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ULTRASONOGRAPHY IN DIABETIC NEPHROPATHY AND ITS CORRELATION WITH RENAL FUNCTION TESTS.

Radiodiagnosis

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ABSTRACT

PURPOSE- To document the ultrasound finding in Diabetic nephropathy patients and to correlate them with renal function studies..
METHODS- Two groups (56 chronic diabetic patients ,49 normal controls) were studied .All of them had ultrasonography of kidneys for studying renal morphology and renal doppler indices.All the participants had blood and urine studies done as part of renal function.
RESULTS-. In the diabetic group, the size of the kidneys was smaller compared to the controls and the renal resistive index was significantly increased. Serum creatinine levels showed good correlation with the renal resistive index.
CONCLUSIONS-. The present study suggests that imaging of the renal by sonography (gray scale as well as Color Doppler imaging) is helpful in assessment of the long term complications of diabetes mellitus like diabetic nephropathy.

KEYWORDS

Diabetic nephropathy,Renal ultrasonography- renal morphology and renal doppler- renal function studies-correlation.

INTRODUCTION

Evidence from literature suggests that approximately half of the diabetics in the population are undiagnosed, (1). The long-term microvascular complications of diabetes mellitus include Diabetic peripheral neuropathy,Diabetic nephropathy and Diabetic retinopathy, Sonography is a safe and an easily available method, increasingly used nowadays for the assessment of complications of diabetes mellitus especially Diabetic Nephropathy.The gray scale findings like renal size and cortical echoes as well as the Color Doppler duplex Sonography of the renal arteries are assessed in Diabetic Nephropathy. Currently, there is limited literature available on the correlation of Renal Doppler(2) with the laboratory values like HbA1c levels, serum creatinine, urinary microalbuminuria in Diabetic Nephropathy .

The present study proposes to assess the severity of the long-term microvascular complications especially Diabetic nephropathy by non-invasive imaging methods like Gray – Scale Ultrasound imaging and Color Doppler Duplex Sonography and correlates these imaging findings with the clinical, laboratory indices of these disease complications.

MATERIALS AND METHODS

Fifty six patients (30 males and 26 females) with type 2 diabetes,from our Diabetic clinic outpatient department, were enrolled in this..Our control group consisted of 49 healthy volunteers(28 males and 21 females) without diabetes mellitus. None of the participants received hemodialysis.

All the participants gave their full consent in writing. The procedures followed were in accordance with the ethical standards of the committee on human experimentation of our institution.Their physical measurements like height,weight,BMI ,blood pressure,etc. were calculated. (Table-1).All the participants had their blood tests for glucose (fasting and post prandial, random),HbAc1 ,blood urea,serum creatinine, and urine for microalbuminuria(Table-2)

A.Inclusion criteria:
Known case of type–II Diabetes mellitus for more than 10 years on treatment (with either insulin or oral hypoglycemic drugs or both) registered in the diabetic clinic of our institute.

B. Exclusion criteria:
1. Patients on hemodialysis for end stage renal disease (due to altered laboratory parameters confounding the study)
2. Patients with Essential Hypertension JNC-7 Stage II(SBP > 160 mm Hg, and DBP > 100 mm Hg). The renal resistive index is altered significantly with patients having blood pressure higher than 160/100 mm Hg. Patients with pre hypertension and JNC-7 Stage I Hypertension (SBP 120 – 159 mm Hg and DBP 80 – 99 mm Hg) however are included in our study(36)
3. Patients with high Body Mass Index (more than 40 kg/ m2) were retrospectively excluded from the study because obtaining renal Doppler indices was technically difficult .
4. Patients known to have other endocrine disturbances like hypothyroidism or Cushing's syndrome, etc. were excluded.

RENAL IMAGING WITH B-mode and COLOR DOPPLER

After due Patient preparation ultrasonography was done.

The mean length of the normal adult kidneys was 10.7 cm for right kidney and 11.1 cm for left kidney (range 9 – 12 cm)..

Color Doppler duplex ultrasound of the intra-renal vasculature was assessed at the level of interlobar and the arcuate arteries in the upper, mid and lower poles .Renal arterial flow was assessed at the renal hilum, in the middle of the renal artery as well as at its origin from the aorta.. An average of three consecutive values was taken as the final measurement.

The parameters obtained were:
I. Gray Scale imaging
1. Renal size (Length and Width)
2. Renal cortical echotexture
3. Corticomedullary differentiation

II. Color Doppler imaging
1. Peak systolic velocity
2. End diastolic velocity
3. Resistive Index
4. Spectral pattern

The Ultrasound equipment model used was PHILIPS HD 11 with gray scale and Color and Power Doppler facility .It was equipped with automatic measurement facility for the vascular parameters in Doppler study. Low frequency (3.5 – 5 MHz transducer) convex probe was used to study the kidneys. For Doppler assessment, the pulse repetition frequency (PRF) was kept as low as possible, with use of appropriate wall filter and a sampling width of 2 to 5mm.

STATISTICAL ANALYSIS

i).Baseline comparisons were done using Student's unpaired t–test, for the Body mass index and age of the diabetic versus the control group. Ii).Student's t–test was used to compare the patient group and the control group for various parameters obtained from renal ultrasound and Doppler study .

OBSERVATIONS AND RESULTS

Baseline comparability of diabetic and control groups
Out of the 56 diabetic subjects (30 males and 26 females) from 49 to 73 years of age, 7 subjects had a normal BMI (ranging from 18 to 24.9 kg/m2), 39 of them are in the borderline range (25 to 29.9 kg/m2) and the rest 10 of them had a BMI of more than 30.

Duration of diabetes ranged from a minimum of 10 years up to 25 years in our study group. In the control group, out of the 49 controls (28 males and 21 females) aged 49 to 68 years, 14 controls had a normal BMI, 19 of them are in the borderline range and 16 of them had a BMI more than 30. The age, height, weight, BMI and diastolic blood pressure of both the groups are comparable at baseline. The systolic blood pressure of the diabetic group was significantly higher than the control group ($p < 0.0001$). The demographic data of the groups is shown in Table 1

Comparison of the laboratory parameters and correlation with sonographic imaging findings

The fasting and 2-hour plasma glucose levels (after a 75 gram oral glucose challenge test) were obtained both in the diabetic and control group. In the diabetic group, all the subjects had either an increased fasting glucose (>126 mg/dl) or increased 2-hour plasma glucose levels (>200 mg/dl) or both. Among the 49 controls, 36 had an impaired glucose tolerance (defined as a fasting glucose of 100 – 125 mg/dl or 2 hour plasma glucose of 140 – 199 mg/dl) or both. Random blood glucose in the control group was been obtained and none of them is more than 200 mg/dl. There was a statistically significant difference in the blood glucose levels between the diabetic and the control groups($p<0.01$).

HbA1c levels – Comparison with laboratory and imaging findings:

The distribution of HbA1c levels in the diabetic and control group is shown in Graph 2.In the diabetic group, 49 out of 56 subjects had an HbA1c of more than 6.5% which suggests poor glycemic control. In the control group, there was no value of HbA1c more than 6%. In the diabetic group, there was a positive correlation between the level of HbA1c and the 2 hour plasma glucose ($r= 0.67$ and P value < 0.0001). The control group however did not show similar correlation. The duration of diabetes mellitus in the study group also had a positive correlation with the HbA1c levels HbA1c levels in the diabetic group also showed significant positive correlation with serum creatinine, urinary microalbuminuria and renal resistive index (Graph 1) which are indices of the stage and severity of diabetic nephropathy. The above observations imply that a poor glycemic control is associated with progression of diabetic nephropathy as evidenced by a rise in serum creatinine, urinary levels of albumin and an elevated renal resistive index obtained from the renal arterial Doppler study.

Diabetic nephropathy – our imaging findings:

The gray scale and Color Doppler imaging findings of diabetic and control groups are shown in Table 3. In the diabetic group, the size of the kidneys was smaller compared to the controls and the renal resistive index was significantly increased ($p <0.01$)(3) Serum creatinine levels showed good correlation with the renal resistive index (The Pearson's correlation coefficient $r = + 0.66$, p value <0.01) (4). The renal size (both the length and the width of kidneys) had a good negative correlation with the level of serum creatinine as well as the renal resistive index in the diabetic group implying that changes in renal morphology, renal arterial hemodynamics and renal function occur simultaneously and progress hand in hand in diabetic nephropathy (5).. Moreover, urinary levels of microalbuminuria did not show significant correlation with the renal Sonographic findings or Renal Doppler study.

DISCUSSION

The present study showed a significant positive linear correlation between the renal resistive index and serum creatinine levels.(Graph 2) Serum creatinine level indicates the degree of diabetic nephropathy and acts as a serum marker of the degree of renal impairment. The correlation between RI and Serum creatinine found in the present study suggests that renal resistive index is helpful in evaluation of patients with diabetic nephropathy(8)

There was a significant positive correlation between renal resistive index and HbA1c levels which is a marker of glycemic control. The degree of renal hemodynamic changes reflected in the resistive index depends upon the degree of renal arteriolosclerosis that is affected by the adequacy of the glycemic control. In conclusion(10), the present study suggests that a strict control of blood glucose levels is absolutely essential to prevent the renal vascular changes occurring in diabetic nephropathy.In the current study, the size of kidneys (length and width) (6)was found to have a significant negative correlation with the renal resistive index (Graph-3). As the diabetic group in our study had type II diabetes mellitus for at least a period of 10 years, the reduction in renal size and the corresponding increase in renal resistive index might be a parallel association due to the common pathogenesis operating in progression of medical renal disease in long-term diabetes mellitus. Such an association has also been found out by Park et al

CONCLUSION

The present study suggests that imaging of the renal by sonography (gray scale as well as Color Doppler imaging) is helpful in assessment of the long term complications of diabetes mellitus like diabetic nephropathy. Sonography can be used to follow up patients with long term diabetes mellitus and can complement the routine laboratory tests Baseline evaluation of recently diagnosed diabetes mellitus should include assessment of sonographic parameters of renal size, echogenicity, hemodynamic parameters including the renal resistive index (7)

Table 1: Baseline parameters of the study subjects

Sl No	Parameter	Diabetics (Mean ± SD)	Controls (Mean ± SD)	p - value (Student t-test)
1	Sample size (n)	56	49	-
2	Male/Female	30/26	28/21	-
3	Age (years)	58.80 ± 5.65	58.6 ± 5.79	0.83
4	Height (cm)	160.13 ± 7.09	158.94 ± 8.74	0.45
5	Weight (kg)	69.99 ± 8.05	69.29 ± 8.90	0.67
6	BMI (%)	27.29 ± 2.67	27.68 ± 4.67	0.6
7	Average duration of diabetes mellitus (years)	12.3 ± 2.78	n.a	-
8	Systolic blood pressure (mm Hg)	132.9 ± 6.81	125.7 ± 9.39	< 0.0001
9	Diastolic blood pressure (mm Hg)	77.5 ± 10.0	79.5 ± 9.59	0.30

Table 2: Laboratory parameters of the study subjects

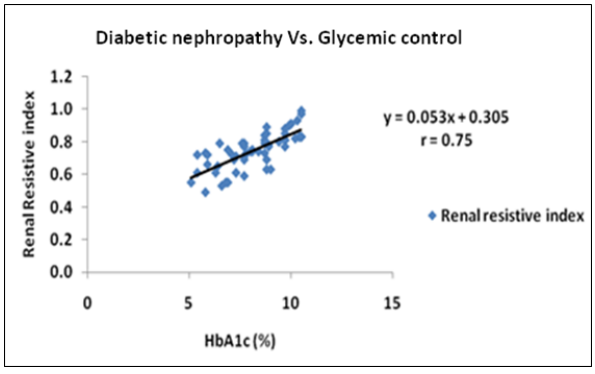
Sl No	Parameter	Diabetics (Mean ± SD)	Controls (Mean ± SD)	P value
BLOOD GLUCOSE				
1	Random blood glucose (mg/dL)	142.02 ± 29.27	134.12 ± 15.01	0.09
2	Fasting glucose (mg/dL)	129.39 ± 8.60	104.59 ± 14.76	< 0.0001
3	2-hour plasma glucose(mg/dL)	230.12 ± 13.70	158.64 ± 22.72	< 0.0001
4	HbA1c (%)	8.20 ± 1.55	5.03 ± 0.54	< 0.0001
LIPID PROFILE				
1	Total Cholesterol (mg/dL)	257 ± 55.59	177.4 ± 11.46	< 0.0001
2	Triglycerides (mg/dL)	333.5 ± 129.8	128.3 ± 15.68	< 0.0001
3	LDL Cholesterol (mg/dL)	151.9 ± 32.13	111.69 ± 10.68	< 0.0001
4	HDL Cholesterol (mg/dL)	38.4 ± 3.25	40.1 ± 3.61	0.01
5	VLDL Cholesterol (mg/dL)	66.67 ± 25.95	25.66 ± 3.13	< 0.0001
RENAL FUNCTION TESTS				
1	Blood urea (mg/dL)	27.88 ± 19.73	22.79 ± 3.88	0.07
2	Serum creatinine (mg/dL)	1.21 ± 0.86	0.89 ± 0.11	0.01
3	Urine microalbuminuria (µg/min)	559.49 ± 803.69	17.51 ± 9.03	< 0.0001

Table 3. Renal Imaging findings. Comparison between diabetic and control groups

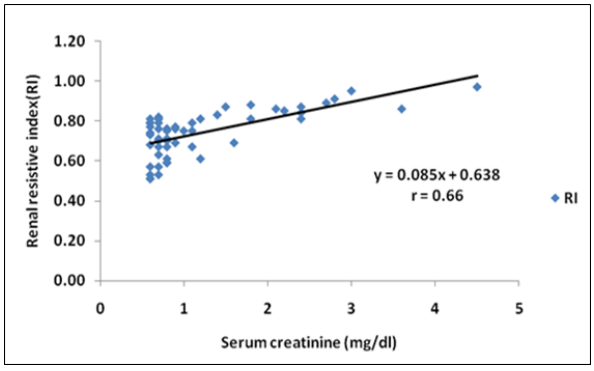
Sl No	Study parameter	Diabetic subjects (n=56)		Controls (n=49)		P value*	
		Rt kidney (Mean ± SD)	Lt kidney	Rt Kidney	Lt Kidney	Rt Kidney	Lt Kidney
GRAY SCALE IMAGING FINDINGS							
1	Length(cm)	9.05 ± 1.15	9.33 ± 1.19	9.8 ± 0.86	10.29 ± 0.86	< 0.01	< 0.01
2	Width(cm)	4.42 ± 0.47	4.56 ± 0.49	5.04 ± 0.61	4.86 ± 0.61	< 0.01	< 0.01

RENAL ARTERY DOPPLER PARAMETERS							
1	PSV (cm/s)	34.95 ± 4.47	35.38 ± 4.37	42.47 ± 2.95	41.72 ± 4.1	< 0.01	< 0.01
2	EDV(cm/s)	8.88 ± 4.33	9.15 ± 4.34	13.85 ± 2.58	13.6 ± 2.65	< 0.01	< 0.01
3	RI	0.75 ± 0.11	0.74 ± 0.11	0.67 ± 0.05	0.67 ± 0.05	< 0.01	< 0.01

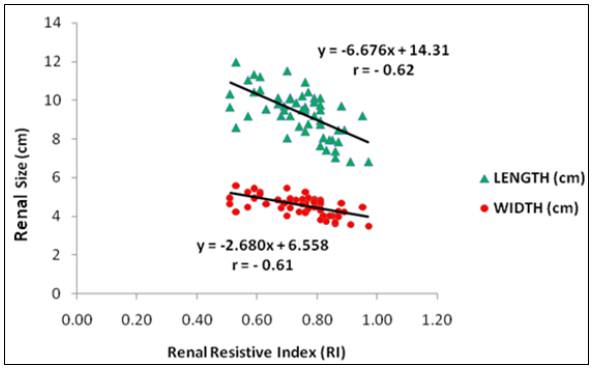
Graph.1 Scatter diagram showing the correlation between HbA1c levels and Renal Resistive index in the Diabetic group



Graph 2 Diabetic nephropathy – correlation between serum creatinine and renal resistive index (RI) in the diabetic group



Graph 3 Correlation between Gray scale renal imaging .As the renal size decreases resistive index increases (linear negative correlation)



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