Diagnostic Value of Unenhanced Computerized Tomography Urography in the Evaluation of Acute Renal Colic

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This study prospectively evaluated the diagnostic value of unenhanced computerized tomography (CT) urography in patients with acute renal colic. Fifty-nine patients with clinical manifestations of acute renal colic underwent unenhanced helical CT to evaluate urinary tract abnormalities. Reformatted three-dimensional CT urography was performed in all patients. The findings were correlated with ureteroscopy, surgical findings, histopathologic findings, and clinical course. CT urography detected urinary abnormalities in 57 of 59 patients with the clinical manifestation of acute renal colic, including 45 cases of urolithiasis, three urinary malignancies, one congenital abnormality, and eight ureteral strictures (due to chronic inflammation or fibrosis). CT urography showed negative findings in the urinary system in two patients, and after clinical follow-up, urinary abnormality was excluded in these patients. Incidental findings of extrarenal disease were noted in six patients (pulmonary abnormalities, n = 2; gallstones, n = 4). Only one patient with urolithiasis was misdiagnosed as having a renal tumor by CT urography. The sensitivity and specificity of CT urography in diagnosing urolithiasis was 97.8% (44/45) and 100% (14/14), respectively. Three-dimensional CT urography is a newly developed modality to evaluate anomalies of the urinary tract. The highly accurate diagnostic value of CT urography makes it a suitable alternative or substitutive modality in patients with acute flank pain.

Key Words: CT urography, renal colic, urolithiasis

Helical computerized tomography (CT) scan has recently become a primary diagnostic tool to evaluate abnormalities of the urinary system. Good imaging resolution and rapid examination time render it the most effective and promising modality for evaluating urinary disorders, especially in patients with acute clinical symptoms that require immediate correct diagnosis. Recent studies show that unenhanced helical CT scan is an accurate examination for diagnosing urolithiasis, and can prevent the adverse effects caused by administration of intravenous contrast medium (allergy to contrast medium or deterioration of impaired renal function) in traditional intravenous urography (IVU). Coronal CT urography imaging uses reformatted three-dimensional (3D) imaging techniques and is similar to IVU in image orientation, which is more appreciated by clinicians. In addition to the advantage of more convenient imaging interpretation in CT urography, according to Van Beers et al [1], CT urography also improves the diagnosis rate of urolithiasis when analyzing axial CT images and CT urography altogether. In this study, patients with clinical manifestations of renal colic highly suggestive of urolithiasis underwent unenhanced CT scan and reformatted 3D CT urography. The diagnostic value of CT urography was correlated with surgical intervention, ureteroscopy, and...
clinical course. The pitfalls of diagnosing urolithiasis from CT urography are also discussed.

**Patients and Methods**

From March 2001 to September 2002, 59 consecutive patients (34 men, 25 women; mean age, 54.3 years; range, 14–84 years) who had acute renal colic highly suggestive of urinary tract abnormalities underwent unenhanced helical CT to evaluate the urinary system. Women who were pregnant or preparing for pregnancy were excluded from the study. Unenhanced helical CT studies were performed using a multidetector row CT scanner (Light speed QX/I version 1.3; GE Medical Systems, Milwaukee, WI, USA). Unenhanced images were obtained by helical scanning from the kidney to the urinary bladder using a collimator of 5 mm and a pitch of 6 at 200 mAs. Images were reconstructed at a thickness of 2.5 mm and an interval of 1.25 mm. 3D reconstructions of unenhanced axial images were performed at the workstation (GE Advantage Windows 4.0; GE Medical Systems) by an experienced technician supervised by a radiologist expert in genitourinary radiology. The 3D imaging reconstructions in coronal projection and in bilateral 25° to 35° coronal oblique projections were created using a multiple planar reconstruction algorithm. Two radiologists without knowledge of the results of IVU or other imaging results independently interpreted these 3D images as well as 2D axial CT images. Any discrepancy in interpretation between the two radiologists was resolved by consensus. The results of CT urography were retrospectively compared with other clinical results (ureteroscopy, surgery or spontaneous passage of the stones) and imaging examinations (retrograde pyelography or sonography).

**Results**

Urolithiasis was confirmed in 45 of 59 patients (76.3%) with acute renal colic, 20 with ureteroscopy, six by surgical intervention, 14 due to spontaneous passage of stones, and five by other imaging modalities (sonography and retrograde pyelography) (Figures 1 to 3). Three patients (5.1%) were found to have a malignancy in the urinary system (Figures 4 and 5). Congenital anomaly of the urinary system (duplication with hydronephrosis with upper moiety) was shown in one patient (1.7%). The other eight patients (13.6%) were confirmed to have ureteral stricture due to fibrosis or chronic inflammation by pathologic findings. CT urography precisely depicted the urolithiasis in 44 of 45 patients (Table). One patient with a radiolucent kidney stone was misdiagnosed as having a malignancy of
the kidney (Figure 3), as shown by surgical intervention. There were no false-positive results in this study. Therefore, the sensitivity and specificity of CT urography in diagnosing urolithiasis were 97.7% and 100%, respectively.

CT urography also correctly diagnosed malignancy of the urinary system in three patients (one with renal cell carcinoma of the right kidney, two with urotheelial cell carcinoma of the ureter and urinary bladder), congenital anomaly (duplication of the right kidney) in one patient, and ureteral stenosis in eight patients (due to chronic inflammation in three patients and to previous surgical ureteral injury in one patient). CT urography in these non-urolithiasis patients correlated well with histopathologic findings ($n=6$) and pyeloureteroscopy ($n=9$). Negative CT urography studies were noted in two patients, who had no discernable urinary system disorder on follow-up study. Additional abnormal findings other than in the urinary system were shown in six patients (pleural effusion, $n=2$; gallstones, $n=4$).

**Discussion**

Although helical CT scan is an effective and promising modality in evaluating acute symptoms of the urinary system, IVU is the mainstay and first-line modality in most institutes in Taiwan for the evaluation of acute renal colic with clinical suspicion of urolithiasis because of the cost of CT examination and radiation exposure. However, the long examination time of IVU may delay an accurate diagnosis and proper management for patients. The risk of adverse reactions to contrast medium cannot be completely avoided. In addition, IVU may not provide sufficient information if the urinary system is not opacified due to impaired renal function. It is also suggested that IVU performed immediately after acute onset of renal colic may increase the risk of fornix rupture. Other contraindications to administration of intravenous iodine contrast medium include a history of allergy, hyperthyroidism, multiple myeloma, and pheochromocytoma. Furthermore, the imaging quality of IVU may be affected by abdominal gas, fecal material, and other osseous structures such as transverse processes of the lumbar spine or sacrum. In these instances, it is difficult to identify partially obstructing urolithiasis from IVU study [2]. IVU is also limited in detecting radiolucent stones. Thus, clinicians may need to order additional examinations for further evaluation of patients with acute renal colic, thereby increasing cost and time to diagnosis. In contrast, unenhanced helical CT
urography has excellent imaging resolution, a shorter examination time, and reduced radiation exposure compared to conventional CT, and no risk from administration of intravenous contrast medium.

Studies in recent years have shown a higher sensitivity and specificity for helical CT compared to IVU [3–5]. It was reported that noncontrast CT demonstrates superior sensitivity to IVU (100% vs 64%) in detecting renal tract calculi [6]. Reformatted 3D CT urography is superior to conventional CT because of its substantially greater quality and its use of increasingly sophisticated workstations, which is likely to lead to new approaches in the use of imaging data and in the communication of results to clinicians. According to Van Beers et al [1], the higher sensitivity of stone detection on abdominal radiographs was reached when the interpreters viewed radiographs in conjunction with CT scans and CT urography, which is compatible with our experience (Figure 5). According to our results, reformatted 3D CT urography clearly depicted stones in 44 of 45 patients who were retrospectively proved to have urolithiasis. The sensitivity and specificity of CT urography in diagnosing urolithiasis were 97.7% and 100%, respectively. One patient with a radiolucent stone in the right kidney, which only had faint marginal calcification, was misdiagnosed as having a tumor in the renal pelvis (Figure 3). Although most urinary tract stones are radiopaque on CT, due to their variable components and in extremely rare conditions, urinary tract stones may be of soft tissue density, which may cause inaccurate diagnosis [7]. False-negative results of CT studies have been reported, with rates ranging from 2% to 7% [8,9]. These false-negative results have been attributed to a probable combination of volume averaging (small stone size relative to collimation) and stone composition. Except for the patient with confusing imaging features that resulted in incorrect interpretation, CT urography correctly detected the numbers and locations of urinary tract stones in all cases (Table). In most cases, urolithiasis is distinct from urinary tract neoplasms in that their CT features show uniform density of calcification, lack of a soft tissue component, and no adjacent structure destruction. Phleboliths in the pelvic region may mimic distal uretal stones on CT urography, which would cause diagnostic problems, especially in patients with less retroperitoneal adipose tissue [10–12]. Hamm et al suggested that scanning at thinner primary slice thickness (3 mm) from the acetabulum to the pubic symphysis might improve differentiation of phleboliths from distal ureteral stones [7]. In our experience, indirect ancillary findings on CT urography, such as periureteral stranding, calyceal ectasia, hydronephrosis, or hydroureter, are also helpful in differentiating between these two entities.

CT urography is also useful in distinguishing urolithiasis from vascular calcification, which sometimes results in difficulty in interpreting axial imaging on conventional CT scans (Figure 5). Furthermore, unenhanced 3D CT urography also detected malignancy of the urinary system in three
patients with clinical manifestations mimicking urolithiasis. Several abnormalities other than those arising from the urinary system were identified in six patients, including pleural effusion and gallstones. Recent results have also identified extraurinary causes in 16% to 45% of patients presenting with flank pain [8,13,14]. These included such entities as diverticulitis, adnexal masses, and appendicitis. According to these investigators, unenhanced CT urography is of high value in early diagnosis of these non-urinary abnormalities with similar clinical manifestations to urolithiasis.

Nevertheless, we found limitations to CT urography in discriminating fibrosis or chronic inflammatory processes from urothelial cell carcinoma of the urinary tract. Diffuse wall thickening of the ureter and urinary bladder were depicted on CT urography in three patients, but the imaging information obtained from unenhanced CT urography was not sufficient to make a confident diagnosis. In this situation,

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<th>Table. Numbers and locations of 60 cases of urolithiases in 45 patients</th>
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UPJ = ureteropelvic junction; U/3 = upper third of the ureter; M/3 = middle third of the ureter; L/3 = lower third of the ureter; UVJ = ureterovesical junction.
biopsy, post-contrast CT scan, or urine analysis is recommended.

The results of our CT urography study add to the evidence that this is a useful and promising modality in the survey of urolithiasis in patients with acute renal colic. Although it has limitations in differentiating chronic inflammatory changes from tumors in some situations, reformatted 3D CT urography still provides important information for clinicians to properly manage non-urolithiasis patients with similar clinical manifestations.

REFERENCES