The Study of Ultrasound and Doppler in Diabetic Renal Disease Correlative Study with Biochemical Parameters. -A Cross Sectional Study

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ABSTRACT-
Background: Diabetes mellitus affects the whole vascular system, leading to both microvascular and macrovascular complications [1]. Diabetic nephropathy is the dreadful microvascular complication of diabetes mellitus, which lead to end stage kidney disease (ESKD), which increase the risk of cardiovascular mortality [2]. Duplex sonography of the renal artery provides an easily applicable, non-invasive, and well-established way to assess changes in renal vasculature caused by diabetes [5]. In this study, detecting subtle changes in renal vasculature with renal artery Doppler, particularly RI (RESISITIVE INDEX) values, and correlating with biochemical parameters such as creatinine, and urine albumin, helps the physician for accurate management of diabetes patients preventing complications. **Objective**: Evaluation of renal sono-morphological characteristics using gray scale ultrasound and renal vascular resistance by doppler in patients with diabetic renal disease. Correlation among renal ultrasound, colour doppler, and biochemical parameters in diabetic renal disease . **Methods**: A time-bound, cross-sectional study, was conducted in the Department of Radio-diagnosis, M.G.M. Medical College and M.Y. Associate Hospital, Indore, Madhya Pradesh, India after receiving approval from Institutional Scientific and Ethical Committee. The duration of the study was from September 2022 to September 2023. A total of 108 patients of type II diabetes mellitus were included in the study. **Results**: out of total 108 of patients who were diagnosed with type II diabetes mellitus ,maximum no of patients (28.7%) in age group of 50-60 years. .In our study, male preponderance was observed in our study with 65.74% patients being male. On basis of biochemical parameters divided in 4 subgroups majority of patients 38% were fall under subgroup IV (renal failure) followed by subgroup I(preclinical) 27.8 %, subgroup II (incipient nephropathy) 18.5% and subgroup III (overt nephropathy) 18.5%. Majority of patients in subgroup IV (renal failure) 76.2 to 81.5% revealed gradeII /III renal parenchymal echogenicity changes.In our study most of the patients belonging to subgroup I (80%) had normal RI value while most of the patients belonging to subgroup II (70%), subgroup III (80%) and subgroups IV (94.74%) had increased RI values indicating raised renal vascular resistance as the disease progresses. R.I shows strong positive correlations with Blood Urea Nitrogen (BUN) ,Urine protein (Alb) and Creatinine levels higher R.I may coincide with elevated levels of these renal function markers. **Conclusion**: our study demonstrates Renal Doppler is a non-invasive modalitythat can be used in association with biochemical parameters of patients with diabetic nephropathy. An increasing intra-renal resistive index value could prompt the physician to a more rigid control of blood sugars and hypertension inthis subgroup of diabetic patients delaying the progression to end-stage renal failure .

Keywords: Renal doppler, resistive index, creatinine, diabetes.

INTRODUCTION:

This Diabetes mellitus (DM) is typified by hyperglycemia brought on by a malfunction in either the action or secretion of insulin, or both. Globally, it is a significant contributor to morbidity and mortality.Diabetes mellitus affects the whole vascular system, leading to both microvascular and macrovascular complications [1].Among various microvascular complications, Diabetic nephropathy is the dreadful microvascular complication of diabetes mellitus, which lead to end stage kidney disease (ESKD), which increase the risk of cardiovascular mortality [2].

Approximately 463 million adults aged 20–79 years are currently living with diabetes. Approximately 30-40 % patient of type 2 diabetes and 40 -50 % of patients of type 1 diabetes are affected by microvascular complications.Almost half (46.2%) of deaths associated with diabetes occur in people under the age of 60 years [1].It is estimated that death owing to renal disease is 17 times more common in diabetics than in nondiabetics. Along with other causes of chronic kidney disease, diabetic nephropathy is a major contributor to end-stage renal disease worldwide, in both developed and developing nations [3]. In kidney, renal pathological changes leading to diabetic nephropathy are mainly secondary to atherosclerosis of the intrarenal and extrarenal arteries together with microangiopathy of the glomerular capillaries,

afferent arterioles, and efferent arterioles, which lead to increased resistance in vascular bed, which further lead to microalbuminuria which is the earliest detectable change in diabetic nephropathy [4]. Duplex sonography of the renal artery provides an easily applicable, non-invasive, and well-established way to assess changes in renal vasculature caused by diabetes [5].Resistive index (RI), one of the parameters in the renal artery doppler, is the ratio of the maximum flow velocity obtained from the Doppler measurements of the main renal and intrarenal arteries to the difference between the maximum and minimum (end-diastolic) flow velocity.

In this study, detecting subtle changes in renal vasculature with renal artery Doppler, particularly RI (RESISITIVE INDEX) values, and correlating with biochemical parameters such as creatinine, and urine albumin, helps the physician for accurate management of diabetes patients preventing complications [5].

MATERIAL AND METHODS:

A time bound, cross-sectional study, was conducted in the Department of Radio-diagnosis, M.G.M. Medical College and M.Y. Associate Hospital, Indore, Madhya Pradesh, India after receiving approval from Institutional Scientific and Ethical Committee.The duration of the study was from September 2022 to september2023. A total of 108 patient of type II diabetes mellitus were included in the study.

INCLUSION CRITERIA: Patients diagnosed as type II diabetes mellitus.Age of the patients: above 20 yrs.Both sexes included.

EXCLUSION CRITERIA: Patients with glomerular or tubulointerstitial diseases other than diabetic renal disease. Patient with severe uncontrolled hypertension.

STUDY PROTOCOL: Patient with type II diabetes mellitus referred to the Department of Radiodiagnosis for their KUB ultrasonography were enrolled for the study after the inclusion and exclusion criteria were applied . The study group was divided into four main subgroups based on biochemical data and the clinical stage of diabetic renal impairment.

Subgroup I: Patients with type II diabetes who do not exhibit any signs of diabetic kidney damage, either clinically or biochemically. Subgroup II: Type II diabetic patients with incipient diabetic nephropathy as reflected by presence of microalbuminuria (urine albumin excretion in the range of 30 to 300 mg/dl which is not detected by routine methods used for the detection of urine protein. Subgroup III: Patients with type II diabetes who had overt proteinuria (nephropathy) but no signs of renal impairment, such as elevated blood urea nitrogen and serum creatinine. Subgroup IV: Type II diabetic patients in renal failure secondary to diabetic nephropathy.
Patients informed consent was acquired, and patient privacy was upheld.
A thorough medical history was obtained, and a clinical examination was carried out.
All examinations were performed using a low frequency 3.5 MHz convex array probe.

Ultrasound technique:

POSITIONING: Patients Patient was put in supine position. Use adequate amount of gel. Ultrasound probe positioned gently on the flank in an oblique projection and kidney visualized in longitudinal axis. The right kidney was examined in the supine position through the liver. The transducer was angled obliquely if the liver was small. With the patient in the left side-up position, his/her left arm extended over the head and using a coronal approach the kidney was visualized through the spleen.

CONVENTIONAL ULTRASOUND PARAMETERS MEASURED:

Length of the kidneys : The most exact measurement of renal size is renal volume, which shows strongest correlation with height, weight and total body area.Bipolar renal length is accepted in literature as a good indicator of renal size.

Renal cortical echogenicity : Literature suggests that the normal adult renal cortex is less echogenic than adjacent normal liver, while renal cortical echogenicity equal to or greater than the echogenicity of the liver indicates kidney disease.

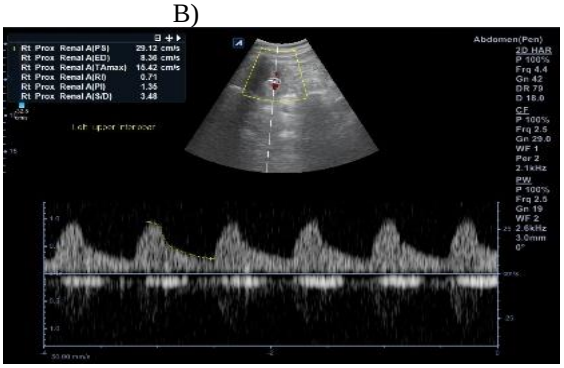
Renal doppler : Correlation was drawn between the various biochemical parameters recorded and the ultraso.und and Doppler parameters by statistical analysis

CASE 1 64 year old diabetic male belongs to overt nephropathy subgroup III

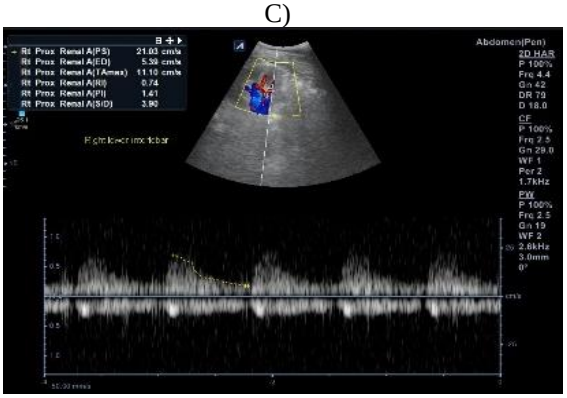
A)

B)

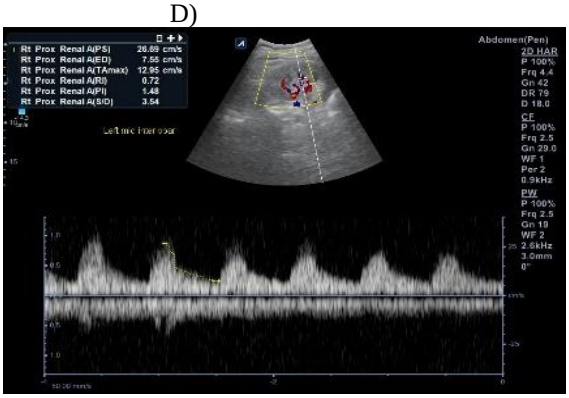
C)



D)



E)



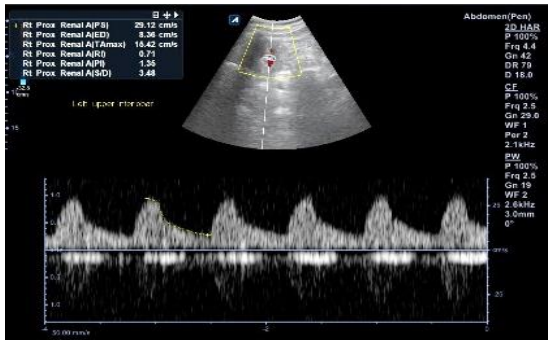
F)

On B- mode TAS abdominal ultrasound, A) and B) image showing Right kidney measures 7.5cm and left kidney measures 7cm with bilateral raised renal echotexture.
On color doppler, C), D) , E) and F) showing mean renal resistive index of bilateral kidney was raised (0.74.)

CASE 2 68 year old diabetic male belong to overt nephropathy subgroup III

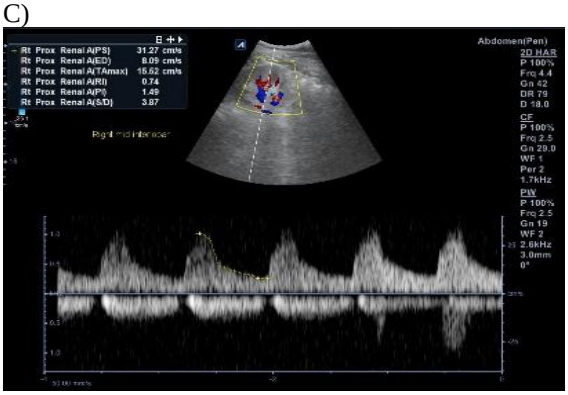
A)

B)



B)

C)



E) F)

On B- mode TAS abdominal ultrasound, A) and B) image showing Right kidney measures 10.8cm and left kidney measures 8cm with bilateral raised echotexture.
On color doppler, C), D) , E) and F) showing mean renal resistive index of bilateral kidney was raised (0.72)

STATISTICAL ANALYSIS: Correlation was evaluated using Analysis of Variance (ANOVA) and Pearson correlation. Data is considered significant at 5% level of significance (p- value <0.05). Statistical Package for the Social Sciences (SPSS) software version 25.0 was used for statistical analysis.

RESULTS:
Out of total 108 of patients who were diagnosed with type II diabetes mellitus ,maximum no of patients (28.7%) in age group of 50-60 years.In our study, male preponderance was observed in our study with 65.74% patients being male. In our study majority of patients 35.19% had diabetes of 5 to 10 years duration.

Table no. 1 Distribution of patients into various subgroups based on biochemical parameters.

Sub groups	No of patients (N)	Percentage (%)
Subgroup I (preclinical)	30	27.8
Subgroup II (incipient nephropathy)	20	18.5
Subgroup III (overt nephropathy)	20	18.5
Subgroup IV (renal failure)	38	35.2

In our study majority of patients were in subgroup IV (35.2%) followed by subgroup I (27.8%) subgroup III (18.5%) and subgroup IV (18.5%).

Table no. 2 Distribution of patients on the basis of right renal echogenicity in various subgroups .

Subgroups	Echogenicity (Grade)				Total
	Normal	Grade I	Grade II	Grade III	

	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)
Subgroup I	26	86.6	4	13.3%	0	0 %	0	0	30	100 %
Subgroup II	14	70	5	25 %	1	5 %	0	0	20	100 %
Subgroup III	11	55%	5	25 %	4	20 %	0	0	20	100 %
Subgroup IV	0	0	12	31.5%	21	68.4%	5	13.15	38	100 %

subgroup I predominantly revealed normal echogenicity. Subgroup II shows mostly normal echogenicity but some cases exhibits grade I (25%) renal parenchymal echogenicity and grade II (5%) renal parenchymal echogenicity.20% of patients in subgroup III revealed grade II renal parenchymal echogenicity. Majority of patients in subgroup IV (81.5%) revealed gradeII /III renal parenchymal echogenicity changes.

Table no. 3 Distribution of patients on the basis of left renal echogenicity in various subgroup.

Final Diagnosis	Echogenicity (Grade)								Total	
	Normal		Grade I		Grade II		Grade III			
	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)	(N)	(%)
Subgroup I	28	93.3	2	6.6	0	0	0	0	30	100
Subgroup II	15	75	3	15	2	10	0	0	20	100
Subgroup III	10	50	6	30	4	20	0	0	20	100
Subgroup IV	0	0	9	23.6	23	60.5	6	15.7	38	100

Subgroup I predominantly revealed normal echogenicity. Subgroup II shows mostly normal echogenicity but some cases exhibits grade I (15%) renal parenchymal echogenicity and grade II (10%) renal parenchymal echogenicity.20% of patients in subgroup III revealed grade II renal parenchymal echogenicity. Majority of patients in subgroup IV (76.2%) revealed gradeII /III renal parenchymal echogenicity changes.

Table no. 4 Distribution of patients on the basis of RI in various subgroups **.**

Final Diagnosis	Doppler (Resistivity Index)		Total
	Normal (<0.7)	High (>0.7)	
Subgroup I	24 80 %	6 20 %	30 100 %
Subgroup II	6 30 %	14 70 %	20 100 %
Subgroup III	4 20 %	16 80 %	20 100 %
Subgroup IV	2 5.26%	36 94.74%	38 100 %
Total	36	72	108

Most of the patients in the subgroup I (80 %) had a normal resistive index value on colour doppler examination .70 % of patients in subgroup II revealed increased RI value on colour doppler examination , whereas 80%- 94.7% patients in subgroup III- subgroup IV respectively revealed increased R.I values in our study.

Table no. 5 Pearson Correlation between ultrasound, Doppler and biochemical parameters

Parameters	Renal length (RK)	Renal length (LK)	Echogenicity (Grade)	R.I value (Doppler)
Blood Urea Nitrogen (mg/dl)	r = 0.047	r = 0.066	r = 0.453	r = 0.781
Creatinine (mg/dl)	r = -0.072	r = -0.058	r = 0.471	r = 0.956
Urine Protein (Alb)	r = -0.121	r = -0.130	r = 0.461	r = 0.712

Renal length (RK and LK) shows weak positive correlations with Blood Urea Nitrogen (BUN) ,Urine protein (Alb) and Creatinine levels in our study. Echogenicity (Grade) exhibits moderate positive correlations with BUN, Creatinine, and Urine Protein (Alb) suggesting that higher grades of echogenicity may coincide with elevated levels

of these renal function markers. R.I shows strong positive correlations with Blood Urea Nitrogen (BUN), Urine protein (Alb) and Creatinine levels, higher R.I may coincide with elevated levels of these renal function markers.

DISCUSSION

Out of 108 patients, Male preponderance was observed in our study with 65.74% patientsbeing male. Female were 34.25% in our study. A similar study by M.Naroei Nejad et al (2009),where among diabetics 58% of the patients were men.

In our study increased serum creatinine level >1.4 mg/dl level were seen in 35% . 64% in our study had normal serum creatinine level. This indicates that a majority of the patients had creatinine levels within the normal range, with a minority showing elevated levels. Similar studies done by Sari Ahmet et al (1996) also reflected that 38.24% had increased serum creatinine level >1.4mg/dl and 61.76% reflected normal serum creatinine level.

On basis of biochemical parameters cases were divided in 4 subgroups. Majority of patients 35.2% were fall under subgroup IV renal failure followed by subgroupI preclinical (27.8 %), subgroup II incipient nephropathy(18.5%) and subgroup IIIovert nephropathy (18.5%) . A similar results were obtained in the study by ManishShaw et al (2015), where 36.6% % of patients were under subgroup IV renal failure, followed by subgroup I preclinical (28.3%) , subgroup II incipient nephropathy (18.3%) and subgroup III overt nephropathy (16.6%).

In our study most of the patients belonging to preclinical subgroup I (80%) had normal RI value while most of the patients belonging to subgroup II (70%), subgroup III (80%) and subgroups IV (94.74%) had increased RI values indicating raised renal vascular resistance as the disease progresses. It might probably be indicating a raised peripheral vascular resistance due to arteriosclerosis in intrarenalvasculature. A similar study done by Manish Shaw et al 2016 most of the patients belonging to preclinical subgroup I (70.5%) had normal RI value while most of thepatients belonging to subgroup II (72.7%), subgroup III (80%) and renal failure subgroups IV (90.9%) had increased RI values.

Sai Shankar et al 2019 The grouping I (preclinical) had somewhat higher mean resistive index values (>0.7), indicating that doppler ultrasound may be able to identify diabetic kidney disease at an early stage. When diabetic nephropathy progressed, resistive index values increased with time.

In our study Pearson Correlation coefficient method of statistical analysis was used for drawing correlations between ultrasound, doppler, and biochemical parameters. Renal length (RK and LK) shows weak positive correlations with Blood Urea Nitrogen (BUN) ,Urine protein (Alb) and Creatinine levels in our study. Echogenicity (Grade) exhibits moderate positive correlations with BUN, Creatinine, and Urine Protein (Alb) suggesting that higher grades of echogenicity may coincide with elevated levels of these renal function markers. R.I shows strong positive correlations with Blood Urea Nitrogen (BUN) ,Urine protein (Alb)and Creatinine levels higher R.I may coincide with elevated levels of these renal function markers. A similar study done by Manish Shaw (2016) previous investigations have observed a strong positive association between serum creatinine and resistive index previous investigations have observed a strong positive association between serum creatinine and resistive index [1,17,40].

LIMITATIONS: Acknowledging the limitations of this study, Our study was a cross sectional study and thus no follow up was possible and the changes in the various parameters over time could not be measured.

CONCLUSION:

our study demonstrates Renal Doppler is a non-invasive modal ity that can be used in association with biochemical parameters of patients with diabetic nephropathy. An increasing intra-renal resistive index value could prompt the physician to a more rigid control of blood sugars and hypertension inthis subgroup of diabetic patients delaying the progression to end-stage renal failure.

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