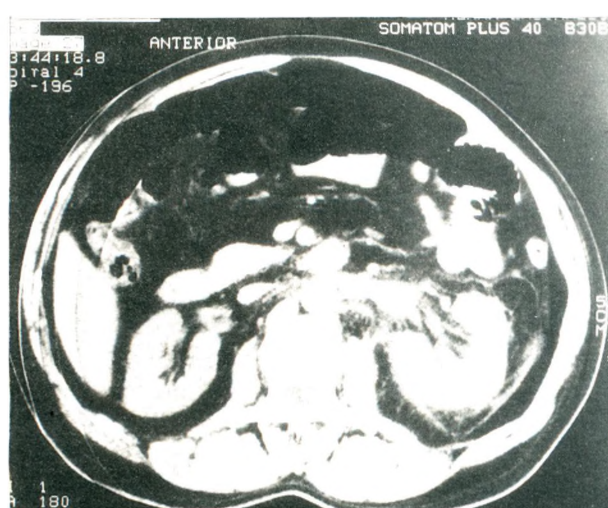

Fig.3c.: Severe perirenal fluid and fat stranding around the ipsilateral kidney due to acute obstruction

passage was observed out of 48 patients, who had mean 4.38±1.35 mm. stone diameter (3.0-6.9 mm.). On the other hand, only in 6 patients (19.3%) ureteral stone was spontaneously passed out of 31 having mean 8.23±0.89 mm. stone diameter (7.0 - 10.0 mm.). Retrograde ureteroscopic stone extraction was performed in the remaining 16 and 25 patients of the former and latter groups, respectively. All passed stones (n:6) were smaller than 7.4 mm. stone diameter in the latter group.

The difference of mean stone diameter between the successfully passed (n:38) and unpassed (n:41) group was statistically significant [(2.0-7.4 mm; mean 4.37±1.63) vs. (4.0-10.0 mm; mean 7.35±1.81), $p<0.05$] (Fig. 4).

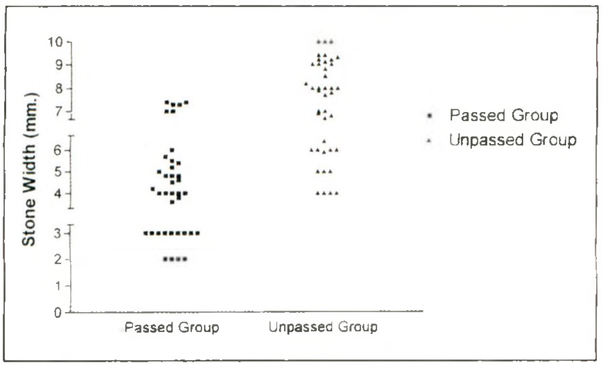

Fig.4.: Distribution of stone widths for passed (n:38) and unpassed (n:41) groups. Mean stone diameters were 4.37 ± 1.63 and 7.35 ± 1.81 mm. for spontaneously passed and unpassed groups, respectively.

In the remaining 12 of 67 patients evaluated with spiral CT for acute flank pain other problems rather than urolithiasis were found. In this group there were cases of 3 appendicitis, 4 common bile duct stones, 2 lumbar disc herniations, 1 diverticulitis, 1 ruptured ovarian cyst and 1 peritoneal carcinomatosis with vesico-rectal fistula.

In one case studied with non-contrast spiral CT for acute flank pain there was a pelvic opacity found equivocal for ureter stone. Subsequent IVU suggested phleboliths at the corresponding location and lumbar disc herniation was found on further multidisciplinary evaluation.

Follow-up of all patients with urinary stones after treatment or spontaneous passage revealed no residual stone disease. Based on our findings in patients with acute renal colic, non-contrast spiral CT was 100% sensitive (negative predictive value) and 98% specific (positive predictive value) for diagnosis of urolithiasis. These values were determined according to the elimination of stones with appropriate treatment approach as ESWL, ureterorenoscopy and open surgery or spontaneous passage.

DISCUSSION

Due to its high accuracy and the short time needed without contrast, spiral CT has emerged as a preferable alternative to IVU for diagnosis of urolithiasis in clinical practice. The series by Fielding et al (8) reporting 100% sensitivity and 97% specificity of spiral CT support this argument and the results of our study, which revealed 98% specificity and positive predictive value with 100% sensitivity and negative predictive value. Besides the presence and localization of stones further information can be obtained with spiral CT of urinary tract such as size and density of stones, obstructive parameters including hydronephrosis, hydroureter or perinephritic fluid as a result of rupture of fornices and degree of obstruction (7). Combination of unilateral ureteral dilatation and perinephritic stranding had 97% positive predictive value for stone disease. Conversely, the absence of both signs had 93% negative predictive value for excluding stone disease (9). Non-contrast spiral CT can be used for prediction of a favorable outcome especially in ureteral stones. In our series, mean diameter was significantly larger in patients with unsuccessful conservative treatment than with spontaneous stone passage. Also spontaneous passage of ureteral stones having less than 7 mm. diameters, were observed in 67% of patients. Neverthless, the successfully passed ratio was 19% in ureteral stones more than 7 mm. diameter. All passed stones (n:6) were smaller than 7.4 mm. diameter in the latter group. In Dalrymple series (9) average size of the stones that passed spontaneously is 4.6 mm., whereas those requiring interventional approach are 6.0 mm. ($p<0.002$). They pointed out that 80% of stones 4 mm. or less were spontaneously passed. On the other hand, this cut-off value was given as 7 mm. in Boulay's and Takahashi's series (6,7) which is confirmed by our series as less than 7.4 mm. stone diameter in spontaneously passed group. Due to the fact that the size of the stone has great importance for therapy and faulty diameter determination may cause an inappropriate therapeutic approach, stone width measurement is crucial during the assessment. In Boulay's series (6) stone size was the only variable associated with conservative versus interventional treament, while stone location and degree of ureteral dilatation did not appear to affect treatment choice. It was shown that spiral CT offers significantly improved accuracy in determining stone size compared to traditional imaging techniques such as plain radiography and nephrotomography (10).

This approach to patients presenting with acute flank pain enables also evaluation of other intra-abdominal organs besides the urinary system for subsequent management and medical or surgical therapy of extra-urinary pathologies. Therefore, the initial high cost related to the spiral CT as an early test in patients with acute flank pain appears to be warranted due to its substitution for other radiological tests and the short time leading to diagnosis. Smith et al. reported the accuracy of spiral CT as 96% in urinary stone disease along with 97% in diagnosis of extra-urinary pathologies (2). In the same series no further radiological diagnostic work-up beyond spiral CT was necessary in acute management of intra-abdominal extra-urinary conditions. The findings of our study were similar, except an upright abdominal plain graphy done additionally in 3 cases, suggesting acute appendicitis.

As a diagnostic work - up tool taking less than 10 minutes without the need for bowel cleaning and intravenous or intestinal contrast, the non-contrast spiral CT is rapid and comfortable initial approach to patients in acute flank pain especially in the emergency room. However, the inability to assess renal function and the urinary mucosa are main disadvantages of non-contrast spiral CT. In addition, it has been suggested that renal function might be indirectly interpreted by the presence of hydronephrosis, perinephritic strading and ureter dilatation (6,11). Evaluation of lesions related renal infarction or renal tumors requires contrast CT scan, which plays also a role for diagnosis and staging of uroepithelial tumors as a potential cause of obstruction and hematuria (8). Although pelvic phleboliths are common, the confusion with ureter stones on spiral CT rarely creates need for contrast studies such as IVU (2.1%) . The "tail sign", which has been recently reported with its 100% specificity and 65% sensitivity in differentiating phleboliths from ureteral calculi at unenhanced helicial CT, might decrease the requirement of IVU in the assessment of distal ureteral stone (12). In spite of its limited role regarding renal function and in non-obstructive distal ureter stones, Teh et al claimed that non-contrast spiral CT can be used as the method of choice without need for other tests (13). Spiral CT has also advantages against ultrasound which is an operator dependable modality with limited ability to detect early obstruction and stones in the mid-ureter. Yılmaz et al. suggested that a ureteral stone cannot be excluded with normal ultrasonography and IVU findings, unless spiral CT is performed, because of its low sensitivity and negative predictive value compared with that of spiral CT (14).

In conclusion non-contrast spiral CT of the urinary tract appears as a method of choice in the emergency room for evaluation of acute flank pain with its high specificity and sensitivity and features including characterization of stones, not only stone size but also chemical composition of the stone (15), and its potential to predict stone passage and evaluate other intra-abdominal organs as well as patient comfort and safety.

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