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A study on ultrasonography in renal obstruction

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Abstract

Doppler USG enables detection of subtle intrarenal blood flow changes associated with various pathophysiologic conditions. Platt *et al.* suggested that Doppler USG is promising for distinguishing obstructive from non-obstructive dilatation in a small group of patients. This prospective case control study was carried at a tertiary care centre. All patients presenting to the emergency medical division with symptoms of unilateral acute renal colic were part of this analysis. The kidney on the side of obstruction is 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. 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. We also evaluated the mean RI in right and left kidney separately. 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.

Keywords: Ultrasonography, renal obstruction, doppler USG

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^[1]. 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. It has been reported that the diagnosis of obstructive uropathy may be missed by USG because pyelocaliectasis may occur late in obstructive conditions and often the findings are normal despite severe renal dysfunction^[2].

Animal studies have shown that there is a definite rise in vascular resistance in the renal arteries when the kidney is obstructed. Arterial RI measurements by duplex Doppler USG have been advocated for the diagnosis of obstruction. Doppler USG enables detection of subtle intrarenal blood flow changes associated with various pathophysiologic conditions. Platt *et al.* suggested that Doppler USG is promising for distinguishing obstructive from non-obstructive dilatation in a small group of patients^[3, 4].

Our aim is to evaluate and compare the Doppler waveform alterations in unilateral acute renal obstruction (UARO) with the contralateral normal kidney as a control. We consider 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.

Methodology

This prospective case control study was carried at a tertiary care centre. All patients presenting to the emergency medical division with symptoms of unilateral acute renal colic were part of this analysis. The kidney on the side of obstruction is 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 grey-scale images. At least three Doppler spectra were obtained from interlobar arteries along the border of the medullary pyramids and their mean is taken. The Doppler waveforms are made using the lowest pulse repetition frequency possible without aliasing.

This is 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 is set at 2-5mm. 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. Mean RI value is calculated for each kidney. The most common reason for obtaining a normal RI in the presence of significant obstruction is a technical error [60]. The use of correct scale (pulse-repetition frequency) to expand the waveform size to fill as much of the available display as possible, without aliasing, is crucial.

Results

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. We also evaluated the mean RI in right and left kidney separately. 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. The mean RI of obstructed kidneys with proximal obstruction was higher in both kidneys. However the difference was not statistically significant.

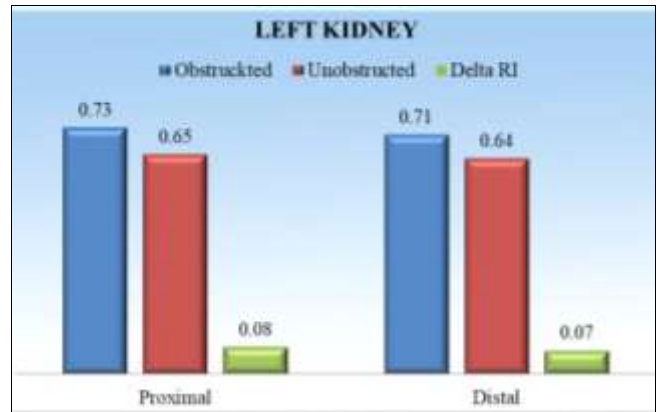


Fig 3: Relationship of resistivity indices with site of obstruction in left kidney

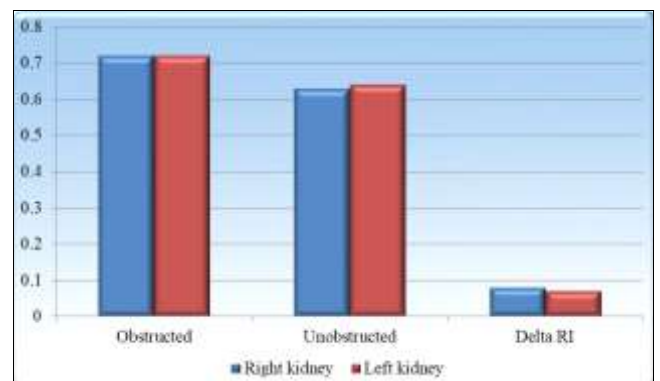


Fig 4: comparison of RI of obstructed and unobstructed kidneys on right and left side.

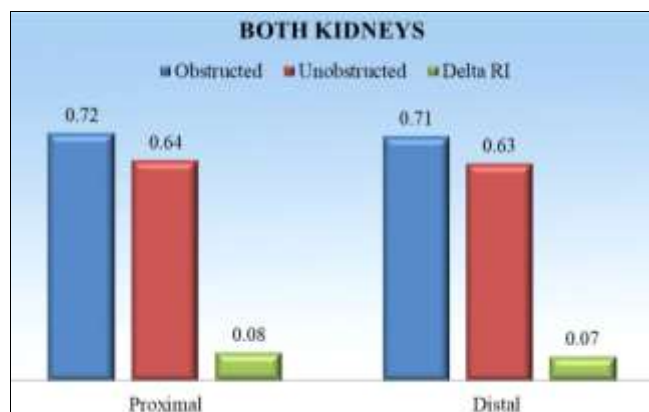


Fig 1: Relationship of resistivity indices with site of obstruction

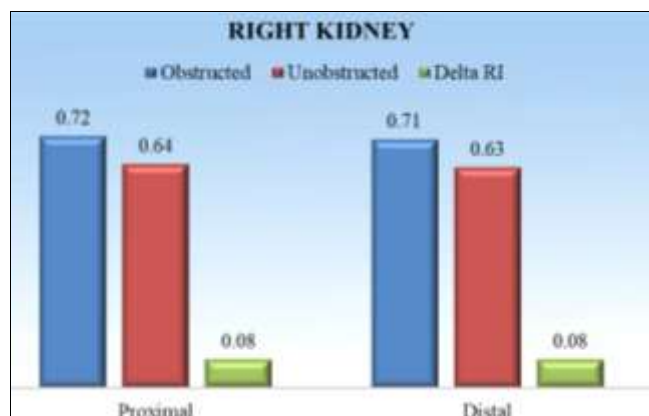


Fig 2: Relationship of resistivity indices with site of obstruction in right kidney

Eighty (80%) patients had complete, while twenty (20%) had partial obstruction. RI value in completely obstructed kidneys (0.72 Vs 0.71; $p < 0.05$). However, even in partially obstructed kidneys, RI was significantly higher than in the contralateral (unobstructed) kidney. Thus, the degree of obstruction (complete vs partial) was an important parameter affecting the RI value in this study.

Table 1: Relationship of Resistivity indices with degree of obstruction

Column1	Column2	Column3	Column4
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

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 ≥ 0.7 in our study. Using this discriminatory value of a threshold RI of ≥ 0.7 in our study. Using this discriminatory value, the overall sensitivity was 94% and specificity 95%.

In patient having complete obstruction, the sensitivity 96% while specificity was 95%. In patients having partial obstruction, the sensitivity reduced to 85% specificity remained 95%.

Discussion

In our study of 100 patients, we found that RI in obstructed kidneys was significantly higher than in the unobstructed kidneys (0.72 Vs0.63; $p < 0.0001$). 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. Our results correlate well with many studies reported earlier.

Previous investigators have shown that the increase in RI occurred after maximum six hours of clinical obstruction. However, admission to hospital in first five hours after the onset renal colic is uncommon. We were unable to investigate the shortest duration of acute renal obstruction that can cause elevation of RI, as all the present patients presented with a renal colic of more than six hours duration. We divided our patients into three groups (6-12 h, 13-18h and 19-24h) based on the duration of the renal colic. RI values were similar in all three groups of patients. In patients with renal colic for more than six hours, conflicting results have been obtained with respect to the effect of duration on RI. We agree with Platt *et al.* [5] and Shokeiret *al.* [6] that kidneys obstructed for more than 12h do not have a significantly higher RI than those with obstruction of shorter duration. On the other hand, de Toledo *et al.* [7] reported that the RI was significantly higher in patients with renal colic of more than 24h. Duration of obstruction is based on the clinical symptoms but true duration of obstruction may be variable.

We also studied the effect of degree of obstruction on RI values. Our results showed that the RI value in completely obstructed kidneys was significantly higher than in partially obstructed kidneys (0.72 Vs0.71; $p < 0.05$)

In a recent study de Toledo *et al.* [7] investigated the diagnostic accuracy of Doppler USG in complete as well as partial acute renal obstruction in 64 patients. With a threshold of RI of ≥ 0.70 and of Δ RI ≥ 0.06 , they showed a sensitivity of 92% in 37 patients with complete obstruction. Shokeir AA *et al.* [6] showed a sensitivity of 86% in 42 patients with complete obstruction. Petrisor *et al.* [8] investigated 'Value of Duplex Doppler Ultrasonography in Renal colic' in complete as well as partial obstructed kidney. In complete obstruction they found RI > 0.70 in 87%, Δ RI > 0.06 in 90% with sensitivity of 90%. In partial obstructed kidney, they found RI ≥ 0.70 in 58.3% and Δ RI > 0.06 in 64.5% of patients with sensitivity of 82%. Haroun Azmi [9] published 'Duplex Doppler sonography in patients with acute renal colic' In the 14 patients with complete urinary obstruction, RI and delta RI values were 0.70 and 0.09, whereas in the 28 patients with partial urinary obstruction, these values were 0.64 and 0.03. These were similar to our results (0.7 Vs 0.63). This shows significantly high sensitivity in completely obstructed kidney than partial obstruction.

Kavakli H S *et al.* [10] found in their study of 'Diagnostic value of renal resistive index for the assessment of renal colic'. A total of 70 participants were included 43 patients with acute unilateral ureteral obstruction due to a stone disease seven patients with flank pain without stone disease. There were statistically significant differences in the RI between the stone-positive group and stone-free groups (0.71 Vs 0.62). This showed high sensitivity of acute renal obstruction than unobstructed kidney as in our study.

Conclusion

Doppler USG is a useful diagnostic tool in unilateral acute renal obstruction. The sensitivity of grey scale USG for detecting obstruction was found to be 77.5%. Doppler USG was useful in diagnosing obstruction even when USG findings were normal. The duration of symptoms at presentation or the site of obstruction did not affect the RI values in acute renal obstruction. Patients with complete obstruction had significantly greater RI values than those having partial obstruction.

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