Accuracy for Diagnosis of Patients Presented with Painless Hematuria by MDCT Urography

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ABSTRACT

Background: Computed tomography urography (CTU) is a relatively new diagnostic imaging examination providing comprehensive evaluation of the upper and lower urinary tract. CTU is justified as a first-line test for patients with macroscopic hematuria, at high-risk for urothelial cancer.
Objective: To assess the role of multi-detector row CT (MDCT) urography, using a MDCT for evaluation of patients presenting with painless hematuria, in Siriraj Hospital, Bangkok, Thailand.
Methods: Between 2006 and 2008, 16 consecutive MDCT urography examinations were retrospectively reviewed by two radiologists. Sensitivity, specificity, PPV, NPV and accuracy of MDCT urography compared with surgical, histopathological findings and other imaging modalities were calculated.
Results: In 11 out of 16 patients, the causes of painless hematuria were identified on MDCT urography. The most common cause was benign urothelial lesions in 5 cases. About uroepithelial malignancies, a detectable smallest lesion was about 0.8 cm in diameter.
Conclusion: Sixty-four row MDCT urography provided satisfactory results in detection of urinary tract lesions with high accuracy in painless hematuria patients.

Keywords: MDCT urography, painless hematuria

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The term CTU is often used in clinical practice for a multitude of MDCT techniques in evaluation of the urinary tract. CTU is defined as a diagnostic examination optimized for imaging of the kidneys, ureters and bladder. The examination involves the use of multidetector CT with thin-slice imaging, intravenous administration of a contrast medium, and imaging in the excretory phase. Imaging in the excretory phase, either early or delayed, is thus a mandatory part of any CTU protocol. (CT Urography Working Group of the European Society of Urogenital Radiology (ESUR)).[1]

CTU has begun to replace other imaging techniques, especially intravenous urography (IVU) and is currently performed for a variety of indications.

Given the relatively high radiation doses associated with multiphase technique, pre-test probabilities for cancer should be taken into consideration. CTU can be justified as a first line test for the upper and lower urinary tract in hematuria patients with a high pre-test probability for TCC. Important risk factors include age >40 years, macroscopic hematuria, smoking, history of GU malignancy, and occupational exposure.[1,2]

Thus, the purpose of our study was to retrospectively determine the accuracy of MDCT for the depiction and localization of urinary tract lesions in patients presenting with painless hematuria.

MATERIALS AND METHODS

Patient selection

Patients who underwent MDCT urography between January 2006 and December 2008, referred to the department of Radiology, Siriraj Hospital are included.

Inclusion criteria is all patients who underwent MDCT urography presented with painless hematuria. Whilst, exclusion criteria are patients in whom clinical examination reveals no cause of hematuria.

Imaging of MDCT urography from thirty-five patients were searched from our picture archive computerized system (PACS) and our report system in the radiologic department. Complete review of each patients medical record from outpatient documentary cards were also performed. Eight patients were excluded from the study due to presenting with other causes which were acute flank pain, fever with chill, chronic abdominal distension, chronic

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pelvic pain, abnormal vaginal bleeding and abnormal ultrasonographic findings from check up. A further six pediatric patients were also excluded in which MDCT urography were objectively used to evaluate associated congenital anomalies of genitourinary tract. Finally, five cases were removed from the study due to no other imaging modalities or pathological diagnosis to compare. There were sixteen consecutive patients that met our study inclusion criteria (age range 17-91 years, mean age 62.5 years), divided into eight male and eight female patients, respectively.

MDCT data correlation

The findings of MDCT urography were retrospectively correlated with clinical findings, other imaging modalities, cystoscopy, retrograde pyelography and pathohistological diagnosis.

Imaging findings from eight of the sixteen were documented on the basis of other imaging modalities including intravenous pyelography (IVP), voiding cystourography (VCUG) and ultrasonographic results. Pathological diagnosis was used as standard references in three cases. One case was confirmed by retrograde pyelography. Cystoscopies were done in another four patients.

MDCT protocols

All patients were examined in the prone position on an available MDCT system with sixty four detector rows MDCT (GE Medical systems, USA).

Oral contrast media were not routinely used, but plain water was given as a negative oral contrast agent instead. Additional rectal contrast as tolerated up to 200 ml. of water was also done and a tampon used in woman.

An intravenous line of either 18 or 20 gauge was placed in an antecubital vein. Normal saline solution hydration 250 ml. then diuretics (furosemide 0.5 mg/kg) were performed before entering the CT room for good distension of the ureteric segment and urinary bladder. An intravenous injection of 100 ml of non-ionic contrast media with 370 mg of iodine per ml at 2 ml/s was performed with a dedicated, motor-driven, computer controlled pump that was electronically linked to the MDCT system.

MDCT images were obtained with scanning sequences as follows; scannogram (scout), axial precontrast phase, corticomedullary phase (delayed 30 seconds), nephrographic phase (delayed 2 minutes) and excretory phase (delayed 10 minutes). All axial scans were done as 1.25 mm. thickness.

The scan range routinely included was from the hepatic dome to the pubic symphysis in noncontrast and excretory phases and covered the kidneys in corticomedullary and nephrographic phases by scanning superiorly to inferiorly.

Tube voltage was invariably set to 120 KVp (150 KVp in obese patients) and 300 mA. Multiplanar reconstruction with a axial slice thickness of 1.25 mm. were also obtained into coronal and sagittal views on all MDCT phases.

Interpretation and statistical analysis

Two radiologists (NN, KM) examined all MDCTU images routinely in axial views consistent with multiplanar reformatting in sagittal and coronal \views.

The readers were blind to the clinical history, clinical findings, clinical outcome and were not allowed to review any previous or other associated imaging modalities. In case of disagreement in the two reviewers, consensuses by two other reviewers were done to get a final imaging diagnosis.

The sensitivity, specificity, PPV, NPV and diagnostic accuracy (including 95% confidence intervals) of MDCT urography were statistically calculated. Institute ethic committee approval was obtained: 084/2551 (EC4), Faculty of Medicine Siriraj Hospital, Mahidol University.

RESULTS

All MDCT urography images from sixteen patients presented with painless hematuria met study inclusion criteria and were retrospectively reviewed. In the study of eleven cases, painless hematuria developed without other specific symptoms. MDCT urography of the remaining five cases were done with a clinical history of urothelial neoplasms to rule out tumour recurrence.

On a per patient basis, both readers reached a sensitivity of 100% and a specificity of 100% (Table 1) with complete agreement on the presence or absence of lesions from the urinary tract when all MDCT phases were considered (n = 16).

When we did subgroup analyses, the causes of hematuria from MDCT urography in eleven patients were

TABLE 1. Detection of urinary tract lesions in patients with history of painless hematuria by MDCT in the unenhanced, corticomedullary, nephrographic, and excretory (CT urography) phases of imaging combined.

MDCT reading	Sensitivity	95% CI	Specificity	95% CI
Per-patient analysis (n=16)				
Reader 1	11/11 (100%)	74.1%-100%	5/5 (100%)	56.6%-100%
Reader 2	11/11 (100%)	74.1%-100%	5/5 (100%)	56.6%-100%

Positive predictive value (PPV) = 11/11 (100%)
Negative predictive value (NPV) = 5/5 (100%)

TABLE 2. Detection of malignant lesions in patients with history of painless hematuria by MDCT in the unenhanced, corticomedullary, nephrographic, and excretory (CT urography) phases of imaging combined.

MDCT reading	Sensitivity	95% CI	Specificity	95% CI
Per-patient analysis (n=11)				
Reader 1	2/2 (100%)	34.2%-100%	8/9 (88.8%)	56.4%-98%
Reader 2	2/2 (100%)	34.2%-100%	8/9 (88.8%)	56.4%-98%

Positive predictive value (PPV) = 2/3 (66.7%)
Negative predictive value (NPV) = 8/8 (100%)

TABLE 3. Detection of tumour recurrence in patients with history of painless hematuria by MDCT in the unenhanced, corticomedullary, nephrographic, and excretory (CT urography) phases of imaging combined.

MDCT reading	Sensitivity	95% CI	Specificity	95% CI
Per-patient analysis (n=5)				
Reader 1	3/3 (100%)	43.8%-100%	2/2 (100%)	34.2%-100%
Reader 2	3/3 (100%)	43.8%-100%	2/2 (100%)	34.2%-100%

Positive predictive value (PPV) = 3/3 (100%)
Negative predictive value (NPV) = 2/2 (100%)

indentified, dividing into benign urinary conditions or no detectable definite urinary lesion (n = 9) and malignant urinary conditions (n = 2).

Five of the six lesions were interpreted as benign lesions, diagnosed as hemorrhagic renal cysts, renal calculi, calyceal stone with superimposed periureteric infection, neurogenic bladder and neurogenic bladder with suspicion of vesicoureteral reflux.

One of six patients revealed a false positive finding from MDCT urography, which demonstrated as large filling defect and suspected to be malignant lesion but, clinical hematuria subsided after medical treatment without any specific surgical procedure and was defined by a clinician as a benign lesion (Fig 4).

Another three cases were found to be true negative from MDCT urography. Due to no specific diagnosis from imaging modalities and cystoscopy, clinicians decided that these patients were to receive conservative treatment and results showed that symptoms had resolved completely.

Two of eleven imaging studies were analysed as renal malignant tumour and malignant infiltrative urinary bladder lesion involving the left ureterovesical junction. Sensitivity and specificity of interpretation from both readers were 100% and 88.8%, respectively (Table 2). Histopathological diagnosis in one case was confirmed as renal cell carcinoma. The other one was further investigated by retrograde pyelography and a malignant filling defect was found at the left ureteropelvic junction (UVJ) with an infiltrative lesion at the urinary bladder. Furthermore, Lung metastases were detected by CT of the chest. However, no pathological tissue was proven in this case.

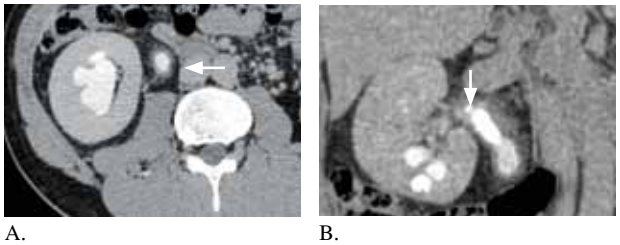
MDCT urography in the remaining five patients were performed to rule out tumour recurrence. Both readers attained a sensitivity and a specificity of 100% and 100%, respectively (Table 3).

Other associated genitourinary findings that we discovered included hydronephroses, renal calculi, simple renal cyst, parapelvic cyst, bifid collecting system, small size of kidney with atrophic change and enlarged prostate gland.

We also noticed other intra-abdominal findings from MDCT urography such as liver cyst, liver hemangioma, calcified granuloma of the liver, colonic diverticula, ovarian cyst and nabothian cyst.

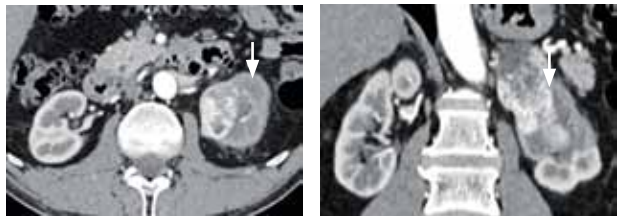
DISCUSSION

Patients with risk factors for significant urologic disease should be considered for a urologic evaluation after one episode of properly documented microscopic hematuria.[3,4] These risk factors include the development of gross hematuria or irritable voiding symptoms, a history of smoking or chemical exposure, all adults older than 40 years, previous urologic history, a history of urinary tract infection or pelvic irradiation, analgesic abuse (e.g., phenacetin), or cyclophosphamide exposure.[3]



A. B.

Fig 1. A 46-year-old man, known case symptomatic right renal stone presented with clinical urinary tract infection and microscopic hematuria. A,B. Axial and coronal view showed right calyceal stone with mild right hydronephrosis and right periureteric fat stranding, respectively.



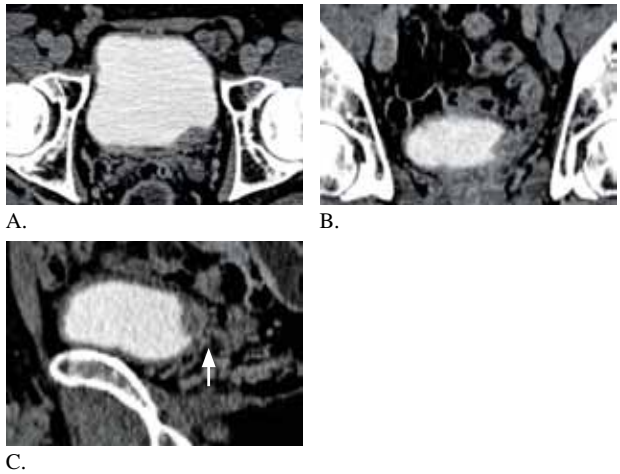
A. B.

Fig 2. A 53-year-old man presented with gross hematuria for 1 month S/P left radical nephrectomy. A heterogeneous arterial enhancing mass at right upper pole of kidney with perinephric fat stranding, biopsy proven renal cell carcinoma. (A,B axial and coronal view)

While the concept of MDCT urography has been utilized for nearly a decade, there is still no universally accepted technique. Anyway, as it becomes more interesting to urologists due to better visualization of urinary tract abnormalities and the study request is more well-known, so we decided to do imaging data collection and a retrospectively review. This was in order to evaluate the accuracy for diagnosis of patients presented with painless hematuria, and in addition was to adjust a suitable MDCT urography protocol for our hospital.

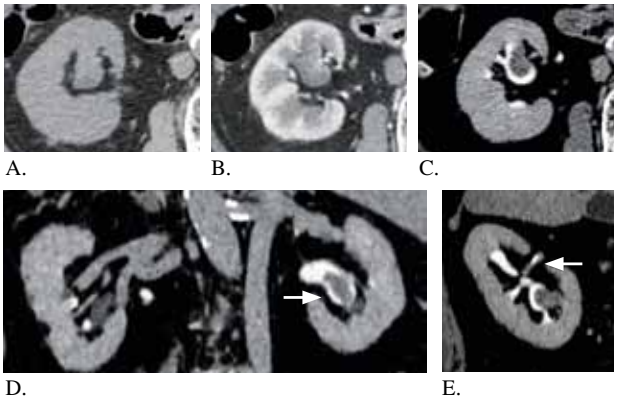
As mentioned earlier, MDCT urography with superior contrast resolution appears to enable more effective detection and characterized numerous benign and malignant conditions involving the kidneys, upper urinary tracts, and urinary bladder. In our study, both readers reached a sensitivity of 100%, a specificity of 100% (Table 1) in detection of urinary tract lesions in patients with history of painless hematuria. When we did subgroup analyses to identify the malignant lesions, the sensitivity and specificity of interpretation from both readers were 100% and 88.8%, respectively (Table 2).

CTU is playing an increasing role in the detection and characterization of numerous benign renal and



A. B. C.

Fig 3. A 74-year-old man presented with gross hematuria for 1 month. An infiltrative lesion along left posterolateral site of urinary bladder wall with left UVJ involvement is depicted. This lesion is measured about 8 x 25 mm. (A,B,C axial, coronal and sagittal view) Retrograde pyelography confirmed malignant filling defect. Further CT chest revealed lung metastases.



A. B. C. D. E.

Fig 4. A 91-year-old woman developed gross hematuria for 3 days (A,B,C) non-contrast, parenchymal and excretory phase axial view appeared as heterogeneous soft tissue mass occupying in right renal pelvis, also shown on coronal and sagittal view (D,E), respectively. Clinical hematuria resolved after medical treatment without any specific surgical procedure.

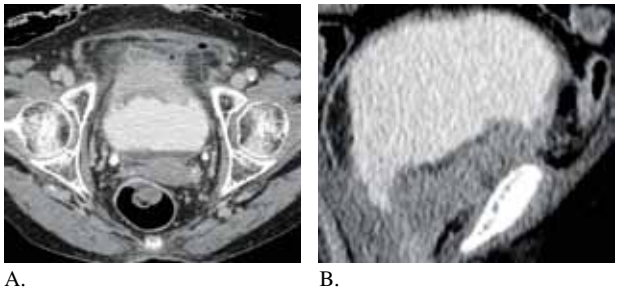
urinary tract processes. Five of six lesions were interpreted as benign lesions in our study as aforementioned. Better characterization of right calyceal stones with mild right hydronephrosis and right periureteric fat stranding were depicted as shown (Fig 1).

Another crucial benefit is three-dimensional volume-rendered imaging which is useful for displaying renal and urinary tract anatomy and they can be rotated in any plane.

While CT has mainly been used to stage the extra-urinary extent of urothelial carcinoma, our retrospective analysis suggests that MDCT urography may be useful to detect and localize or rule out urothelial carcinoma in patients with a history of previous urothelial carcinoma or painless hematuria.

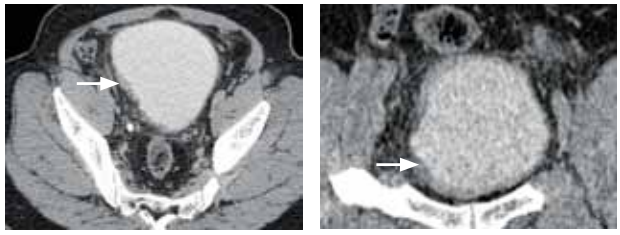
Urothelial neoplasms commonly present as a single or as multiple irregular filling defects on MDCT urography. When urothelial neoplasms are large, they may be seen a discrete mass. Focal urinary tract wall thickening is another finding that can suggest the presence of a urothelial neoplasm. Caoili et al., found that greater than 50% of upper urinary tract neoplasms present as focal circumferential urothelial wall thickening.[5]

While cystoscopy is still considered by most to be the gold-standard for evaluation of the urinary bladder, MDCT urography is playing an increasing role in the detection of urinary bladder urothelial neoplasms. Turney et al.,[6] found CTU to be an accurate method of detecting bladder cancers in patients with hematuria, with a determined CTU sensitivity of 93% and a specificity of 99% when compared to cystoscopy in their study.



A. B.

Fig 5. A 87-year-old woman presented with persistent asymptomatic hematuria for months S/P TUR-BT. Mucosal irregularity and mass like lesion at anterior wall of urinary bladder was noted, biopsy proven to be recurrent papillary urothelial carcinoma. (A,B axial and sagittal view)



A. B.

Fig 6. A 58-year-old woman, known case of low grade urothelial carcinoma S/P TUR-BT. A right posterolateral wall thickening of urinary bladder with perilesional fat stranding was shown, biopsy proven to be recurrent urothelial carcinoma with serosal invasion. (A,B axial and coronal view)

We accurately interpreted two malignant lesions as true positive, but misinterpreted one benign case as a malignant lesion (Fig 2,3,4).

We also observed the smallest size of the lesion that we could localize measured about 8 mm. at the right posterolateral wall of the urinary bladder including its extraurinary tract extension (Fig 6).

Our data are limited by the fact that this is a retrospective study and only a small overall number of patients were included.

CONCLUSION

MDCT urography detects individual urinary tracts affected by urothelial carcinoma with high sensitivity and specificity. Thus, MDCT urography may be useful for both tumor detection and extraurinary staging in urothelial carcinoma. Further research will be necessary to compare the performance of MDCT with other imaging modalities in the detection and localization of upper urinary tract tumors.

As evidenced by numerous recent publications on the topic, the MDCTU technique appears to still be evolving. A prospective study in our hospital might be necessary to confirm the significance of benefits in numerous patients for diagnosis in painless hematuria patients and to evaluate the most suitable MDCT urography techniques for best visualization of urinary tract.

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