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ROLE OF COLOR DOPPLER IN OBSTRUCTIVE UROPATHY

Dr. Ashwin Choudhary[1] (PG Resident 3rd Year), Dr. Sheetal Singh[2] (Prof. & HOD) Dr. Amlendu Nagar[3] (Professor), Dr. Sonal Banzal[4] (PG Resident 3rd Year) & Dr. Saba Alvi[5] (PG Resident 3rd Year)

[1,2,3,4,5] Dept. of Radio Diagnosis, Index Medical College Hospital& Research Centre, Indore, M.P.

First Author: Dr. Ashwin Choudhary

Corresponding Author: Dr. Sonal Banzal

ABSTRACT

Introduction- Obstructive uropathy is one of the most commonly encountered problem in clinical practice. It is defined as structural impedance to the flow of urine anywhere along the urinary tract leading to pelvicalyceal dilatation. The resulting renal parenchymal damage caused by a virtue of the obstructive uropathy is collectively termed "obstructive nephropathy".

AIMS

Diagnostic Accuracy of Color Doppler in Obstructive Uropathy

Objectives-

1. Role of Color Doppler in Obstructive Uropathy
2. To determine the renal arterial hemodynamic changes induced by obstructive uropathy using Doppler ultrasonography.
3. To evaluate the diagnostic accuracy of renal venous doppler ultrasound in diagnosing obstructive uropathy
4. To evaluate the ability of this modality to differentiate obstructed from non-obstructed kidneys.

Materials and methods- The study was conducted in Department of Radio diagnosis of Index Medical College Hospital and Research Centre, Indore .

Our study include 100 patients out of these 50 were Obstructed Kidney and 50 were control

Results - PUJ and VUJ are most commonly involved in our study 30% and 30%respectively

On Color doppler Mean resistive index and mean venous Impedance value between Obstructed and control is statistically calculated 0.723 and 0.307. In our study mean arterial PSV in Obstructed and control group is calculate to be 31.14 and 17 respectively, and Mean venous PSV in obstructed and control group calculated to be 23.9 and 15.2 respectively

Conclusion- In conclusion from the study it is evident that the Arterial resistive index and venous impedance measurement by Doppler ultrasound has a high sensitivity and specificity in detecting acute renal colic.

INTRODUCTION

Obstructive uropathy is one of the most commonly encountered problem in clinical practice. It is defined as structural impedance to the flow of urine anywhere along the urinary tract leading to pelvicalyceal dilatation. The resulting renal parenchymal damage caused by a virtue of the obstructive uropathy is collectively termed "obstructive nephropathy".

While conventional US is a sensitive method for detecting Upper Urinary Tract dilatation with upto 98% sensitivity reported in earlier studies [1] it lacks the ability to provide significant

physiological data on renal status and, hence cannot specifically assess the cause of obstructive dilatation [1]

Urinary tractobstructionis common cause of acute and chronic renal failure which can be easily diagnosed and evaluated based on Ultrasound. Elevation of intraluminal ureteral pressure can be due to obstruction of the urinary tract, this can lead to increase in the hydrostatic pressure and get transmitted directly to nephron tubules [2] .

An external renal pelvis is another non obstructive dilatation of the pelvis and can be regarded as a normal physiological and anatomical variant. The intrarenal collecting system is normal in this situation.

The Grading system for Hydronephros is are divided in to IV Grades [15] -

1. Grade I (Mild) - little Blunting of calyceal fornices
2. Grade II (Moderate)- Blunting and enlargement of calyceal fornices but easily seen shadow of papillae.
3. Grade III (severe)– Rounding of calices with obliteration of papillae
4. Grade IV (Very severe) – Extreme calyceal ballooning

The Arterial Resistive index is a calculated flow parameter in ultrasound, derived from the maximum, minimum, and mean Doppler frequency shifts during a defined cardiac cycle. Along with the Pulsatility index, it is typically used to assess the resistance in a pulsatile vascular system.

The Venous impedance, is calculated by the value of the peak flow signal and diastolic flow . As Vein narrows there is slow flow with loss of Phasicity , PSV increases and Venous Impedance decrease.

The advantages of using Ultrasound imaging include its mobility, low cost, and no need for contrast media as well as the ability to detect fluid collection which result from obstruction. Other imaging techniques, such as IVU and radioisotope scans can also be used as complementary tools for diagnosis however, cannot replace the gold standard test which is Ultrasound.

Grey–scale Ultrasound are sensitive detectors of Hydronephrosis but differentiation of obstructed and non obstructed Kidney cannot always be made on such investigations and would require the use of a Color doppler scan.

Here **Color Doppler** may have an important role in differentiating Obstructed Kidney from Non Obstructed Kidney. Obstructive uropathy is usually associated with dilatation of urinary tract proximal to site of obstruction .However not all dilatation is obstructive in nature . The purpose of my study is also to properly evaluate the ability of this modality in order to distinguish between the obstructed kidneys from non-obstructed onesis also crucial when treatment is required particularly in children in whom needless urgery may be avoided. (fig 7,8)

In my study we have evaluated the role of color doppler in the appropriate and correct detection of obstructive uropathy

AIM

Diagnostic Accuracy of colour doppler in Obstructive Uropathy

OBJECTIVES

1. Role of color doppler in Obstructive uropathy
2. To determine the renal arterial hemodynamic changes induced by obstructive uropathy using Doppler ultrasonography.
3. To evaluate the diagnostic accuracy of renal venous doppler ultrasound in diagnosing

obstructive uropathy

4. To evaluate the ability of this modality to differentiate obstructed from non-obstructed kidneys.

MATERIALANDMETHODS:

The study was conducted in Department of Radio diagnosis of Index Medical College Hospital and Research Centre, Indore. Duration of study was January-2020 to August-2021

Our study include100 patients out of these 50 were Obstructed Kidney and 50 were control .These study population were predominately males, constituting 70 males and 30 were females. The patients were in the age group of around 14 to 72 years and the mean age of 100 study population was calculated to be 35.86 +- 11 year.

Once patient having clinical details like abdomen pain, burning micturition, haematuria sonography was performed with the unaware of which kidney had the obstruction and size and site of obstruction noted. The 50 patients without evidence of renal disease served as a control group. This group consisted of 35 men and 15 women whose mean age, like that of the test group, was 50 ± 13 years (age range, 23–66 years).

Color Doppler ultrasound of the interlobar arteries and veins of both kidneys was performed, with arterial resistive index as well as the impedance indexes is calculated .The mean and standard deviations were calculated for each of the variables measured, and the differences between the obstructed and unobstructed kidneys were tested using a Chi-square test and paired t test. Informed consent was obtained from each patient in our study, and the protocol conformed to the ethics committee guidelines.

The Degree of pyelocaliectas is was assessed in each kidney on the grey scale images. Pelvicalyceal obstruction was graded as absent, mild, moderate, severe and very severe. At least five Color Doppler spectra were obtained from more than three regions in each kidney. Doppler signals were obtained from the arcuatearteries and vein at the corticomedullary junction, inter lobararteries and veins along the border of medullary pyramids or both. Optimal calibration of the settings on the Ultrasound deviceis reliable readings, including setting the lowest possible machine valve filter to detect the low velocities typical of intrarenal arteries. Of even greater importance is the use of smallest possible frequency range without aliasing (artifacts caused by blood flow velocities exceeding an upper limit defined by the frequency rate of the Color Doppler). This maneuver maximizes the deflection of the Color Doppler spectrum from baseline and fills as much of the scale as possible. This simple adjustment increases accuracy by producing a large spectrum, minimizing the relative error of measurement when positioning the cursor or placing the calipers.

Actual Arterial resistive index and Venous impedance calculations may be done using the integrated software of the ultrasound unit or by hand measurements of hard copy using calipers.

USis performed to the patients in supine or in the lateral recumbent position, allowing kidney visualization via the anterior or lateral ransumbar approach. Most DU examinations may be completed in10-20mts with the patient’s movement and inability to suspend respiration as the main reasons cited in most studies as the cause of more protracted examinations.

For consistent results and with the aim of minimizing physiological variability it has been advocated that patients should be examined after30 minute of rest while supine and under similar ambient conditions. Physiological investigations that have demonstrated post prandialrenal blood flow changes may even warrant that examinations should be performed in the fastings

The three parameters were obtained in both inter lobar arteries and veins in obstructed and non-obstructed kidneys.

1. Arterial resistive index .
2. Venous Impedance
3. PSV

The Arterial resistive index was calculated using the formula:

$$RI = \frac{\text{peaksystolicvelocity} - \text{enddiastolicvelocity}}{\text{peaksystolicvelocity}}$$

RESULTS:

The study was conducted in Department of Radio diagnosis of Index Medical College Hospital and Research Centre, Indore (MP). Duration of study was January-2020 to August-2021

Our study include100 patients out of these 50 were Obstructed Kidney and 50 were control .These study population were predominately males, constituting70 males and 30 were females. The patients were in the age group of around 14 to 72 years and the mean age of 100 study population was calculated to be 35.86 +- 11 year (Table 1) (Bar 1)

In our study the Middle age group between 20-40 year are predominately constituting almost 60% of study population.

The mean age of obstructed patient and control group was calculated to be 32.96 and 36.76 respectively.

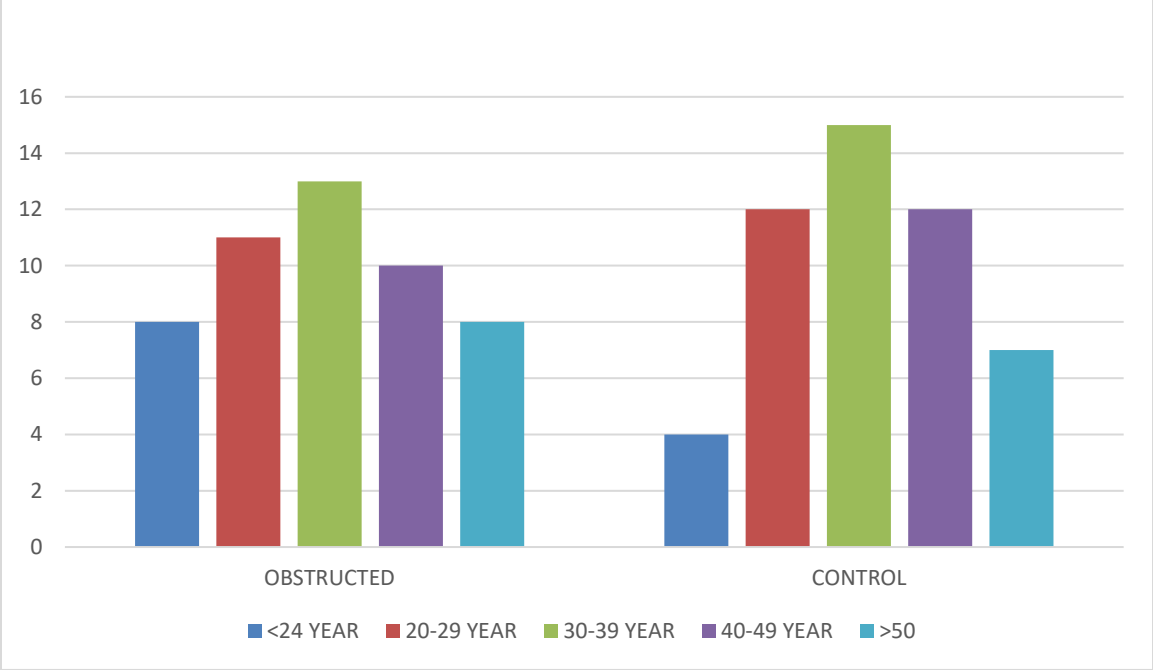
Table 1. Age group wise distribution of obstructed and control patient in our study

AGE	NO OF OBSTRUCTED	PERCENTAGE	NO OF CONTROL	PERCENTAGE
<20 YEAR	8	16%	2	4%
21- 30 YEAR	14	28%	10	20%
31-40 YEAR	13	26%	23	46%
41-50 YEAR	8	16%	9	18%
>50 YEAR	7	14%	6	12%
TOTAL	50		50	

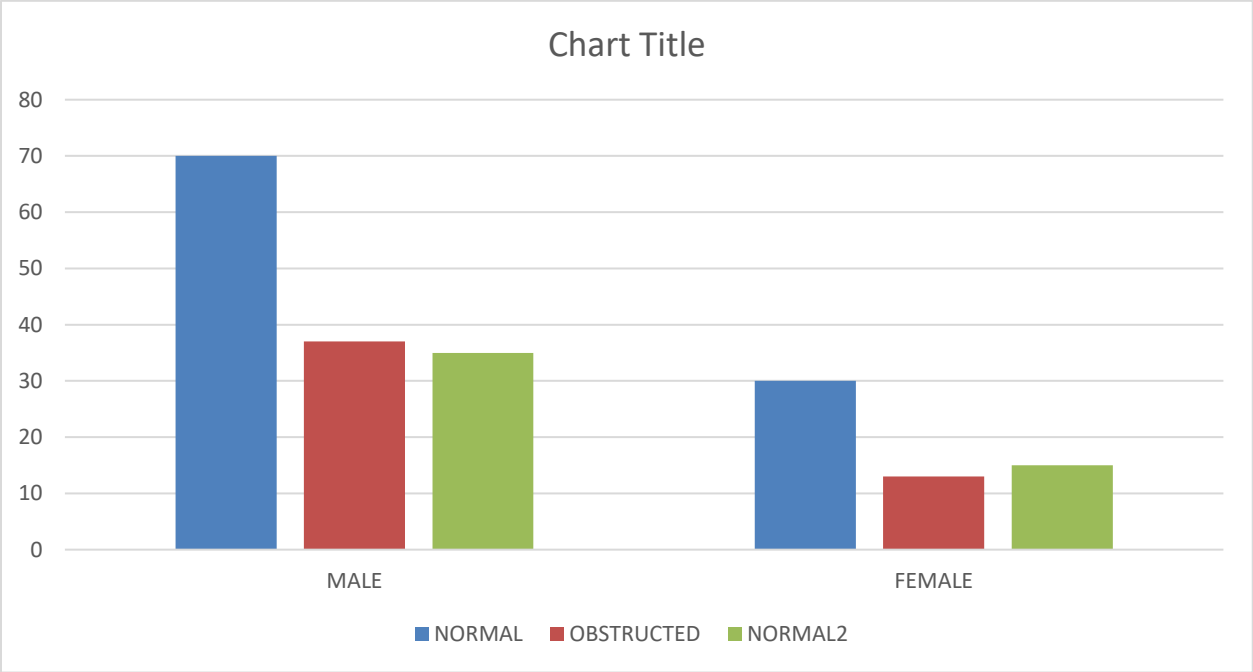
Table 2. Sex wise distribution of obstructed and control group

TOTAL NO PATIENT	OBSTRUCTED	PERCENTAGE	CONTROL	PERCENTAGE

MALE	37	74%	35	70%
FEMALE	13	26%	15	30%
TOTAL	50		50	



Bar Chart 1 : Age group wise distribution of obstructed and control patient in our study



Bar chart 2. Sex wise distribution of obstructed and control group

In our study the overall ratio of male to female came out to be 2.33:1 and in obstructed and control group ratio is calculated to be 2.84:1and 2.33:1 respectively, with higher predominance of obstruction noted in male then female

All these patients presented to our outpatient department with acute onset abdomen pain. The duration of pain was stratified into three categories :-

1 Duration of pain <24 hours

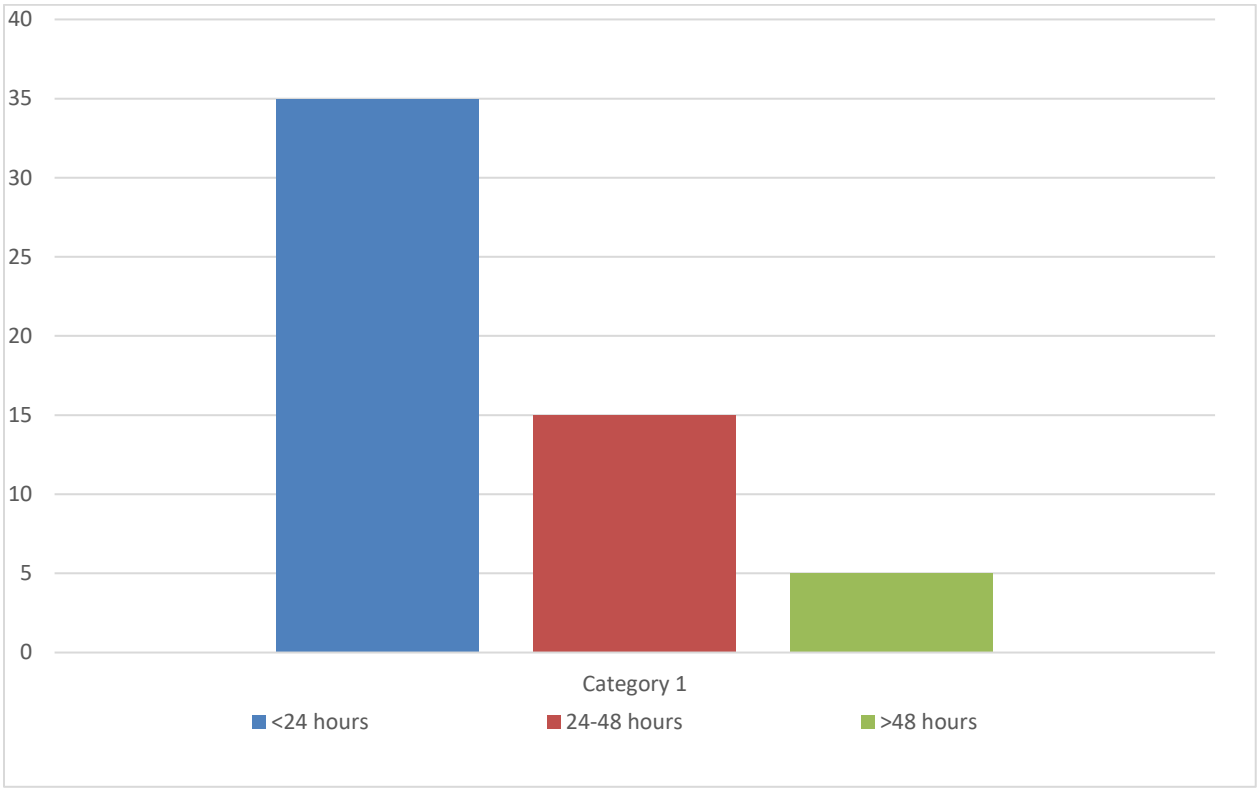
2 Duration of pain 24-48 hours

3 Duration of pain >48 hours

In our study the Duration of abdomen pain was less then 24 hours are predominately constituting 70% and more then 25 hours were 30%.(Table 3) (Bar 3)

Table 3 Duration of pain wise distribution in Obstructed patient

DURATION OF PAIN	NO OBSTUCTED	PERCENTAGE
<24 HOURS	35	70%
24-48 HOURS	10	20%
>48 HOURS	5	10%
TOTAL	50	

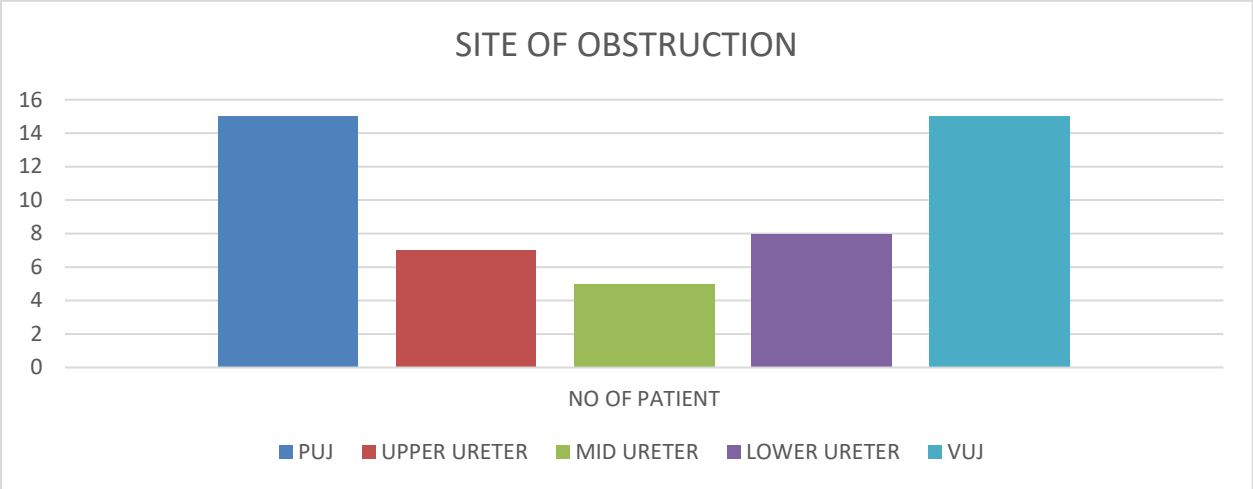


Bar Char 3. Duration of pain wise distribution in Obstructed patient

In our study PUJ obstruction seen in 30% , upper ureter obstruction seen in 14 %,mid ureter obstruction seen in 10%,lower ureter obstruction seen in 16% and VUJ obstruction seen in 30%. PUJ and VUJ are most commonly involved in our study 30 %and 30% respectively (Table 4) (Bar 4) (fig-1,2,3,4,5)

Table 4. Site wise Obstruction wise distribution of Obstructed patient on B mode Ultrasonography.

SITE OF OBSTRUCTION	NO OBSTRUCTED	PERCENTAGE
PUJ	15	30%
UPPER URETER	7	14%
MID URETER	5	10%
LOWER URETER	8	16%
VUJ	15	30%
TOTAL	50	



Bar Char 4. Site wise Obstruction wise distribution of Obstructed patient on B mode Ultrasonography.

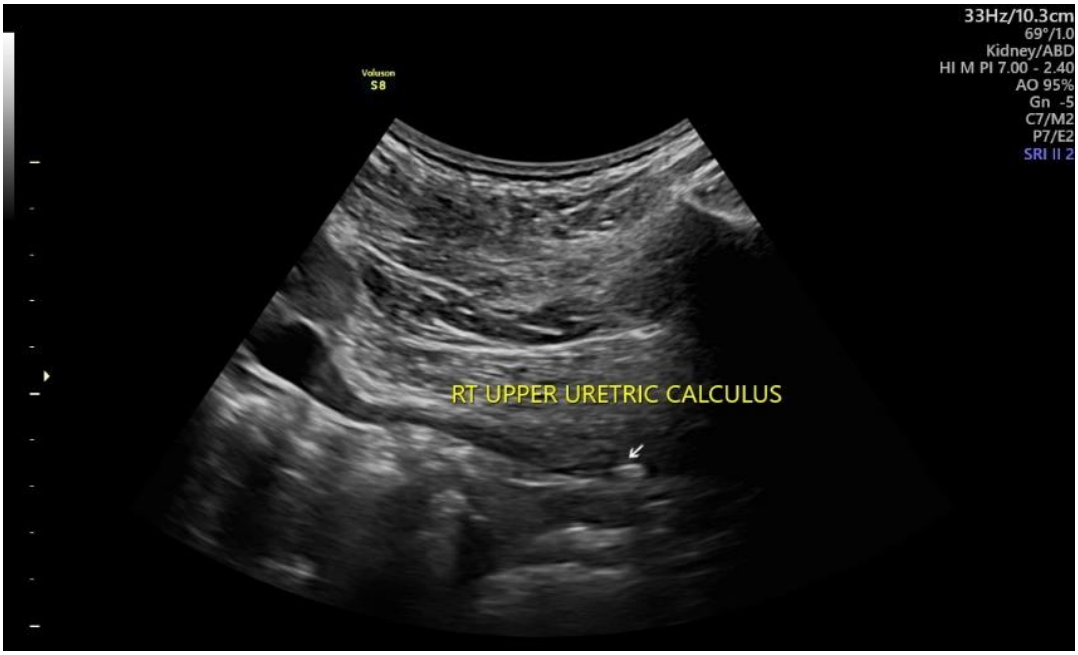


Fig 1 .Showing Right upper ureteric calculus with Hydrouretero-nephrosis proximal to site of obstruction on B Mode

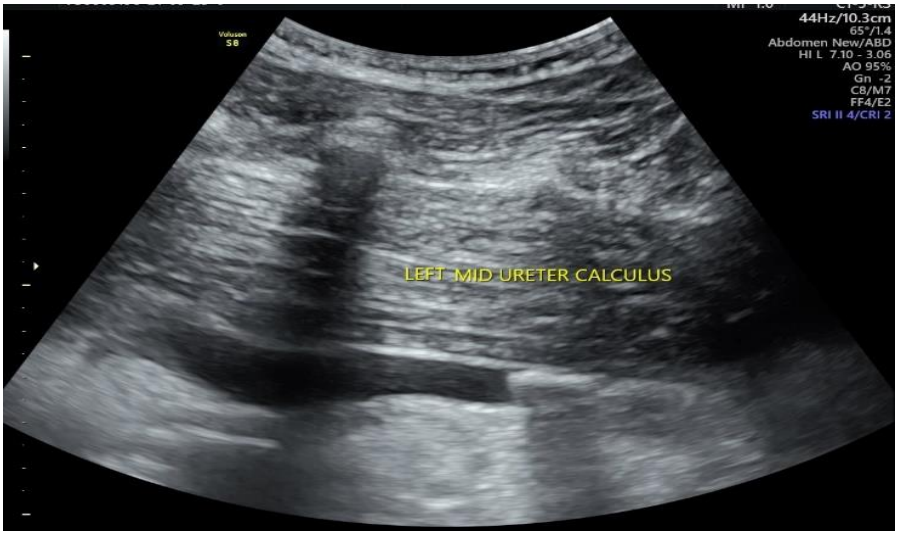


Fig 2 .Showing Left Mid ureteric calculus with Hydrouretero-nephrosis proximal to site of obstruction on B Mode

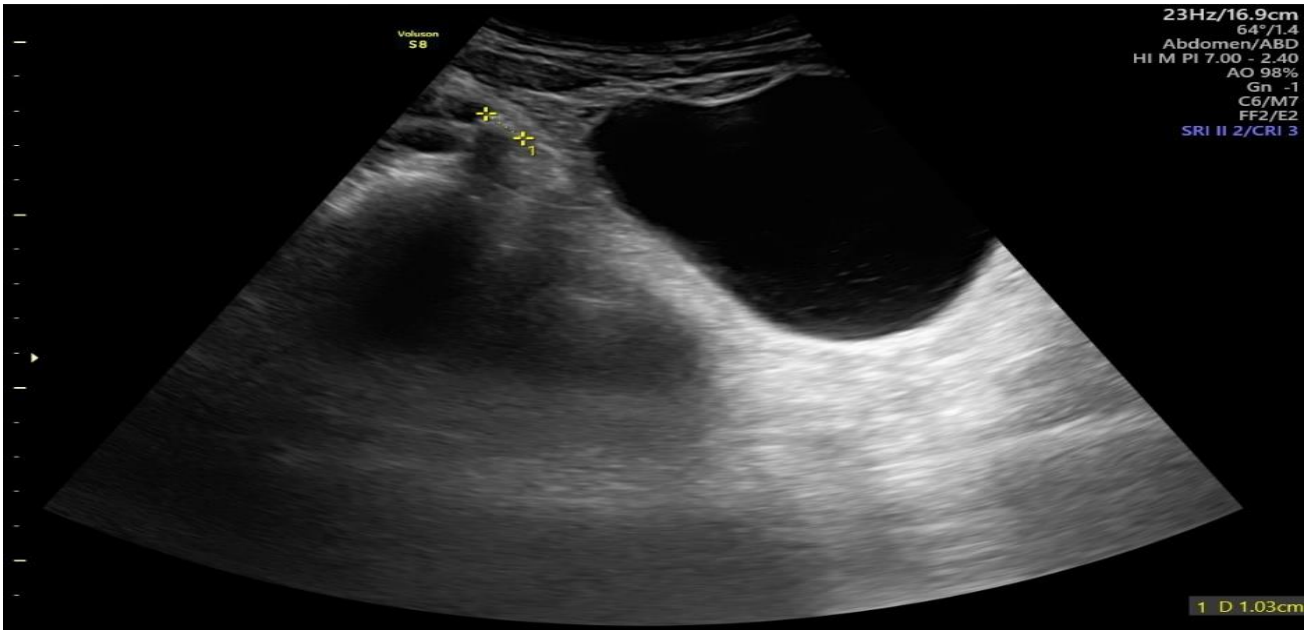


Fig 3. Showing Left Lower ureteric calculus on B Mode

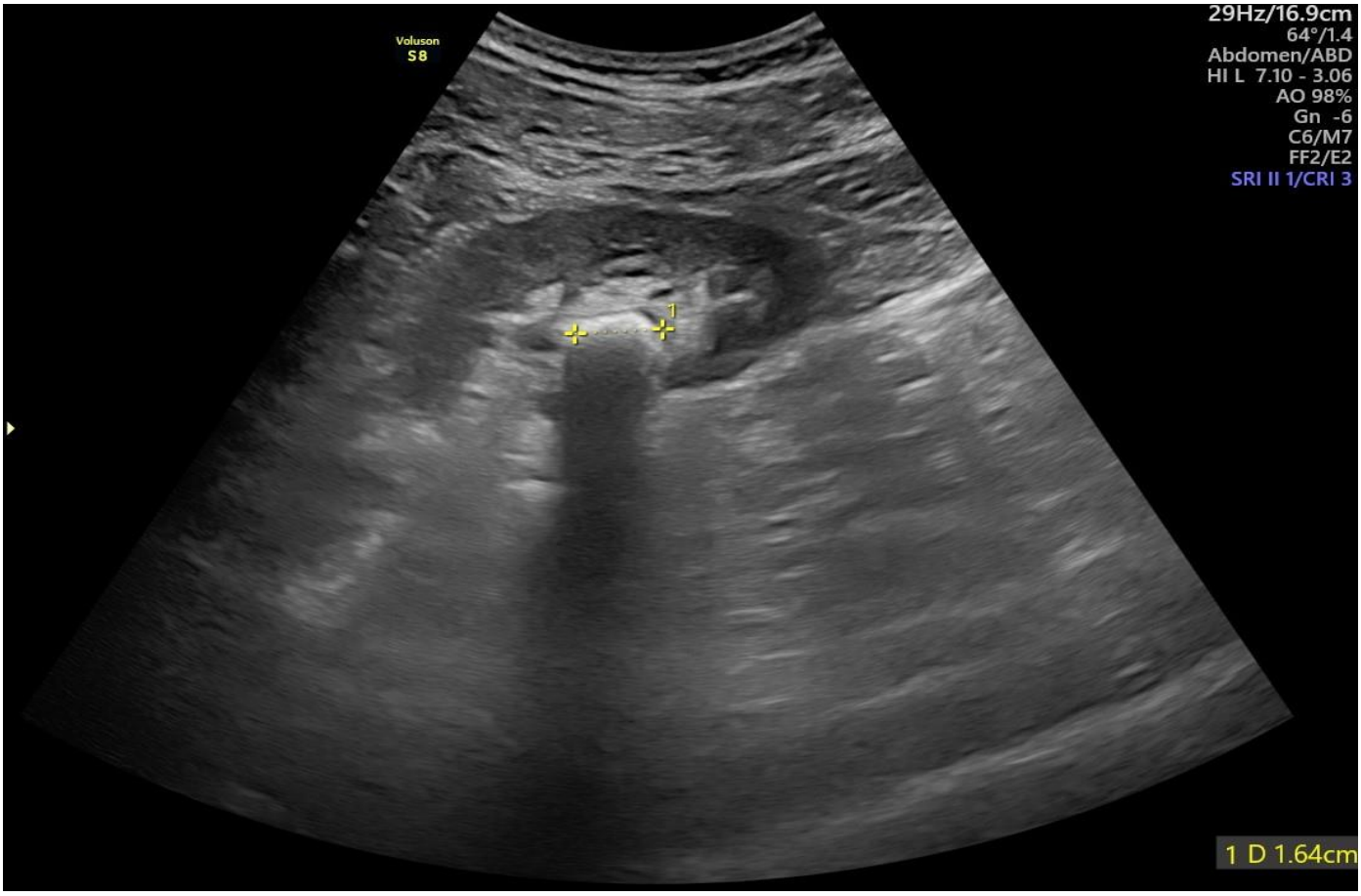


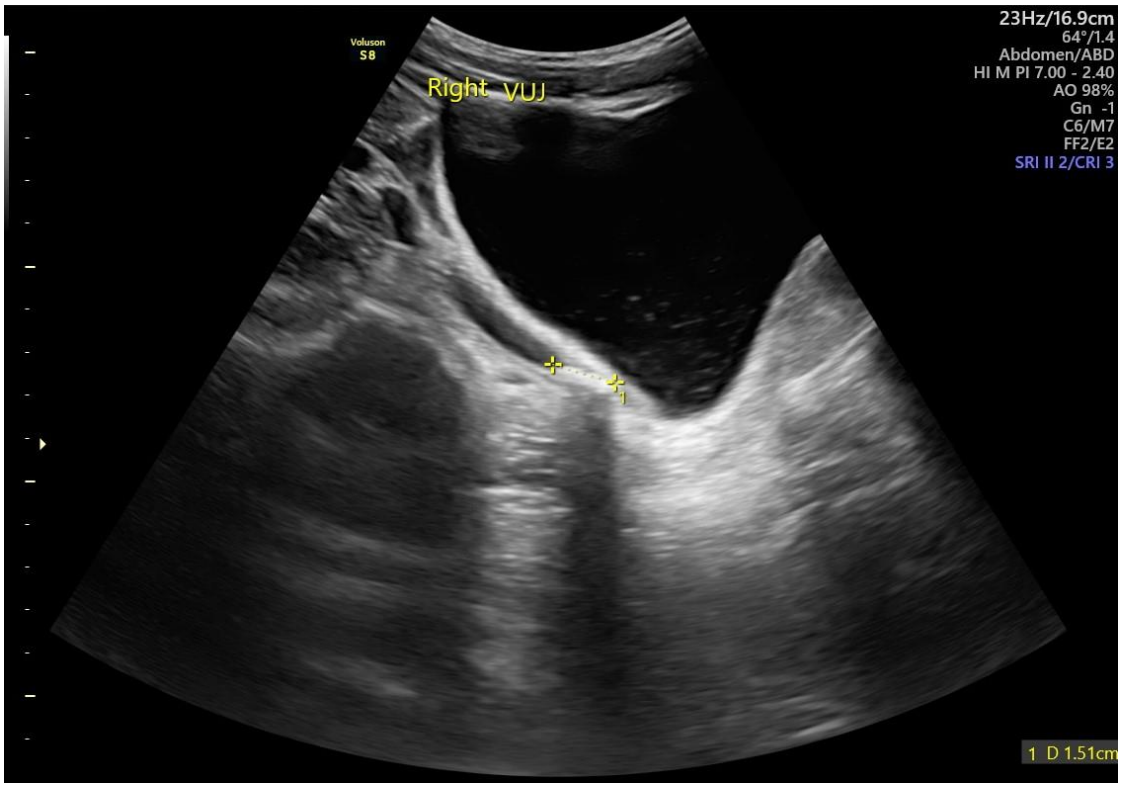
Fig 4 .Showing Left PUJ calculus on B Mode

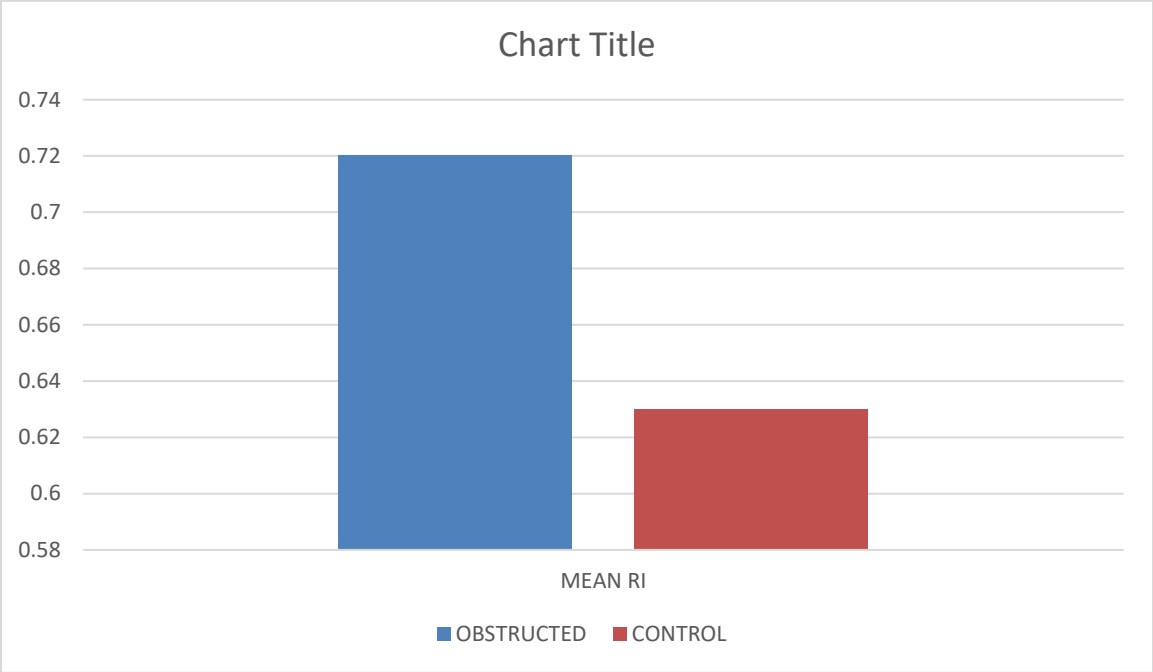
On Color doppler Mean resistive index and mean venous Impedance value between Obstructed and control is statistically calculated 0.723(Standard deviation 0.03) and 0.307 (Standard deviation 0.07) respectively.
In our study statistically P value calculated to be 0.00001 is significant (less then0.05)(Table 5) (Bar 5)

Table 5. Showing Mean Resistive Index and Mean Venous Impedance in Obstructed and Control patient

COLOR DOPPLER FINDING	OBSTRUCTED	CONTROL	P VALUE
MEAN RESISTIVE INDEX	0.723(0.03)	0.638(0.04)	P VALUE – 0.00001 <0.05 IS SIGNIFICANT
MEAN VENOUS IMPEDANCE	0.307(0.07)	0.421(.04)	

Fig 5 . Showing Right VUJ calculus on B Mode





Bar Chart 5. Showing Mean Resistive Index and Mean Venous Impedance in Obstructed and Control patient.

In our study statistically P value of resistive Index among age group 14-72 year of Obstructed patients were calculated to be 0.5029 which is Insignificant as it is more then 0.05(Table 6)
(Bar 6)
In our study statistically P value of venous impedance among age group 18-66 of Obstructed patients were calculated to be 0.9774 which is Insignificant as it is more then 0.05(Table 7)
In our study statistically P value of resistive Index among Male and Female Obstructed patients were calculated to be 0.4184 which is Insignificant as it is more then 0.05 (Table 8)
In our study statistically P value of Venous Impedance among Male and Female Obstructed patients were calculated to be 0.4518 which is Insignificant as it is more then 0.05(Table 9)

In our study mean arterial PSV in Obstructed and control group is calculate to be 31.14 and 17 respectively, and Mean venous PSV in obstructed and control group calculated to be 23.9 and 15.2 respectively. (Table 10)(Bar 7)

In these study, all obstructed and control group, Resistive index Sensitivity was 84% and Specificity was 90%.PPV was 89.36% with confidence interval 78.38% TO 95.11% and NPV was 84.91% with confidence interval 74.75% to 91.44%. Here Diagnostic Accuracy was 87%(Table 11 12 13)

In these study, all obstructed and control group, Venous Impedance Sensitivity was 90% and Specificity was 80%. PPV was 81.82% with confidence interval 71.95% TO 88.76% and NPV was 88.89% with confidence interval 77.49% to 91.35%. Here Diagnostic Accuracy was 85 %(Table 14)

DISCUSSION

IVU and Ultrasonography are the two most common imaging examinations used in patients with acute renal colic to determine whether obstruction is present. Examination with US is particularly use full in conditions when IVU is contraindicated, e.g. in pregnancy, a history of reaction to contrast material, renalimpairment and repeated episode of renalcolic.

However conventional Ultrasonography is an in accurate test for obstruction, because dilatation of the collecting system is often seen in unobstructed kidneys and may not occur or may occur late in obstructed kidneys. Thus the present study aimed to determine the role of color doppler ultrasound in the diagnosis of acute obstruction.

The role of color doppler ultrasound in the evaluation of acute renal obstruction has been vigorously debated(3-8). Rodgers et.al., (7) found an elevated resistive index in acutely obstructed kidneys, especially when compared with the resistive index with a control group of healthy subjects the similar results were obtained.

Platt et.al.,(3) in 23patients with acute unilateral obstruction .however others reported that DU is highly insensitive for detecting acute renalcolic(11): Tublinet. Al. correlated the results of color doppler ultrasound with those of urography in 32 patients presenting with renal colic. When the published discriminatory thresholds for renal obstruction(mean resistive index >0.70 is applied , the sensitivity and specificity of were only 44% and 82% only , respectively . This marked discrepancy in the results could be explained by the difference in the degree of renal obstruction.

In a study of de Toledo et.al., (8) investigated the diagnostic accuracy of color doppler ultrasound in complete as well as partial renal obstruction in64 patients . with a threshold of >0.70 and they showed a sensitivity of 92% in 37 patients with complete and 48% in 27patientswithpartial obstruction.

The most common reason for obtaining a normal RI in thepresence of significant renal obstruction is a technical error that is simple to correct. As described previously the use of correct scale (pulse repetition frequency) to expand the wave form size to fill as much as the available display as possible without aliasing is crucial. With this strategy, errors in measurements of arterial resistive index are reduced and flow at the end of diastole generally can be differentiated from background machine noise and wall filter.

In comparison with Venous haemodynamic there is slow flow with loss of Phasicity and high resistance flow is noted in obstructed kidney and the Mean Venous impedance values on the obstructed group was 0.30 were lower than on the control group 0.42. And the sensitivity and specificity were 84% and 90%.Our study is compared to Grant A Bateman et al (13) and SunaÖzhanOktar et al(14), and the Difference in venous impedance indexes was noted in all these three studies.

In study of Grant A Bateman et al (13) Mean venous Impedance was 0.38(0.25) in obstructed and 0.45(0.18) in control group

On other hand in the study of SunaOzhanOktar et al(14) Mean venous Impedance was 0.25(0.07) in obstructed and 0.42(0.18) in control group

Our findings were similar to that of Grant A Bateman et al and SunaÖzhanOktar et al

In our study it conclude that Arterial resistive index and venous impedance measurement by doppler ultrasound is a sensitive and a highly specific test that can contribute significantly to the

diagnosis and management of acute unilateral renal obstruction, particularly in situations in which IVU is undesirable or contraindicated as in pregnancy, contrast allergy or compromised renal function(Table 23)

CONCLUSION:

In conclusion from the study it is evident that the Arterial resistive index and venous impedance measurement by Doppler ultrasound has a high sensitivity and specificity in detecting acute renal colic.

The sensitivity and specificity of arterial resistive index in our study correlates with the finding of Plattet al, Shokeiret al, Malitecet al, Corderica et al were very similar to our study.

In comparison the venous impedance index values in the obstructed group mean was 0.30 it is lower than control group side mean 0.42. Our study is compared to Grant A Bateman et al and SunaÖzhanOktar et al, Difference in venous impedance indexes was noted in all these three studies. These findings were very similar to that of Grant A Bateman et al and SunaÖzhanOktar et al

Arterial resistive index and venous Impedance measurements are not significantly influenced by age and sex in our study.

In conclusion Arterial resistive index and venous impedance measurement by doppler ultrasound is a sensitive and a highly specific test that can contribute significantly to the diagnosis and management of acute unilateral renal obstruction, particularly in situations in which IVU is undesirable or contraindicated as in pregnancy, contrast allergy or compromised renal function.

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