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# Role of Renal Resistive Index in Unilateral Acute Renal Obstruction, Diabetic and Hypertensive Nephropathy

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**ABSTRACT**

Find out the role of Resistive Index and compare the Doppler waveform alterations in unilateral acute renal obstruction (UARO) with the contralateral normal kidney as a control.To evaluate the role of duplex Doppler renal resistive index as a predictor of progression of nephropathy in chronic medical diseases especially in diabetes mellitus and hypertension and mainly primary objective of this study was to determine whether the intra renal resistive index can be used as a predictor of progression of disease in patients with unilateral acute renal obstruction and chronic medical renal diseases especially diabetic and renal diseases.

**Keywords:**
Doppler renal resistive index,Renal diseases,Diabetic Mellitus, Renal obstruction

## 1.Introduction

Ultrasound and Doppler are noninvasive modalities for evaluation of kidney in various local and systemic diseases. Ultrasound evaluation of kidneys has the additional advantage of being free from ionizing radiation and its possible harmful effects. Renal sonography has been used fairly routinely in patients with azotemia to exclude possible obstructive uropathy, to measure the size of kidneys and to evaluate the parenchymal echogenicity of the kidneys.(1) Duplex ultrasonography has provided an easily applicable and non-invasive method for investigating renal haemodynamics. Nowadays, a lot of work has been directed towards the use of Doppler in evaluation of renal vascular resistance by using Doppler indices like resistive index in various systemic conditions like acute renal obstruction, Diabetes mellitus, Systemic hypertension, Haemolytic uremic syndrome. (2-3)

Renal colic (RC) is one of the most common conditions seen in the emergency department (ED). Ranging from 2% to 12% in the general population and it accounts for 30-35% of all urological emergencies. The incidence is higher in men (10-20% Vs 3-5% in women), and 30-40% of all patients experience a symptomatic recurrence within 5 years (1-3).Obstructive uropathy can be defined as any blockage of urine drainage from the kidney (renal calyces or renal pelvis), ureter, or bladder (4). As a result of the blockage, urine backs up into the kidneys, causing dilatation of the ureter, renal pelvis, and renal calyces, which can damage the kidney if it is not treated. The appearance of dilated or enlarged renal pelvis and calyces is referred to as hydronephrosis and is a symptom of obstructive uropathy (5). The most common causes of obstructive uropathy include stones in kidneys (nephrolithiasis) (6), ureter (ureterolithiasis) or anywhere in the urinary tract (urolithiasis) (7,8). Diabetes mellitus and hypertension are among the most common chronic noncommunicable diseases and are main preventable risk factors for end-stage renal failure, coronary heart diseases and stroke.DM and HTN are collectively known as Syndrome X (9). India currently, has around 40 million cases of DM and these numbers are projected to be doubled by the year 2030(10). Anticipating an epidemic like an increase in the number of diabetic patients India has been called as the ‘diabetic capital of the world (11). The prevalence of type 2 DM has risen from 1.2% to 11% over last three decades(12). HTN affects about one billion people worldwide (13) and it is estimated that by 2025, up to 1.56 billion adults worldwide will be hypertensive (14). The prevalence of HT is rapidly increasing in developing countries and is said to be one of the leading causes of death and disability among the elderly

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(15) due to adoption of western lifestyles and the stress of urbanization both of which are expected to increase the morbidity associated with unhealthy lifestyles (10). The complications associated with diabetes and hypertension can be divided into macrovascular and microvascular disorders. Macrovascular complications include coronary artery disease, myocardial infarction, congestive heart failure, stroke, and peripheral vascular disease. microvascular complications of diabetes include retinopathy, nephropathy, and neuropathy. The leading cause of noncongenital blindness is diabetes-related retinopathy, and that of end-stage renal disease is diabetic nephropathy. In addition, foot ulcers and peripheral artery disease in diabetic patients account for two-thirds of all nontraumatic amputations. (16)

The primary objective of this study was to determine whether the intra renal resistive index can be used as a predictor of progression of disease in patients with unilateral acute renal obstruction and chronic medical renal diseases especially diabetic and hypertensive nephropathies.

## 2.Materialsandmethods:

**Typeofstudy-prospectivestudy.**

In this prospective analysis, two groups of patients are taken.

**Group 1**: patients presenting to the emergency medical division with symptoms of unilateral acute renal colic, out patients , in-patients admitted with obstructive uropathy

**Group 2:** patients with diabetes mellitus and hypertension (recently diagnosed-less than 5 years,5 to 10 years and more than 10 years) presenting with complications of diabetes and hypertension (nephropathies) are selected.

**SOURCE OF DATA:** The main source of data for this study will be patients referred from various Department s of Sri Lakshmi Narayana Institute of Medical Sciences And Research, Pondicherry.

**SAMPLE SIZE**: 120 patients were taken for the study.

**STUDY DURATION**: Study was carried out for two years. The study was approved by the Scientific and Ethics Committee of the Institute.

**INCLUSION CRITERIA:**

Unilateral renal calculi causing obstruction. Patients diagnosed with diabetes mellitus and hypertension. Patients in age group of 20 to 65 years.

**EXCLUSION CRITERIA:**

Patients with bilateral renal calculi, Normal anatomic variants of kidneys and ureter. Post renal transplant kidney patients. Pregnant females where right sided pelvicalyceal dilatation is a physiologic entity. Patients with bilateral outflow tract obstruction like benign prostatic hyperplasia (BPH), bladder tumors, Trauma and Congenital anomalies.

## 4. Instrumentationused:

ULTRASONIX SONIX-SP ultrasonography machine, curvilinear probe of 3.5 MHz is recommended together with the use of colour or power Doppler to help vessel localization. Obstruction was confirmed by intravenous urography or computed tomography scan where ever required. Required laboratory investigations – serum creatinine , glycosilated hemoglobin (HbA1c) , random blood sugar and lipid profile (total serum cholesterol).

Technique:

As resistance to blood flow progressively increases from the hilar arteries toward the more peripheral parenchymal vessels, it is generally recommended that sampling for Renal Resistive Index should be done at the level of the arcuate or interlobar arteries, adjacent to medullary pyramids..

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## 5. Statistical analysis:

Results are expressed as mean ± standard deviation. Categorical variables were presented as number (percentage) and were compared by the or Fisher exact test. Difference between two means were compared by student 't' test for paired /unpaired observations as appropriate. sensitivity and specificity are done by binary classification test.
In all the above tests the "p" value of less than 0.05 was accepted as indicating statistical significance. In this analytical study, 120 patients were taken – 50 patients with unilateral acute renal colic, 35 diagnosed cases of diabetes mellitus and 35 diagnosed cases of hypertension. Doppler ultrasound was performed in all cases, intravenous pyelography for patients with renal colic for confirmation of renal calculi and required laboratory investigations like serum creatinine, total cholesterol, glycosilated hemoglobin and microalbuminuria.

## 6. Results

**FIGURE 1:** Shows Unilateral Acute Renal Obstruction

Proximaluretericobstruction:


Figure 1 -Xray KUB showing a calculus at the level of lower border of L2 veretbra suggesting proximal ureteric calculus.

**FIGURE 2:**Shows Distal Ureteric Obstruction


Figure 2 - IVP at 10 minutes image showing a intra ureteric calculus at the level of S2 vertebra with no contrast filling in the left ureter.

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**FIGURE 3** – Shows Completely Obstructed Ureteric Calculus

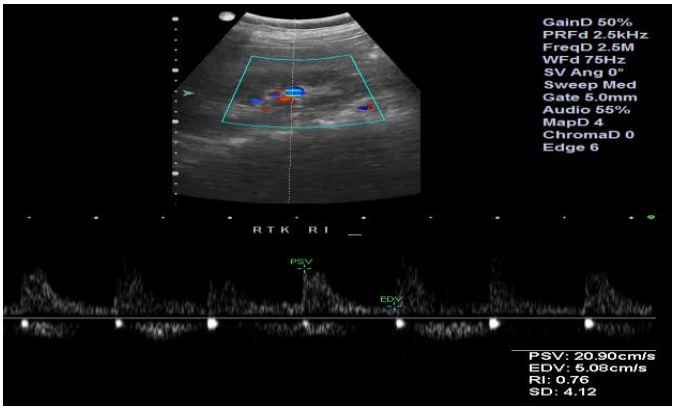


Figure 3 – mean renal resistive index value in the above completely obstructed ureteric calculus patient was 0.76.

**FIGURE 4** - Showing The Mean Resistive Index Value Differentiation In Proximal And Distally Ureteric Obstructed Calculi Patients.

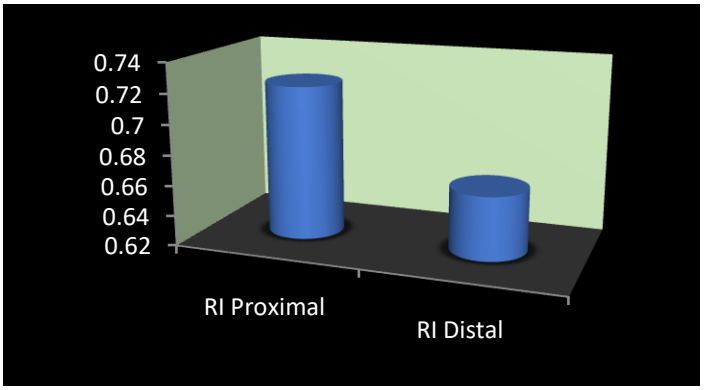


Figure 4 - showing the mean resistive index value differentiation in proximal and distally ureteric obstructed calculi patients..

**FIGURE 5:**Shows A 30 Year Old Patient With Recently Diagnosed Diabetes (Showing Normal Mean Resistive Index.

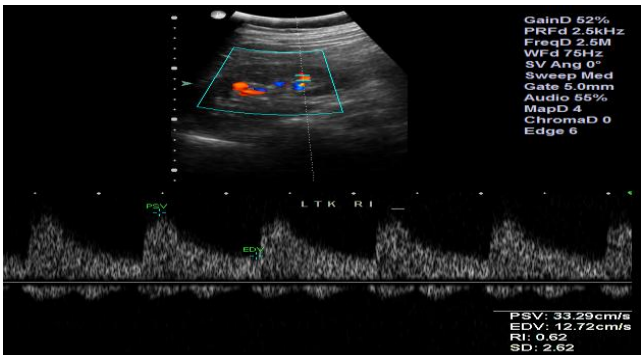


Figure 5 – A 30 year old patient with recently diagnosed diabetes (random blood sugar value 176 mg/dl) showing normal mean resistive index.

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**FIGURE 6:**Shows Diabeticretinopathy

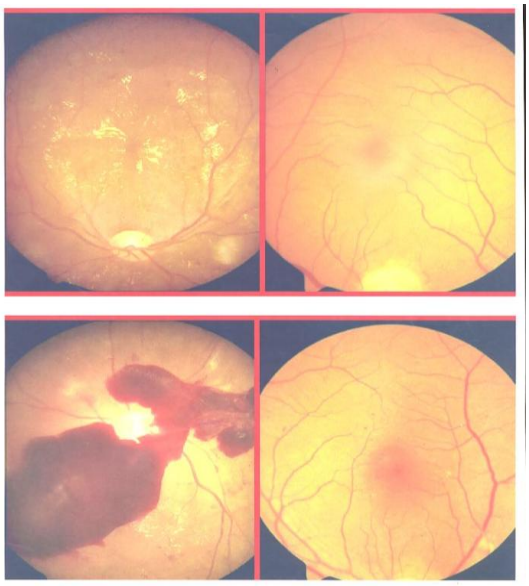

Figure 6 - Fundoscopy images – upper two images showing hard exudates involving all four quadrants with dot ‘n’blot hemorrhage in more than two quadrants with clinically significant macular edema( severe non proliferative diabetic retinopathy).lower images showing severe diabetic retinopathy with vitreous hemorrhage.

**FIGURE 7:**Shows The Hypertensive Retinopathy

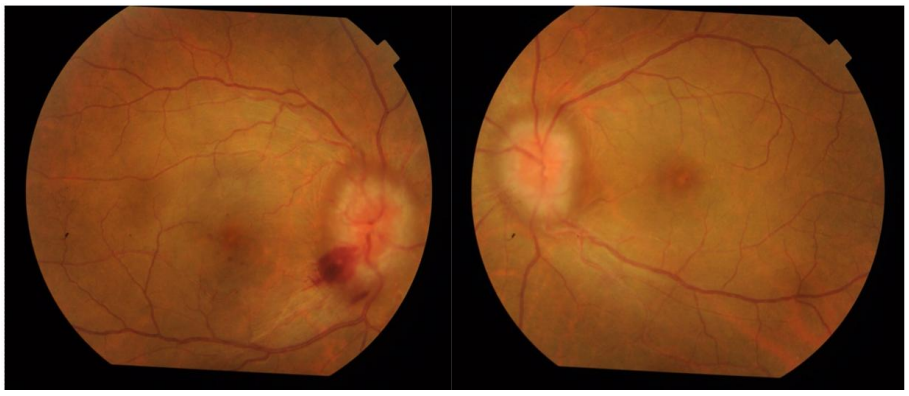

Figure 7 – showing fundoscopy images with grade 4 hypertensive retinopathy according to keith wagner barker classification.Disc margins are blurred with vessel attenuation.flame shaped hemorrhages are seen.macula appears dull.

**TABLE 1-** Comparision Of Changes In Ri And Serum Creatinine Value In Hypertensive Patients After One Year Of Followup.

| | Sensitivity | Specificity | Positivepredictivevalue | Negativepredictivevalue | ‘P’value |
|---|---|---|---|---|---|
| Renalobstruction | 80 | 100 | 100 | 83.3 | <0.0001 |

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| | | | | | |
|---|---|---|---|---|---|
| Diabetes | 84 | 70 | 87.50 | 63.6 | <0.0001 |
| Hypertension | 88 | 80 | 91.6 | 72.7 | <0.0001 |

Table 1- overall sensitivity, specificity, postive predictive value, negative predictive value and 'p' value of renal resistive index

## 7. Discussion

Conventional ultrasound and Doppler provides a non-invasive way of evaluation of kidneys in diabetic nephropathy. Conventional ultrasound evaluation of kidneys in renal diseases is of limited value in most cases after hydronephrosis has been excluded. A few investigators have attempted to use real time sonographic parameters such as relative echogenicity and renal size to identify and characterize renal medical disease.(17,18) This study was designed to evaluate the role of intrarenal resistive index in patients with unilateral acute renal obstruction,diabetes mellitus and hypertensive patients in various stages of disease progression. Biochemical parameters like RBS, lipid profile (total serum cholesterol), HbA1c,serum creatinine and urine parameters like proteinuria were determined and their correlation with conventional ultrasound parameters and resistive index was studied. A total of 120 patients (60 patients with unilateral acute renal calculus ,35 diabetics and 35 hypertensives).(19)

Renal Doppler Ultrasonography is a highly sensitive and specific test that can be useful in the diagnosis of acute unilateral renal obstruction and can be used to measure renal blood flow as well as to calculate RI. The RI is a ratio of peak systolic velocity and end diastolic velocity measured by the Doppler ultrasonography (20-22) . According to the results of our study, with 80% sensitivity and 100% specificity,RI is useful for the early identification of renal colic patients in the emergency department, particularly for those who must avoid radiation and contrast agents.(20)

Diabetic nephropathy is a frequent microvascular complication of Diabetes mellitus. Early functional and structural abnormalities may be present a few years after the onset of the disease. In these last decades, Doppler ultrasonography has provided an easily applicable and noninvasive method for investigating renal haemodynamics. The renal resistive index reflects intrarenal vascular resistance (23,24). The mechanisams for increased RI values in patients with decreased glomerular function is unknown. In advanced DN, glomeruli become sclerotic, tubuli become atrophic, and interstitial fibrosis is increased. Sclerotic glomeruli may cause increased blood flow resistance measurable at an upstream interlobar artery. Increased interstitial fibrosis may cause elevated RI values. studied renal RI in patients with chronic tubulointerstitial nephritis. They found that RI measurement allows the early identification of both normotensive and hypertensive patients with chronic TIN, when renal function is still preserved. Renal RI values were linearly related to uricaemia and to filtration ratio values . In a series published more recently Heine et al. showed that in patients with chronic kidney disease, intrarenal RI linearly increased with a progressive impairment of renal function and independently reflect both local renal damage and systemic vascular disease (25-27) Recently, Liu et al. examining 387 Chinese type 2 diabetic patients demonstrated significantly higher mean RRI values in those with microvascular diabetic complications, including nephropathy, retinopathy or sensory neuropathy, in comparison with subjects without complications.

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In the present study we followed-up patients for twelve months. This study is a part of a longitudinal study in which we follow-up patients with DM and DN and we ask whether serial periodic RI measurements offer advantages over well-proved clinical or laboratory parameters in predicting the progress of the disease. The present study confirms a very good correlation between RI and renal functional parameters with 84% sensitivity and 70% specificity which are correlating with the previous studies. (28)

Confirmed that high RRI is a strong, independent predictor of CV target organ damage and renal dysfunction. A high resistive index is associated with a great difference in velocity between the systolic and the diastolic phase that, in part, depends on the degree of peripheral arterial stiffness.(29) Hypertension may cause nephrosclerosis or glomerulosclerosis, reducing the intrarenal vascular surface area and increasing vascular resistance even in the unaffected kidney.(21) The evaluation of RRI in hypertensive patients reveals significantly higher values than normotensive subjects, even without overt nephropathy. (29) Nevertheless, lower RRI values were associated with low renal and CV target organ damage.(30) This finding is not surprising because patients with hypertension in an early phase maintain stable function even over long periods. This is especially true when a good control of BP is achieved using antihypertensive agents that might convey additional specific CV protection beyond BP control.(31) In this condition, the alteration in renal vascular resistance is probably functional and reversible, partly caused by vascular changes such as vasoconstriction mediated by circulating angiotensin II or other neuroendocrine agents. While in an advanced phase, the alteration is structural and irreversible. Although RRI may not be useful in the differential diagnosis of intrinsic renal disease because it does not differ in the various types of renal parenchymal diseases.(29) It is also well known that high RRI values are associated with poor renal prognosis. Parolini et al.(27) in a group of 86 subjects with hypertensive nephropathies showed that patients with RRI >0.7 were characterized by rapid progression of renal dysfunction and a decrease in eGFR >50 % during 6 years of observation. In an observation of 281 patients with CKD, Sugiura et al.(32) demonstrated significantly higher incidence of worsening renal function in patients with RRI >0.7. Renal resistive index >0.7 together with proteinuria, eGFR\50 ml/min/1.73 m2 and high systolic BP ([140 mmHg) were independent predictors of renal function deterioration. Radermacher et al.,(33) showed that a very high RRI of at least 0.80 or higher reliably identifies hypertensive patients, without renal artery stenosis, at risk for progressive renal disease.(3) Our results suggest that the RI of intrarenal arteries could be a useful marker for early organ damage and might be a predictor of future CV complications in hypertensive patients.

## 8. Conclusion:

Doppler USG is a useful diagnostic tool in unilateral acute renal obstruction. The sensitivity of gray 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. Doppler US must be used routinely in patients with advanced stage renal parenchymal disease. Any increase in the RI values obtained from the main renal and interlobar arteries must bring to mind the possibility of advancing renal damage and progression to chronic medical renal disease. I conclude that Intrarenal resistivity index as assessed by duplex ultrasonography is a non-invasive parameter that can be correlated with the clinical profile and biochemical parameters of renal dysfunction in patients of unilateral acute renal obstruction and chronic medical renal

diseases mainly in type II Diabetes mellitus with diabetic nephropathy and hypertensive nephropathy. It correlates significantly with worsening renal function

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