



DOPPLER SONOGRAPHIC EVALUATION OF INTRARENAL ARTERIES IN ACUTE RENAL OBSTRUCTION

Radiology

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ABSTRACT

Introduction: Acute ureteric colic is one of the most commonly encountered acute abdominal conditions. Diagnosis of obstruction caused by ureteric calculus occasionally becomes challenging if there is inadequate dilation of the urinary tract proximal to obstruction. In such a situation, intra-renal artery Doppler parameters can be used as a diagnostic tool. Our study compared intra-renal arterial Doppler in patients with obstructed and non-obstructed kidneys presenting with symptoms of unilateral acute renal colic. **Materials and Methods:** This descriptive study was undertaken among 50 patients in the department of radio diagnosis and imaging at Kempegowda Institute of Medical Sciences Hospital, Bengaluru from November 2022 to April 2023. **Results:** Doppler changes in acute unilateral renal obstruction were studied in 50 patients with contralateral normal kidney as control. The age of the patients ranged from 25 to 65 years and out of 50 patients, 35 were men and 15 women. The mean Resistivity Index (RI) in obstructed kidneys was significantly higher than in unobstructed kidneys (0.75 vs 0.56). **Conclusion:** Doppler ultrasound study is useful diagnostic tool in suspected acute unilateral renal obstruction as Renal Doppler indices can demonstrate altered renal perfusion before pelvicalyceal system dilatation thus increasing the accuracy of ultrasound in the investigation of renal disease. An RI value > 0.7 has good sensitivity and specificity in our study. The results obtained in the study were comparable to those of pioneer studies conducted worldwide.

KEYWORDS

Renal Doppler indices, Acute renal obstruction, Obstructive uropathy, Pelvicalyceal system (PCS)

INTRODUCTION

Ultrasonography remains a commonly used modality in the initial evaluation and diagnosis of renal obstruction. It can dependably detect dilatation of the urinary system proximal to the level of obstruction, which is an indirect evidence for the diagnosis. Minor dilatation of the pelvicalyceal system is a well-recognized finding in some patient with severe obstruction.

Ultrasound can miss out renal obstruction in a small pelvicalyceal system if not dilated. The obstructed pelvicalyceal system fails to dilate presumably because of low diuresis resulting from dehydration, underlying renal parenchymal disease and intermittent obstruction by calculus or decompression of the pelvicalyceal system through a tear of a calyceal fornix. In the diagnosis of renal obstruction, the sensitivity of ultrasound is much better than its specificity.

One problem relates to the fact that ultrasound can image a fluid filled collecting system, which may not necessarily be pathological. These situations include a baggy extra-renal type of pelvis, a compound upper pole calyx and an over-distended urinary bladder. Fluid within the collecting system is often visualized during active diuresis after an overload of oral fluids. A similar situation arises during the osmotic diuresis induced after intravenous injection of hypertonic contrast medium for urography. In addition, ultrasound visualizes a variety of dilated but non-obstructed systems, especially in reflux, or other non-obstructive causes of calyceal dilatation e.g. papillary necrosis, mega calyces, infection and residual dilatation due to previous stone or surgery.

Acute complete ureteric obstruction is associated with changes in renal blood flow as well as with an increase in renal pelvic pressure. In the first few hours, renal blood flow increases, most likely because of afferent arteriolar dilatation. After three to five hours, renal blood flow decreases, probably because of afferent arteriolar vasoconstriction produced by prostaglandins and other vasoactive substances. Decreased renal blood flow persists after 24 hours, at a time when the pressure within the collecting system is returning towards normal. The decrease in renal blood flow during obstruction can be demonstrated with Doppler ultrasound using the resistive index (RI). The time course of the RI changes is exactly as might be predicted from knowledge of the pathophysiology, increasing approximately six hours after acute calculus obstruction and remaining at its peak from 6 to 48 hours.

MATERIALS AND METHODS

It was a prospective observational study conducted in Kempegowda Institute of Medical Sciences, Bengaluru, from November 2022 to

April 2023.

With a study population of 50 patients.

Inclusion Criteria

All patients with symptoms of acute renal obstruction presenting to the emergency department within 24 hours of onset of unilateral acute renal colic were part of this analysis.

Exclusion Criteria

- Patients with history of
 - Renal parenchymal disease
 - Chronic renal obstruction
 - Renal trauma
 - Bilateral renal obstruction
- Patients on dialysis
- Patients having
 - A single kidney
 - congenital anomaly of the kidneys

The selected patients were subjected to gray scale ultrasonography and Doppler for evaluation of intrarenal arteries.

Evaluation by Ultrasound and Doppler study

The kidney on the side of obstruction was treated as the case kidney and the contralateral normal (unobstructed) kidney served as the control.

All patients underwent USG and Doppler in Philips affinity using 4 to 10 MHZ superficial linear transducer.

Presence or absence of pelvicalyceal system dilatation was assessed in each kidney on the gray-scale images.

At least three Doppler spectra were obtained from interlobar arteries along the border of the medullary pyramids and their mean was taken.

The Doppler waveforms were made using the lowest pulse repetition frequency possible without aliasing. This maximized the size of the Doppler spectrum and decreased the percentage error in the measurements. In addition, the lowest possible wall filter for each ultrasound scanner was used.

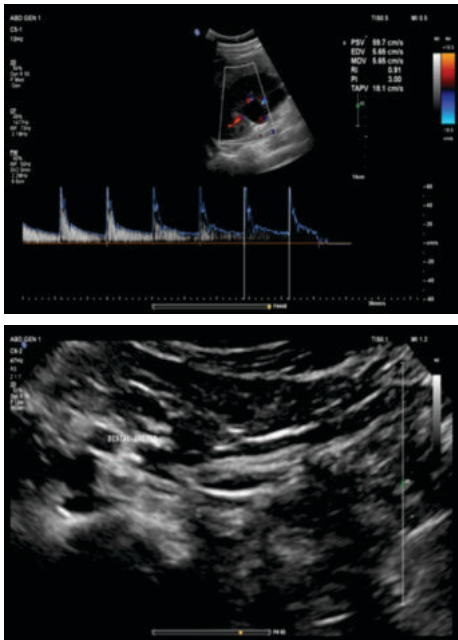
The Doppler sample width was set at 2-5 mm. The renal RI was calculated as follows: (peak systolic velocity - end diastolic velocity)/peak systolic velocity, with the RI difference (delta RI) determined as the difference in RI of the corresponding and

contralateral kidney. Mean RI was calculated for each kidney.

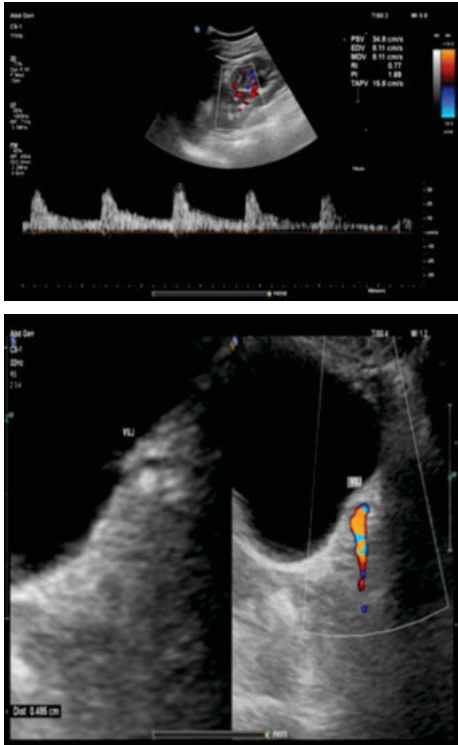
Study Scheme



Representative Images
C/O Distal Ureteric Calculus



Vuj Calculus



Statistical Analysis

Pearson Chi Square tests was used to find the association between Obstructed and unobstructed kidney. The level of significance [P-Value] was set at P<0.05.

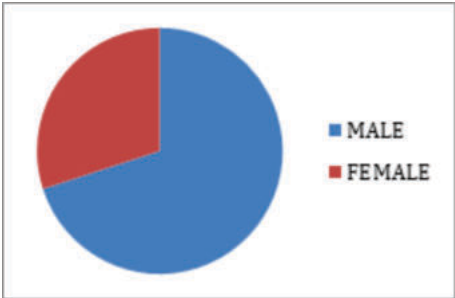
Statistical Package for Social Sciences [SPSS] for Windows, Version

22.0. Released 2013. Armonk, NY: IBM Corp. was used to perform statistical analyses.

Results:

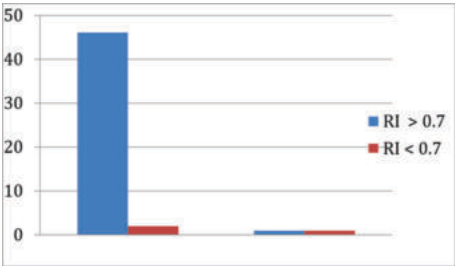
Sex Distribution

GENDER	MALE	FEMALE
NUMBER	35	15



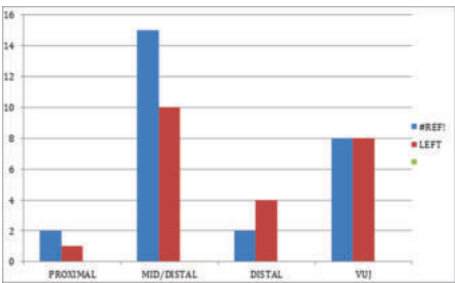
Acute Renal Obstruction

RI	Hydroureteronephrosis	No Hydroureteronephrosis
>0.7	46	02
<0.7	01	01



Site Of Obstruction

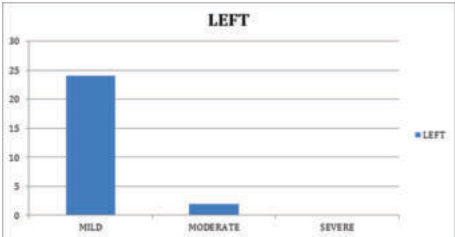
SITE OF CALCULUS	FREQUENCY
RIGHT PROXIMAL	2
RIGHT MID/DISTAL	15
RIGHT DISTAL	2
RIGHT VUJ	8
LRFT PROXIMAL	1
LEFT MID/DISTAL	10
LEFT DISTAL	4
LEFT VUJ	8

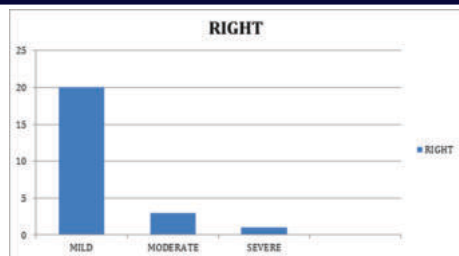


Grey Scale Finding In Obstructed Kidney

OBSTRUCTED KIDNEY	RIGHT	LEFT
MILD	20	24
MODERATE	03	02
SEVERE	01	0

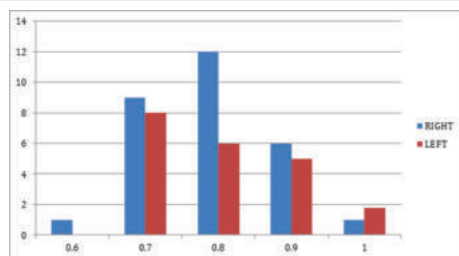
Frequency Of Patients With Hydroureteronephrosis





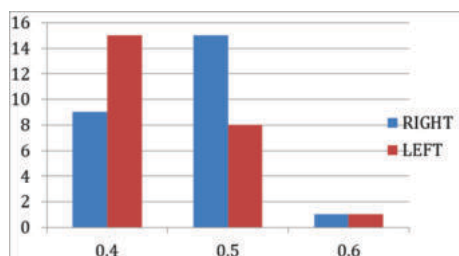
RI Indices In Obstructed Kidney

RI	RIGHT	LEFT
0.6	01	01
0.7	09	08
0.8	12	06
0.9	06	05
1.0	01	02

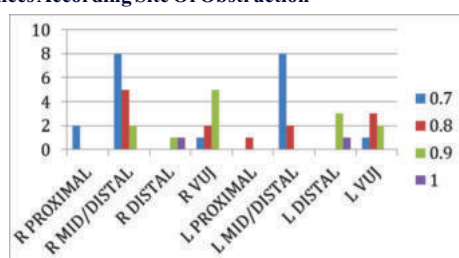


RI Indices In Unobstructed Kidney

RI	RIGHT	LEFT
0.4	09	14
0.5	18	08
0.6	01	01

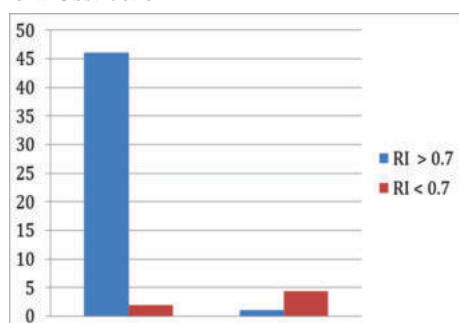


RI Indices According Site Of Obstruction



RI	HUN	NO HUN
>0.7	46	02
<0.7	01	01

Acute Renal Obstruction



	SENSITIVITY	SPECIFICITY
RI > 0.7 In acute renal obstruction	97.8%	33.3%

Sensitivity : 97.8%

Specificity : 33.3%

PPV : 95.8%

NPV : 33.3%

By using a cut off RI value of >0.70 in acute unilateral renal obstruction sensitivity obtained in my study was 97.8% and a specificity of 33.3%.

DISCUSSION

Grayscale ultrasound is the investigation of choice in the initial evaluation of acute renal obstruction, as it is easily available, portable and non-ionizing. However, urinary system dilatation seen on conventional gray scale USG has been shown to be sensitive (97.8%) but not specific (33.3%) in the diagnosis of renal obstruction.

Traditionally, the evidence of renal obstruction provided by USG has been indirect and dependent on the anatomical criteria of dilatation of the PCS and ureter proximal to the level of obstruction. However, USG fails to reveal hydronephrosis in acute obstruction of the kidney in up to 35% of cases. More direct functional evidence of obstruction has usually required scintigraphy but recently, Doppler US techniques have been used to obtain functional information in suspected renal obstruction.

USG imaging may miss the diagnosis of obstruction in a variety of situations. Mild dilatation may be overlooked or considered clinically insignificant. Some patients with obstructive renal failure may show no PCS dilatation. The reasons for this are unclear; in some patients it may relate to dehydration or to decompression of the pelvicalyceal system by rupture of a calyceal fornix. PCS dilatation may be missed if the PCS system is filled with blood clot, calculus, tumor or pus. Intermittent ureteric obstruction, particularly caused by ureteric calculi, may also lead to a failure to visualize the collecting system with USG. On the contrary, in an attempt not to miss the diagnosis of obstruction in patients with only mild PCS dilatation, the false positive rate of diagnosis may be as high. Causes of a false-positive diagnosis include: (i) Visualization of a normal PCS system, when there are anatomical variants such as extrarenal pelvis, when the bladder is distended or under conditions of diuresis (ii) Visualization of a dilated but unobstructed system when there is vesico-ureteric reflux (VUR), a distensible system after previous obstruction or infection, dilated calyces (e.g. in papillary necrosis or reflux nephropathy) or during normal pregnancy. (iii) Central renal fluid collections other than the PCS, including normal vessels renal artery aneurysm and peripelvic cysts.

Acute unilateral ureteric obstruction results in a complex sequence of changes in renal blood flow and ureteric pressure. In the first two hours, the renal blood flow increases, because of afferent arteriole vasodilatation and the ureteric pressure increases. From two to six hours after obstruction, the renal blood flow decreases, secondary to vasoconstriction of the efferent arterioles and the ureteric pressure remains elevated. Subsequently, at six to eighteen hours, the renal blood flow remains reduced, because of vasoconstriction of the afferent arterioles and the ureteric pressure decreases.

RESULTS

- Doppler changes in acute unilateral renal obstruction were studied in 50 patients with contralateral normal kidney as control.
- The age of the patients ranged from 25 to 65 years and out of 50 patients, 35 were men and 15 women.
- The mean Resistivity Index (RI) in obstructed kidneys was significantly higher than in unobstructed kidneys (0.75 vs 0.56).

CONCLUSION

- Doppler ultrasound study is useful diagnostic tool in suspected acute unilateral renal obstruction as Renal Doppler indices can demonstrate altered renal perfusion before pelvicalyceal system dilatation thus increasing the accuracy of ultrasound in the investigation of renal disease.
- An RI value > 0.7 has good sensitivity and specificity in our study. The results obtained in the study were comparable to those of pioneer studies conducted worldwide.

Limitations of Study

US is an operator dependent examination and the results are much affected by patient body habitus.

Increase in RI of intrarenal vessels is also detectable in case of vascular or parenchymal diseases (renal vein thrombosis, acute renal insufficiency, renal artery stenosis, etc.)

Ethical Statement

Prior institutional ethical committee (KIMS/IEC/D101/M/2022) clearance and patient consent was obtained.

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