ROLE OF INTRARENAL RESISTIVITY INDEX BY DUPLEX ULTRASONOGRAPHY IN DIABETIC NEPHROPATHY AND ITS CLINICO BIOCHEMICAL CORRELATION

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Article History: Received on 27th December 2017, Revised on 1st January 2018, Published on 10th January 2018

ABSTRACT

Diabetic nephropathy is among the common causes of end stage renal disease. Conventional ultrasound and color Doppler provide easily available, affordable noninvasive follow up method for evaluation of kidneys in diabetic nephropathy. In diabetic nephropathy, the glomerulosclerosis and interstitial fibrosis causes alteration in intrarenal hemodynamics causing raised intrarenal vascular resistance reflected by increased intrarenal resistivity index (IRI).

The aim of the study is to evaluate intrarenal resistivity index by duplex ultrasonography in diabetic nephropathy patients and correlating them with clinical and biochemical parameters.

This was a cross sectional study carried out over 2 years period from September 2013 to September 2015. Patients of Type 2 diabetes as per WHO criteria having nephropathy were included.

A total of 96 patients of diabetic nephropathy were studied and divided into two groups based on IRI. Group I (n=54) with IRI > 0.70 and group II (n=42) with IRI ≤ 0.70. Group I patients had significantly higher mean age and mean duration of diabetes compared to group II. Group I patients also had higher blood urea and serum creatinine 3.91 ± 1.63 vs 1.34 ± 0.85 mg/dl compared to group II. Around 83.33 % patients in group II were in early stage of nephropathy whereas 85.18 % in group I were in established stage of nephropathy. Among the complications of diabetes, presence of retinopathy correlates well with advanced diabetic nephropathy (IRI>0.70).

Intrarenal resistivity index (IRI) by duplex USG is a non-invasive parameter that can be correlated with clinico biochemical parameters of diabetic renal dysfunction and hence can be used as a prognostic indicator in follow up of diabetic nephropathy.

Keywords: Diabetic nephropathy; color Doppler; ultrasound; intrarenal resistivity index

I. INTRODUCTION

Diabetes Mellitus (DM) refers to a group of common metabolic disorders that share the phenotype of hyperglycaemia. The metabolic dysregulation associated with DM causes secondary pathophysiologic changes in multi organ systems that impose a tremendous burden on individual with diabetes and on health care system.

Diabetes mellitus is classified into Type 1 and Type 2 on the basis of pathogenesis. Type 1 diabetes is result of complete or near total insulin deficiency. Type 2 diabetes is a heterogenous group of disorders characterised by variable degrees of insulin resistance, impaired insulin secretion and increased glucose production.

Diabetes mellitus is one of the most common chronic diseases across the world and number of diabetic patients is on rise. In 2013 as per International Diabetes Federation, an estimated 381 million people had diabetes and its number is estimated to double by 2030. Prevalence of type 2 DM is approx. 90% all diabetic patients. As per recently published ICMR-INDIAB national study, there are 62.4 million people with type 2 diabetes and 77 million people with pre diabetes in India and the incidence is still increasing.

Diabetes related complications affect many organ systems which can be vascular and non vascular. Among vascular
complications it may be macro vascular (CAD, PAD, cerebrovascular disease) or micro vascular (retinopathy, neuropathy and nephropathy). Micro vascular complications account for majority of morbidity associated with the disease.

Diabetic nephropathy is one of the micro vascular complications which is also the leading cause of chronic kidney disease (CKD), ESRD and CKD requiring renal replacement therapy. It is a progressive kidney disease caused by angiopathy of capillaries in the kidney glomeruli leading to GBM thickening and glomerular sclerosis (due to intra glomerular hypertension). It is characterized by albuminuria which progresses from normoalbuminuria to microalbuminuria to macroalbuminuria ultimately leading to ESRD. Diabetic nephropathy complicates approximately 30% cases of type 1 and 20% cases of type 2 DM. However most diabetic patients with end stage renal disease (ESRD) have type 2 DM because of greater prevalence of type 2 DM worldwide (90% of all diabetics).

Laboratory tests like urinary protein and serum creatinine have been traditionally used in diagnosis and follow up of diabetic nephropathy. Among various imaging techniques for renal pathologies Ultrasound and renal Doppler are initial non invasive modalities for Evaluation of kidneys in various local and systemic diseases (both anatomical and vascular features), obstructive nephropathy, guiding renal biopsies for tissue diagnosis. These are easily accessible, cost effective and non invasive and with advantage of no radiation hazard Ultrasound has allowed evaluation of diabetic nephropathy by use of both gray scale and colour Doppler. Gray scale helps in evaluation of morphology of kidneys and colour Doppler duplex ultrasonography (CDDS) in evaluation of alteration of renal perfusion noninvasively by interrogating intrarenal arteries for resistivity index (IRI).

Normal value of IRI ranges from 0.58 to 0.68 in normal kidneys. So 0.70 may be taken as reasonable upper limit for normal RI values in adult population IRI detect early changes in blood flow (caused by changes in compliance and resistance of intrarenal vessels) reflecting progression of diabetic nephropathy.

II. AIMS AND OBJECTIVES:
1. Evaluation of renal sonomorphological characteristics and intrarenal resistivity index (IRI) by duplex ultrasonography in diabetic patients having nephropathy.
2. Correlation among intrarenal resistivity index and clinico biochemical parameters.

III. MATERIALS AND METHODS
This cross sectional study was conducted in the department of Radiodiagnosis, S.C.B. Medical College, Cuttack between September 2013 to September 2015. 96 Diabetic patients having nephropathy underwent ultrasound with Doppler evaluation of intrarenal resistivity index and were evaluated for clinical history (duration of diabetes, history of diabetic complications and family history of type 2 diabetes, retinoscopic findings) and biochemical parameters (fasting blood glucose, 2-h postprandial glucose, serum creatinine, blood urea nitrogen, lipid profile, urinary albumin and microscopic findings).

Inclusion criteria
1. Patients of Type 2 Diabetes mellitus (as per WHO criteria) having nephropathy
2. Age group > 20 years
3. Both males and females

Exclusion criteria
1. Type 1 Diabetes mellitus
2. Glomerular or tubulointerstitial diseases other than diabetic nephropathy (SLE, SS, RA)
3. Renal artery stenosis
4. Obstructive uropathy
5. Severe uncontrolled hypertension
6. Drug or toxin induced nephropathy
7. U/L or B/L contracted kidneys on sonography
Both kidneys were evaluated by PHILIPS HD 7 ultrasound machine using a 3.5 MHz convex array probe. Patient was put in supine position and ultrasound probe was positioned gently on the flank in an oblique projection and kidneys were visualized in longitudinal axis.

Using gray scale ultrasound, size of kidneys and renal cortical echotexture were evaluated. Renal cortical echogenicity was assessed by comparing its echogenicity with that of nondiseased liver and renal sinus. Normal echogenicity of renal cortex is less than that of the liver. Increased cortical echo is interpreted when the echogenicity is greater than that of the liver or equal to sinus echo. (5,6,7)

For intra renal Doppler study both colour Doppler and pulsed Doppler methods were used. Intra renal vascular structures were visualized using colour Doppler. Sample volumes of 2-4 mm were obtained by positioning the cursor of pulsed Doppler mode at the mid portion of the interlobar arteries with flow along renal pyramids and angle was adjusted to less than 60 degrees. Doppler spectral waveforms were obtained at lowest possible pulse repetition frequency possible without aliasing. Peak systolic velocity (PSV) and end diastolic velocity (EDV) were automatically calculated from the spectral waveforms.

Doppler ultrasound indices measured

Resistivity index = PSV-EDV

\[
\text{Resistivity index} = \frac{\text{PSV}}{\text{EDV}}
\]

Three intrarenal resistivity indices were obtained from upper, mid and lower poles of each kidney and the mean of six values of both kidneys were calculated. The mean resistivity index value was calculated for statistical analysis.

Patients were divided into 2 groups for comparison, group I with normal IRI > 0.7 and group II with IRI ≤ 0.7. Data were reported as mean ± SD when normally distributed. All data were expressed in percentage. IRI and clinic biochemical parameters were correlated and compared and results were analyzed in relation to previous similar studies.

**IV. RESULT**

The study consisted of total 96 patients who were divided into 2 groups basing on intrarenal RI values: Group I (mean IRI > 0.70) → n = 54

Group II (mean IRI ≤ 0.70) → n = 42

Comparison to be done between these 2 groups for various clinico biochemical parameters.

**TABLE 1. IRI AND AGE & DURATION OF DIABETES IN DN PATIENTS**

<table>
<thead>
<tr>
<th></th>
<th>Group I (IRI &gt; 0.70)</th>
<th>Group II (IRI ≤ 0.70)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AGE (IN YRS)</strong></td>
<td>64.46 ± 6.69</td>
<td>53.66 ± 5.96</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td><strong>DURATION (IN YRS)</strong></td>
<td>13.7 ± 4.42</td>
<td>6.69 ± 2.25</td>
<td>&lt; 0.0001*</td>
</tr>
</tbody>
</table>

*Statistically significant

The mean age in group I is 64.46 ± 6.69 yrs. which is significantly higher than that of group II which is 53.66 ± 5.96 yrs. The mean duration of diabetes mellitus in group I is higher than group II which is statistically significant (13.7 ± 4.42 vs 6.69 ± 2.25 yrs)

**TABLE 2. IRI AND SEX DISTRIBUTION**

<table>
<thead>
<tr>
<th>SEX</th>
<th>Group I (IRI &gt; 0.70) n = 54</th>
<th>Group II (IRI ≤ 0.70) n = 42</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MALE</strong></td>
<td>31</td>
<td>24</td>
</tr>
<tr>
<td><strong>FEMALE</strong></td>
<td>23</td>
<td>18</td>
</tr>
</tbody>
</table>
Group I have 31 males and 23 females and group II have 24 males and 18 females with almost similar M:F ratio as that of group I.

### TABLE 3. IRI AND RISK FACTORS FOR DIABETIC NEPHROPATHY

<table>
<thead>
<tr>
<th>RISK FACTORS AND COMPLICATIONS</th>
<th>Group I (IRI &gt; 0.70) n=54</th>
<th>Group II (IRI ≤ 0.70) n=42</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMOKING</td>
<td>18 (33.33 %)</td>
<td>6 (14.28 %)</td>
<td>0.0359*</td>
</tr>
<tr>
<td>ALCOHOL CONSUMPTION</td>
<td>19 (35.18 %)</td>
<td>14 (33.33 %)</td>
<td>1.000ns</td>
</tr>
<tr>
<td>HYPERTENSION</td>
<td>31 (57.40 %)</td>
<td>9 (21.42 %)</td>
<td>0.0004*</td>
</tr>
<tr>
<td>F/H/O DM</td>
<td>10 (18.51 %)</td>
<td>7 (16.67 %)</td>
<td>1.000ns</td>
</tr>
<tr>
<td>OBESITY</td>
<td>31 (57.40 %)</td>
<td>16 (38.09 %)</td>
<td>0.0678ns</td>
</tr>
<tr>
<td>DYSLIPIDEMIA</td>
<td>35 (64.81 %)</td>
<td>14 (33.33 %)</td>
<td>0.0037*</td>
</tr>
</tbody>
</table>

*statistically significant; ns not significant

Among various risk factors most common risk factors in group I are dyslipidemia, obesity and hypertension whereas in group II most common risk factors are alcohol consumption, dyslipidemia and obesity. However significant correlation is noted between raised IRI and some of risk factors like hypertension, smoking and dyslipidemia. Among complications of diabetes, retinopathy and CAD are significantly associated with raised IRI (> 0.70). In both groups most common complication associated with nephropathy is retinopathy (74 % in group I and 21.42 % in group II).

### TABLE 4. IRI AND BIOCHEMICAL PARAMETERS

<table>
<thead>
<tr>
<th>BIOCHEMICAL PARAMETERS (IN MEAN ± SD)</th>
<th>Group I (IRI &gt; 0.70) n=54</th>
<th>Group II (IRI ≤ 0.70) n=43</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLOOD UREA NITROGEN (BUN) in mg/dl</td>
<td>64.50 ± 18.45</td>
<td>45.88 ± 9.62</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>SERUM CREATININE in mg/dl</td>
<td>3.91 ± 1.63</td>
<td>1.34 ± 0.85</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>FBS in mg/dl</td>
<td>141.87 ± 24.87</td>
<td>135.50 ± 17.64</td>
<td>0.1628ns</td>
</tr>
<tr>
<td>2 HR PPBS in mg/dl</td>
<td>191.83 ± 47.41</td>
<td>176.21 ± 37.03</td>
<td>0.0820ns</td>
</tr>
<tr>
<td>HbA1c in percentage</td>
<td>8.18 ± 1.07</td>
<td>7.61 ± 0.73</td>
<td>0.0039*</td>
</tr>
</tbody>
</table>

*statistically significant; ns not significant
The blood urea (64.5 ± 18.45 vs 45.88 ± 9.62 mg/dl) and serum creatinine (3.91 ± 1.63 vs 1.34 ± 0.85 mg/dl) levels are higher in group I with IRI > 0.70 than group II with IRI ≤ 0.70. No significant correlation is noted between FBS, PPBS values and IRI in both the groups. Group I has higher mean value of HbA1c than group II (8.18 ± 1.07 vs 7.61 ± 0.73 %).

### TABLE 5. IRI AND PROTEINURIA

<table>
<thead>
<tr>
<th>PROTEINURIA</th>
<th>Group I (IRI &gt; 0.70) n=54</th>
<th>Group II (IRI ≤ 0.70) n=42</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MICROALBUMINURIA(MI)</td>
<td>8</td>
<td>35</td>
<td>&lt; 0.0001*</td>
</tr>
<tr>
<td>OVERT PROTEINURIA (OP)</td>
<td>46</td>
<td>7</td>
<td>&lt; 0.0001*</td>
</tr>
</tbody>
</table>

*statistically significant; ns not significant

8 (14.8%) out of 54 patients in group I (IRI > 0.70) have microalbuminuria and rest of 46 (85.18%) patients have overt proteinuria. In group II (IRI ≤ 0.70) 35 (83.33%) patients out of 42 patients have microalbuminuria and 7 (16.6%) patients have overt proteinuria.

### TABLE 6. IRI AND GREY SCALE USG FEATURES

<table>
<thead>
<tr>
<th>USG(GRAY SCALE)</th>
<th>Group I (IRI &gt;0.70) n=54</th>
<th>Group II (IRI ≤0.70) n=42</th>
</tr>
</thead>
<tbody>
<tr>
<td>CORTICAL ECHOTEXTURE</td>
<td>NORMAL 37</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>INCREASED 17</td>
<td>2</td>
</tr>
<tr>
<td>CORTICOMEDULLARY DIFFERENTIATION(CMD)</td>
<td>NORMAL 45</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>ALTERED 9</td>
<td>1</td>
</tr>
</tbody>
</table>

Both group I and II have more percentage of patients having normal cortical echotexture and normal CMD. 17 patients in group I and 2 in group II have increased cortical echo and 9 in group I and 1 in group II have altered CMD.

### TABLE 7. IRI AND MEAN SIZE OF KIDNEYS (RIGHT KIDNEY)

<table>
<thead>
<tr>
<th>KIDNEY SIZE (In mm)</th>
<th>Group I (IRI &gt; 0.70) n=54</th>
<th>Group II (IRI ≤ 0.70) n=42</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RIGHT LENGTH</td>
<td>92.70 ± 7.35</td>
<td>95.23 ± 5.23</td>
<td>0.062*ns</td>
</tr>
<tr>
<td>WIDTH</td>
<td>40.72 ± 4.99</td>
<td>41.38 ± 5.25</td>
<td>0.531*ns</td>
</tr>
<tr>
<td>LEFT LENGTH</td>
<td>92.45 ± 7.77</td>
<td>94.23 ± 5.32</td>
<td>0.207*ns</td>
</tr>
<tr>
<td>WIDTH</td>
<td>41.66 ± 4.58</td>
<td>41.67 ± 4.32</td>
<td>0.991*ns</td>
</tr>
</tbody>
</table>
The right kidney mean sizes in both groups are group I: 92.70 ± 7.35, 40.72 ± 4.99 mm and group II: 95.23 ± 5.23, 41.38 ± 5.25 mm. The left kidney mean sizes in both groups are group I: 92.45 ± 7.77, 41.66 ± 4.58 mm and group II: 94.23 ± 5.32, 41.67 ± 4.32 mm.

V. DISCUSSION

The present study included 96 diabetic patients having nephropathy. They were divided into two groups depending on their mean intrarenal resistivity index (IRI) by duplex ultrasonography as Group I: patients having IRI > 0.70 (n=54) and Group II: patients having IRI ≤ 0.70 (n=42).

Among 96 patients of diabetic nephropathy, Group I patients have significantly higher mean age than group II patients (p value <0.0001). stage of nephropathy advances as age increases along with intrarenal RI possibly due to advanced arteriosclerosis.

Raut et al in Indian diabetic nephropathy patients similarly found significantly higher mean age in patients with IRI > 0.70 (p value <0.0001,) than patients with normal IRI. In study done by Platt et al, patients with IRI > 0.70 were older as compared to those with IRI ≤ 0.70 (62 yrs vs. 42 yrs). Similar results were obtained by Ishimura et al (β = 0.277).

The male: female ratio in group I is 1.34: 1 where as in group II it is 1.33: 1, so sex distribution shows no significant difference. This is consistent with the study done by Raut et al.

The mean duration of diabetes mellitus in patients of group I (IRI > 0.70) is significantly higher as compared to group II (IRI ≤ 0.70) (13.7 ± 4.42 vs 6.69 ±2.25 yrs). Platt et al similarly observed that patients with IRI > 0.70 had a mean duration of diabetes of 20 years vs 11 years in those with IRI < 0.70 which was statistically significant. The present study also corroborates with the studies done by Ishimura et al (β = 0.221) and Raut et al (p value < 0.0001).

However Milovanceva popovska et al and Nosadini et al did not find any statistically significant correlation between duration of diabetes and IRI. This difference may be due to lower cut off value for IRI (0.70) and the difference in epidemiologic parameters of the study groups.

Smoking habit was present in 18 patients of group I (33.3 %) and 6 in group II (14.28 %). This difference is quite significant (p value = 0.03).

Raut et al found similar results. Nosadini et al also observed that smoking habit was present in a significant number of patients with IRI > 0.80 than compared to that with IRI < 0.80. Smoking accelerates atherosclerosis and nicotine increases the vascular resistance ultimately leading to hypertension and raised IRI. Chuahirun et al found that the proportion of patients affected by low GFR was significantly higher in current smokers. According to Bisenbach et al and Gambaro et al smoking increases risk of developing microalbuminuria in type 2 DM.

As per the present study 57.4 % patients in group I with raised IRI (>0.70) have hypertension as compared to 21.42 % in group II with normal IRI (≤ 0.70) and the difference is statistically significant (p value =0.0004). Raut et al, Ishimura et al and Milovanceva popovska et al found similar significant correlation between raised arterial blood pressure and IRI. Nosadini et al also found that RI index is significantly correlated with increased blood pressure and decreased renal function and it reflects severe endothelial dysfunction.Amini et al found that with presence of hypertension, there was a three times higher risk and faster progression of diabetic nephropathy.

In present study dyslipidemia is present as a risk factor in 35 (64.81 %) patients in group I and 14 (33.3%) patients in group II with statistically significant difference.

Raut et al found similar results (p value < 0.001). Nosadini et al similarly found that the mean plasma cholesterol was significantly elevated in patients with IRI > 0.80 compared to those with IRI < 0.80 (221 ± 15 vs. 189 ± 15). However Ishimura et al did not find any significant correlation between total cholesterol level and renal resistive index (p value 0.24). Aryal et al observed that dyslipidemia was significant in the form of elevated serum cholesterol, LDL and triglycerides in those with nephropathy than those without nephropathy.

Other risk factors as obesity, alcohol, F/H/O DM although higher in group I patients, shows no significant correlation with IRI in present study.
In present study patients with IRI > 0.70 (group I) have significantly higher percentage of CAD (22.2% vs 11.9%) and retinopathy (74.04% vs 33.3%) than patients in group II (CAD p value 0.012 and retinopathy p value < 0.0001).

Raut et al also found significantly higher percentage of retinopathy in Indian diabetic nephropathy patients having IRI > 0.70 (79.54% vs 27.78%). They also found significantly higher number of CAD in patients with IRI > 0.70 (p value <0.001).

Nosadini et al similarly found that a significant number of patients with IRI > 0.80 had CAD compared to those with IRI < 0.80 (69.69% vs 12.24%). Ishimura et al also observed that diabetes retinopathy was present in a significantly higher number of patients with IRI > 0.80 compared to those with IRI < 0.80. Among the various stages of diabetes retinopathy, preproliferative and proliferative stage of diabetic retinopathy was more common in patients with IRI > 0.80.

In the present study although there are more number of nephropathy and PVD complications in group I, it is not statistically significant.

The present study shows group I (IRI > 0.70) have both higher blood urea and serum creatinine values than group II (IRI ≤ 0.70) which is statistically significant (p value < 0.0001). Group I have mean BUN of 64.5 ± 18.45 mg/dl as compared to 45.88 ± 9.62 mg/dl in group II. Serum creatinine levels in group I is 3.91 ± 1.63 mg/dl vs. 1.34 ± 0.85 mg/dl in group II.

Raut et al in a study similarly observed that patients with IRI > 0.70 had significantly higher BUN (49.84 ± 22.65 vs 31.98 ± 8.99 mg/dl) and serum creatinine (2.29 ± 1.46 vs 0.99 ± 0.35 mg/dl) compared to those with normal IRI. Milovanceva popovska et al also observed that mean creatinine clearance in patients with IRI > 0.70 was 47.4 ± 4.9 compared to that of 51.4 ± 7.6 with IRI < 0.70 which was statistically significant. Platt et al observed that patients with IRI more than 0.70 had a mean serum creatinine of 3.2 mg/dl compared to that of 1.1 mg/dl in patients with IRI < 0.70. Nosadini et al found that the mean creatinine clearance in patients with IRI < 0.80 was 91 ± 7 ml/min whereas in patients with IRI > 0.80 it was 70 ± 8 ml/min. IRI might be useful to identify the cohort of microalbuminuric patients with more severe renal lesions and those prone to develop a rapid decay of GFR without performing routinely the invasive procedure of renal biopsy and IRI > 0.80 had a strong correlation with the GFR and creatinine clearance.

Thus with the decline in renal function reflected by the serum creatinine and creatinine clearance, the intrarenal hemodynamics are also altered reflected by the rise in IRI.

In the present study no statistically significant difference was observed in FBS and 2 hr PPBS between group I (IRI > 0.70 ) and group II (IRI ≤ 0.70 ). These findings are similar to that of Raut et al and Ishimura et al.

Present study shows group I (IRI > 0.70) shows higher mean value of HbA1c as compared to group II with normal IRI (IRI ≤ 0.70) (8.18 ± 1.07 vs 7.61 ± 0.73) which is statistically significant. However no significant correlation was observed by Nosadini et al (7.3 ± 0.6 vs 7.4 ± 0.7) and Ishimura et al.

85.18% patients in group I are having overt proteinuria as compared to 16.67% in group II being in established stage of nephropathy (p value < 0.0001). Whereas group II have significantly higher patients with microalbuminuria and being in early stage of nephropathy (83.33% vs 14.81%). Thus proteinuria is significantly associated with raised IRI.

Raut et al observed similar results (82.95% vs 19.44%). Platt et al observed that as the stage of nephropathy progresses towards the established stage, IRI significantly increases. Thus IRI is typically elevated in established nephropathy but is often normal in early clinical stages of disease.

Milovanceva popovska et al also observed that IRI is significantly affected by proteinuria. Nosadini et al found that 24% of patients with raised IRI > 0.80 had overt proteinuria compared to that of just 5% patients with IRI < 0.80 which was statistically significant. Jude et al found that proteinuria was significantly higher in established stage of nephropathy group. Ishimura et al observed that IRI was elevated in diabetic nephropathy, usually at an advanced stage.

In present study both group I and group II had higher percentage of normal appearing kidneys on gray scale with
normal cortical echotexture and corticomedullary differentiation (CMD). However 17 patients in group I (IRI > 0.70) have raised cortical echotexture out of which 9 patients had altered CMD. Mostly patients with altered renal morphology have raised IRI and belong to established stage of nephropathy although there is no statistically significant correlation. Also both group I and group II have no significant difference in kidney sizes.

Raut et al also found similar results (9.7×5.3 and 9.4×5.1 cm vs 8.5×4.4 and 8.3×4.5 cm). According to Majdan et al who studied patients of diabetic nephropathy with and without chronic renal failure found that most of type 2 DM patients with CRF had small kidneys which mean they had ischemic, hypertonic or inflammatory nephropathy accompanying type 2 DM.

VI. CONCLUSION

Diabetes mellitus is one of the most common chronic diseases with Diabetic nephropathy being a frequent microvascular complication of diabetes mellitus leading to maximum number of end stage renal diseases (ESRD).

The major presenting feature of diabetic nephropathy is microalbuminuria which gradually progresses to overt proteinuria leading to ESRD. Renal biopsy can identify the cohort of microalbuminuric patient with more severe renal lesions which are prone to develop rapid decay of GFR, but as it is invasive hence not preferable.

Conventional gray scale ultrasound and colour Doppler ultrasound provides easily available, affordable noninvasive follow up method for evaluation of kidneys in diabetic nephropathy.

Conventional ultrasound evaluation of kidneys in diabetic nephropathy is of limited value in most cases as it lacks accuracy as visual interpretation of echogenecity and renal size are subjective method. In present study we observed that most of diabetic nephropathy patients whether in early stage or established stage have normal cortical echotexture and maintained CMD. Only in advanced stage of nephropathy cortical echotexture and CMD are altered.

In diabetic nephropathy, the glomerulosclerosis and interstitial fibrosis causes alteration in intrarenal hemodynamics causing raised intrarenal vascular resistance. The intrarenal resistivity index (IRI) obtained from interlobar arteries reflects intrarenal vascular resistance. The predominant histopathologic changes in diabetic kidneys are found in the vascular compartment which explains why an increase in renal vascular resistance may be found earlier than changes in ultrasound morphology.

In the present study raised IRI (>0.70) appears to be associated with various clinical factors as prolonged duration of DM, higher age group, risk factors as smoking, hypertension, dyslipidemia. Also complications of DM as CAD and retinopathy appear to have significant correlation with raised IRI. These may be due to effects of accelerated atherosclerosis, activation of rennin angiotensin system and progressive arteriosclerosis.

The present study also shows a good correlation between intrarenal resistivity index (IRI) and renal functional parameters as serum creatinine and BUN and also with HbA1c. Hence IRI can be used as an adjunct indicator of renal function in diabetic kidney disease especially in advanced clinical diabetic nephropathy. Also intrarenal vascular resistance is affected by long term glycaemic control.

As with proteinuria which is hallmark feature of diabetic nephropathy, raised IRI (>0.70) is significantly associated with overt proteinuria. Hence raised IRI > 0.70 can identify diabetic patients at risk of progressive renal disease and subsequently renal failure. IRI is mostly found to be in normal range (IRI ≤ 0.70) in microalbuminuric patients indicating inability of this parameter (IRI) to detect early changes of diabetic renal disease.

So IRI as assessed by duplex ultrasonography is a non invasive parameter that can be correlated with clinico biochemical parameters of renal dysfunction in type 2 diabetic patients having nephropathy. It correlates significantly with worsening renal function. It can be used in association with biochemical parameters in the follow up of patients with diabetic nephropathy. An increasing intrarenal resistivity index value could prompt the physician to a more rigid control of blood sugars and hypertension in this subgroup of diabetic patients delaying the progression to end stage renal failure. The role of this parameter in patients with microalbuminuria requires further studies correlating intrarenal resistivity index with other biochemical parameters like 24 hr protein estimations in a prospective study with patient follow-up.
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Figure 1. Normal Intrarenal Vascular supply of kidney

Figure 2. Kidneys showing increased cortical echo with normal CMD

Figure 3. Doppler recording from left mid pole interlobar artery showing absent sharp systolic upstroke, rounding of systole and reduced forward diastolic flow with RI 0.79
Figure 4. KIDNEYS SHOWING INCREASED CORTICAL ECHO WITH ALTERED CMD

Figure 5. Doppler recording from right mid pole interlobar artery showing absent sharp systolic upstroke, rounding of systole and absent forward diastolic flow with RI 0.95