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MDCT Urography Evaluation of Patients with Painless Hematuria

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Abstract: Hematuria defined as the presence of blood in urine is one of the most common manifestations of urinary tract disease and can be painless or painful. Malignancies are the most common cause of painless hematuria. The aim of the present study is to evaluate the role of MDCT in patients with painless hematuria and to study the MDCT features of various common etiologies causing it. This prospective observational study included a total of 31 patients who presented with painless hematuria referred for CT urography. CT urography was done in all the patients on 128 slice Philips Multi-detector CT (MDCT). CECT imaging findings were interpreted independently and tabulated and subsequently correlated with pathological findings in all but one patient. Most of the patients were in the 51-60 years age group i.e. 15(48.38%)with twice male predominance (2:1).Most common cause of painless hematuria in our study was bladder TCC seen in 17(54.86%) cases followed by renal masses i.e, 11(35.48%) cases , two cases of benign prostatic hyperplasia and 1 case of complicated renal cyst. MDCT was 100% sensitive in our study in detecting bladder neoplasm and its extension and was 92% sensitive in characterizing renal neoplastic masses. MDCTU in the patients with painless hematuria can be considered as the first line imaging modality for detection of neoplastic masses with high sensitivity and specificity. It additionally also provides detailed information regarding local infiltration of the tumor, lymphadenopathy and metastasis and thus has invaluable role in staging.
Keywords: MDCT, Painless, Hematuria, Urography.

INTRODUCTION

Hematuria defined as the presence of blood in urine is one of the most common manifestations of urinary tract disease[1] with an incidence of 4/100 patients per year[2]. It can originate from any site along the urinary tract. The common causes include urinary tract malignancies, urolithiasis, infections, trauma and rare causes include vascular malformation and aneurysms, bleeding disorders, benign tumors, nephrological disease like IgA nephropathy, however transient benign physiological conditions like vigorous physical exercise, sexual intercourse and artifactual causes like medications, menstrual blood and food (eg. Beets), can also cause hematuria[3,4].

Hematuria may be painful (classically associated with urinary calculi or UTI) [5, 6] or painless (classically associated with the underlying malignancies), Evaluation of hematuria starts with a full patient history, physical examination, laboratory investigations and radiological imaging [3].

Until the beginning of the 21st century, intravenous urography (IVU) and ultrasound were the initial radiological methods for genitourinary imaging. But now a days MDCT urography is emerging as the imaging modality of choice[7].It is rapidly becoming acceptable as the preferred test for diagnosing urinary tract disease responsible for haematuria because of superior spatial resolution, higher speed, isotropic reconstruction capability, excellent 3D multiplanar reformats and depiction of entire urinary tract in single breath hold examination[8]. 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, ureters and bladder which is of extreme value in picking up early neoplasms which are an important cause of painless

hematuria [9]. The present study was done to illustrate the role of MDCT for the depiction and localisation of urinary tract lesions that are frequently associated with painless haematuria.

The present study was undertaken with the aim to evaluate the role of MDCT in patients with painless hematuria and to study the MDCT features of various common etiologies causing painless hematuria.

MATERIALS AND METHOD

This prospective observational study was conducted over a period of two years in a tertiary care teaching hospital in North India and included patients with painless hematuria (gross/microscopic) referred for CT urography, after necessary approval from the institutional ethics committee.

Patients of all age groups with painless hematuria referred to our department for MDCT Urography were included in the study. Patients with painful hematuria, history of trauma**,** patients with altered renal parameters**,** history of previous allergic reaction to contrast media, non-urological and medical causes of hematuria and pregnant and lactating patients were excluded from our study.

All the patients were informed about the study and a prior informed consent was obtained in a written form from all the patients/ guardians in case of children. A detailed clinical history and relevant investigations including hematological, biochemical and previous radiological imaging findings were recorded. All the patients were called to the radiology department after six hours of fasting. Children were asked to come with two hours fasting

First plain sections were taken from the diaphragm to the bladder on 128 slice Philips Multidetector row CT scanner with the following technique: a collimator of 5 mm, a pitch of 1.5/2, and with150- 200 mA, KV 120. This was followed by Second phase i.e, the corticomedullary phase, which was acquired following a delay of 25-80 seconds after administration of 100 ml (2.5ml/sec) of intravenous non-ionic low osmolar contrast medium (lohexol) to differentiate normal variants of renal parenchyma from renal masses and for better depiction of tumour hypervascullariy. This was followed by reprographic phase, after delay of 90- 100 seconds following contrast administration to evaluate the renal parenchyma and the last phase i.e, pyelography phase which was taken after 8-10 minutes post IV contrast administration, to evaluate the urothelial.

The Images were reconstructed at a thickness of 0.5 mm. The axial as well as reformatted coronal and sagittal images were viewed on a work station for evaluation. Histopathological correlation was done in all the patients except one (the patient had a complicated renal cyst).

RESULTS

A total of 31 patients with painless haematuria were included in the study. Majority of the patients were in the age group of 51 to 60 years ,that is 15(48.38%) cases, followed by 60-70 years i.e, 9 (29%) and 41-50 years in 3(9.7%). The oldest patient was 82 years of age and youngest was 2 years of age. Male predominance was noted with male: female ratio of 2:1.

Bladder mass was the most common cause of painless haematuria in our study found in 17(54.83%) cases, followed by renal aetiologies (including renal masses and complicated cyst) in 12(38.70%) cases and prostatic aetiology in 2(6.47%) cases (Table 1)

Table-1: **Distribution of causes of painless haematuria on the basis of site**

Location	Number of cases	Percentage (%)
Kidney	12	38.70 %
Bladder	17	54.83 %
Prostate	2	6.47%

Bladder Transitional Cell Carcinoma (TCC) was the most common cause of painless haematuria in our study seen in 17(54.86%) cases with majority of the cases having gross haematuria i.e, in 16 cases, while microscopic was seen in 1 case. The 2nd most common cause was Renal Cell Carcinoma (RCC) seen in 8(25.80%) cases, followed by Wilms tumor and Benign Prostatic Hypertrophy(BPH) seen in 2 (6.45%) cases each. 1 case each of complicated renal cyst and oncocytoma were also noted as the cause of painless haematuria. The distribution of the causes of painless haematuria on the basis of various pathologies is enlisted in Table 2.

Table-2: Distribution of the causes of painless haematuria

Pathologies	Gross hematuria	Microscopic hematuria	Total no of patients
Bladder TCC	16	1	17 (54.86%)
RCC	6	2	8 (25.80%)
Wilms tumor	2	0	2 (6.45%)
Oncocytoma	0	1	1 (3.22 %)
BPH	1	1	2 (6.45%)
Complicated renal Cyst		1	1 (3.22%)
	26	5	31

Out of total 17 patients of bladder neoplasm causing painless haematuria, there was a definite male predominance with male to female ratio of 12:5. Majority of the patients were in 5th to 6th decade of age. Nearly all patients presented with gross haematuria i.e 16 patients (94.1%) All cases were histopathologic ally proven as TCC. On MDCT the lesions were seen as enhancing mass peaking at 105 HU and majority of cases showed papillary mass protruding in lumen, focal thickening . VUJ involvement was seen in 11(64.70%) cases, calcification in 2(11.7%) cases while local infiltration in 9 cases. (Table3) MDCT was 100% sensitive in our study in detecting bladder neoplasm and its extension (Figure 1,1.1.2,2.1.3,3.1).

Table-3. N=17, Features of bladder neoplasm on MDCT

Diagnosis	Enhancment	Growth Pattern	Calcification	VUJ inv	Hydroneph	Hydro Ureter	Focal wall thickness	Local infiltration	Metastasis
TCC	17 (100%)	12 (70.5%)-Papillary 3(17.6%)-Invasive 2(11.5%)-Nodular	2 (11.7%)	11 (64.70%)	8 (47%0	7(41.17%)	11 (64.70%)	9 (52.94%)	0

11 cases of renal neoplastic masses was included in our study, out of which 9 were reported as RCC and 2 as Wilms tumor. RCC had a male predominance with male is to female ratio of 5:3 and majority of the cases was seen in 51-60years of age. All 9 cases of RCC showed intense heterogeneous post contrast enhancement with mean CT value (100+_48HU in CM phase). Necrosis and lymphadenopathy was found in 4(50%) patients, haemorrhage in 2(25%), calcification and hydro nephrosis in 3(37.5%) whereas metastasis to bone, lung and liver in 1 case each. Two patients of wilms tumor were aged 3 and 2 and half years respectively with male: female ratio 1:1. Necrosis and haemorrhage was seen in 1(50%) patient. (Image no 4, 5, 6) One case of Renal mass was misdiagnosed as RCC on MDCT, but was later proven as Oncocytoma on histopathology. MDCT was 92% sensitive in characterizing renal neoplastic masses. The neoplastic renal masses exhibited characteristic CT features on MDCT Urography which are enlisted in Table 4.

Table-4: **CT features of neoplastic renal masses on MDCT (N=11)**

Diagnosis	Enhancement	Necrosis	Hemorrhage	Calcification	Fat	Hydronephrosis	Lymphadenopathy	Renal vein invasion	IVC invasion	Bone Metastasis	Liver metastasis	Lung metastasis
RCC	9 (100%)	4 (50%)	2 (25%)	3 (37.5%)	0	3 (37.5%)	4 (50%)	4 (50%)	3 (37.5%)	1 (12.5%)	1 (12.5%)	1 (12.5%)
Wilms	2(100%)	1(50%)	1(50%)	0	0	0	0	0	0	0	0	0

Two cases of BPH were detected as the cause of painless hematuria in our study, 1 patient each presented with gross and microscopic hematuria respectively. Both cases showed enlargement of prostate with indenting median lobe in to the bladder. Saggital and Coronal reformatted images were helpful in differentiating enlarged prostate from polypoidal bladder growth. (Image no 8,8.1,8.2)

1 female patient of aged 45years presented with microscopic hematuria was diagnosed as complicated renal cyst which was seen as a large well defined exophytic bilobed fluid density lesion involving right kidney with hyperdense rim, thin internal septations and specks of calcifications and no post contrast intrinsic and peripheral enhancement on MDCT Urography. (Image no 7)

BLADDER TCC

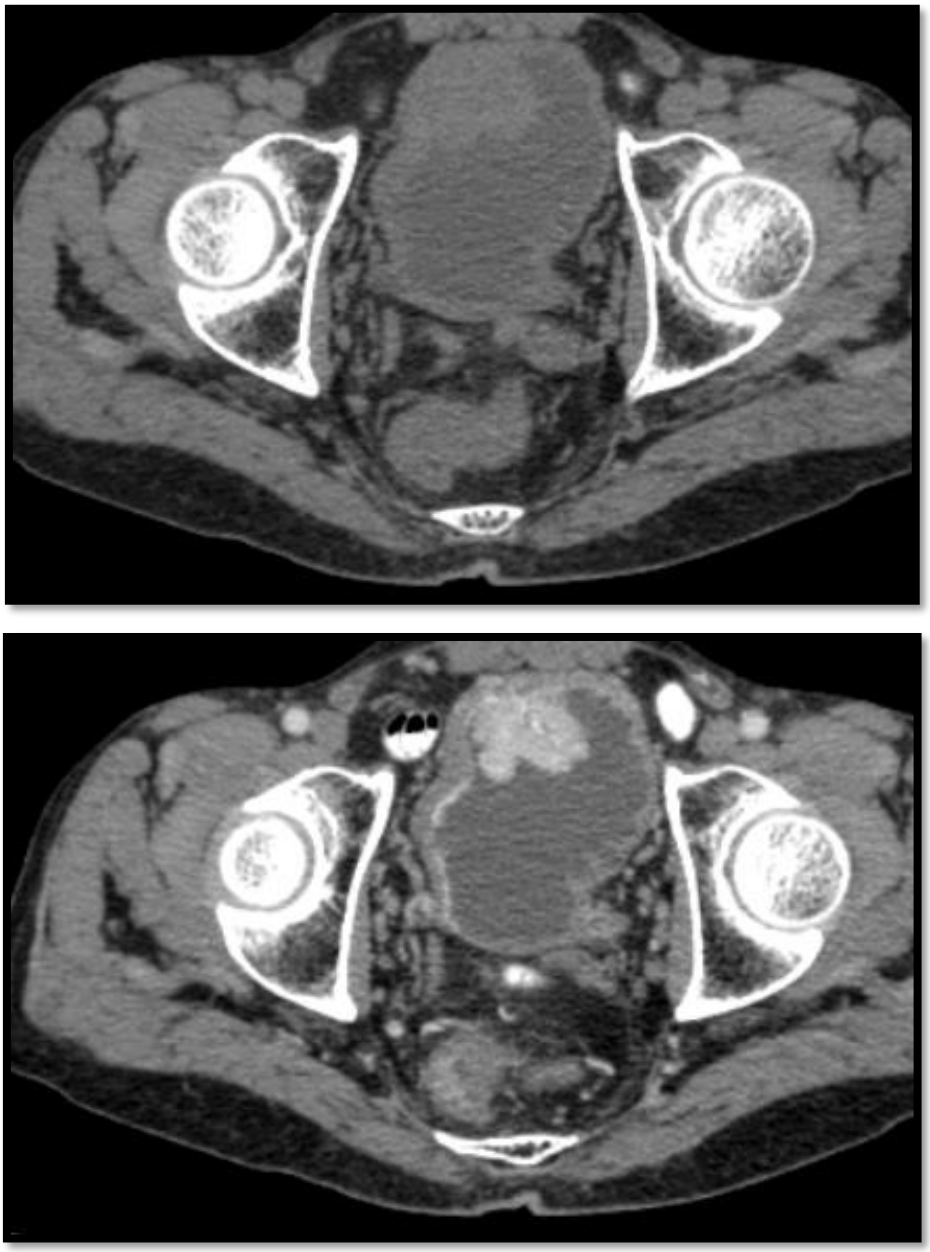


Fig-1,1.1: Axial images of a patient in pre and post contrast phase showing a polypoidal growth involving anterior wall. Moderate to intense post contrast enhancement (pre contrast 50-70HU, post contrast 100-150HU).Diffuse wall thickening noted involving anterior, lateral and base of bladder relatively sparing posterior wall-Bladder TCC

BLADDER TCC

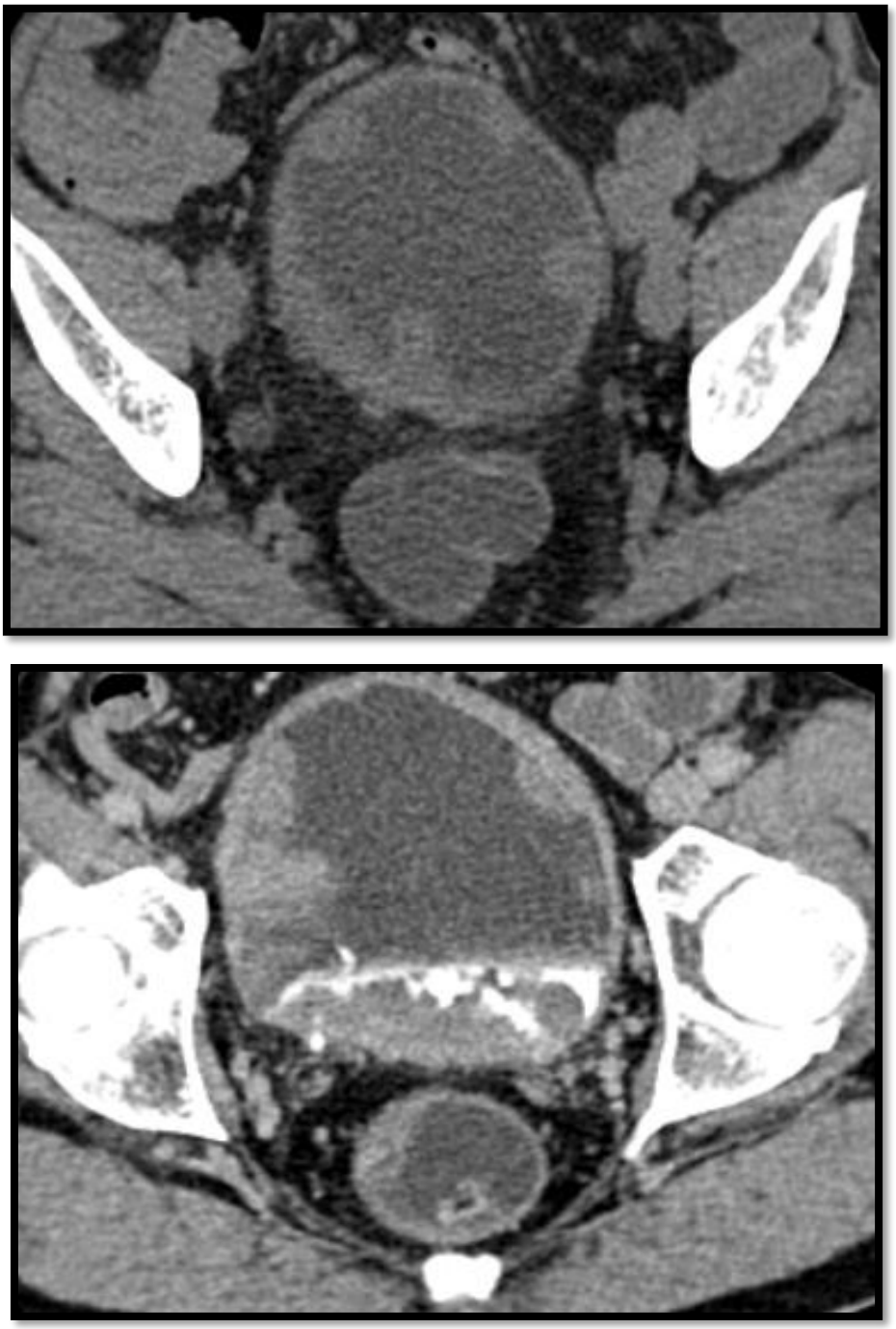


Fig-2,2.1:Axial images in pre and post contrast phase showing a multiple, well defined, soft tissue density peduncalated polypoidal lesions with irregular papillary projections with underlying mural wall thickening arising from whole extent of the bladder projecting into the lumen of urinary bladder-TCC Bladder

BLADDER TCC WITH VUJ INVOLVEMENT

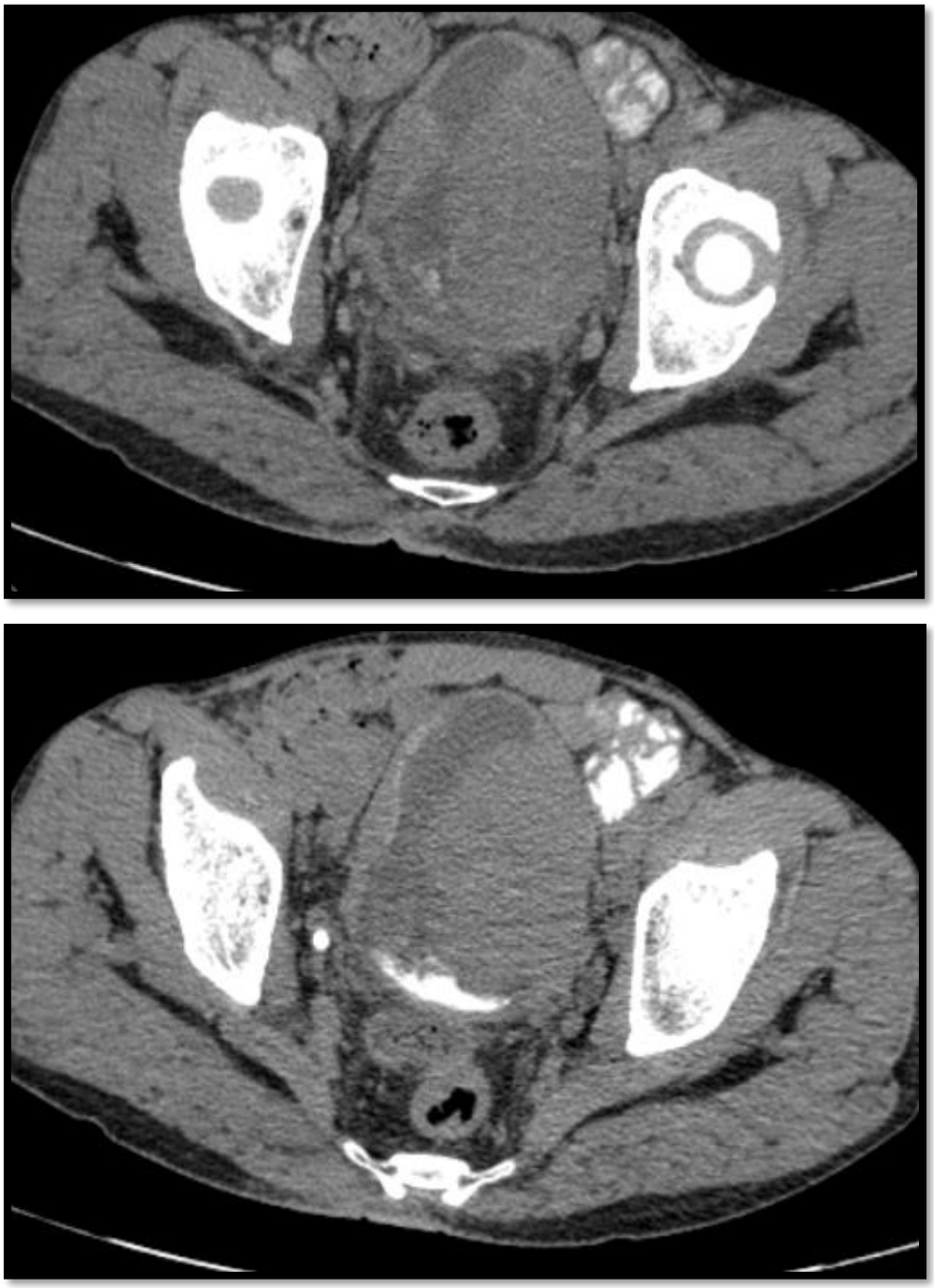


Fig-3,3.1: Axial image of NCCT and CECT in soft tissue window showing a heterogenous enhancing eccentric infiltrative broad base of urinary bladder(showing intraluminal component) with relatively hypodense areas within, another lesion with similar features noted in the right lateral wall. Loss of perivesical fat planes especially on left side with involvement of bilateral VUJ –Diffusely bladder neoplasm with significant luminal compromise involving bilateral VUJ, perivesical space and prostate involvement

LEFT RCC

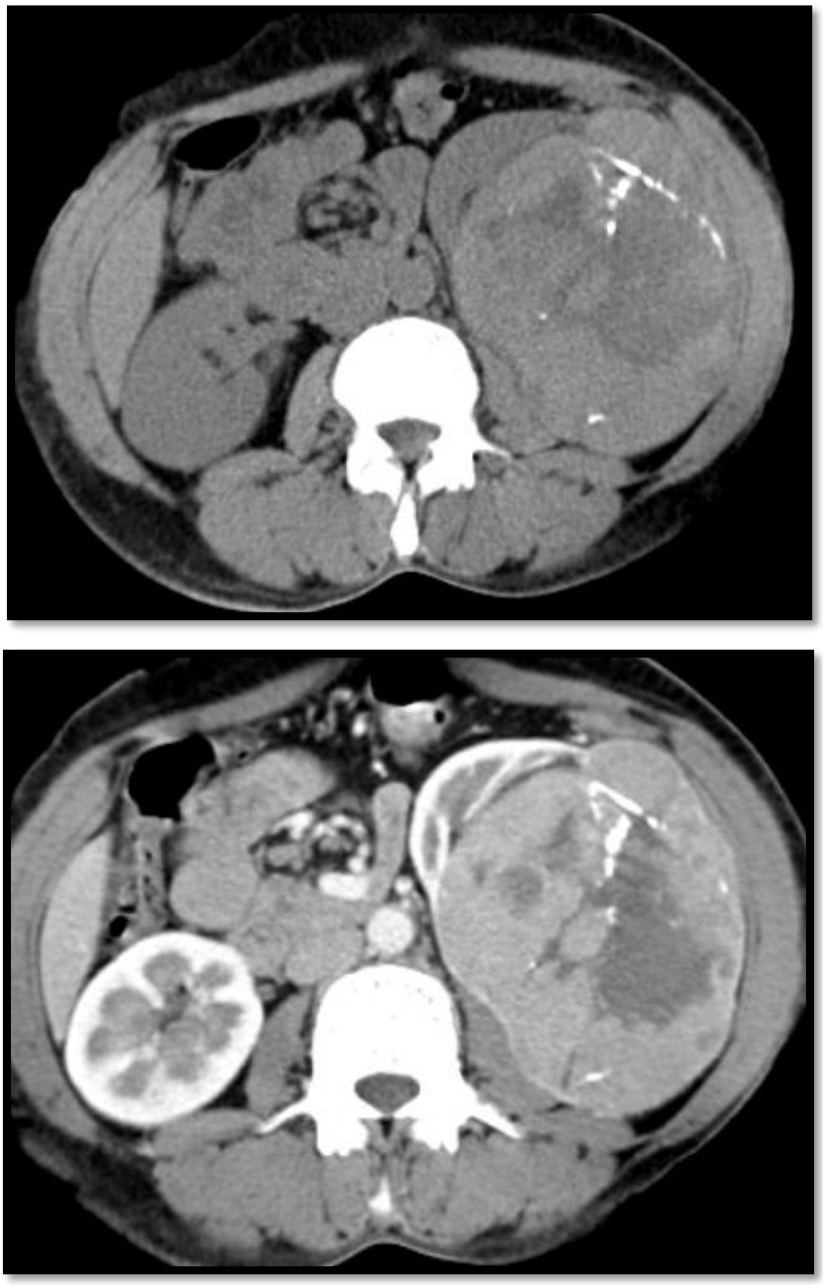


Fig-4,4.1:An axal image in NCCT and CECT phase in soft tissue window showing a large ill defined infiltrative heterogeneously enhancing mass lesion in left kidney showing calcification and internal non enhancing areas with in ie. Necrosis-Left RCC

LEFT RCC WITH RENAL VEIN THROMBUS

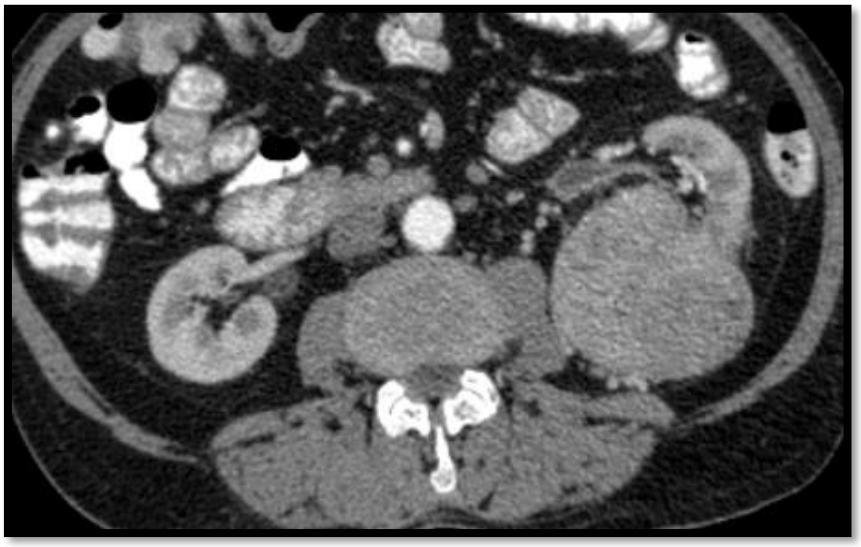


Fig-5: **Axial Images of a patient in soft tissue window showing a large ill-defined infiltrative heterogeneously enhancing mass lesion in CM phase (pre contrast 30-40HU and post contrast 90-110HU) arising from mid and lower pole of left kidney with exophytic appearance and multiple internal non enhancing areas likely necrosis – Left Renal Cell Carcinoma**

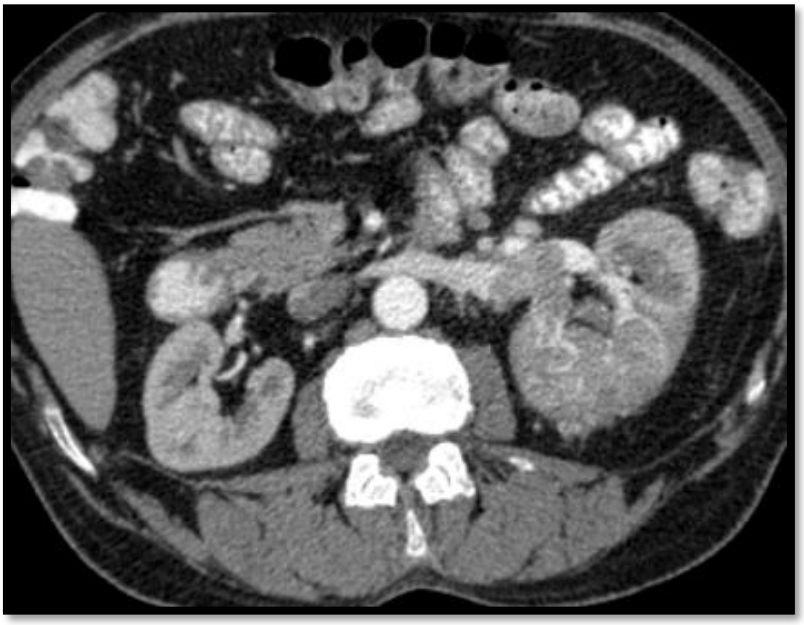


Fig-:5.1-Mass is seen extending into hila and invading left renal vein causing its expansion with intraluminal enhancing thrombus

RIGHT WILMS TUMOR

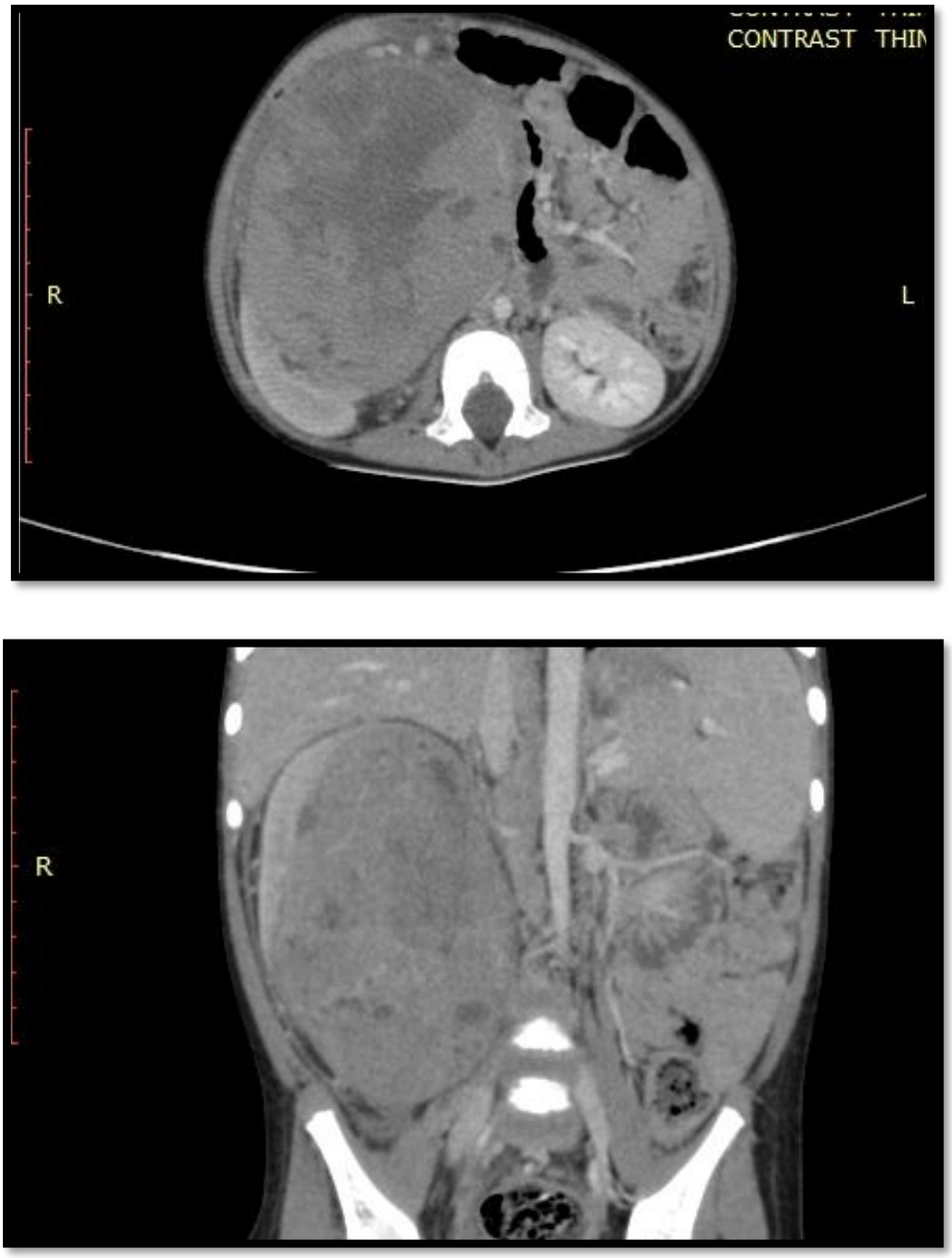


Fig-6,6.1: Axial and coronal image of a patient in soft tissue window showing a large ill-defined mass lesion arising from upper and mil pole of right kidney showing predominantly heterogeneously post contrast enhancement (pre contrast 20-40 HU, post contrast 70-100HU) and multiple internal non enhancing areas likely necrosis-Right Wilms Tumor

RIGHT RENAL COMPLICATED CYST

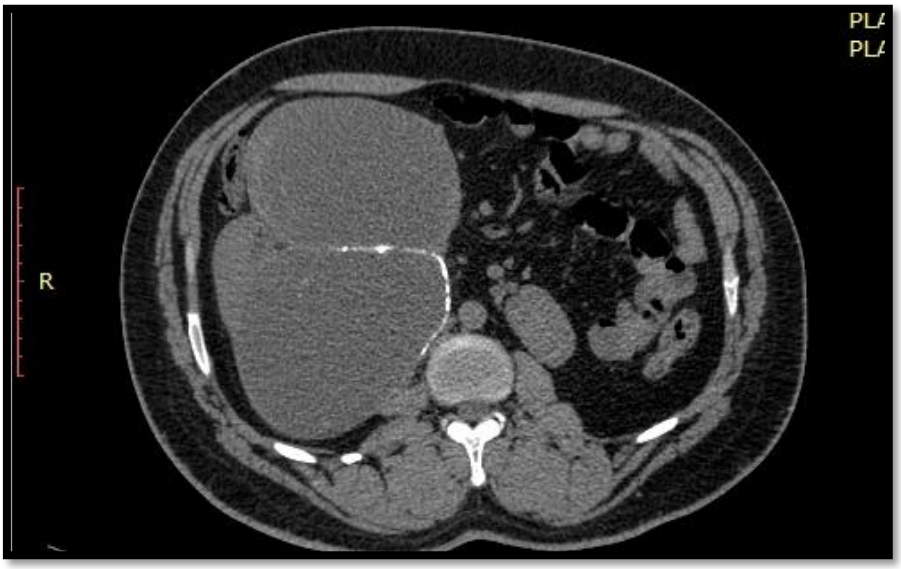
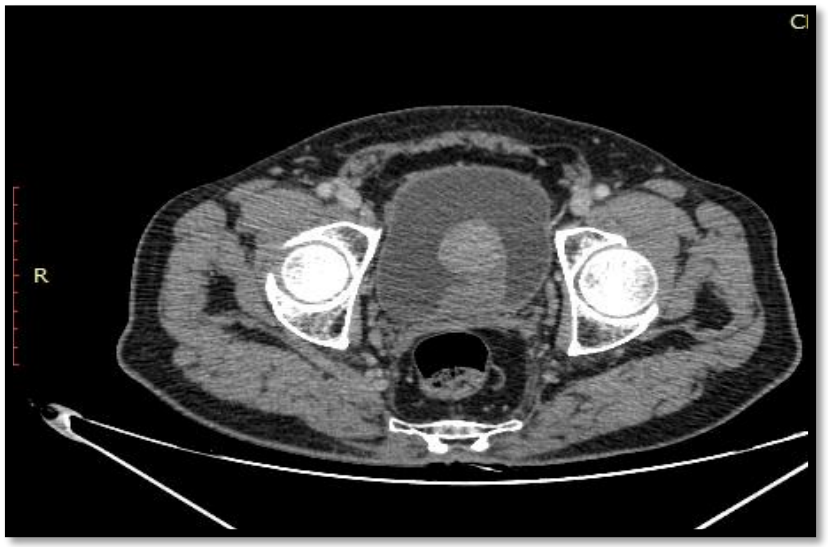


Fig-7:Axial images showing a large exophytic bilobed cystic lesion with wall calcifications and thick internal debris with no intrinsic enhancement on arterial phase or no internal vascularity arising from interpolar region of right kidney causing mass effect over the surrounding structures-Right complicated renal cyst

BPH



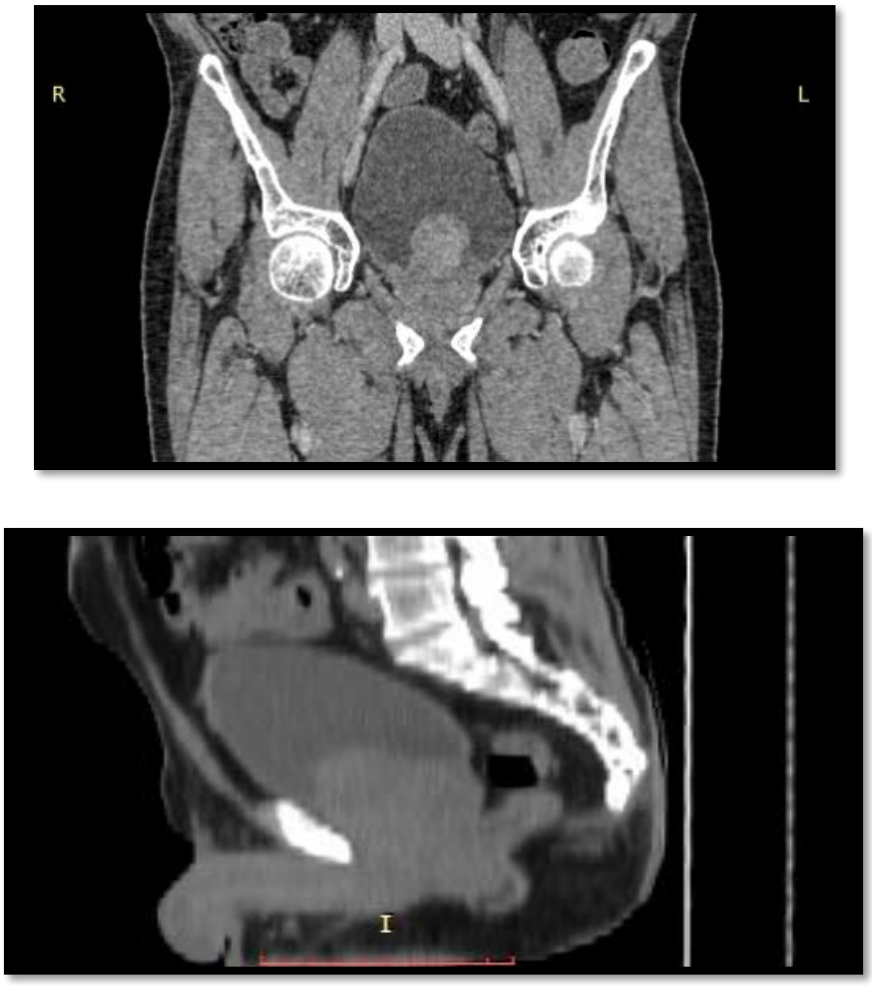


Fig-8,8.1,8.2:Axial, Coronal and Saggital image in soft tissue window showing a enlarged prostate intending median lobe-Benign Prosate Hypertrophy

DISCUSSION

Painless hematuria is classically associated with the underlying malignancies, 30% of patients with painless hematuria are found to have a malignancy [5], and prevalence of urinary tract carcinomas among patients with macroscopic haematuria has been reported to be as high as 19% [10].

CT urography is firmly established as the overall most sensitive modality for determining the cause of haematuria. It is the gold standard in the detection of renal parenchymal masses, urinary tract urothelial tumors, and extrinsic lesions. The main limitation of CTU is the associated radiation exposure and this was initially a major factor which prevented it from becoming universally accepted as the first-line investigation in patients with haematuria [11].

CT was 100% sensitive in detecting bladder neoplasm in our study. Out of the total 17 patients of bladder neoplasms causing hematuria, there was a definite male preponderance; similar distribution was reported in a study done by Yaman *et al*. [12]. 5th to 6th decade age distribution was also seen in studies done by Koss *et al.* [13] and Yaman *et al.* [12]. Neary all patients of bladder masses presented with painless and gross hematuria. Similar clinical symptomatology has been reported by previous authors like Hahn14 in bladder neoplasms. In our study bladder TCC was the most common histopathological type of malignancy encountered, which is similar to the findings of other studies by Rathi V e *et al*. [15].

All cases of TCC i.e.17(100%) were seen as enhancing mass lesion peaking at 105 HU and majority of the cases showed papillary mass protruding into lumen in 12/17(70.5%) cases and focal wall thickening in 8/16(50%).In addition lymphadenopathy was noted in (52.94%), extravesical or periureteral spread in (52.94%), similar findings are seen in other studies like Wong You Cheong *et al.*[16] Jade *et al.*[17], Kim *et al.* [18]. Calcification was seen in 11.7% cases in our study, while Kim *et al*. [19] reported calcification in 8% of cases. The slight larger percentage of tumors with calcification in our study is probably due to smaller study group.

Renal neoplastic masses were the 2nd most common cause of painless hematuria in our study. CT was 92% sensitive in detecting, staging and of characterizing renal masses and differentiating benign from malignant lesions which is similar to other study [20].

The peak age group affected was 51-60years followed by 61 -70 years of age, which was in close agreement with study done by Subramanyan and Bosniak [21] who found that majority of RCC occurred above 40 years of age. Male were more commonly affected than females with male is to female ratio of 3:2 These demographics are in close agreement with the findings of Gudbjarston *et al*.[22] and Verhoest *et al.*[23] who also reported a male predominance.

All RCC showed intense heterogenous post contrast enhancement with mean CT density (100+_48HU in CM phase and 90+_37 NP). Necrosis was found in 4 patients (50%), Haemorrhage was seen in 2 patient (25%), calcification and hydronephrosis in 3(37.5%) patients each. Extension through renal vein and IVC was seen in 4(50%) and 23(37.5%)patients respectively. Out of 8 cases of histopathologically proven RCC, 1 patient each had lung, brain and bone metastasis.Similar features in RCC have been described by McClenan *et al.*[24], Jung *et al.*[25],Young *et al.*[26], Kim *et al*.[27], Jinzaki *et al.*[28] Sheath *et al*.[29].

In our study calcification was seen in 3(37.5%) cases, renal vein invasion in 4(50%), IVC invasion in 3(37.5%%) cases and distant metastasis in 3 cases, while in the study done by Sheath *et al*.[29] renal vein involvement was seen in 23%, IVC in 4-10%, calcification in 30%. McClenan *et al.* [24] noted calcification and distant metastasis in 11% cases each. This disparity may be explained because of less number of cases of RCC in our study

One case of oncocytoma was misdiagnosed as RCC on MDCT. Currently, there is no specific CT finding to differentiate oncocytoma from RCC. They typically show homogeneous enhancement after intravenous contrast, although a significant number of renal cell carcinomas also have a homogeneous appearance. Several authors have reported Oncocytoma is difficult to differentiate from RCC on MDCT [20].

Both patients of wilms tumor were below the age of 5 years which is in concordance with the study done by Lonergan *et al*. [30] who reported the peak incidence of wilms tumour at 3-4 years with 80% of cases below 5 years of age. In our study both the cases of wilms tumor were seen as enhancing renal masses with necrosis and hemorrhage in 1 (50%). No evidence of renal vein invasion and metastasis were noted in either of the cases, these findings are similar to the study done by Lowe and Cohen *et al*. [31].

BPH was seen in two elderly aged males presented with macroscopic and microscopic hematuria. Saggital multiplane reformatting images were useful in differentiating enlarged prostate from polypoidal bladder growth [32]. Complicated cyst was seen in a female patient of aged 50years .The findings and age bracket were similar to study done by Pollack [33].

CONCLUSION

Painless haematuria is very commonly associated with the underlying malignancies. MDCTU in these patients can be considered as the first line imaging modality for detection of neoplastic masses with high sensitivity and specificity. . It additionally also provides detailed information regarding local infiltration of the tumor, lymphadenopathy and metastasis and thus has invaluable role in staging.

Thus, MDCT urography may be useful for both tumor detection and extraordinary staging in urothelial carcinoma. The primary deterrent however limiting its universal acceptance is the radiation dose which it incurs. Contrast-enhanced CT is also more sensitive than IVU and

CONCLUSION

Painless haematuria is very commonly associated with the underlying malignancies. MDCTU in these patients can be considered as the first line imaging modality for detection of neoplastic masses with high sensitivity and specificity. . It additionally also provides detailed information regarding local infiltration of the tumor, lymphadenopathy and metastasis and thus has invaluable role in staging.

Thus, MDCT urography may be useful for both tumor detection and extraurinary staging in urothelial carcinoma. The primary deterrent however limiting its universal acceptance is the radiation dose which it incurs.

REFFERENCE

1. Song JH, Beland MD, Mayo-Smith WW. Hematuria evaluation with MDCT urography: is a contrast-enhanced phase needed when calculi are detected in the unenhanced phase. American Journal of Roentgenology. 2011 Jul;197(1):W84-9.
2. Bruyninckx R, Buntinx F, Aertgeerts B, Van Casteren V. The diagnostic value of macroscopic haematuria for the diagnosis of urological cancer in general practice. Br J Gen Pract. 2003 Jan 1;53(486):31-5.
3. Hicks LA, Harrison LH, Flannery B, Hadler JL, Schaffner W, Craig AS, Jackson D, Thomas A, Beall B, Lynfield R, Reingold A. Incidence of

pneumococcal disease due to non-pneumococcal conjugate vaccine (PCV7) serotypes in the United States during the era of widespread PCV7 vaccination, 1998–2004. The Journal of infectious diseases. 2007 Nov 1;196(9):1346-54.
4. Gerber GS, Brendler CB, Wein AJ, Kavoussi LR, Novick AC, Partin AW, Peters CA. Campbell-Walsh urology. Ch. 2007;3:96.
5. Bruyninckx R, Buntinx F, Aertgeerts B, Van Casteren V. The diagnostic value of macroscopic haematuria for the diagnosis of urological cancer in general practice. Br J Gen Pract. 2003 Jan 1;53(486):31-5.
6. Ho ET, Johnston SR, Keane PF. The haematuria clinic-referral patterns in Northern Ireland. Ulster Med J 1998;67:25–8.
7. Nikolić O, Stojanović S, Till V, Basta-Nikolić M, Petrović K, Vučaj-Ćirilović V. Multislice computed tomography urography in the diagnosis of urinary tract diseases. Vojnosanitetski pregled. 2011;68(5):417-22.
8. Rathi V, Shah S, Nimbalkar C, Patankar K. Role of multidetector ct urography in evaluating patients with haematuria. JOURNAL OF EVOLUTION OF MEDICAL AND DENTAL SCIENCES-JEMDS. 2016 Jul 25;5(59):4130-6.
9. Haaga JR, DograVS, ForstingM, Gilkeson RC, Kwon H, CT and MRI of the whole body. 5th edition vol 2. John F Kennedy;1863 1952
10. Edwards TJ, Dickinson AJ, Natale S, Gosling J, Mcgrath JS. A prospective analysis of the diagnostic yield resulting from the attendance of 4020 patients at a protocol-driven haematuria clinic. BJU international. 2006 Feb 1;97(2):301-5.
11. Moloney F, Murphy KP, Twomey M, O'Connor OJ, Maher MM. Haematuria: an imaging guide. Advances in urology. 2014 Jul 17;2014.
12. Yaman Ö, Baltaci S, Arikan N, Yilmaz E, Gögüs O. Staging with computed tomography, transrectal ultrasonography and transurethral resection of bladder tumour: comparison with final pathological stage in invasive bladder carcinoma. BJU International. 1996 Aug 1;78(2):197-200.
13. Koss JC, Arger PH, Coleman BG, Mulhern Jr CB, Pollack HM, Wein AJ. CT staging of bladder carcinoma. American Journal of Roentgenology. 1981 Aug 1;137(2):359-62.
14. Pollack HM, editor. Clinical urography: an atlas and textbook of urological imaging. Saunders; 1990.
15. Rathi V, Shah S, Nimbalkar C, Patankar K. Role of multidetector ct urography in evaluating patients with haematuria. JOURNAL OF EVOLUTION OF MEDICAL AND DENTAL SCIENCES-JEMDS. 2016 Jul 25;5(59):4130-6.
16. Wong-You-Cheong JJ, Wagner BJ, Davis Jr CJ. Transitional cell carcinoma of the urinary tract: radiologic-pathologic correlation. Radiographics. 1998 Jan;18(1):123-42.
17. Harrington KD. Major neurological complications following percutaneous vertebroplasty with polymethylmethacrylate. JBJS Case Connector. 2001 Jul 1(7):1070-3.
18. Kim JK, Park SY, Ahn HJ, Kim CS, Cho KS. Bladder cancer: analysis of multi–detector row helical CT enhancement pattern and accuracy in tumor detection and perivesical staging. Radiology. 2004 Jun;231(3):725-31.
19. Moon WK, Kim SH, Cho JM, Han MC. Calcified bladder tumors: CT features. Acta Radiologica. 1992 Jan 1;33(5):440-3.
20. Tsili AC, Argyropoulou MI. Advances of multidetector computed tomography in the characterization and staging of renal cell carcinoma. World journal of radiology. 2015 Jun 28;7(6):110.
21. Subramanyam BR, Bosniak MA. Renal parenchymal and capsular tumors in adults. Radiology Diagnosis—Imaging—Intervention. Philadelphia: JB Lippincott. 1988:1-3.
22. Gudbjartsson T, Thoroddsen A, Petursdottir V, Hardarson S, Magnusson J, Einarsson GV. Effect of incidental detection for survival of patients with renal cell carcinoma: results of population-based study of 701 patients. Urology. 2005 Dec 31;66(6):1186-91.
23. Verhoest G, Veillard D, Guillé F, De La Taille A, Salomon L, Abbou CC, Valéri A, Lechevallier E, Descotes JL, Lang H, Jacqmin D. Relationship between age at diagnosis and clinicopathologic features of renal cell carcinoma. European urology. 2007 May 31;51(5):1298-305.
24. McClennan BL, Deyoe LA. The imaging evaluation of renal cell carcinoma: diagnosis and staging. Radiologic clinics of North America. 1994 Jan;32(1):55-69.
25. Jung SC, Cho JY, Kim SH. Subtype differentiation of small renal cell carcinomas on three-phase MDCT: usefulness of the measurement of degree and heterogeneity of enhancement. Acta Radiologica. 2012 Feb;53(1):112-8.
26. Young JR, Margolis D, Sauk S, Pantuck AJ, Sayre J, Raman SS. Clear cell renal cell carcinoma: discrimination from other renal cell carcinoma subtypes and oncocytoma at multiphasic multidetector CT. Radiology 2013; 267: 444-453
27. Kim JK, Kim TK, Ahn HJ, Kim CS, Kim KR, Cho KS. Differentiation of subtypes of renal cell carcinoma on helical CT scans. American Journal of Roentgenology. 2002 Jun;178(6):1499-506.
28. Jinzaki M, McTavish JD, Zou KH, Judy PF, Silverman SG. Evaluation of small (≤ 3 cm) renal masses with MDCT: benefits of thin overlapping reconstructions. American Journal of Roentgenology. 2004 Jul;183(1):223-8.

29. Sheth S, Scatarige JC, Horton KM, Corl FM, Fishman EK. Current concepts in the diagnosis and management of renal cell carcinoma: role of multidetector CT and three-dimensional CT. Radiographics. 2001 Oct;21(suppl_1):S237-54.
30. Pickhardt PJ, Lonergan GJ, Davis Jr CJ, Kashitani N, Wagner BJ. From the Archives of the AFIP: Infiltrative Renal Lesions: Radiologic-Pathologic Correlation. Radiographics. 2000 Jan;20(1):215-43.
31. Lowe RE, Cohen MD. Computed tomographic evaluation of Wilms tumor and neuroblastoma. Radiographics. 1984 Nov;4(6):915-28.
32. Shinagare AB, Sadow CA, Sahni VA, Silverman SG. Urinary bladder: normal appearance and mimics of malignancy at CT urography. Cancer Imaging. 2011;11(1):100.
33. Pollack HM, Banner MP, Arger PH, Peters J, Mulhern Jr CB, Coleman BG. The accuracy of gray-scale renal ultrasonography in differentiating cystic neoplasms from benign cysts. Radiology. 1982 Jun;143(3):741-5.