

A COMPARISON OF FINDINGS IN NON-OBSTRUCTIVE RENAL DISEASE USING DOPPLER ULTRASOUND AND HISTOPATHOLOGY

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ABSTRACT

BACKGROUND

In 53 patients with non-obstructive renal disease, we compared the Doppler indices along with the corresponding histopathological findings.

METHODS

Patients were subjected to Doppler ultrasound before biopsy was performed. Doppler indices, particularly the Resistivity Indices (RI) values were calculated. Biopsy was performed under ultrasound guidance and samples were sent for histopathological analysis. Histopathological Examination (HPE) findings were compared with recorded RI.

RESULTS

RI values between 6-7 were seen in purely glomerular diseases with no interstitial involvement. RI values between 7.1-7.5 were seen in diseases which involved both the interstitium and glomeruli. Purely interstitial diseases showed RI values greater than 7.5.

CONCLUSIONS

RI values calculated in patients with non-obstructive renal disease help in accurately classifying the type of renal disease. Doppler ultrasound can be a very useful adjunct to HPE in medical renal disease and help differentiate interstitial from glomerular diseases.

KEYWORDS

Non-obstructive Renal Disease, Resistivity Index, Renal Doppler, Renal Parenchymal Disease, Renal Ultrasound.

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INTRODUCTION: Ultrasound imaging in renal disease has always been a challenge for radiologists and the nephrologist. Gray scale imaging does not always correlate with biochemical parameters of renal function.¹ Few of the cases associated with elevated serum creatinine can have normal appearing kidneys on Gray scale ultrasound and vice versa. In this study, we analysed the value of Doppler ultrasound in addition to Gray scale imaging in non-obstructive kidney disease. Doppler Indices help to further classify the predominant type of kidney disease based on the RI values.²

In 53 patients with non-obstructive kidney disease, the histopathological examination findings were correlated with the RI values. Two important inferences emerged: 1) Not in all cases of renal dysfunction were the RI values elevated. 2) Based on the RI values, it was possible to differentiate which component was involved in the renal dysfunction.

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In our study, RI values ranging between 5-7 were seen in purely glomerular diseases with no interstitial involvement. Values between 7.1-7.5 were seen in diseases which involved both interstitium and glomeruli. Purely interstitial diseases showed values greater than 7.5.

AIM AND OBJECTIVES:

- A) To correlate RI values with the corresponding histopathological examination results.
- B) To verify if RI can be used as a means of classifying the type of non-obstructive Renal Parenchymal Disease.

MATERIALS AND METHODS: We compared the HPE findings and the Doppler ultrasound findings in 53 patients with proven non-obstructive kidney disease at Sri Ramachandra Medical College from June 1, 2010 to January 20, 2011. Ultrasound was performed using Low frequency ultrasound probe (5 MHz), GE Voluson and Logic E machines. All the patients were subjected to Doppler ultrasound prior to an Ultrasound-guided Renal Biopsy. The RI values were calculated and compared with the HPE findings.

Inclusion Criteria: We defined renal disease based on either elevated creatinine (more than 1.2 mg/dL), reduced Glomerular filtration rate (GFR) on scintigraphy, albuminuria or clinical findings like reduced urine output, anasarca, etc.

Exclusion Criteria: Patients who have undergone transplantation and those with obstructive kidney disease were excluded from the study by eliciting a careful history and performing Gray scale ultrasound. Neonates, children less than 5 years and patients more than 60 years were excluded due to inherent variations in the Doppler spectrum. Patients with renal artery stenosis were also excluded from the study.

Ultrasound-guided Renal Biopsy: Biopsy was performed under ultrasound guidance in all the patients. Ultrasound is the Imaging modality of choice for guiding interventions in an organ such as liver or the kidney, which move dynamically with respiration³. Under local anaesthesia and under strict aseptic precautions, the low frequency curvilinear probe is coated with a sterile acoustic transmission gel and covered with a sterile sheath. The kidneys are visualised in the lumbar region after positioning the patient prone or in the lateral oblique position. A pillow is preferably placed beneath the abdomen with a view to 1) minimise respiratory movement 2) induce a mild kyphosis which has an effect of uncovering the kidneys from beneath the costal margins.

The right kidney which is usually located at a lower level than the left- is easier to biopsy without interference from costal shadows, and is preferred for biopsy over the left kidney unless otherwise indicated. The lower pole is targeted for biopsy due to the paucity of major traversing vessels, and due to easier access- as the entire lower pole is well below the costal margin during all phases of respiration.⁴ Patients were asked to hold breath in deep inspiration. An 18-gauge spring loaded automated biopsy device, manufactured by Bard- was used in all the cases to take 1-2 core biopsy specimens.⁵ Samples were sent for histopathological examination and findings were compared with the corresponding resistivity indices.

RESULTS: 53 patients who suffered from both acute and chronic non-obstructive renal diseases, were evaluated by Doppler ultrasound before subjecting them for biopsy. Gray scale ultrasound was performed in all patients to evaluate renal size, cortical echogenicity and rule out obstruction. Gray scale findings varied from normal to increased cortical echoes with loss of corticomedullary differentiation. Doppler spectrum of the intrarenal branches of the renal artery were analysed and compared with the histopathological examination reports.

Out of the 53 patients, 29 were male and 24 were female patients (M: F - 1.2: 1). The age group varied from 8 years to 56 years. Although all Doppler indices were recorded in every patient, only the RI values were correlated with HPE findings. Three patients were excluded from the study due to sample inadequacy for HPE analysis.

Patients were divided into three groups based on the resistivity indices. RI values ranging between 0.50-0.70 as group I, values between 0.71-0.75 as group II and values greater than 0.75 as group III. Out of the 50 patients, 31 (63%) patients came under group I, 09 (18%) patients under group II and 10 (19%) patients under group III. On correlation with HPE reports, group I patients had purely glomerular disease; group II patients had both glomerular and interstitial disease and group III patients had purely interstitial disease. 100% correlation between the HPE findings and the pre-defined RI value groups was obtained (Table 1). Among the patients who had glomerular disease (Group I) - focal segmental glomerulosclerosis was the most common HPE finding, followed in order by minimal change disease, rapidly progressive glomerulonephritis, and IgA nephropathy. Among the patients who had interstitial disease (Group III) - both acute and chronic interstitial disease were present on HPE. Among the patients who had mixed disease (Group II) - there was a combination of glomerular and interstitial pattern of involvement on HPE.

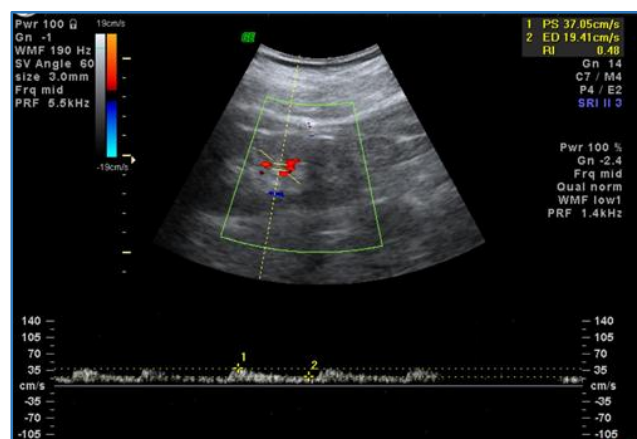


Fig. 1a: A 50-year-old man with Symptoms of Renal Failure with Associated Diabetes underwent Doppler Ultrasound prior to Biopsy



Fig. 1b: Needle Tip is seen on Ultrasound during Guided Biopsy

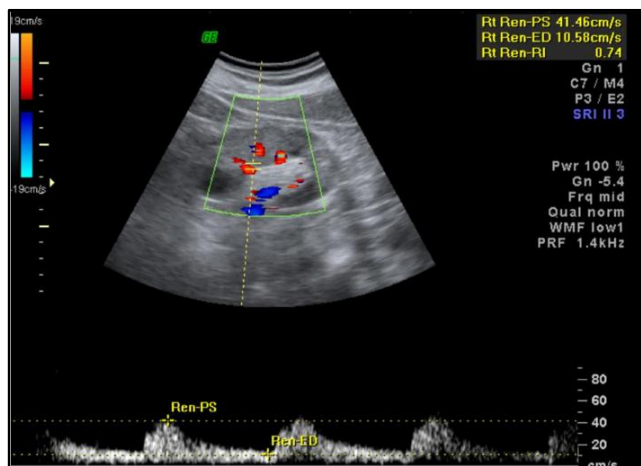


Fig. 2: A 38-year-old Female Patient with Symptoms of Renal Failure Underwent Duplex Doppler

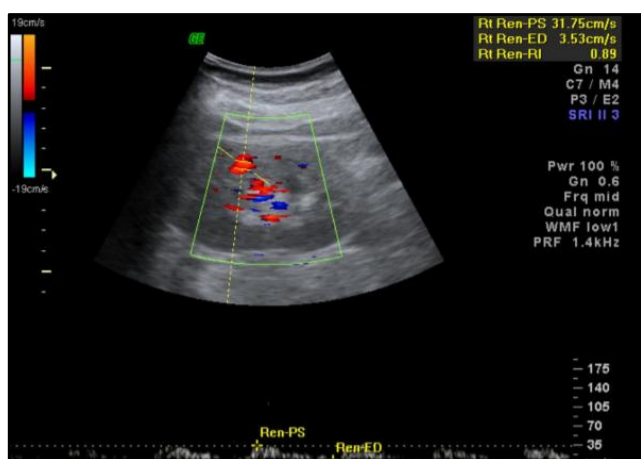


Fig. 3a: A 28-year-old Male Patient with Symptoms of Fever and Pyuria underwent Doppler

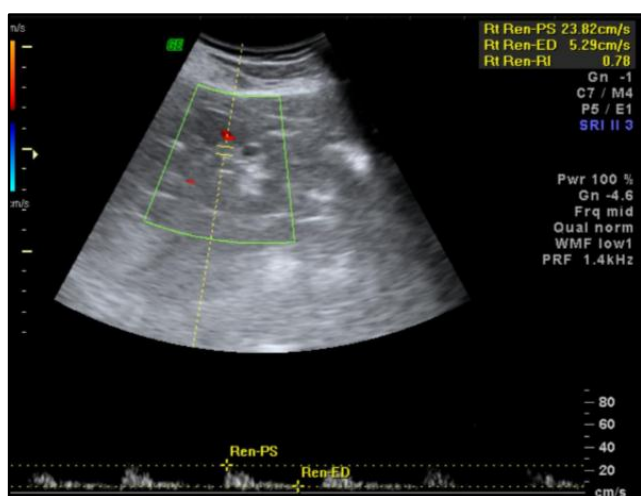


Fig. 3b: A 50-year-old Female Patient with a History of Reflux Nephropathy Underwent Duplex Doppler Ultrasound

	Group I	Group II	Group III
Number of Patients	31	09	10
Percentage of Study population	63%	18%	19%
Resistivity Index	0.50-0.70	0.71-0.75	>0.75
HPE Report	Glomerular Disease	Glomerular + Interstitial Disease	Interstitial Disease
% Correlation between HPE & RI range	100%	100%	100%

Table 1

DISCUSSION: Ultrasound imaging in non-obstructive renal disease has always posed a diagnostic challenge. Gray scale imaging can either be normal, show mild increase in echos, or loss of corticomedullary differentiation.⁶ Hence Doppler Ultrasound—both Colour Doppler and Pulsed Doppler Imaging play an important role in identifying renal diseases especially in acute setting when Gray scale imaging is normal. Intrarenal duplex Doppler sonography can provide physiologic information reflecting the status of renal vascular resistance.⁷ Most of the Doppler studies performed till date consider RI value greater than 0.70 as high.⁷ Even in patients with renal disease, the Doppler spectrum helps us to identify the type of renal disease,⁸ not all renal diseases manifest with elevated RI. RI value can be normal (< 0.71) in conditions purely affecting the glomerulus. Elevated RI > 0.75 is commonly seen in conditions affecting the interstitium. Intrarenal Doppler is also useful in identifying latent renal problems, even before it manifests clinically.

Intrarenal Doppler waveforms were variable in very young children, infants and very old people, due to inherent anatomical changes and hence were not included in the study.⁹ The usual range of normal RI values are not applicable in children less than 3-4 years.¹⁰ and neonates and in very old people more than 60 years of age. Though the above-mentioned group of population has an inherently high vascular resistance, markedly elevated resistivity indices should be considered abnormal. In the presence of elevated creatinine values, it is to some extent possible to differentiate glomerular from interstitial diseases, if not accurately. In an acute setting, colour Doppler can be used to differentiate prerenal failure from acute tubular necrosis as the latter presents with elevated RI.¹¹ In our study, we included patients between the ages of 5-60 yrs.

All the patients had elevated creatinine values or other markers of renal dysfunction as mentioned in the inclusion criteria. Before Ultrasound-guided biopsy was performed in these patients we sampled the intrarenal arterial waveform and calculated the resistivity indices. Depending on the range of RI values, the patients were classified into three groups and their corresponding histopathological examination findings correlated to elicit an association between RI value and the type of renal disease.

Group I patients had purely glomerular disease; group II patients had both glomerular and interstitial disease and group III patients had purely interstitial disease. 100% correlation between the HPE findings and the pre-defined RI value groups was obtained. There were three patients who had inadequate sample for the pathologists to report and hence they were excluded from the study. No difference in tissue yield was observed between free hand versus ultrasound-guided renal biopsy in various studies.¹²

There was elevation of resistivity indices above 0.75 in all patients who had only tubule-interstitial involvement. In patients who had only glomerular involvement, the resistivity indices were within normal range, i.e. below 0.71. There were few who had resistivity indices between 0.71 and 0.75 and on correlation with histopathology, they were found to have a combination of interstitial and glomerular disease. There were several studies regarding this in the early 90s but the findings were disputed by a number of studies performed later.^{13,14}

Duplex Doppler is also useful in monitoring patients.¹⁵ on treatment for renal diseases. A decrease in the resistivity indices correlates well with clinical improvement. In our study, we followed up few patients who were put on medical management with serial resistivity indices measurement. In few of them, there was marked decrease in resistivity index and in a few there was persistent elevation of RI which indicated a poor prognosis.¹⁶ RI can also pick up latent renal diseases early.¹⁷ Though Doppler is not a replacement for histopathological analysis, it can be used as a useful adjunct in patients with renal disease and also help in monitoring patients on treatment.¹⁸

CONCLUSION: Duplex Doppler is a very useful tool in patients with non-obstructive renal diseases. In our study, we were able to correlate RI values with corresponding HPE results in all patients except the ones who were excluded for biopsy sample inadequacy. Our study establishes that RI values accurately help in classifying the type of non-obstructive renal disease. Serial RI value measurements also help in monitoring the response of patients on treatment. Hence, this study proves the usefulness of duplex Doppler in renal diseases, knowing the inherent variations depending on the varying factors as described above.

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