ORIGINAL RESEARCH PAPER

Radiodiagnosis

CT UROGRAPHY IN EVALUATION OF PATIENTS WITH MACROSCOPIC HEMATURIA.

KEY WORDS: MDCT Urography, Nephrographic phase, pyelographic phase, Nephrolithiasis

Dr. J.Abdul Gafoor	MDRD,DMRD,prof & HOD, Department of Radiodiagnosis, Kurnool medical college ,kurnool.
Dr. M. Kiran Kumar*	Junior Resident, Department of Radiodiagnosis, Kurnool medical college ,kurnool. *Corresponding Author
Dr. B. Suresh	MDRD,Associate professor, Department of Radiodiagnosis, Kurnool medical college ,kurnool.
Dr. D.Harinath	MDRD,assistant professor, Department of Radiodiagnosis, Kurnool medical college ,kurnool.

ABSTRACT

Haematuria is one of the most common manifestations of urinary tract. Haematuria can originate from any site along the urinary tract and has a wide range of causes including calculi, neoplasm, infection, trauma, medications, coagulopathy and renal parenchymal diseases.The concept of CTUrography(CTU) is more appropriate as both the renal parenchyma and urothelium can be evaluate patients with haematuria by a single imaging technique with a high degree of sensitivity and specificity.

Aims: The purpose of this study is an attempt to define the accuracy of CT urography in evaluation of patients with macroscopic haematuria and to study the most common etiology of macroscopic haematuria

Methods and Material: Prospective study of fifty patients with history of macroscopic haematuria, between 18-75 years of age will be subjected to study which includes out patients, inpatients, referral patients coming to, Government General Hospital, Kurnool.

Results And Conclusions: MDCT Urography was able to define lesions with a sensitivity of 97%, specificity of 100%, and an accuracy of 98% when the images were evaluated in unenhanced, corticomedullary and nephrographic phases. Out of 50 cases, 35 cases were diagnosed to be non-neoplastic,and 15cases were diagnosed to neoplastic. The most common pathology was urolithiasis accounting for 56% of the pathology causing hematuria.

INTRODUCTION

Hematuria is one of the most common manifestations of the urinary tract. Hematuria can originate from any site along the urinary tract and has a wide range of causes including calculi, neoplasm, infection, trauma, medications, coagulopathy and renal parenchymal diseases.[1]

The concept of CT urography (CTU) is more appropriate as both the renal parenchyma and urothelium can be evaluated with one relatively non-invasivecomprehensive examination[2]. The rationale for CT urography is that patients with haematuria can be fully investigated by a single imaging technique with a high degree of sensitivity and specificity[3].It is especially suitable for patients presenting with hematuria where the urinary tract must be assessed for stone disease and neoplasms of the kidney and /or urothelium[4].

CT urography combines the benefits of excretory urography with those of cross-sectional imaging into a single study which depicts the renal parenchyma, collecting system and ureters. This technique is based on the acquisition ofnon-enhancedand enhanced CT scans of the abdomen and pelvis, including the essential acquisition of thin-section helical CT scans of the urinary tract during the excretory phase of enhancement. Multiplanar two dimensional reformation images are produced from axial source images during the excretory phase. CT urography offers several advantages for imaging the urinary tract: single breath-hold coverage of the entire urinary tract with the absence of respiratory misregistration, rapid imaging with optimum contrast medium opacification and reduced partial volume effect as appropriate slices can be selected from the volumetric data[6]

MATERIALS AND METHODS

Source Of Data:

Fifty patients with a history of macroscopic hematuria, between 2-75 years of age were subjected to study which included outpatients, inpatients, referral patients of Government General Hospital, Kurnool Medical College, Kurnool. Method of collection of data was by patient evaluation through detailed history as per standard proforma and excluded Patients below 2 and above 75 years of age,Pregnant and lactating patient, Severe renal failure, Cardiac failure,Multiple myeloma,p revious allergic reaction to contrast media and patients with non-urologic causes of hematuria (trauma). Special attention was given towards onset of pain, hematuria and associated loss of weight, limb oedema. Later necessary physical examination was performed.

CT Urography Technique:

Patients were kept nil orally 4 hours prior to the CT scan to avoid complications while administrating contrast medium. Risks of contrast administration were explained to the patient and consent was obtained prior to the contrast study. Routine anteroposteriortopogram of the abdomen was initially taken in all patients in the supine position with the breath held. Axial plain sections of 5 mm thickness weretaken from the level of lung base to the level of ischial tuberosities. In all the cases plain scan was followed by intravenous contrast scan in suspend. Next was the corticomedullary and nephrographic phase, which was acquired following a delay of 40- 60seconds and 90- 100 seconds respectively after administration of 120 ml of intravenous iodinated contrast, to evaluate the renal parenchyma. Followed by the pyelographic phase which was taken 5 -10 minutes following administration, to evaluate the urothelium from the pelvicalyceal system to the bladder. This was performed with a Multidetector-row CT scanner (GE Bright Speed Elite) CT scans will be obtained from the kidneys to the bladder with the following techniques a collimator of 5 mm, a pitch of 1.5/2, and with 20 mAs. Images were reconstructed at thickness reconstructions were made done as and when necessary. The magnification mode was of 2.5 mm. Post-study reconstructions were done at 2.5mm.Sagittal and coronal commonly employed, and the

scans were reviewed on a direct display console at multiple window settings (abdomen 320/40; lung window 1400/-600; the bonewindow of 2400/200). The pathological lesions were evaluated with respect to pre and postcontrast attenuation values, the size, the location of the lesion, the presenceof calcification, the presence of fat stranding and extension into the adjoining structures.

RESULTS

In this study, the maximum patients were in the range of 41-50 years. In this study, there was a slight male preponderance (52%) when compared to females who accounted for 48% of the study with a male to female ratio of 1.08:1. Out of 50 cases 28 cases were diagnosed to have urolithiasis, 8cases of renal neoplasm, 7 cases of bladder and ureteric neoplasm and other inflammatory and nontumorous lesions were 5 cases.8 out of 28 patients(28.5%) of urolithiasis were in the age group of 31-40 years.3 out of 6 patients(50%) of patients with renal cell carcinoma were in the age group of 41-60 years while 3 out 6 patients (50%) of bladder cell carcinoma were in the age group of 61-70 years1 out of 1(100%) of patients with Wilms tumour were in the age group of <20 years. There was a slight male (53.6%) preponderance in patients with urolithiasis when compared to females (46.4%). There was a female preponderance (83.4%) in patients with RCC when compared to males (16.6%). TCC was distributed equally between males (50%) and females (50%). 1 out of 1 (100%) renal metastases were in a male patient. Painful hematuria was found in 28 out of 28 (100%) patients with urolithiasis whileHematuria was painless in 14 out of 15 cases (93.4%),3 out of 3 (100%) patients with inflammatory lesions had fever associated with hematuria. 5 out of 8 (62.5%) renal masses causing hematuria was located in the right kidney. Overall there were 32 calculi in the urinary tract21 out 32 (65.25%) calculi were there in the kidneys, 9out of 32 (27.9%) were thereIn the ureters and 2 out of 32 (6.3%) were in the bladder. 22 out of 28 (78.6%) patients with urolithiasis were diagnosed to have obstructive urolithiasis as against 6 out of 28 (21.4%) who were diagnosed to have non Obstructive urolithiasis. Out 50 cases with hematuria, 31 (62%) cases had renal pathologies.Most common cause was Nephrolithiasis in 18 out 31 patients accounting for (58%)With renal pathologiesSecond most common renal pathology was RCC with 6 out of 31 patients (19%)10 out 18 (55%) patients had right nephrolithiasis.4 out 6 (66.6%) of patients with RCC were on the right side.1 out 1 (100%) of ADPKD and XGP had bilateral lesions. In this study, the mean attenuation of renal neoplasms in unenhanced phase was29 HU.Mean attenuation of renal neoplasms in the corticomedullary phase was 51 HU and in Nephrographicphase, it was 79 HU.

Fig: Coronal reformatted CTU image in nephrographic phase showing right renal cell carcinoma invading inferior surface of liver – stage IV

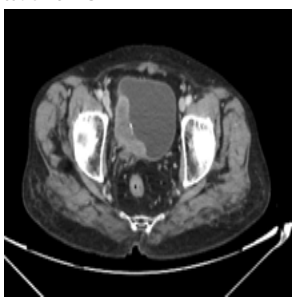

Fig: Axial contrast enhanced CT image showing focal wall thickening and intraluminal growth-T2N0Mx-stage1

DISCUSSION

In this study, the maximum percentage of patients was in the age range of 41 to 50 years (26%),and there was a male preponderance (52%) when compared to females who accounted for (48%) of cases.

Regarding Age Distribution Among Individual Pathologies In Our Study:

Out of 50 cases 28 were diagnosed to have urolithiasis. 8 out of 28 patients (28.5% of urolithiasis were in the age range of 31-40years. Urolithiasis was seen to affect almost all age groups with the youngest patient with urolithiasis being 22 years and the oldest patient being 70 years. The age ranges for inflammatory lesions were between 31 -7 0 years, with a case of abscess in the age group of 51 -60 years xanthogranulomatous pyelonephritis in the age group of 31 - 40 years and papillary necrosis in the age group of 61-70years. Cases with Renal cell carcinoma and transitional cell carcinoma were in the age group 31 -70 years. With 50% of patients with RCC in the age group between 41- 50 years. Cases with transitional cell carcinoma were in the age group 31-70years with 50% of patients with TCC in the age group between 61 70 years. 1out of 1 case of metastases was in the age group of 61-70 years.1 out of 1 case of Wilms tumour was in the age group of < 20 years.

In This Study, Regarding Gender Distribution In Individual Pathologies

Overall there were 26 (52%) males and 24 (48%) females; the male to female ratio was 1.08:1. There was female preponderance in cases of renal cell carcinoma(53.4%)when compared to males (16.6%). There was equal distribution among males and female cases of transitional cell carcinoma with a male to female ratio of 1: 1. 15 out of 28 urolithiasis cases were in males (53.6%). 1 out of 1 case (100%) of renal abscess, ureteric neoplasm, renal metastases and hemorrhagic cyst cases was in males. 1 out of 1(100%) case of ADPKD and papillary necrosis were in females.

In This Study Regarding Symptom Distribution In Individual Pathologies

Painful hematuria was found in 35 out 5 (70%) of patients with urolithiasis while hematuria was painless in rest of the patients (30%). 3 out 3 (100%) patients with inflammatory lesions had fever associated with hematuria. 28 out of 28 (100%) of patients with urolithiasis had painful hematuria. 15 out of 15 (100%) of patients with urothelial neoplasms had weight loss along with hematuria. 4 out of 5 patients with urothelial neoplasm had a mass per abdomen. Non-tumorous benign lesion presented with either mass(50%) or fever (50%).

In This Study Regarding The Distribution Of Urinary Tract Abnormalities,

There were 28 cases of urolithiasis, 15urothelial neoplasms, 3 inflammatorylesions viz renal abscess (n = 1), xanthogranulomatous pyelonephritis (n=1). papillary necrosis (n = 1) and 2 non tumorous lesions which includesADPKD (n=1), hemorrhagic cyst (n= 1). A positive diagnosis was established in 48 out of 50 (96%) of patients who underwent CT urography. The positive diagnosis was confirmed by histopathological testing in all cases of neoplasm, and by urological follow up in all inflammatory and non-tumorous conditions. In 1 patient CT urography failed to identify the cause of hematuria,but neither did the urologic surveillance protocol with follow up for at least the next 6 months. Of 8 renal masses, 6 were diagnosed to have renal cell carcinoma. 1 was diagnosed to renal metastasis from colonic carcinoma,and 1 was diagnosed to have Wilm's tumour. 6 out of 6 cases of bladder lesions were correctly diagnosed to have transitional cell carcinoma. Other causes like xanthogranulomatous pyelonephritis, renal abscess, papillary necrosis were also correctly diagnosed by our CT urography protocol. Non-tumorous lesions namely ADPKD and solitary hemorrhagic cyst were also diagnosed by CT urogram.

However, CT failed to recognize a lesion which was later identified by the urological surveillance protocol and established a false positive diagnosis in 1patient. Overall the CT protocol established the correct diagnosis in 48 of the50 patients (96%),Our Ct urogram protocol correctly identified 28 out 28 cases of urolithiasis (100%) which deemed responsible for hematuria. One case was false negatively diagnosed to be normal which was later proved on to be ureteral transitional cell carcinoma (low grade).

Justin M Albaniet al. in 2007 determined the usefulness of computerized tomographic urography for the initial evaluation of patients with hematuria as analternative to excretory urography. A source of hematuria was identified inpatients (41.3%) in the computerized tomographic urography cohort. The most commonly diagnosed lesions being renal calculi (18.9%), ureteral calculi (2.7%) and renalpelvic masses (2.3%) in the upper tract, and bladder masses (8,1%).prostatic abnormalities(5.4%) and inflammatory disorders (3.5%) in the lower tract.Computerized tomographic urography exhibited a significantly high sensitivity in detecting upper tract pathology (94.1%).

R Peter Lokken et al. in 2012 March conducted a study to evaluate the diagnostic yield of CT urography in an evaluation of young adults with hematuria. A clinically significant source was found in 83 of 375 examinations (22.1%), including 42 of 142 (29.6%) for gross hematuria, 29 of 181 (16.0%) for microscopic hematuria, and 12 of 52 (23.1%) for hematuria of unspecified subtype. The most common clinically significant findings were renal or ureteral calculi (75.3%): four malignancies were also detected.

Table : Comparison With Sensitivity And Specificity With Other Studies.

Study	Sensitivity	Specificity	PPV	NPV	Accuracy
Current	97%	100%	100%	50%	98%
Justin m albani	94.1%	93%	83%	NA	NA
Ek lang(2001)	92%	94%	94%	92%	NA
Ek lan(2004)	91%	94%	93%	93%	NA
R peter LOkken	97.5%	100%	NA	NA	NA

In this study regarding urolithiasis,

Urolithiasis was most common in the age group of 31 - 40 years 8 out of 28patients (28.5%). There was a slight male (53.6%) preponderance in patients with urolithiasis when compared to females (46.4%). Painful hematuria was found in all 28 out 28 (100%) of patients with urolithiasis 21 out 32 (65.25%) calculi were there in the kidneys, 9 out of 32 (27.9%) were there in the ureters,and 2 out of 32 (6.3%) were in the bladder. Nephrolithiasis was the most common renal pathology deemed to be responsible for hematuria 18 out of 31 patients (58%).

Regarding renal cell carcinoma. Renal cell carcinoma showed a larger attenuation in the nephrographic phase with a mean 22.5HU value of the difference between the nephrographic phase and unenhanced scans. The involvement of the renal vein, inferior vena cava, adrenals, lymph nodes,liver and the appendicular skeleton, was seen only in malignant renal cell carcinoma and Wilms tumour.

In this study, all the malignant renal neoplasms showed soft tissue attenuation on the pre-contrast scans and showed mean attenuation value of 51±8.2HU in the corticomedullary phase and 79±16.4 in the nephrographic phase. Of importance is the difference in attenuation between the corticomedullaryand nephrographic phases, malignant lesions showed a mean increase by HU The findings in the present study correlate well with Zagoria et al. study whereinthe author has found that vascular solid renal neoplasms showed mean attenuation value of 104±146 and 90±37 in CMP and NP respectively.

Table : ComparisonWith Zagoria et al. Study.

PHASE	CURRENT STUDY	ZAGORIA ET AL
UE	29±2	NE
CMP	51±8.2	104±46
NP	79±16.4	90±37
NP-CMP	47.2±18.7	22

CONCLUSION

Out of 50 cases, 35 cases were diagnosed to be non-neoplastic,and 15cases were diagnosed to neoplastic. The most common pathology was urolithiasis accounting for 56% of the pathology causing hematuria.

MDCT Urography was able to define lesions with a sensitivity of 97%, specificity of 100%, and an accuracy of 98% when the images were evaluated in unenhanced, corticomedullary and nephrographic phases. The advantages of MDCT include (a): the use of contiguous single breath hold data acquisition, thereby decreasing or eliminating respiratory motion artifacts (b) the ability to perform thin section scanning with small interval reconstruction, which decreased partial volume artefacts and increased sensitivity of lesion detection and (c) the ability to acquire images in corticomedullary,nephrographic and excretory phases perform three dimensional SSD,MIP<VRTand curved plane reformatting.

Thus, MDCT Urography with good reformatting techniques had excellent accuracy in the detection and characterization of urinary tract pathologies causing hematuria.

REFERENCES

1. Song JH ,Beland MD, Mayo-Smith WW. Hematuria evaluation with MDCT urography.AJR 2011 :197:W84-W89
2. Cowan NC, Turney BW ,Taylor NJ, McCarthy CL. Crew JP Multi-Detector CT urography for diagnosing upper urinary tract urothelial tumour.BJU international2006;99:1363-1370
3. Grainger RG, Allison DJ, AamA, Dixon: Textbook of radiology.st edition vol 1.Churchill Livingstone;1863-1883
4. JinzakiM. TanimotoA, ShinmotoH, Horiguchi, Satok, KuribayashiS, Silverman SG, Detection of bladder tumours with MDCTU AJR 2007:188:913-918
5. HaagaJR, DograVS, ForstingM.Gilkeson RC, Kwon H,CT and MRI of the whole body. 5th edition vol 2 John F Kennedy:1863-1952.
6. Maher M, Kalra KM, Rizzo S.Mueller PR, Saini S. Urinary Tract Imaging with Multidetector CT Urography in Patients with Hematuria. Korean Journal of Radiology 2004;5:1-10
7. Noroozian, Cohan RH,Caoili, CowanNC, Multislice CT urography: state of the art.The British journal of radiology 2004;77:S74-S86
8. Lang EK, Macchia RJ, Thomas R, Computerized tomography tailored for the assessment of microscopic Hematuria. The journal of urology 2002; 167: 547–554.
9. Sultana SR.Goodman GM,Byrne DM, Baxby, Microscopic haematuria: urological investigation using a standard protocol. British Journal of Urology 1996;78:691-698
10. Albani JM, Ciaschini MW, Streem SB. The Role of Computerized Tomographic Urography in the Initial Evaluation of Hematuria. The journal of urology 2007; 177:644-648.
11. Jinzaki M, Jeffrey D. MeTavish Kelly H, Zou. Evaluation of Small (-3 cm) Renal masses with MDCT Benefits of Thin Overlapping Reconstructions AJR 2004;183:223-228
12. Choi SK, Jeon SH, Chang Characterization of Small Renal Masses Less than 4 cm with Quadriphasic Multidetector Helical Computed Tomography: Differentiation of Benign and Malignant Lesions. Korean J Urology 2012; 53 159-164
13. Lokken RP, SadowCA, SilvermanSG Diagnostic Yield of CT Urography in the Evaluation of Young Adults with Hematuria AJR 2012: 198:609 615
14. LinWC, Wang JH, Wei CJ, Assessment of CT Urography in the Diagnosis of Urinary Tract Abnormalities. Journal of the Chinese Medical Association 2004;64:73-78
15. Liu WC, Mortelé KJ, SilvermanSG, Incidental Extraurinary Findings at MDCT urography in patients with hematuria: Prevalence and Impact on Imaging Costs AJR 2005; 185:1051-1056
16. Nicholos MMJ, Raptopoulosi V, Schwar RK, Sheiman RG, Panos AK. Prassopoulos, Excretory Phase CT Urography for Opacification of the Urinary tract AJR1998; 170:1261-1267
17. Lang EK, Thomas R, Davis R. Myers I Multiphasic helical computerized tomography for the assessment of microscopic hematuria: a prospective study The Journal of Urology 2004; 171:237-243
18. Zagoria RJ, Gasser T, Leyendecker JR. Bechtold RE. Dyer RB, Differentiation of renal neoplasms from high-density cysts: Use of attenuation changes between the corticomedullary and nephrographic phases of computed tomography. Journal of computer assist tomogr 2007; 31:37-41.
19. Sheafor DH, Barbara S. Hertzberg, Freed KS. Non enhanced Helical CT and the

US in the Emergency Evaluation of Patients with Renal Colic: Prospective Comparison Radiology 2000;217:792-797
20. Einstein DM, Herts BR, Weaver R. Evaluation of Renal Masses Detected by Excretory Urography: Cost-Effectiveness of Sonography Versus CT, JA 1995; 164
21. Atasoy C, Yag ci C, Fitoz S. Cross-sectional imaging in ureter tumours: Findings and staging accuracy of various modalities. Journal of Clinical Imaging 2001;25:197-202
22. Datta SN, Allen GM, Evans R. Vaughton KC, MG Lucas Urinary tract ultrasonography in the evaluation of haematuria a report of over 1000 cases. Ann R Coll Surg England 2002;84:203-205
23. Sadow CA, Wheeler SC, Kim J, Ohno-Machado L, Silverman SG, the Positive predictive value of ct urography in the evaluation of upper tract urothelial cancer. AJR 2010:195:337-343