

Original Research Article

Doppler sonography in acute renal obstruction and role of intra venous urography: a study in a tertial care centre

Raghunath Anant Nagvekar*, Pooja Nagvekar

Department of Radiology, Krishna Institute of Medical Sciences, Malakpur, Karad, Maharashtra, India

Received: 19 October 2016

Accepted: 24 October 2016

*Correspondence:

Dr. Raghunath Anant Nagvekar,
E-mail: dr.amolnagvekar@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: Arterial RI measurements by duplex Doppler USG have been advocated for the diagnosis of obstruction. In most centres, obstruction is indicated by an RI greater than 0.70 or a difference of greater than 0.10 between the kidneys. Our aim was to evaluate and compare the Doppler waveform alterations in unilateral acute renal obstruction (UARO) with the contralateral normal kidney as a control.

Methods: 100 patients presenting to the emergency medical division with symptoms of unilateral acute renal colic were subjected to USG and Doppler USG. The renal RI was calculated in comparison to the collateral normal kidney.

Results: The mean resistivity index (RI) was higher in obstructed kidneys in all cases. 80% patients had complete, while 20% had partial obstruction. RI value in completely obstructed kidneys was 0.72 versus 0.71; $p < 0.05$. However, even in partially obstructed kidneys, RI was significantly higher than in the contralateral (unobstructed) kidney. The diagnostic accuracy of the Doppler was 96% sensitive in the complete obstruction cases and 85% in patients with partial obstruction.

Conclusions: Doppler USG is a useful diagnostic tool in unilateral acute renal obstruction, with RI values being significantly higher in patients with complete obstruction than in patients with partial obstruction.

Keywords: Acute renal obstruction, Complete obstruction, Doppler sonography, Partial obstruction

INTRODUCTION

USG 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 diagnosis. However, urinary system dilatation seen on USG has been shown to be sensitive (90%) but not specific (65-84%) in the diagnosis of renal obstruction.

Arterial RI measurements by duplex Doppler USG have been advocated for the diagnosis of obstruction. Doppler USG enables detection of subtle intrarenal blood changes associated with various pathophysiologic conditions.

Doppler USG is especially promising for distinguishing obstructive from non-obstructive dilatation in a small group of patients.¹

Acute obstructive uropathy is a commonly encountered condition occurring in inpatient and outpatient settings. Unilateral obstruction to urinary outflow typically occurs, with little if any change in measured renal function in a healthy individual. However, the less common bilateral form results in measurable changes in kidney function.

Unenhanced helical CT has both a high sensitivity of 95-98% and a high specificity of 96-100% in detecting ureteral calculi in the acute setting.²⁻⁶ Calcified and non-calcified calculi may be identified, along with the

location and size of the stone. Secondary signs of obstructive uropathy, including hydronephrosis, perinephric and periureteral stranding, as well as ureterectasis, are well demonstrated on CT.⁷

Traditionally, the evidence of renal obstruction provided by USG has been indirect and dependent on the anatomical criterion 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.⁸⁻¹⁰ Mild dilatation may be overlooked or considered clinically insignificant.¹¹ Some patients obstructive renal failure may show no PCS dilatation.¹² And in some patients it may relate to dehydration or to decompression of the pelvicalyceal system by rupture of a calyceal fornix.¹³

Doppler sonography is an additional tool that may be employed when radiation exposure is undesirable, such as in pregnant patients. The mean resistivity index (RI), which is a measure of impedance to renal blood flow, may be raised when obstruction to urine outflow exists. In most centers, obstruction is indicated by an RI greater than 0.70 or a difference of greater than 0.10 between the kidneys.

The aim was to evaluate and compare the Doppler waveform alterations in unilateral acute renal obstruction (UARO) with the contralateral normal kidney as a control. We considered the utility of Doppler waveform alterations in UARO patients presenting without dilatation of the pelvicalyceal system. We also studied the effect of site and degree of obstruction and timing of the Doppler evaluation after onset of symptoms on Doppler waveform alterations.

METHODS

This prospective case controlled study was carried out at Krishna Institute of Medical Sciences by the Department of Radiology during the period two years. 100 patients presenting to the emergency medical division with symptoms of unilateral acute renal colic were included into the 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

were subjected to USG and Doppler USG using a 3.5 to 5 MHz transducer.

Presence or absence of PCS 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 was to maximize the size of the Doppler spectrum and decrease the percentage of 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 contra lateral kidney.

IVU was also used to detect the site and degree of obstruction. The site of obstruction was considered to be proximal, if it was up to or proximal to the L3 vertebral level and distal, if beyond. The degree of obstruction was considered complete in cases with delayed excretions of contrast material and partial in a patient with prompt excretion of contrast. In patients with a non-dilated PCS, increasingly dense nephrogram on IVU or demonstration of calculus on CT, were excluded from the analysis. Patients with surgical or medical renal disease were also excluded from this study.

RESULTS

Out of the 100 patients, 77 were males and 23 were females. The mean age (in years) in men is 31.36 ± 11.23 (17-61) was lower as compared to women 32.69 ± 12.55 (17-65), although this difference was not statistically significant. The mean resistivity index (RI) was higher in obstructed kidneys in all cases. The difference in RI between obstructed and unobstructed kidney (delta RI) ranged from 0.03 to 0.15 with a mean delta of 0.08. Most of the patients (54%) were evaluated between 6-12 hours, 26% within 13-18 hours and 20% within 19-24 hours after the onset of symptoms. RI values were similar in all three groups, showing that there was no association with time.

Table 1: Relationship of resistivity indices with duration of obstruction.

RI Values	6-12 hours (n = 54)	13-18 hours (n = 26)	19-24 hours (n = 20)	P value
Obstructed kidney (RI)	0.72 ± 0.01	0.71 ± 0.01	0.72 ± 0.01	NS
Unobstructed kidney (RI)	0.64 ± 0.02	0.63 ± 0.02	0.63 ± 0.01	NS
Delta RI	0.07 ± 0.02	0.08 ± 0.02	0.08 ± 0.02	NS

The site of obstruction was proximal in 42 (42%) cases and distal in 58 (58%) cases. The mean RI of the

obstructed kidneys with proximal obstruction was higher (0.72 ± 0.01). However, the difference was statistically

not significant. Out of 100 patients 52 patients had obstruction of right kidney and 48 patients had obstruction of left kidney. Out of 52 obstructed right kidneys 23 (44.3%) patients had proximal obstruction and

29 (55.7%) patients had distal obstruction. Out of 48 obstructed left kidneys 19 (39.5%) patients had proximal and 29 (60.5%) patients had distal obstruction.

Table: 2: Relationship of resistivity indices with site of obstruction.

	Mean RI of Proximal obstruction	Mean RI of normal on other side	Delta RI	Mean RI of proximal obstruction	Mean RI of normal on other side	Delta RI
Both kidneys	0.72±0.01	0.64±0.03	0.08	0.71±0.02	0.63±0.03	0.07
Left kidney	0.73±0.02	0.65±0.02	0.08	0.71±0.03	0.64±0.01	0.07
Right kidney	0.72±0.01	0.64±0.03	0.08	0.71±0.01	0.63±0.03	0.08

Table: 3 Relationship of resistivity indices with degree of obstruction.

RI Values	Complete	Partial	P-value
Obstructed kidney (RI)	0.72±0.01	0.71±0.02	< 0.05
Unobstructed kidney (RI)	0.64±0.02	0.63±0.02	NS
Delta RI	0.08±0.02	0.07±0.02	NS

Eighty (80%) patients had complete, while twenty (20%) had partial obstruction. RI value in completely obstructed kidneys (0.72 versus 0.71; $p < 0.05$). However, even in partially obstructed kidneys, RI was significantly higher (Table 3) than in the contralateral (unobstructed) kidney.

On USG, PCS dilatation was absent in 9 patients while it was moderate to large in 91 cases. RI was elevated in both groups. Doppler USG was useful in diagnosing acute renal obstruction even in those cases with mild/absent PCS dilatation on USG.

We studied the statistical value of a threshold RI of $\geq 0.$, wherein, the overall sensitivity was found to be 94% and specificity was 95%. In patient having complete obstruction, the sensitivity was 96% while specificity was 95%. In patients having partial obstruction, the sensitivity reduced to 85% specificity remained 95%.

DISCUSSION

Acute unilateral ureteric obstruction results in a complex sequence of changes in renal blood flow and ureteic pressure.¹⁴

Since USG gives only an indirect evidence of the renal obstruction a more direct 'functional' evidence of obstruction has been an essential requirement. Of late, Doppler US techniques have been used to obtain functional information in suspected renal obstruction.¹⁵

In our study of 100 patients, we found that RI in obstructed kidneys was significantly higher than in the unobstructed kidneys (0.72 versus 0.63 ; $p < 0.0001$). The

RI was higher in obstructed kidneys in all cases. The difference between the obstructed and unobstructed kidneys (delta RI) ranged from 0.03 to 0.15 with mean Δ RI of 0.08.

In a study by Rodgers et al found an elevated RI in normal contralateral kidneys and with a control group of healthy subjects.¹⁶ Similar results were obtained by Platt et al in 23 patients with acute unilateral ureteric obstruction.¹ However, other authors have reported Doppler to be highly insensitive for detecting acute renal colic. In a study by Tublin et al, Doppler was not found to be sensitive in identifying the obstruction in the kidneys.¹⁷

Few studies have shown the increase in RI to occur after as little as 6 hours of clinical obstruction.¹ Since the admission into the hospital before 5 hours is normally uncommon, we were unable to identify the shortest duration if acute renal obstruction which is capable of causing an elevated RI. However, in our study, the RI values were similar in all three groups (6-12 hours, 13-18 hours and 19-24 hours) of patients. This was in accordance to the studies by Platt et al and Shokier et al, who reported that kidneys obstructed for more than 12 hours do not have a significantly higher RI than those with obstruction of shorter duration.^{18,19}

In contrast, Toledo et al reported that the RI was significantly higher in patients with renal colic of more than 24 hours.²⁰ The variation in the observations could be related to the fact that the duration of obstruction in all these studies was based on clinical symptoms which may not correlate with anatomical obstruction.

In our study the diagnostic accuracy of the Doppler was 96% sensitive in the complete obstruction cases and 85% in patients with partial obstruction. In a similar study by Toledo et al, a sensitivity of 92% in patients with complete and 48% in patients with partial obstruction was observed.²⁰ In yet another study by Shokeir AA et al sensitivity of 86% in and 62% in patients with complete and partial obstruction respectively was reported.¹⁹

CONCLUSION

Doppler USG is a useful diagnostic tool in unilateral acute renal obstruction, with RI values being significantly higher in patients with complete obstruction than in patients with partial obstruction. In comparison with USG, whose sensitivity was 77.5%, the sensitivity of Doppler was 96%, making it a more useful in diagnosing the obstruction among the patients.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Platt JF, Rubin JM, Ellis JH. Acute renal obstruction: evaluation with intrarenal duplex Doppler and conventional US. *Radiology*. 1993;186(3):685-8.
2. Smith RC, Verga M, McCarthy S. Diagnosis of acute flank pain: value of unenhanced helical CT. *Am J Roentgenol*. 1996;166(1):97-101.
3. Smith RC, Verga M, Dalrymple N. Acute ureteral obstruction: value of secondary signs of helical unenhanced CT. *Am J Roentgenol*. 1996;167(5):1109-13.
4. Dalrymple NC, Verga M, Anderson KR. The value of unenhanced helical computerized tomography in the management of acute flank pain. *J Urol*. 1998;159(3):735-40.
5. Levine JA, Neitlich J, Verga M. Ureteral calculi in patients with flank pain: correlation of plain radiography with unenhanced helical CT. *Radiology*. 1997;204(1):27-31.
6. Karam AR, Birjawi GA, Sidani CA, Haddad MC. Alternative diagnoses of acute appendicitis on helical CT with intravenous and rectal contrast. *Clin Imaging*. 2007;31(2):77-86.
7. Fielding JR, Fox LA, Heller H. Spiral CT in the evaluation of flank pain: overall accuracy and feature analysis. *J Comput Assist Tomogr*. 1997;21(4):635-8.
8. Ellenbogen PH, Scheible FW, Talner LB, Leopold GR. Sensitivity of grey-scale ultrasound in detecting urinary tract obstruction. *Am J Roentgenol*. 1978;130:731-3.
9. Laing FC, Jeffrey RB, Wing VW. USG versus excretory urography in evaluating acute flank pain. *Radiology*. 1985;154:613-6.
10. Mostbeck GH, Zontsich T, Turetscher K. Ultrasound of kidney: obstruction and medical diseases. *Eur Radiol*. 2001;11:1878-89.
11. Amis ES, Cronan JJ, Pfister RC, Yoder IC. Ultrasonic inaccuracies in diagnosing renal obstruction. *Urology*. 1982;19:101-5.
12. Rascoff JH, Golden RA, Spinowitz BS, Charytan C. Non-dilated obstructive nephropathy. *Arch Intern Med*. 1983;143:696-8.
13. Millet PJ, Pelle-Francoz DP, Laville M, Gay F, Pinet A. Non-dilated obstructive acute renal failure: Diagnostic procedures and therapeutic management. *Radiology*. 1986;160:659-62.
14. Gulmi FA, Felsen D. Pathophysiology of urinary tract obstruction. In Walsh PC, Reti KAB, Vaughan ED, Wein AJ, eds. *Cambell's Urology*. 7th ed. Chapt 9. WB Saunders: Philadelphia; 1998:350.
15. Platt JF, Rubin JM, Ellis JH. Lupus nephritis: predictive value of conventional and Doppler US and comparison with serologic and biopsy parameters. *Radiology*. 1997;203:82-6.
16. Rodgers PM, Bates JA, Irving HC. Intrarenal Doppler ultrasound studies in normal and acutely obstructed kidneys; *The British J Radiol*. 1992;65:207-12.
17. Tublin ME, Dodd GD, Verdile VP. Acute renal colic: diagnosis with duplex doppler us. Department of Radiology, University of Pittsburgh Medical Center, Pa *Radiology*. 1994;193(3):697-701.
18. Platt JF, Ellis JH, Rubin JM. Role of renal Doppler imaging in the evaluation of acute renal obstruction. *Am J Roentgenol*. 1995;164:379-80.
19. Shokeir AA, Abdulmaaboud. Resistive index in renal colic: a prospective study. *BJU Int*. 1999;83:378-82.
20. De Toledo LS, Martinez-Berganza Asensio T, Cozcolluela Cabrejas R, de Gregorio Ariza MA, Pardina Cortina P, Ripa Saldias L. Doppler duplex ultrasound in renal colic. *Eur J Radiol*. 1996;23:143-8.

Cite this article as: Nagvekar RA, Nagvekar P. Doppler sonography in acute renal obstruction and role of intra venous urography: a study in a tertial care centre. *Int J Adv Med* 2017;4:23-6.