



Intrarenal Artery Resistive Index – An Invaluable Tool In Detecting Obstructive Uropathy

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ABSTRACT

Background: Ultrasound is more sensitive than being specific in the diagnosis of renal obstruction. Ultrasound provides less details about the pelvicalyceal anatomy and incomplete visualization of the dilated ureter. It cannot provide the functional information; thus, it lacks the specificity of the excretory urography. In a significant number of cases ultrasound proves to be less sensitive, where pelvicalyceal system dilatation is absent. This study evaluates the use of intrarenal artery resistive index in detecting obstructive uropathy.

Aim: Comparison of intrarenal arterial doppler RI in obstructed vs non-obstructed ureters and evaluating the diagnostic precision of intrarenal doppler resistive index in ureteric obstruction.

Methodology: This prospective study included 100 patients in the age group of 18 to 70 years, with acute ureteric colic secondary to unilateral ureteric obstruction caused by calculus, that is validated either by grey scale imaging and aliasing in colour doppler or by Intravenous Urography. The intra-renal RI values were recorded in every patient.

Result: RI was higher in obstructed kidneys in all the cases with a Mean RI of > 0.06. The mean peak systolic velocity (PSV) value and the end diastolic velocity (EDV) value were lower in the obstructed kidney as compared to the non-obstructed kidney.

Conclusion: The conventional evaluation of kidneys, ureter and bladder are done using grey scale imaging. In a few instances standard greyscale evaluation falls short, when collecting system dilatation is absent. Hence adding the duplex doppler with RI as marker, to the standard protocol of obstructive uropathy evaluation proves to be a highly sensitive tool for diagnosis.

Keywords: Intrarenal artery, Resistive index, Obstructive uropathy, Peak systolic velocity, End diastolic velocity.

Aim & Objectives

1. Comparison of patients with obstructed vs non-obstructed ureters by intrarenal arterial doppler.
2. To evaluate the diagnostic precision of intrarenal doppler resistive index in ureteric obstruction.

Introduction

Ultrasound can easily detect the dilatation of renal pelvi-calyceal system. Minimal dilatation of pelvi-calyceal system is seen in some patients with severe obstruction, especially in the cases of ureteric calculus. Even an expert observer may miss renal obstruction in a small proportion of patients, where pelvicalyceal system

dilatation is absent. The failure in dilatation may probably due to low diuresis resulting from obstruction by calculus or decompression of the pelvi-calyceal system caused by calyceal fornix tear, dehydration and underlying renal parenchymal disease.

Ultrasound is more sensitive than being specific in the diagnosis of renal obstruction. Ultrasound provides less details about the pelvicalyceal anatomy, incomplete visualization of the dilated ureter and it cannot provide the functional information, thus it lacks the specificity of the excretory urography. ⁽¹⁾⁽⁵⁾⁽⁶⁾

Complete acute ureteric obstruction causes an imbalance in the renal blood flow and pressure. In the initial hours, because of afferent arteriolar dilatation there is an increase in renal blood flow. Post 3 to 5 hours, due to afferent arteriolar vasoconstriction produced by prostaglandins and other vasoactive substances, the renal blood flow decreases. ⁽²⁾⁽⁷⁾⁽⁸⁾ Decreased renal blood flow is persistent till 24 hours. The resistive index (RI) of renal artery demonstrates the reduced renal blood flow during obstruction. ⁽⁹⁾⁽¹⁰⁾ The time course of the RI changes depending upon the pathophysiology. It increases approximately after six hours of acute calculus obstruction and sustains a peak from 6 to 48 hours. The RI remains elevated but less markedly. ⁽³⁾

Platt⁶⁷ et al found that obstructed pelvicalyceal systems were associated with RI greater than 0.7, whereas kidneys with dilated non-obstructed systems had RI less than 0.7. A difference greater than 0.06 to 0.10, in RI values between the two kidneys (Δ RI) is considered to be a significant indicator of unilateral obstruction. ⁽⁴⁾

Ultrasonography is a modality that is readily available, non-invasive, dependable, cost effective and harmless. This study focuses on the utility of intrarenal arterial doppler study in obstructive uropathy.

Materials and methods

This prospective study (Case-Control) included 100 patients with acute ureteric colic secondary to unilateral ureteric obstruction caused by calculus, that is validated either by grey scale imaging and aliasing in colour doppler or by Intravenous Urography. This study is done among the age group of 18 to 70 years with GE F8 Logiq, using 3.5 MHz curvilinear transducer.

Length, thickness of the bilateral kidneys, cortical thickness, pelvi-calyceal system, ureter and urinary bladder are the morphological parameters that are measured with grey scale.

Peak systolic velocity, end diastolic velocity and resistivity index (RI) are the doppler parameters that are recorded. Doppler study is done thrice and the waveforms were recorded. Mean RI (Δ RI) from these waveforms were calculated for each kidney. These parameters are obtained for every patient, where normal kidney serves as a control and it is compared with the contralateral obstructed kidney.

When a calculus is detected, maximum size is measured and recorded.

RESULTS

Majority of the men came under the 30 to 40 years age group and majority of the women came under the 25 to 32 years age group. The mean resistivity Index (RI) in obstructed kidneys was significantly higher than in the contralateral unobstructed kidneys, which was 0.75 vs. 0.60; $p < 0.001$. The mean peak systolic velocity (PSV) value and the end diastolic velocity (EDV) value were lower in the obstructed kidney as compared to the non-obstructed kidney and it was statistically significant ($p < 0.05$). The average intra-renal Resistivity Index (RI) was 0.72 among the 100 individuals with a ureteric calculus located downstream. The mean RI of the contralateral normal kidney in the 100 patients was 0.63. The mean intra-renal RI in obstructed kidneys was significantly higher than in unobstructed kidneys (0.72 Vs 0.63; $p < 0.001$). RI was higher in obstructed kidneys in all the cases. The overall sensitivity was 92% using a discriminating value of 0.70 for blockage. Sensitivity was 94% at a mean RI of 0.06.

Pelvicalyceal system dilatation was observed in 96 patients and absent in 4 patients, with calculus at the vesico-ureteric junction in both categories. Both groups revealed identical RI values. Doppler USG was very much helpful in diagnosing acute renal obstruction even in the absence of pelvicalyceal system dilatation. The Mean RI was > 0.06 in both the cases.

DISCUSSION

Platt et al studied that an RI of 0.70 is the threshold for obstructive uropathy. The sensitivity was found to be 92% in patients with acute unilateral ureteric obstruction. For a threshold mean RI value of 0.72, the sensitivity is 50%. But by making the inter-renal RI value ≥ 0.06 as abnormal, the sensitivity rises to 94% as only 4 patients out of 100 patients presenting with unilateral ureteric calculus had an RI difference from the contralateral normal kidney of < 0.06 .

REPRESENTATIVE IMAGES

Case: 1

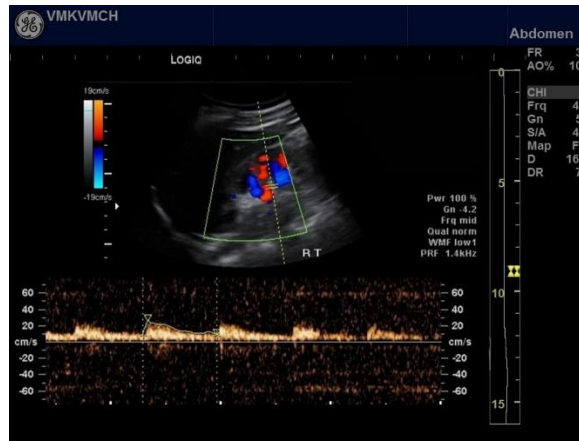


Figure 1: Image showing normal RI value of 0.68 in mid-pole interlobar artery of non-obstructed right kidney.



2A

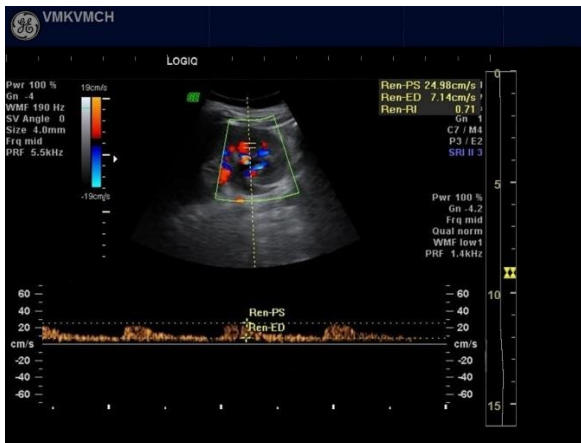
2B

Figure 2A & 2B: Image showing raised RI of 0.76 in mid-pole interlobar artery of left kidney secondary to left VUJ calculus causing proximal hydroureteronephrosis.

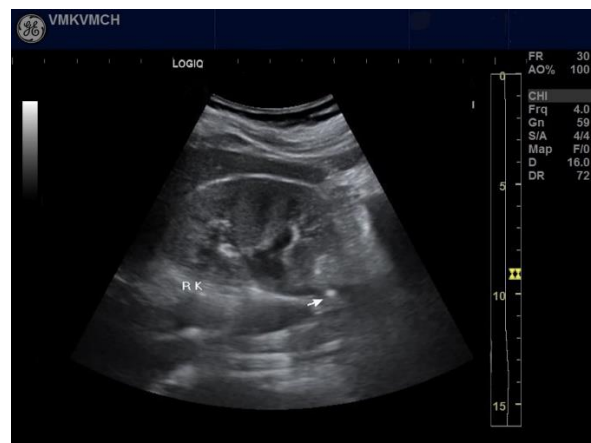
Case: 2



Figure 3: Image showing normal RI value of 0.64 in the mid-pole interlobar artery of non-obstructed left kidney.



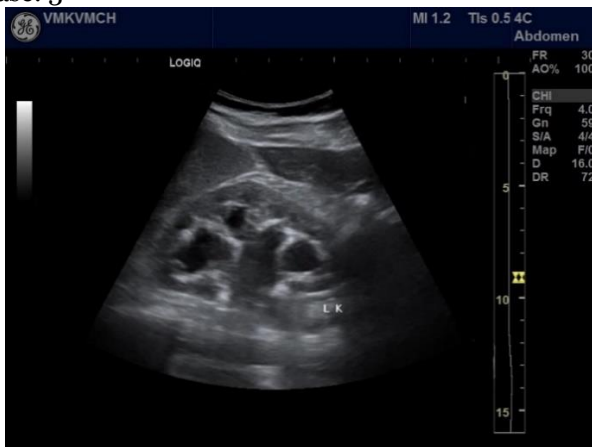
4A



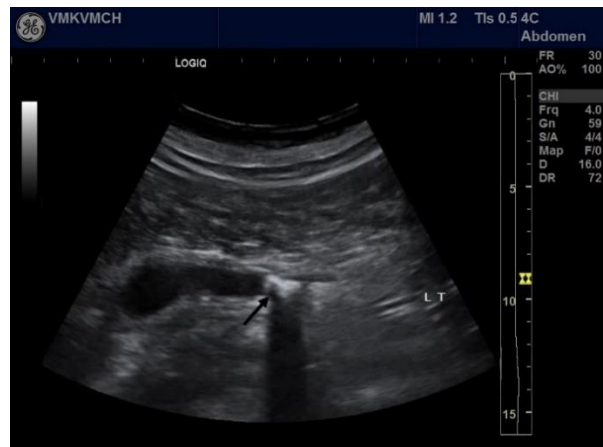
4B

Figure 4A & 4B: Image showing raised RI value of 0.72 in the mid-pole interlobar artery of the right kidney secondary to calculus in the right proximal ureter causing PCS dilatation.

Case: 3

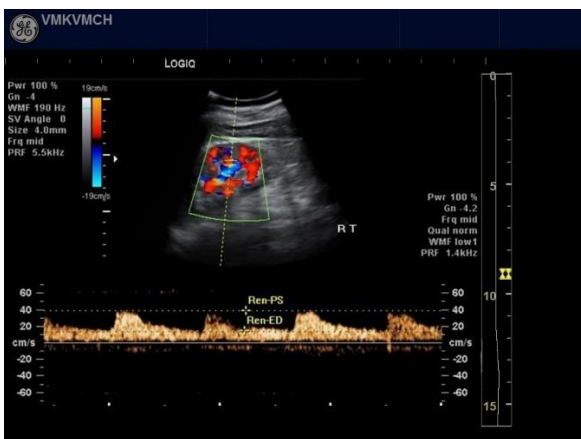


5A

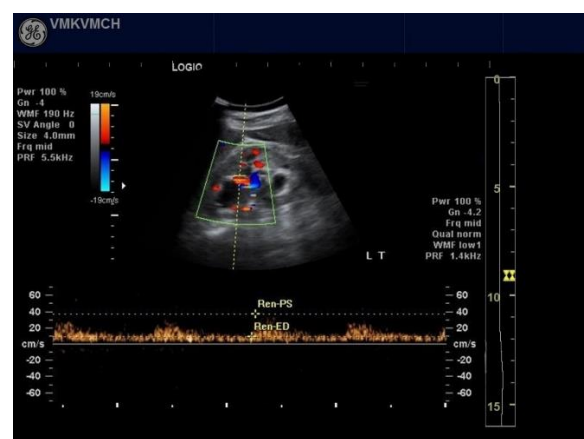


5B

Figure 5A & 5B: Grey scale USG image showing PCS dilatation in left kidney, secondary to distal ureteric calculus.



6A

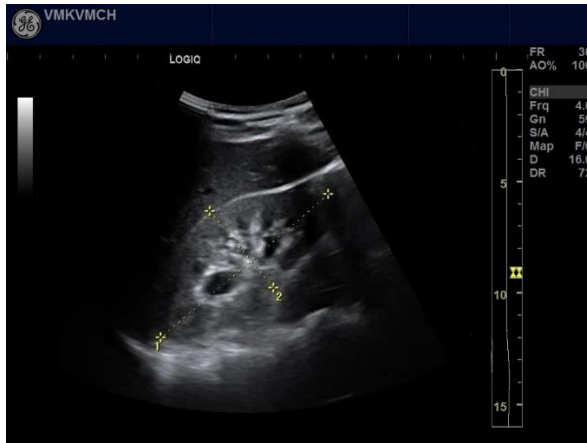


6B

Figure 6A: Image showing raised RI value of 0.76 in the mid-pole interlobar artery of obstructed left kidney.

Figure 6B: Image showing normal RI value of 0.63 in the mid-pole interlobar artery of non-obstructed right kidney.

Case: 4

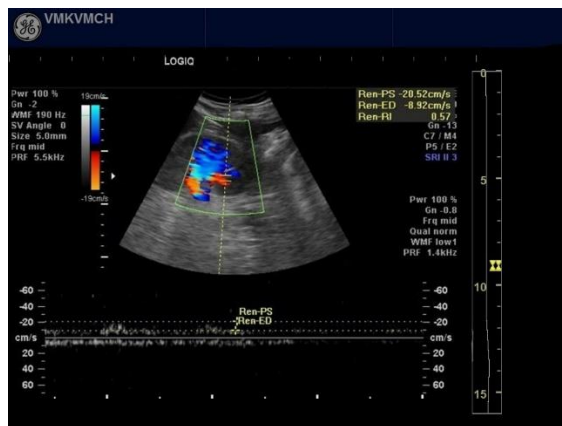


7A

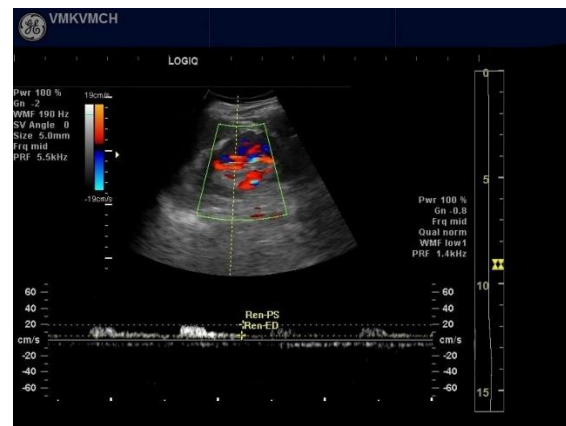


7B

Figure 7A & 7B: Grey scale USG image showing PCS dilatation secondary to right distal ureter calculus.



8A



8B

Figure 8A: Image showing normal RI value of 0.57 in the lower interlobar artery of non-obstructed left kidney.

Figure 8B: Raised RI value of 0.71 in mid-pole interlobar artery of obstructed right kidney.

CONCLUSION

Ultrasonography is the preliminary and prime imaging modality used world-wide to evaluate the patients presenting with acute ureteric/renal colic. The conventional evaluation of kidneys, ureter and bladder are done using grey scale imaging. In a few instances standard greyscale evaluation falls short, when collecting system dilatation is absent. By fixing RI value ≥ 0.06 as abnormal, the sensitivity surges to 94%. Hence adding the duplex doppler with RI as marker, to the standard protocol of obstructive uropathy evaluation proves to be a highly sensitive tool for diagnosis.

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