Ultrasonographic Evaluation of Obstructive Uropathy Compared with CT Urogram

UMAMA-BINTA-ASHRAF[1], MOHAMMAD MIZANUR RAHMAN[2], MD TARIQUL ISLAM[3], HASNA HOMAIRA CHOWDHURY[4], SUNANDA BARMAN[5], MST TOUHIDA AKTER[6], SUMAYA TABASSUM[7], FARZANA HAYAT[8]

Abstract:

Background: *Ultrasonography (USG) is a commonly used cheap and easily available modality to evaluate underlying etiology of obstructive uropathy. Multidetector computed tomography urography (MDCTU) has the advantage of being able to detect not only the level of obstruction but also its different causes like urinary stones junctional stenosis, strictures, injury, retroperitoneal fibrosis, and masses. But it is expensive and has radiation hazards.* ***Objective:*** *To assess the accuracy of ultrasonography in evaluation of obstructive uropathy.* ***Methodology:*** *This cross-sectional study was carried out on 60 cases with clinically suspected cases of obstructive uropathy, in Radiology and Imaging Department of Dhaka Medical College Hospital, Dhaka, Bangladesh from March 2019 to February 2021. All were evaluated with details history & clinical examination and then underwent USG and CT scan.* ***Results:*** *The mean age was 48.5±13.3 years with range from 20 to 75 years. Male to female ratio was 4:1. The majority (60%) patients had loin pain followed by 23(38.3%) renal angle tenderness, 22(36.7%) hematuria, 11(18.3%) poor flow, 10(16.7%) nausea/ vomiting, 08(13.3%) dysuria and 08(13.3%) hesitancy. Causes of obstructive uropathy in 54 patients were detected by USG. USG failed to detect 03(5%) cases who had stone at mid ureter and 03(5%) cases who had urinary bladder mass. Causes of obstructive uropathy were detected by CT Urogram in 56(93.3%) and 04(6.7%) were not detected, among them 02(3.3%) had genital prolapse and 02(3.3%) had benign hyperplasia of prostate. USG diagnosis evaluation for obstructive uropathy were compared with CT urogram diagnosis. Sensitivity of USG was 94.64%, specificity was 75%, accuracy was 93.33%, PPV was 98.15% and NPV was 50%.* ***Conclusion:*** *Ultrasonography is a reliable and alternative modality to CT urogram in the diagnosis of obstructive uropathy.*

Keywords: *Ultrasonography, CT Urogram, Obstructive Uropathy.*

Author of correspondence: Dr. Umama-Binta-Ashraf, MBBS, MD. Registrar, Department of Radiology & Imaging, BIRDEM General Hospital, Dhaka. Email: umamadmc@gmail.com

Introduction:

Obstructive uropathy is a relatively common clinical problem which can occur anywhere from renal tubules to the urethral meatus like in renal pelvis, ureter, bladder and urethra and which if not treated timely can lead to irreversible renal damage[1]. Obstruction of urinary tract can occur during any phase of life, like childhood, adulthood or even during foetal development and can be due to variety of congenital and acquired causes and it can be intra luminal which occurs due to scarring, stones, papillae sloughing and blood clots and it can be extra luminal which occurs due to pressure over ureter and cause obstruction like cancer stricture, enlarged uterus, trauma and enlarged lymph nodes and they can causes either unilateral or bilateral obstruction depending on location[2].

Obstructive uropathy is a disorder of the urinary tract that occurs due to obstructed urinary flow and can be either structural or functional which

1) Registrar, Department of Radiology & Imaging, BIRDEM General Hospital, Dhaka, 2) Professor of Radiology and Principal, Asgar Ali Medical College, Gandaria, Dhaka, 3) Junior Consultant (Medicine), Daudkandi upazilla health complex, Cumilla, 4) Junior Consultant (Radiology & Imaging), M Abdur Rahim Medical College Hospital, Dinajpur, 5) Specialist, (Radiology & Imaging), Square Hospital, Dhaka, 6) Consultant Radiologist (Radiology & Imaging), Cumilla medical centre(pvt) limited, Cumilla. 7) Medical Officer, National Institute of Neurosciences & Hospital, Dhaka and 8) Registrar, Department of Radiology & Imaging, BIRDEM General Hospital, Dhaka.
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occur due to the back-up of urine into the unilateral or bilateral kidneys, depending on the location of the obstruction, causes hydronephrosis and can present as motley of symptoms but will typically involve a combination of difficultly initiating micturition, acute urinary retention, or lower abdominal discomfort and distention which can be acute or chronic[3].

Urinary obstruction affects all age groups, but the majority of cases present in the bimodal distribution and the largest group is made up of people over 60 and more frequently males due to the anatomic presence of prostate (benign prostatic hyperplasia and cancers) and symptoms of urinary retention occur in up to 1% to 2% of men with BPH(Benign prostatic hyperplasia) per year[4].

The severity of symptoms and likely even the number of symptoms present are influenced by the degree, location, and time from the onset of the obstruction and the presence of pain is common in urinary tract obstructions[3].

Many imaging modalities are available to evaluate the patients of obstructive uropathy which include plain radiographs, Intravenous Urography (IVU), Ultrasonography (USG), CT (including CT urography), MRI (including MR urography) and radionuclide studies. USG scores over IVU in detecting the collecting system dilatation in cases of obstruction even when the renal functions are impaired but lacks specificity.

Computed tomography (CT) is considered the imaging gold standard for the diagnosis of renal colic[5,6]. CT has sensitivities of 91-97% and specificities of 91-100% for detecting ureteral stones and also provides information on stone size and location, which can be helpful for predicting successful medical expulsion therapy versus the need for urologic intervention[7,8]. There are multiple reasons to choose CT imaging selectively in this patient population, most notably to rule out other serious disease such as aortic dissection and other surgical emergencies. However, as many as 50% of patients diagnosed with renal colic will have recurrent episodes and may receive multiple CTs throughout their lifetime, adding to costs, increased length of stay, and radiation exposure[9,10,11]. There are currently no validated practice guidelines for the diagnosis and Emergency Department (ED) management of renal colic; thus, the need for a multidisciplinary approach to managing this disease is clear[12,13,14]. The role of emergency physician- (EP) performed ultrasound (US) in the management of patients with renal colic has recently gained more attention, but its incorporation into an accepted algorithm remains debatable[15,16,17]. US has the advantage of using no radiation, and research continues to support its role in the diagnosis and management of renal colic in the ED (Emergeny Department)[18]. The low sensitivity of US for identifying stone size and stone location may limit its usefulness in predicting the clinical course or follow-up planning for patients with renal colic[19]. However, hydronephrosis is easily detected by US and its presence or absence may provide physicians with useful information to assist in renal colic management.

US has limitations that restrict its use in patients with symptoms of acute renal or ureteric colic. Even in those patients in whom it is used, further imaging often required for confirmation and characterization of the obstruction. The presence of obstruction is inferred by visualizing a dilated collecting system. This may be minimal or even absent in acute obstruction. In addition, ureteral calculi are not well demonstrated. Technical limitations to the study such as obesity, bowel gas, operator skill also may result in a false negative result. The source of such errors includes vascular calcifications that may simulate a calculus. Peripelvic cysts, an extrarenal pelvis, or even a normal collecting system may be misinterpreted as representing hydronephrosis. Doppler sonography can help by readily distinguishing renal hilar vessels from a slightly dilated collecting system.

This study is intended to be conducted among the patients presenting with the features of obstructive uropathy to evaluate the efficacy and limitation of ultrasonography in diagnosing and determining the etiology of obstructive uropathy in comparison to computed tomographic evaluation.

Methodology:

This cross-sectional study was carried out on 60 cases with clinical suspicion of having obstructive

uropathy, referred for USG and CT urogram to Radiology and Imaging Department of Dhaka Medical College Hospital, Dhaka, Bangladesh either from OPD or in-patients Department of Urology, DMCH from March 2019 to February 2021. Ultrasonography was done by using a, 'Philips' machine, model Affiniti 30 for detection of obstructive uropathy with curvilinear transducer of 5 MHz. Patient was in supine position in bed with full urinary bladder and longitudinal and transverse scan images were taken. Patient was asked to suspend respiration or perform quiet breathing and then assessment of hydronephrosis in one or both kidneys and images were obtained and recorded. All patients underwent comparative Computed tomography scan with a 128 slice multidetector HITACHI SCENERIA whole body scanner. The anatomic region between the upper margin of the T12 vertebra and symphysis pubis was scanned by 10 mm cut without any contrast. Scanning was repeated after an intravenous injection of contrast media. Dose of contrast media was 1 ml per kg body weight in case of adult, 1.5 ml per kg body weight in case of children. Imaging was obtained in 1 minute for nephrogram phase, 3 minutes for pyelogram phase and 5 minutes for ureterogram phase. Then images were obtained at 10 minutes, 20 minutes, 40 minutes and so on up to full bladder. The final image was obtained after voiding the bladder. Post processing 3D reconstruction of image was done by 6 mm thickness. Then final image was obtained & then interpretation was done by the help of two expert radiologist. Statistical analyses were carried out by using the Statistical Package for Social Sciences version 23.0 for Windows (SPSS Inc., Chicago, Illinois, USA). The mean values were calculated for continuous variables. The quantitative observations were indicated by frequencies and percentages. Chi-Square test with Yates correction was used to analyze the categorical variables, shown with cross tabulation. A "p" value <0.05 was considered as significant. For the validity of study outcome, sensitivity, specificity, accuracy, positive predictive value and negative predictive value of the ultrasonogram evaluation of obstructive uropathy was calculated.

Results:

Table I

Distribution of the study patients by age (N=60)

Age (years)	No of patients(n)	Percentage (%)
20-30	09	15
31-40	06	10
41-50	15	25
51-60	22	36.7
61-75	08	13.3
Mean ±SD (In years)	48.5 ±13.3	
Range (min-max, In yrs)	20 -75	

Table-I shows that more than 22(36.7%) patients belonged to age group of 51-60 years. The mean age was found 48.5±13.3 years with range from 20 to 75 years.

Results regarding gender distribution showed that four fifth patients 48(80%) were male and 12(20%) patients were female. Male female ratio was 4:1.

Regarding the clinical information it was observed that majority (60%) patients had loin pain followed by 23(38.3%) had renal angle tenderness, 22(36.7%) had hematuria, 11(18.3%) had poor flow, 10(16.7%) had nausea/ vomiting, 8(13.3%) had dysuria and 8(13.3%) had hesitancy. Other results depicted that 07(11.7%) had incontinence, 06(10%) had oliguria, 05 (8.3%) had feeling of mass, 05 (8.3%) had abnormal menstrual bleeding and 04(6.7%) had urgency. There was overlapping of the symptoms with multiple responses.

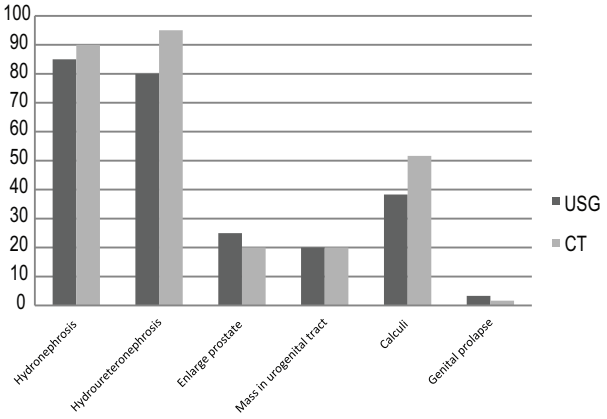

Fig.-1: *Bar diagram showing comparison of Ultrasonogram and CT urogram in evaluation of obstructive uropathy*

Figure 1 shows the comparison of USG & CT diagnosis of obstructive uropathy side by side in a

bar diagram. USG detected hydronephrosis in 85% patients in contrast to 90% by CT, hydroureteronephrosis in 80% patients in contrast to 95% by CT, enlarged postate in 25% patients in contrast to 20% by CT, mass in urogenital tract in 20% patients in contrast to 20% by CT, calculi in 38.33% patients in contrast to 51.67% by CT and genital prolapse in 3.33% patients in contrast to 1.67% by CT.

Table II

Distribution of the study patients according to USG findings (N=60)

USG Findings	No of Patients(n)	Percentage (%)
Detected	54	90
* Stone at Right PUJ	06	10
* Stone at Left PUJ	05	8.3
* Stone at Right VUJ	05	8.3
* Stone at Left VUJ	05	8.3
* Stone at mid ureter	02	3.3
* Urinary bladder mass	10	16.7
* Benign hyperplasia of prostate	15	25
* Cervical growth	04	6.7
* Genital prolapse	02	3.3
Not Detected	06	10
* Stone at mid ureter level	03	5
* Urinary Bladder mass	03	5

Table-II shows that USG detected was 54 cases and failed to diagnose 06 cases. Among the detected cases 15(25%) patients had benign hyperplasia of prostate,10(16.7%) had urinary bladder mass, 06(10%) had stone at PUJ of right kidney, 05(8.3%) had stone at PUJ of left kidney, 05(8.3%) had stone at right VUJ, 05(8.3%) had stone at left VUJ, 04(6.7%) had cervical growth, 02(3.3%) had stone at mid ureter and 02(3.3%) had genital prolapse.

Table III

Distribution of the study patients according to CT urogram findings (N=60)

CT UROGRAM Findings	No of Patients(n)	Percentage (%)
Detected cases	56	93.3
* Stone at Right PUJ	06	10
* Stone at Left PUJ	07	11.7
* Stone at Right VUJ	05	8.3
* Stone at Left VUJ	06	10
* Stone at mid ureter	07	11.7
* Urinary bladder mass	12	20
* Benign hyperplasia of prostate	10	16.7
* Cervical growth	02	3.3
* Genital prolapse	01	1.7
Undetected cases	04	6.7
* Stone at mid ureter level	02	3.3
* Urinary Bladder mass	02	3.3

Table-III shows that CT urogram detected 56 cases of obstructive uropathy. Among them 12(20%) patients had urinary bladder mass, 10(16.7%) had benign hyperplasia of prostate, 07(11.7%) had stone at left PUJ, 07(11.7%) had stone at mid ureter, 06(10%) had stone at right PUJ, 06(10%) had stone at left VUJ, 05(8.3%) had stone at right VUJ, 02(3.3%) had cervical growth and 01(1.7%) had genital prolapse.

Table IV

Comparison between USG and CT urogram findings for detection of etiology of obstructive uropathy

Aetiology of obstruction	USG (n)	CT urogram (n)
Detected cases	56	56
* Stone at Right PUJ	06	06
* Stone at Left PUJ	05	07
* Stone at Right VUJ	05	05
* Stone at Left VUJ	05	06
* Stone at mid ureter	02	07
* Urinary bladder mass	10	12
* Benign hyperplasia of prostate	15	10
* Cervical growth	04	02
* Genital prolapse	02	01
Undetected cases	06	04
* Stone at mid ureter level	03	02
* Urinary Bladder mass	03	02

Table-IV shows that causes of obstructive uropathy were detected by USG in 54 patients in contrast to CT urogram diagnosis of 56 patients. USG failed to diagnose 06 cases correctly while CT urogram had failure fo diagnosis in 04 patients.

Table V

Comparison between USG and CT Urogram diagnosis in the evaluation of causes of obstructive uropathy (N=60)

Cause	USG findings		CT Urogram findings		χ^2	P value
	n	%	n	%		
Detected	54	90	56	93.3	0.44	0.509^{ns}
Undetected	06	10	04	6.7		

ns= not significant, P value reached from chi square test

Table-V shows that in 54(90%) patients causes of obstructive uropathy was correctly diagnosed by USG in contrast to 56(93.3%) patients by CT urogram. The difference was not statistically significant (p>0.05) between two groups.

Table VI

Comparison between CT urogram and USG findings in evaluation for obstructive uropathy (N=60)

USG	CT urogram	
	Detected (n=56)	Not detected (n=4)
Detected (n=54)	53 (True positive)	01 (False positive)
Undetected (n=6)	03 (False negative)	03 (True negative)

P= 0.001, P value reached from Chi square test

Table-VI shows that in the evaluation for obstructive uropathy by USG with CT urogram, 53 were true positive cases, 01 was false positive case, 03 were false negative cases and 03 were true negative cases.

Table VII

Sensitivity, specificity, accuracy, positive and negative predictive values of the USG diagnosis evaluation for detected causes of obstructive uropathy

Validity test	Percentage (%)
Sensitivity	94.64
Specificity	75
Accuracy	93.33
NPV	98.15
PPV	50

Table-VII shows the validity of USG in detecting causes of obstructive uropathy, taking into account of CT urogram as the gold standard. Results shows a sensitivity of 94.64%, specificity of 75%, accuracy of 93.33%, PPV of 98.15% and NPV of 50%.

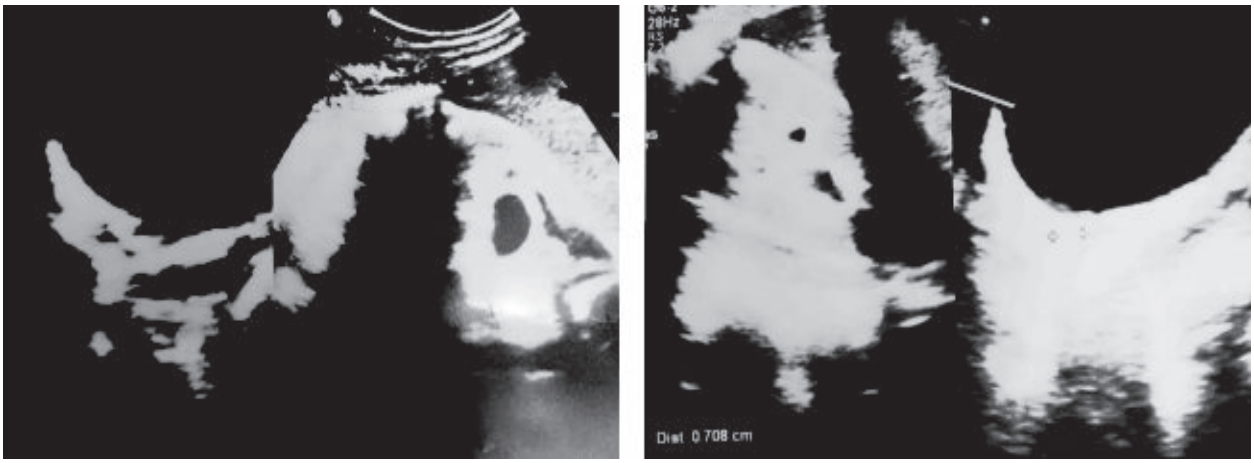

Fig 1a & 1b: *USG showing calculi and bilateral hydroureteronephrosis.*

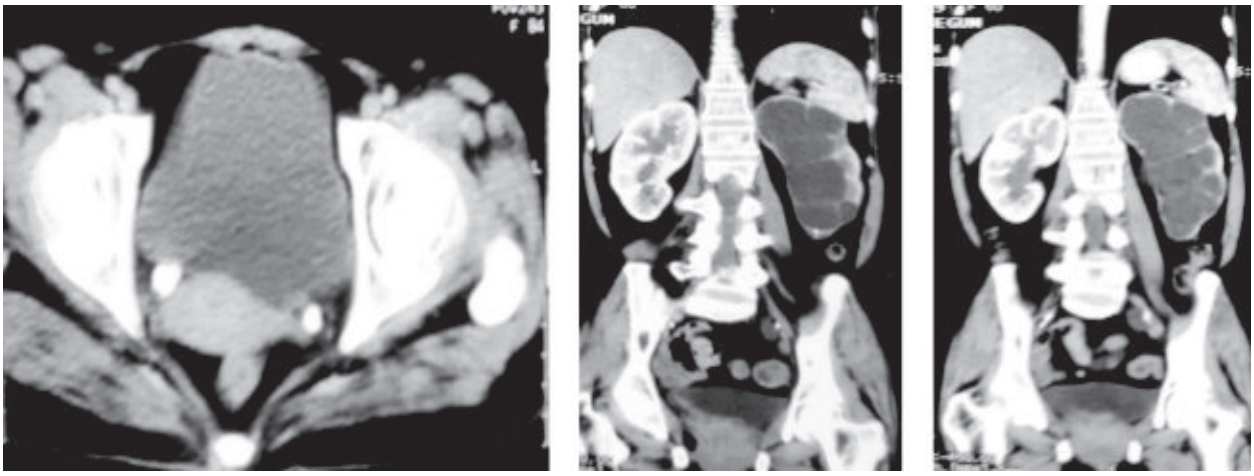

Fig.-1c (Left) : *Pre-contrast axial and* **Fig.-1d & 1e** *(middle and right images): post-contrast coronal nephrographic phase showing bilateral Vesicoureteric junction calculi resulting bilateral hydronephrosis of the same patient.*

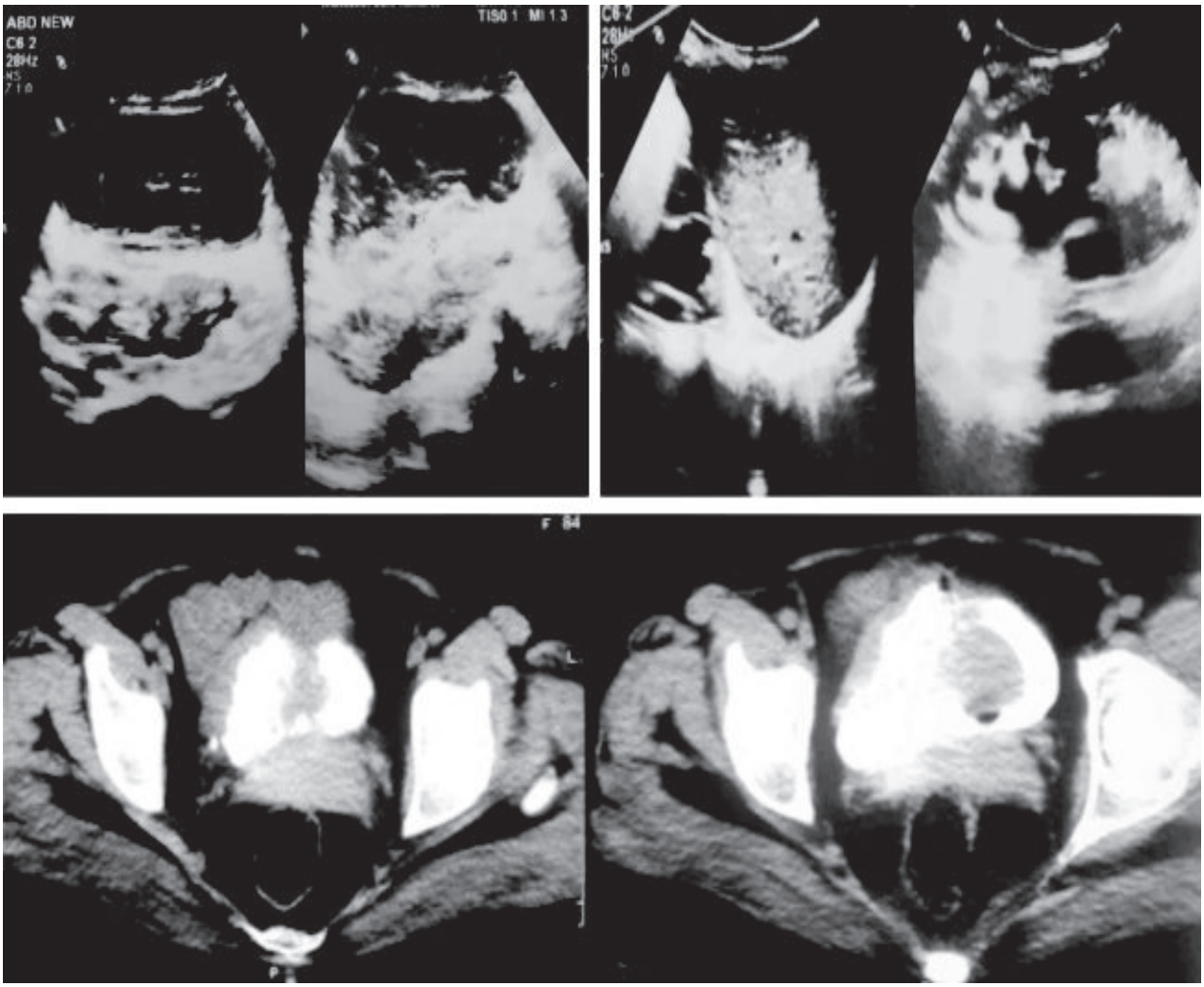

Fig 2a & 2b (Top images): *Showing Transabdominal USG scan and* **Fig 2a & 2b** *(bottom images): axial CT images of Cervical growth invading bladder wall with bilateral hydroureteronephrosis.*

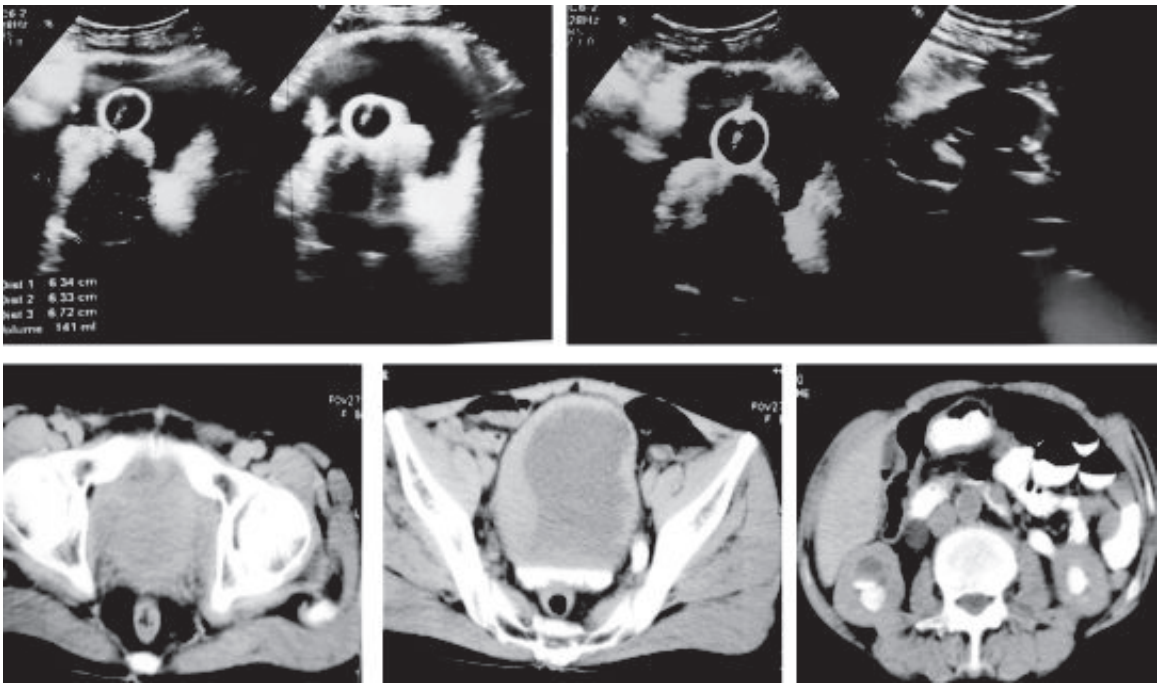

Fig 3a & 3b (Top images): *USG images showing obvious massive enlargement of median lobe of prostate protruding in bladder base resulting in bilateral hydronephrosis.* **Fig 3a, 3b & 3c***: CT axial images of the same patient showing bilateral obstructive uropathy.*

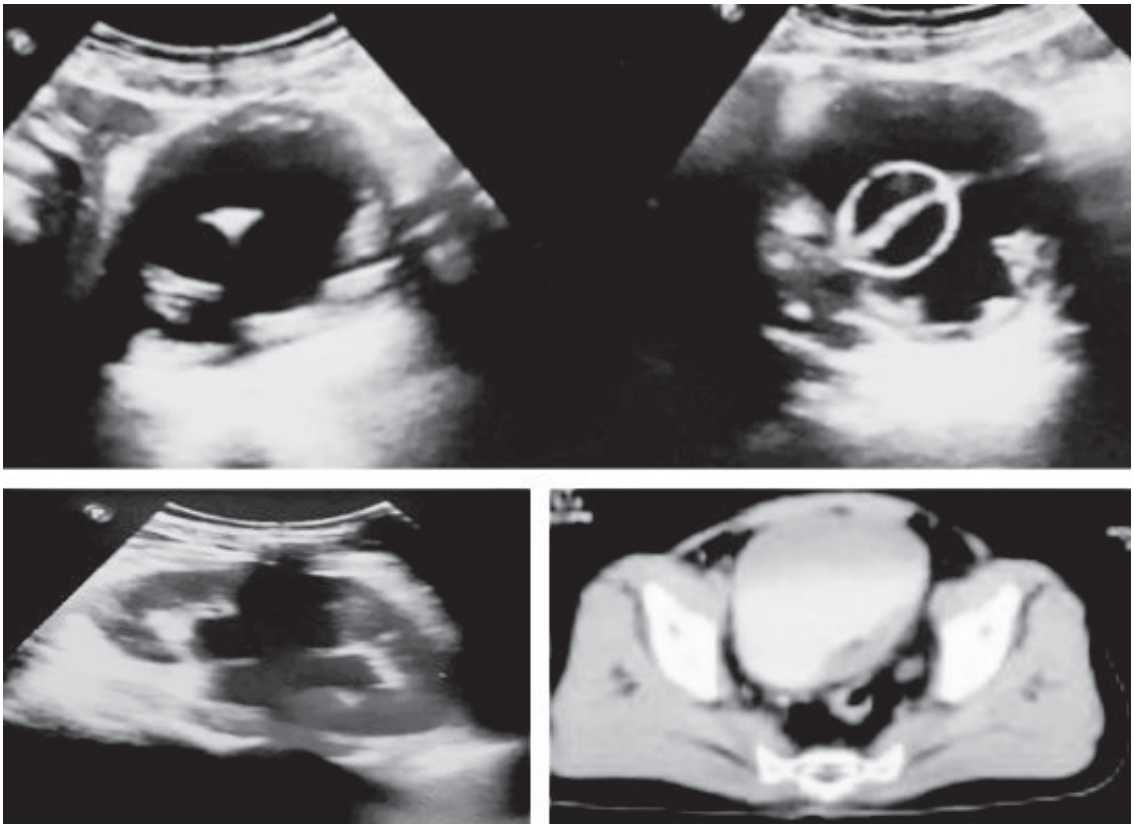

Fig 4a, 4b (Top images) & 4c (Bottom left image): *showing USG &* **4d (Bottom right image)**: *CT Urogram axial image showing Urinary bladder mass with left VUJ invasion resulting upstream urinary obstruction.*

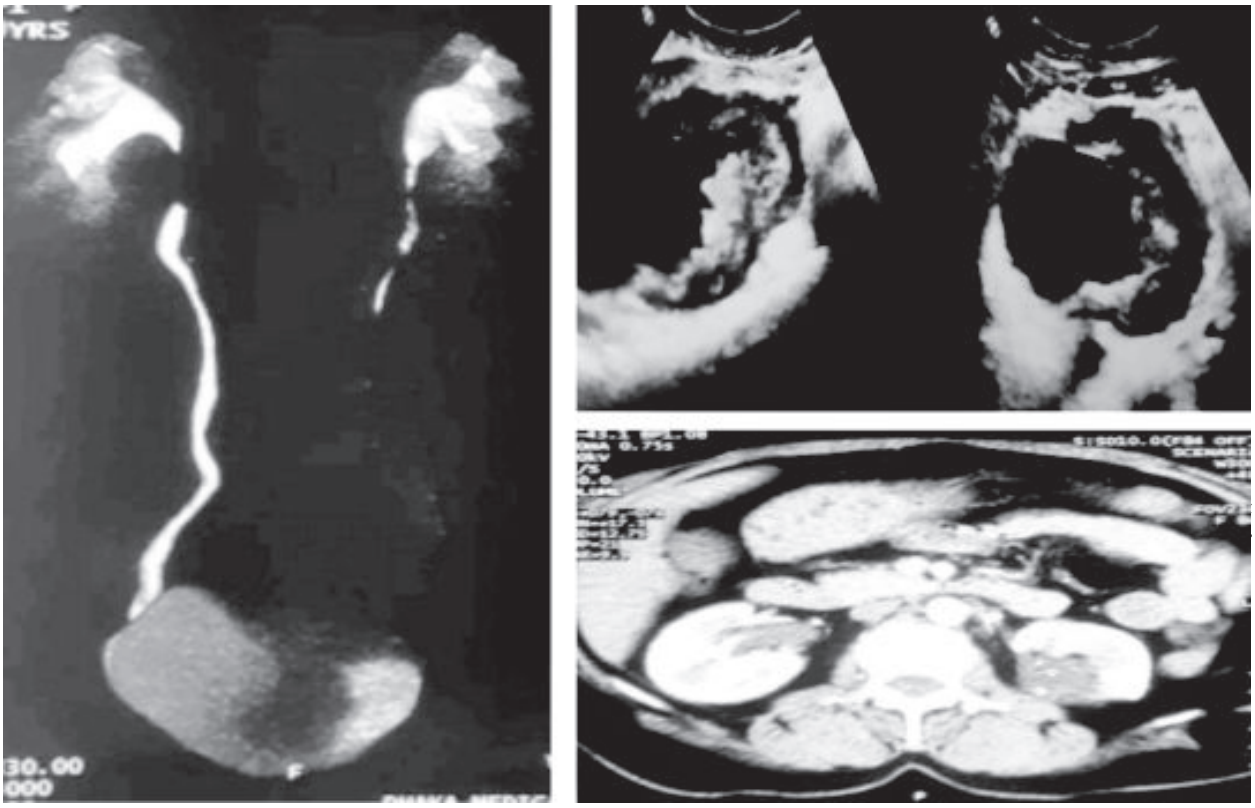

Fig 5a (Left top image): *USG shows the mass well delineated as CT with its effect on kidney & ureter,* **Fig 5b (Right image)**: *showing pre-contrast coronal image and* **Fig 5c (Left bottom image)***: showing enhancing urinary bladder mass with left sided VUJ obstruction resulting in marked hydroureteronephrosis.*

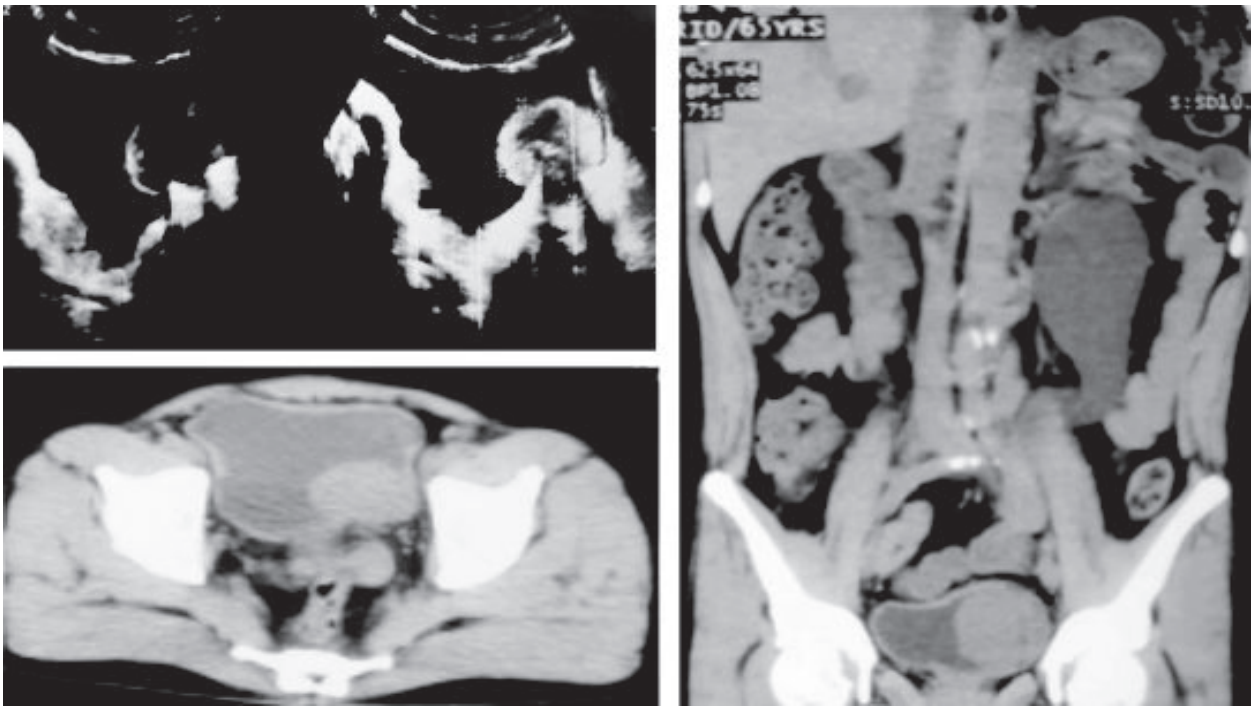

Fig 6a (Left top image): *USG shows the mass well delineated as CT with its effect on kidney & ureter,* ***Fig 6b (Right image)****: showing pre-contrast coronal image and* ***Fig 6c (Left bottom image)****: showing enhancing urinary bladder mass with left sided VUJ obstruction resulting in marked hydroureteronephrosis.*

Discussion:

In this study more than 22(36.7%) patients belonged to age group of 51-60 years. The mean age was found 48.5±13.3 years with range from 20 to 75 years. Similar observation was shown by Apoku et al. showed the mean age of their study subjects of 48.68±16.69 years[20]. Leo et al.[21] study is also in agreement with our study where reported mean age was 43.1±13.6 years. Studies by Idowu et al.[22] and Sharma et al.[23] showed different results with the mean age of the participants of 37.9±7.4 years and 33.5±14.3 years respectively.

Present study showed that four fifth 48(80%) patients were male and 12(20%) patients were female. Male female ratio was 4:1. Leo et al.[21] reported that 170(56.3%) patients were male and 132(43.7%) were female. Apoku et al.[20] reported that the subjects comprised of 27 (45%) men and 33 (55%) women. Sharma et al.[23] observed 31 male and 19 female participants in a study group of 50 patients. In my study male were predominant may be due to different underlying causes related to socio-economic condition in our country.

In this study we observed that majority (60%) patients had loin pain followed by 23(38.3%) renal angle tenderness, 22(36.7%) hematuria, 11(18.3%) poor flow, 10(16.7%) nausea/ vomiting, 08(13.3%) dysuria and 08(13.3%) hesitancy.

In our study it was observed that USG detected 54 cases among them 15(25%) were due to benign hyperplasia of prostate, 10(16.7%) due to urinary bladder mass, 06(10%) due to stone at right PUJ, 05(8.3%) due to stone at left PUJ, 05(8.3%) due to stone at right VUJ, 05(8.3%) due to stone at left VUJ, 04(6.7%) due to cervical growth, 02(3.3%) due to stone at mid ureter and 02(3.3%) due to genital prolapse. Uterine fibroid was the commonest cause of obstructive uropathy in women while enlarged prostate in men was reported by Apoku et al[20]. Leo et al.[21] observed the detection of any hydronephrosis on EP-performed US had a sensitivity of 85% and a specificity of 71%. Earlier studies have shown that ultrasonography is sensitive (≥90%), but not specific (65-84%), in the diagnosis of renal obstruction[24,25].

In our study CT urogram detected 56 cases of obstructive uropathy, among them 12(20%) patients were due to urinary bladder mass, 10(16.7%) due to benign hyperplasia of prostate, 07(11.7%) due to stone at left PUJ, 07(11.7%) due to stone at mid ureter, 06(10%) due to stone at right PUJ, 06(10%) due to stone at left VUJ, 05(8.3%) due to stone at right VUJ, 02(3.3%) due to cervical growth and 01(1.7%) due to genital prolapse. Bafaraj26 showed that in the detection of urinary obstruction by CTU, all the cases of urinary stones were detected by CTU (100%); 2 out of 3 patients were suffering with congenital PUJ obstruction (66.7%), 3 out of 4 patients with neoplastic mass (75%), 1 out of 2 patients with ureteric wall thickening (50%) and 2 out of 3 patients with cysts (66.7%). Ahmed et al.[27] and Sudah et al.[28] demonstrated that UHCT(unenhanced CT) is an excellent method for demonstrating urolithiasis and obstruction in patients presenting with flank pain. Lin et al.[29] recruited 102 patients in their study who underwent CTU, where only 40 patients were proved to have urolithiasis and CTU reached the right diagnosis of 97.5% patients with urolithiasis.

In this study we observed that causes of obstructive uropathy were detected in 54 patients by USG and causes were undetected by USG in 06. Causes of obstructive uropathy were detected as well by CT urogram in 56 patients and in 04 patients etiology were not detected. Bafaraj[26] reported that among the patients who had no USG identified urinary tract abnormalities, CTU detected 66.7%, 75%, 50% and 66.7% with congenital PUJ obstruction, neoplastic mass, ureteric wall thickening and cysts respectively. Leo et al.[21] observed **that EP-performed US can detect the severity of hydronephrosis when compared to CT as the gold standard, (chi-square p<0.001).** Sen et al.[30] reported 03(100%) patients were detected of having congenital PUJ obstruction by USG but only 02(66.66%) were detected by CT.

Present study showed that 54(90%) causes of obstructive uropathy were detected in patients by USG and 56(93.3%) by CT urogram. The difference was not statistically significant (p>0.05) between two groups. Apoku et al.[20] reported that 52 of the 60 study subjects of obstructive nephropathy were identified correctly on B-mode ultrasound. In the same study 54 of the 60 controls were predicted correctly as not having obstructive nephropathy as adjudged by absence of caliectasis.

Our study showed that USG in the evaluation of causes of obstructive uropathy has a sensitivity of 94.64%, specificity of 75%, accuracy of 93.33%, PPV of 98.15% and NPV of 50%. Apoku et al.[20] reported the presence of obstructive nephropathy as documented on B-mode ultrasound having a sensitivity of 86.7% and specificity of 90%. **For the presence of a ureteral stone >5mm on CT, the detection of any hydronephrosis by EP-performed US had a sensitivity of 86%, a** specificity of 37%.

Conclusion:

This study was undertaken to compare Ultrasonographic findings with CT urogram findings in evaluation of obstructive uropathy. In this study, the difference between detection of causes of obstructive uropathy by the two modalities was not statistically significant. Hence, it can be concluded that Ultrasound is able to detect obstructive uropathy in a high percent of patients and its sensitivity, accuracy & positive predictive value is excellent. In patients with strong clinical evidence of obstruction, but a negative USG report, USG should be repeated at regular intervals to look for developing hydronephrosis.

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