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Radio Diagnosis

# Ultrasound Evaluation of Kidneys in Chronic Type II Diabetes

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**Original Research Article**

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**Abstract:** Type II Diabetes Mellitus is a metabolic disorder that is characterised by high blood sugar, insulin resistance and relative lack of insulin. Diabetic Nephropathy (Daibetic kidney disease) is a complication of type 2 diabetes, is the chronic loss of kidney function occuring in those with diabetes mellitus, which leads to multiple changes in the nephrons. This study might help to bridge the gaps in knowledge about diabetic nephropathy especially the betterment of Duplex Doppler ultrasound over the conventional ultrasonography that has limited sensitivity and specificity in detection of ongoing disease process and prognosis as well.
**Keywords**: Type II Diabetes, Diabetic Nephropathy, Ultrasonography.

## INTRODUCTION

Prevalence of type 2 diabetes is expanding its territory all over the world with no realms.(1)In numbers, there were an estimated 422 million adults who were diagnosed with diabetes in the year 2014 which was four times higher than that in the 1980s[2]. Currently there were 62 million of them burdening this country with the silent killer disease [3]. Chronic kidney diseases with its correlates parallel to that of diabetes was affecting about 11% of the population of United States and globally the tally corresponds to more than fifty million individuals[4,5]. Those with moderate to severe CKD were diabetic in about 23% of the patients [6, 7].

### Aims and Objectives

- To examine with the use of Duplex Doppler Ultrasound and to illustrat, whether there was a correlation with various clinical stages of the disease and its sonographic findings.
- To correlate and study asymptomatic patients with elevated renal vascular resistance and patients with mild impairment of renal function.

## METHODOLOGY

### Study Design

The study was Hospital-based comparative cross-sectional study, performed in the Department of Radio – Diagnosis in Sree Balaji Medical College and Hospital, Chennai with the study population including adult male and female population who were known case of Diabetes Mellitus, between April 2017 to October 2018. The study population was 120 subjects.

### Inclusion criteria

- Diabetics aged more than 18 years of age who give consent for the study
- Biochemically diagnosed for nephropathy in cases group

### Exclusion criteria

- Any secondary causes or co-morbid conditions
- Previously diagnosed renal anomalies and chronic renal diseases
- Treated for any known renal pathology in last 1 year

### Tools Used

The patients in the study were evaluated using ultrasonography with a probe of 3.5 – 5 MHZ that is curvilinear Kidney length & thickness of renal parenchyma: The examinations was done with person in supine position. To detect horse – shoe kidneys, the para – aortic region was examined. The width of kidneys, its length, its thickness and cortical size were calculated. Both lower and upper poles were defined. With sublect in decubitus position, sagittal view was also obtained.

**Resistive index**

The technique used in measurement of RI is meticulous as there one has to use high frequency probe supplemented by color or power Doppler sonography. Arcuate arteries that are adjacent to the CM junction and interlobar arteries that are adjacent to medullary pyramids were insonated with Doppler gate of two to four millimeter. For each kidney, the mean resistive index was obtained[34]. Other details collected were demographic parameters like age, gender and other relevant details like history of diabetes mellitus, history of dialysis treatment, serum urea, uric acid concentration,creatinine clearance,eGFR, proteinuria were also collected.

**Statistical methods**

Descriptive statistics: Descriptive analysis was carried out by mean and standard deviation (SD) as well as median and interquartile range (IQR) for quantitative variables, frequency and proportion for categorical variables. Bar diagram, pie diagram and box plots were used for representing the data.

Inferential statistics: The association between explanatory variables and Doppler findings was assessed by cross tabulation and comparison of percentages. Pearson's chi square test, Fisher's exact test, one way ANOVA with post-hoc test of LSD were used to test for the statistical significance. P value < 0.05 was considered statistically significant.

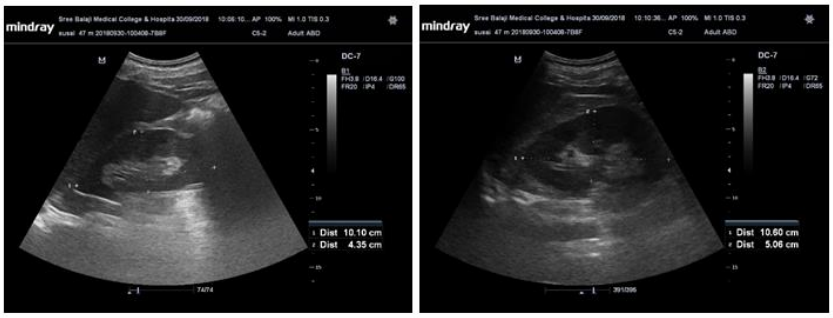


**Fig-1 and 2: shows ultrasound image of the measurement of right and left kidney lengths**


**Fig-3: Shows ultrasound image of the measurement of renal parenchymal thickness**


**Fig-4 and 5: shows increased echogenicity and reduced kidney size and cortical thickness, suggestive of chronic renal disease**

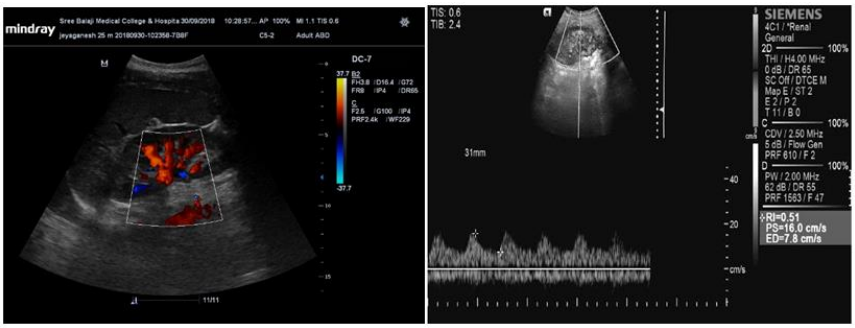


**Fig-6-8: Show colour Doppler study of the kidneys with measurement of resistive index**

## RESULTS AND ANALYSIS

The age group of controls and cases were not significantly differing from each other which is further shown by independent t-test depictive of comparable age distribution.(p>.05)

**Table-1: Age distribution of study subjects**

| Groups | Age (in years) | | p-value |
|---|---|---|---|
| | Mean | SD | |
| Controls (n=30) | 56.4 | 10.8 | 0.12 |
| Cases (n=90) | 58.7 | 11.5 | |
| Independent t-test used; P-value <0.05 is significant. | | | |

**Table-2: Age categorization of the cases (Diabetic Nephropathy)**

| Age categories (in years) | Frequency | Percentage | | p-value |
|---|---|---|---|---|
| <50 | 26 | 28.8 | 15.6 | <.001 |
| 50-69 | 49 | 54.4 | | |
| 70-79 | 13 | 14.4 | | |
| >80 | 2 | 2.2 | | |
| Total | 90 | 100.0 | | |
| Non-parametric chi-square test used; p-value<.05 is significant. | | | | |

It was found that, maximum of the patients were falling under 50-69 age groups (54.4%) that was followed by persons aged <50 years (28.8%) and only 2 persons belonged to age group >80 years.

**Table-3: Gender distribution of the study groups**

| Gender | Groups | | | | $\chi 2$ | p-value |
|---|---|---|---|---|---|---|
| | Controls (n=30) | | Cases (n=90) | | | |
| | No | % | No | % | | |
| Male | 18 | 60.0 | 59 | 65.5 | 2.7 | .10 |
| Female | 12 | 40.0 | 31 | 34.5 | | |
| Pearson's chi-square test used; p-value <.05 is significant; | | | | | | |

**Table-4: Distribution of study subjects**

| Subjects | Number | Percentage |
|---|---|---|
| Control | 30 | 25.0 |
| Diabetic nephropathy Group I | 30 | 25.0 |
| Diabetic nephropathy Group II | 30 | 25.0 |
| Diabetic nephropathy Group III A | 12 | 10.0 |
| Diabetic nephropathy Group III B | 14 | 11.7 |
| Diabetic nephropathy Group III C | 4 | 3.3 |
| Non-parametric chi-square test used; Chi-square = 1.3, p-value=.23 p-value <0.05 is significant | | |

Table 3 shows that, there were a comparatively higher proportion of male participants than their counterparts in both the controls (60.0% vs 40.0%) as well as in cases 65.5% vs 34.5%).

Table 4 shows that, the study subjects were equally dispersed between all the groups with 30 in each of those. In diabetic nephropathy group III, the sub-classifications included group IIIA, group IIIB, group IIIc and maximum representation were from group III B (46.6%) and it was minimum by group IIIc (13.3%).

**Table-5: Distribution of Renal Length between the groups of Right Kidney (in cm)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Control | 10.7 | 11.1 | 10.8 | .11 | 10.9 | 10.8, 11.0 |
| Diabetic nephropathy Group I | 11.6 | 12.1 | 11.8 | .14 | 11.9 | 11.7, 12.0 |
| Diabetic nephropathy Group II | 10.9 | 11.5 | 11.2 | .15 | 11.3 | 11.1, 11.4 |
| Diabetic nephropathy Group III A | 10.7 | 11.2 | 10.9 | .15 | 11.0 | 10.9, 11.1 |
| Diabetic nephropathy Group III B | 9.8 | 10.1 | 9.9 | .18 | 10.0 | 9.9, 10.02 |
| Diabetic nephropathy Group III C | 9.1 | 9.3 | 9.2 | .08 | 9.2 | 9.12, 9.27 |

The median (50th percentile) renal length (inter-quartile range, i.e between 25th percentile and 75th percentile) fluctuated with values of 10.9 (10.8, 11.0), 11.9 (11.7, 12.0), 11.3 (11.1, 11.4), 11.0 (10.9, 11.1), 10.0 (9.9, 10.02) and 9.2 (9.12, 9.27) respectively among controls, group I, group II, group IIIA, group IIIB, group IIIc that have been included in this study.

**Table-6: Distribution of Renal Length between the groups of Left Kidney (in cm)**

| Groups | Min | Max | Mean | SD | Median | IQ Range |
|---|---|---|---|---|---|---|
| Control | 10.9 | 11.5 | 11.15 | .18 | 11.15 | 11.0, 11.3 |
| Diabetic nephropathy Group I | 11.7 | 12.4 | 12.01 | .15 | 12.0 | 11.9, 12.1 |
| Diabetic nephropathy Group II | 11.1 | 11.9 | 11.53 | .17 | 11.55 | 11.4, 11.62 |
| Diabetic nephropathy Group III A | 10.9 | 11.4 | 11.14 | .16 | 11.15 | 11.0, 11.3 |
| Diabetic nephropathy Group III B | 10.1 | 10.7 | 10.42 | .13 | 10.45 | 10.3, 10.52 |
| Diabetic nephropathy Group III C | 9.4 | 9.6 | 9.5 | .09 | 9.5 | 9.42, 9.57 |

The range, mean and standard deviations, median and inter-quartile range were displayed. The statistical analysis used here was one-way ANOVA with LSD post-hoc testing done. The mean and SD of controls, group I, group II, group IIIA, group IIIB, group IIIc were 11.15 ± .18, 12.01 ±.15, 11.53 ± .17, 11.14 ± .16, 10.42 ± .13, 9.5 ± .09 centimeters respectively. Their lengths ranged from 10.9 to 11.5, 11.7 to 12.4, 11.1 to 11.9, 10.9 to 11.4, 10.1 to 10.7 and 9.4 to 9.6 among the controls, group I, group II, group IIIA, group IIIB, group IIIc respectively.

**Table-7: Distribution of Renal parenchymal thickness for Right Kidney (in mm)**

| Groups | Min | Max | Mean | SD | Median | IQ Range |
|---|---|---|---|---|---|---|
| Control | 13.7 | 14.3 | 13.9 | .17 | 13.9 | 13.8, 14.0 |
| Diabetic nephropathy Group I | 14.0 | 15.3 | 14.9 | .30 | 15.0 | 14.9, 15.1 |
| Diabetic nephropathy Group II | 13.8 | 14.4 | 14.1 | .28 | 14.15 | 15.0, 14.3 |
| Diabetic nephropathy Group III A | 13.2 | 14.3 | 13.5 | .23 | 13.5 | 13.4, 13.67 |
| Diabetic nephropathy Group III B | 11.8 | 13.5 | 12.2 | .47 | 12.05 | 11.9, 12.27 |

The mean and SD of controls, group I, group II, group IIIA, group IIIB, group IIIc were 13.9 ± .17, 14.9 ±.30, 14.1 ±.28, 13.5 ± .23, 12.2 ± .47, 10.3 ± .10 millimeters respectively. Their lengths ranged from 13.7 to 14.3, 14.0 to 15.3, 13.8 to 14.4, 13.2 to 14.3, 11.8 to 13.5 and 10.2 to 10.4 among the controls, group I, group II, group IIIA, group IIIB, group IIIc respectively. The median (50th percentile) renal length (inter-quartile range, i.e between 25th percentile and 75th percentile) fluctuated with values of 13.9 (13.8, 14.0), 15.0 (14.9, 15.1), 14.15 (15.0, 14.3), 13.5 (13.4, 13.67), 12.05 (11.9, 12.27) and 10.3 (10.22, 10.3) respectively among controls, group I, group II, group IIIA, group IIIB, group IIIc.

The mean and SD of controls, group I, group II, group IIIA, group IIIB, group IIIc were 14.6 ± .19, 15.5 ±.23, 15.03 ± .21, 14.29 ± .20, 12.38 ± .13, 10.7 ± .09 millimeters respectively. Their lengths ranged from 13.7 to 14.3, 14.0 to 15.3, 13.8 to 14.4, 13.2 to 14.3, 11.8 to 13.5 and 10.2 to 10.4 among the controls, group I, group II, group IIIA, group IIIB, group IIIc respectively. The median (50th percentile) renal length (inter-quartile range, i.e between 25th percentile and 75th percentile) fluctuated with values of 14.6 (14.5, 14.72), 15.6 (15.4, 15.7), 15.0 (14.9, 15.2), 14.25 (14.12, 14.47), 12.4 (12.3, 12.5) and 10.75 (10.7, 10.87) respectively among controls, group I, group II, group IIIA, group IIIB, group IIIc (Table-8).

**Table-8: Distribution of Renal parenchymal thickness for left Kidney (in mm)**

| Groups | Min | Max | Mean | SD | Median | IQ Range |
|---|---|---|---|---|---|---|
| Control | 14.3 | 14.9 | 14.6 | .19 | 14.6 | 14.5, 14.72 |
| Diabetic nephropathy Group I | 15.2 | 15.9 | 15.5 | .23 | 15.6 | 15.4, 15.7 |
| Diabetic nephropathy Group II | 14.7 | 15.4 | 15.03 | .21 | 15.0 | 14.9, 15.2 |
| Diabetic nephropathy Group III A | 14.0 | 14.7 | 14.29 | .20 | 14.25 | 14.12,14.47 |
| Diabetic nephropathy Group III B | 12.1 | 12.6 | 12.38 | .13 | 12.4 | 12.3, 12.5 |
| Diabetic nephropathy Group III C | 10.7 | 10.9 | 10.77 | .09 | 10.75 | 10.7, 10.87 |
| One-way ANOVA with LSD post-hoc test used; F-value= 518.7, p<.001 | | | | | | |

**Table-9: Parenchymal echogenecity in Diabetics**

| Groups | Normo-echogenic | | Hyper-echogenic | | $\chi 2$ | p-value |
|---|---|---|---|---|---|---|
| | No | % | No | % | | |
| Diabetic nephropathy Group I (n=30) | 30 | 100.0 | 0 | 0.0 | 63.8 | <.001 |
| Diabetic nephropathy Group II (n=30) | 30 | 100.0 | 0 | 0.0 | | |
| Diabetic nephropathy Group III A (n=12) | 3 | 25.0 | 9 | 75.0 | | |
| Diabetic nephropathy Group III B (n=14) | 4 | 28.6 | 10 | 71.4 | | |
| Diabetic nephropathy Group III C (n=4) | 0 | 0.0 | 4 | 100.0 | | |
| Fisher's exact test used;p-value<.05 is significant | | | | | | |

The proportion of hyperechogenecity (75.0%, 71.4% & 100%) when compared against normo-echogenecity (25.0%, 28.6% & 0.0%) was higher in diabetic nephropathy group IIIA, IIIB, IIIC respectively

**Table-10: Distribution of Resistive Index between the groups**

| Groups | Min | Max | Mean | SD | Median | IQ Range |
|---|---|---|---|---|---|---|
| Control | .588 | .690 | .648 | .027 | .647 | .630, .675 |
| Diabetic nephropathy Group I | .596 | .744 | .661 | .035 | .663 | .636, .682 |
| Diabetic nephropathy Group II | .612 | .780 | .686 | .047 | .680 | .643, .723 |
| Diabetic nephropathy Group III A | .649 | .790 | .736 | .042 | .747 | .700, .767 |
| Diabetic nephropathy Group III B | .685 | .800 | .739 | .035 | .744 | .709, .763 |
| Diabetic nephropathy Group III C | .822 | .859 | .840 | .015 | .839 | .826, .854 |
| One-way ANOVA with LSD post-hoc test used; F-value= 31.98, p<.001 | | | | | | |

The mean and SD of RI for controls, group I, group II, group IIIA, group IIIB, group IIIc were 0.64 ±.02, 0.66 ±.03, 0.68 ± .04, 0.73 ± .04, 0.73 ± .03, 0.84 ± .01 respectively. Their RI ranged from 0.58 to 0.69, 0.59 to 0.74, 0.61 to 0.78, 0.64 to 0.79, 0.68 to 0.80 and 0.82 to 0.85 among the controls, group I, group II, group IIIA, group IIIB, group IIIc respectively.

**Table-11: Resistive Index comparison**

| Groups | RI <0.70 | | RI ≥0.70 | | $\chi 2$ | p-value |
|---|---|---|---|---|---|---|
| | No | % | No | % | | |
| Control(n=30) | 30 | 100.0 | 0 | 0.0 | 54.4 | <.001 |
| Diabetic nephropathy Group I (n=30) | 26 | 86.7 | 4 | 13.3 | | |
| Diabetic nephropathy Group II (n=30) | 18 | 60.0 | 12 | 40.0 | | |
| Diabetic nephropathy Group III A (n=12) | 3 | 25.0 | 9 | 75.0 | | |
| Diabetic nephropathy Group III B (n=14) | 3 | 21.4 | 11 | 78.6 | | |
| Diabetic nephropathy Group III C (n=4) | 0 | 0.0 | 4 | 100.0 | | |
| Fisher's exact test used; p-value<.05 is significant | | | | | | |

The proportion of RI <0.70 was higher in the controls, group I and group II against the RI ≥ 0.70 group with the values as follows, 100.0% vs 0.0%, 86.7% vs 13.3%, 60.0% vs 40.0% respectively. Contrarily, the proportion of subjects in RI ≥ 0.70 group was higher in diabetic nephropathy group IIIA, group IIIB, group IIIC than the RI <0.70 group and the values are as follows, 75.0% vs 25.0%, 78.6% vs 21.4%, 100.0% vs 0.0% respectively.

## DISCUSSION

Acute and Chronic renal failure can be differentiated with USG. Urological pathologies due to medical nephropathy can be excluded; course of the

disease can be assessed with USG. Our study has overall portrayed the utility of ultrasonography in diagnosing DKD and its clinical relevance.

The following interpretations were made after a prospective observational study on 120 diabetic subjects, grouped into controls (n = 30) and cases (n = ninety) of them had nephropathy due to diabetes.

Based on the measurement of right and left renal length sonologically in diabetic nephropathy subjects, it was interpreted that the length diminished while the disease was getting progressed.

Based on the measurement of right and left renal parenchymal thickness sonologically in diabetic nephropathy subjects, it was interpreted that the renal parenchymal thickness diminished while the disease was getting progressed.

Based on the assessment of renal parenchymal echogenicity, it was interpreted that diabetic nephropathy group I and II had normal echogenicity and group III C had hyperechogenicity on sonographc images.

Based on the distribution of resistive index among diabetic nephropathy subjects, it was interpreted that the resistive index increased when the disease severity was increased.

## CONCLUSION

In assessing the types of nephropathy and the progression, ultrasonographic evaluation plays a vital role .Diabetic nephropathy in type 2 diabetes is not only the cause of chronic renal failure (CRF), but also non-diabetic renal diseases. USG is used for identifying the cause of chronic renal failure in diabetics and various other reasons have to be simultaneously evaluated in order to improve the quality of life of the patients saving the time getting delayed in specific diagnosis. Most of type two diabetics with CRF had “small kidneys” in the study, due to the association with nephropathy in most cases.

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