ROLE OF ULTRASOUND AND DOPPLER IN DIABETIC RENAL DISEASE- CORRELATIVE STUDY WITH BIOCHEMICAL PARAMETERS

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Abstract

INTRODUCTION: Renal ultrasonography and doppler are non-invasive modalities used routinely in patients with azotemia to rule out possible obstructive uropathy, to measure the size of the kidney and to evaluate the renal parenchymal echogenicity. Colourdoppler is used to assess renal vascular resistance by using doppler indices like resistivity index.

AIM: To study the role of grey scale ultrasound, doppler in evaluation of diabetic renal disease and its correlation with biochemical parameters .

Materials and Methods: This cross-sectional study was conducted at MAHARAJA INSTITUTE OF MEDICAL SCIENCES IN Department of Radiology in Vizianagaram India . Ultrasound was done in 50 diabetic patients with grayscale and doppler assessment of both kidneys. Renal characteristics such as renal length , volume and cortical echogenicity, parenchymal thickness, and intra-renal resistive index are correlated with metabolic indicators. All diabetic patients had their blood sugar and urine protein levels measured and the study group is divided into 4 sub-groups based on the clinical stage of diabetic renal disease.

RESULTS: Renal length and parenchymal thickness reduced as disease progressed, Although this finding was not statistically significant.Renal sonographic alterations such as increased parenchymal echogenicity was mostly found in patients of Group III (Overt nephropathy) and IV (renal failure).There was no association between s.creatinine, blood urea nitrogen, and urine protein and renal length or renal parenchymal thickness.In groups II, III, and IV, the RI increased in majority of patients. Even in patients with normal conventional ultrasonography parameters a higher R.I was identified.The intra-renal R.I had positive association with renal functional parameters such as Sr.creatinine and BUN.

Conclusions:

In diabetic renal disease there was no association between s.creatinine, blood urea nitrogen, and urine protein with renal length or renal parenchymal thickness.However the intra-renal R.I had positive association with renal functional parameters .

***Index Terms*— Diabetic renal disease, Intra-renal resistive index, Nephropathy**

I. INTRODUCTION

II. Diabetes type 2 is a significant medical condition that causes a high rate of morbidity and mortality due to micro and macrovascular complications. Diabetes is becoming more frequent all around the world, India is anticipated to be the world's diabetes capital. There are around 70 million diabetic patients in India, with the number anticipated to increase to 100 million by 2030[1].

III. Diabetes is currently the primary cause for chronic renal disease in most nations, including India . Diabetic kidney damage affects 20 to 30% of people after 15 to 20 years of diabetes 2. There are many treatments available to help diabetic nephropathy progress more slowly, but they must be started as soon as possible to be effective.

IV. After 20 years of diagnosis, the cumulative incidence of nephropathy in persons with type 2 diabetes is roughly 25%[3]. Diabetic nephropathy will manifest in 5-10% of them at the time of initial diagnosis, as these people are symptom-free for long periods of time before being clinically diagnosed.

V. Diabetic nephropathy will be a leading cause of morbidity and death in diabetic individuals. Diabetic nephropathy is characterized by persistent albuminuria[4]. Elevated blood pressure, microalbuminuria, and proteinuria are all indicators that glomerular problems are progressing in diabetes individuals.

VI. Cholesterol and LDL cholesterol levels in diabetics are thought as good predictors of atherosclerotic alterations.

VII. Diabetic nephropathy is divided into five stages by the Mogensen staging method, with microalbuminuria as stage 3 (incipient nephropathy). Controlling microalbuminuria is a critical sign for lowering renal and cardiovascular risks in people with Type 2 diabetes[5]

VIII. The most important risk factor for development of diabetic nephropathy is poor glycemic control. Uncontrolled hypertension in patients with poor glycemic control may predispose them even more, according to studies that found individuals with HbA1C >12% and uncontrolled hypertension had a greater risk of developing nephropathy when followed for 20 years[6].

IX. People, who develop type 2 diabetes beyond the age of 50, as well as those with a family history of hypertension and cardiovascular events in first-degree relatives, are more prone to develop nephropathy[7]. Diabetic nephropathy can be avoided entirely by adhering to rigorous glucose and blood pressure guidelines. Diabetic nephropathy screening falls within the category of secondary prevention. Microalbuminuria can be found in Type 1 Diabetes patients who have had the disease for more than five years, as well as Type 2 Diabetes patients who are still in early stages of the disease.

X. Twenty percent of type 2 diabetes patients are likely to develop end-stage renal disease at some time in their lives[8]. Individuals with nephropathy should be identified early and treated appropriately. As a result, slows or prevents the progression of disease to End-Stage Renal Disease.

XI. Diabetic nephropathy has long been diagnosed and monitored using laboratory tests such as urine protein, blood urea, and serum creatinine[9]

XII. Because renal ultrasonography and doppler tests are non-invasive and can rule out obstructive uropathy, quantify kidney size, and evaluate renal parenchymal echogenicity, they are routinely used in patients with azotemia[10]. Many research are currently focusing on the use of Doppler in the assessment of renal vascular resistance.Using Doppler indices such as the resistive index in various systemic disorders such as Diabetes mellitus and Systemic hypertension. Traditional ultrasonography and renal Doppler assessment have been shown to be useful in early detection of diabetic renal disease in investigations[11].

XIII. The purpose of this study is to determine role of greyscale ultrasound and doppler in the evaluation of diabetic renal disease, as well as the relationship between biochemical parameters .

Material and Methods

It is a cross sectional study done in MIMS hospital Nellimarla from June 2021 to May 2022 in 50 patients with type 2 diabetes mellitus over the age of 18 years

- Every case have undergone certain biochemical parameters like FBS, serum creatinine, blood urea, total cholesterol and triglycerides. Urine analysis parameters like microalbuminuria, urine protein (albumin), Urine sugar and microscopic findings will be recorded in all cases.
- For all the cases both kidneys will be examined by color doppler ultrasound unit using 3.5 MHz convex array probe.
- The study group will be divided into 4 sub-groups based on the clinical stage of diabetic renal disease.
  - Sub group I-Preclinical(< 30mg/dlNo albuminuria)
  - Sub group II-Incipient nephropathy(>30 – 300mg/dl-Microalbuminuria),
  - Sub group III- Overt nephropathy(>300mg/dl – Macroalbuminuria),
  - Sub group IV- Renal failure(SrCreatinine>1.4 mg/dL) .
- Renal ultrasonographic evaluation was done using a 3 - 5 MHz probe to examine both kidneys with patient in supine position, and the sonologist on the patient's right side. The kidney is viewed in the longitudinal axis.Conventional ultrasound parameters were evaluated (Renal length ,Thickness of parenchyma and Echogenicity of the renal cortex)

Renal cortical echogenicity is graded:

There are four categories of renal cortical echogenicity:

Normal (grade 0). The cortical echogenicity of right kidney should be lower than that of the liver.

Grade I: The cortex of right kidney has the same echogenicity as the liver.

Grade II: The right kidney cortex has a higher echogenicity than the liver but a lower echogenicity than the renal sinus.

Grade III: Renal cortex has the same echogenicity as the renal sinus (7,8).

Doppler of the Renal System:

The study used a convex array probe with a frequency range of 3 to 5 MHz.

The kidneys were seen longitudinally with the transducer positioned obliquely as stated before.

Color-coded Doppler was used to visualize intrarenal arteries.

Volume of doppler sample:2-4 mm

Angle: <60 degrees

Doppler duration: 5 minutes

Parameters calculated PSV, EDV, RI

The following Doppler Ultrasound Indices were measured:

R.I : PSV-EDV/PSV Where:

R.I. - Resistive index

PSV - Peak systolic flow velocity EDV - End diastolic flow velocity are taken

Biochemical parameters

Blood FBS , Sr. Creatinine, Triglycerides ,Total cholesterol, BUN ,Urine protein, Urine sugar,

Microsopicresults.

The correlation was drawn between the various biochemical parameters recorded and Sonographic parameters by statistical analysis.

STATISTICAL METHODS

Stastical data analysed by appropriate tests of significance (like chi square test , correlation and ANOVA sensitivity, specificity, positive predictive value, negative predictive value, accuracy).

RESULTS

- In 50 patients of type II diabetes. Male predominance was seen. The male: female ratio was 3:1(Figure/table 1)
- The majority of the patients had D.M. for 6 to 10 years, 28 percent for 11 to 15 years, 24 percent for less than 5 years, and 16 percent for more than 15 years. The average D.M. lasted 10.6 + 6.13 years(Figure/table 2).
- Lt. Kidney's mean renal length and parenchymal thickness were slightly larger than Rt kidney(Figure/table3)
- Grade I echogenicity was seen in 42% of the cases, and Grade II echogenicity was observed in 32% of the cases(Figure/table4).
- Doppler Resistive Index was high in 66% of the cases. The mean Doppler resistive index was 0.75034 + 0.113(Figure/table5).
- Distribution based on biochemical parameters: The mean FBS was 192.6 + 105.49; The mean BUN was 31.22 + 23.16, The mean creatine was 2.08 + 1.87, The Total mean cholesterol was 171.96 + 32.32, The mean Triglycerides was 151.62 + 83.34. The p-value was statistically significant(Figure/table6).
- Based on final diagnosis In the majority of the patients had Renal failure(36%), 30% had preclinical diabetic nephropathy, 18% had overt nephropathy, and 16% had Incipient nephropathy(Figure/table7).
- In correlation of USG echogenicity with a final diagnosis

Out of 50 cases 42% of the cases had Grade I echogenicity, and 32% of the cases had Grade II echogenicity. Of Grade I cases, 2% had preclinical nephropathy, 2% had overt nephropathy, and 14% of the cases had renal failure(Figure/table8).

- Correlation of doppler resistivity index with a final diagnosis

Out of 50 cases, the Doppler resistivity index was high in 66% of the cases. Of which preclinical nephropathy was seen in 8% of the cases, Incipient nephropathy was seen in 10% of the cases, Overt nephropathy was seen in 14% of the cases, and renal failure was seen in 34% of the cases. The p-value was statistically significant(Figure/table9).

- Correlation-based on Ultrasound, Doppler and biochemical parameters

There was no correlation between FBS, total cholesterol, or triglyceride levels and any of the ultrasonography or Doppler measurements. The remaining ultrasonography measures had relationship with renal cortical echogenicity grading and RI, whereas BUN, serum creatinine& urine protein had a marginally favourable relationship with renal cortical echogenicity grading and RI.(Figure/table10)

Figures and Tables

Gender	**Frequency**	**Percentage**
Male	**38**	**76%**
Female	**12**	**24%**

Figure/table 1: Distribution based on gender

Renal Length	**Mean ±S.D**	**p-value**
RK	96.76±14.57	0.002
LK	99.64 ±9.17	
Parenchymal thickness		
RK	15.54 ±2.41	0.999
LK	16.76 ±3.25	

Figure/table 2: Distribution based on duration Diabetes Mellitus

Figure/table 3: Distribution based on the renal length, Parenchymal thickness

Echogenicity	Frequency	Percentage
Normal	13	26%
Grade-I	21	42%
Grade-II	16	32%

Figure/table4: Distribution based on ultrasound Echogenicity

Doppler Resistive Index	Frequency	Percentage
Normal (<0.7)	17	34%
High (>0.7)	33	66%

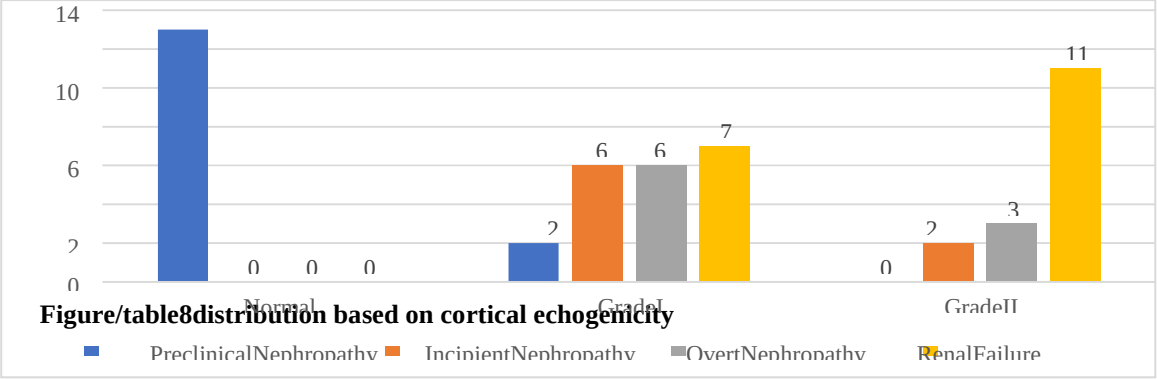
Figure/table5: Distribution based on Doppler Resistive Index Doppler Resistive Index was high in 66% of the cases. The mean Doppler resistive index was 0.75034 + 0.113.

Parameter	Mean ± S.D	p-Value
FBS	192.6 ± 105.49	<0.001
Blood Urea Nitrogen	31.22 ± 23.16	<0.001
Creatinine	2.08 ± 1.87	<0.001
Total Cholesterol	171.96 ± 32.32	<0.001
Triglycerides	151.62 ± 83.34	<0.001

Figure/table6: Distribution based on biochemical parameters

Final Diagnosis	Frequency	Percentage
SubgroupI	15	30%
SubgroupII	8	16%
SubgroupIII	9	18%
SubgroupIV	18	36%
Total	50	100%

Figure/table7: Distribution based on final diagnosis

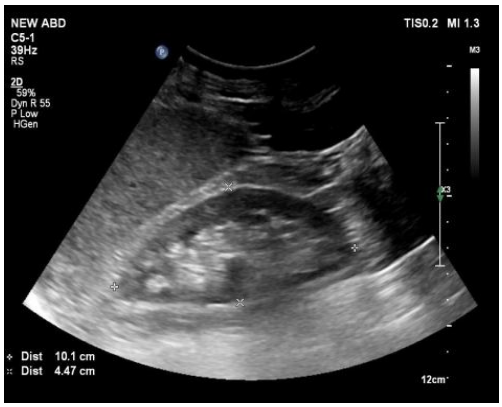


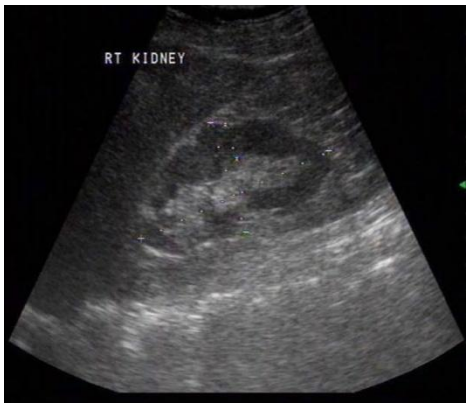
Figure/table8distribution based on cortical echogenicity

Figure/table9:Correlation of doppler resistivity index with a final diagnosis

	(R.K.)	(L.K.)	(R.K.)	(L.K.)	echogenicity (Grade)	R.I. value (Doppler)
FBS (mg/dl)	-0.0576	0.1225	-0.1370	0.0170	0.2536	0.1479
BUN (mg/dl)	0.0430	0.0765	-0.1516	0.0853	0.5458	0.5014
Creatinine (mg/dl)	-0.0756	-0.0685	-0.2494	0.0393	0.4911	0.4533
Total Cholesterol (mg/dl)	0.0444	-0.0848	-0.0065	-0.1483	0.2836	0.0884
TG (mg/dl)	-0.0414	-0.0720	0.0715	-0.2137	0.0681	-0.0505
Urine Protein (Alb)	-0.1213	-0.1303	-0.0093	0.0929	0.4116	0.4503

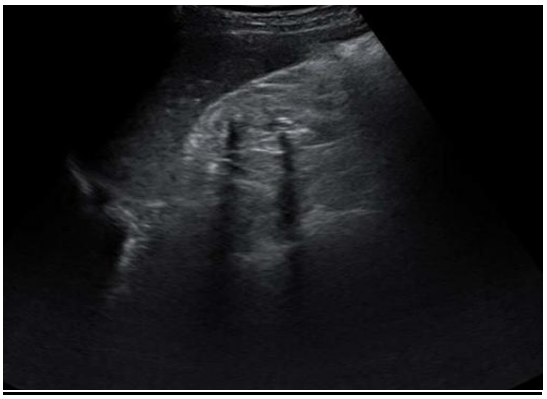
Figure/table10: Correlation-based on Ultrasound, Doppler and biochemical parameters



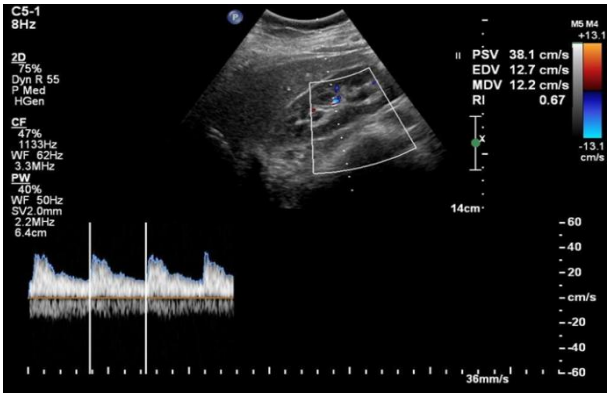


Figure/table11:Right kidney parenchymal echogenicity is normal, Figure/table12: grade 1 increase in echogenicity

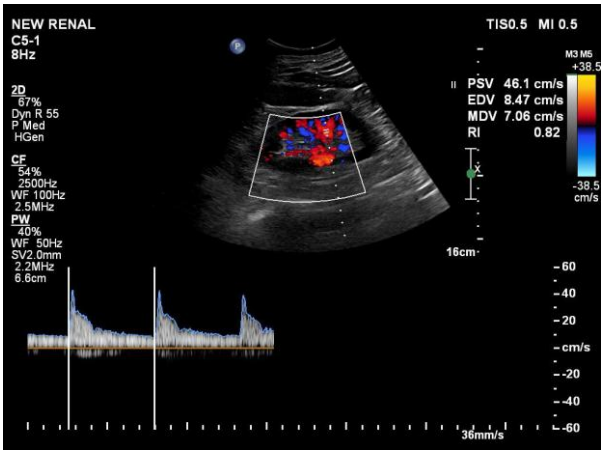
	Preclinical Nephropathy	Incipient Nephropathy	Overt Nephropathy	Renal Failure
Normal(<0.7)	11	3	2	1
High(>0.7)	4	5	7	17
Chi-square	17.431			
p-value	0.0005			



Figure/table 13 : grade III parenchymal echogenicity



Figure/table 14: The left midpole interlobar artery's normal spectral waveform and resistance index were recorded



Figure/table 15: Spectral waveform showing increased resistive index recorded from lower pole interlobar artery

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Conflicts of interest

There are no conflicts of interest.

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