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Clinicopathological Study of Renal Function in Type 2 Diabetics in Ile-Ife, Southwest Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors AAA, SAA and AFA designed the study. Authors AAA and OO performed the statistical analysis. Authors AAA and AA wrote the protocol and wrote the first draft of the manuscript. Author AAA collected data on-field. Authors AAA, ITR and AFA managed the analyses of the study. Author AAK supervised the analysis of the histology slides. Authors AAA, OO and SAA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To determine the prevalence and clinico-pathological correlates of diabetic nephropathy among type 2 diabetics in Southwest Nigeria.
Study Design: Descriptive, cross-sectional.
Place and Duration of Study: Renal Unit, Medicine Department, Obafemi Awolowo University Teaching Hospital, Ile-Ife, Southwest Nigeria.

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Methodology: Percutaneous ultrasound-guided renal biopsy was carried out in 40 consenting type 2 diabetic adults out of 88 patients in stages 3 and 4 chronic kidney disease using the Kidney Disease Improving Global Outcomes classification.
Results: Eighty eight (48.1%) of the one hundred and eighty three subjects with mean age of 58.05(±6.10) years had clinical Diabetic Nephropathy. The duration of diabetes was 9.55(±4.1) years. Median protein excretion was 0.55 g/day. Mean estimated Glomerular Filtration Rate was 45.1(±12) ml/min. Thirty nine renal (97.5%) tissues showed glomerular basement membrane thickening.
There was a positive correlation between the systolic blood pressure and severity of glomerular lesions (r=0.480, p=0.002), interstitial changes (p=0.602, r<0.001) and vascular lesions (0.429, 0.006). The diastolic blood pressure correlated with glomerular lesions (r=0.500, p=0.001), interstitial changes (0.479, 0.002), vascular lesions (p=0.431, r=0.006), nodular glomerulosclerosis (r=0.333, p=0.036) and diffuse glomerulosclerosis (r=0.372, p=0.018). Urinary protein excretion correlated with severity of glomerular lesions (r=0.457, p=0.003), vascular changes (r=0.483, p=0.002) and diffuse glomerulosclerosis (r=0.407, p=0.009). Diabetic retinopathy correlated positively with severity of glomerular lesion (r=0.406, p=0.009) and diffuse glomerulosclerosis (r=0.547, p<0.001).
Conclusion: The prevalence of diabetic nephropathy among type 2 diabetics in Ile-Ife is high. Glomerular basement membrane thickening was the most prevalent renal pathology. There was a positive correlation between blood pressure, protein excretion, retinopathy and renal histology.

Keywords: Diabetic nephropathy; prevalence; type 2 diabetes; Southwest Nigeria; histology.

1. INTRODUCTION

Current statistics have established diabetes mellitus (DM) and by extension, diabetic nephropathy (DN) as a global epidemic but of more concern is its higher rate in the developing countries where health care resources are often inadequate [1,2]. In the past four decades in Nigeria, the prevalence of diabetes has increased steadily from 0.4% to 4.64% [3-5].

Attempts have been made in the past to correlate clinical parameters with surrogate markers of renal function using glomerular filtration rate and proteinuria in our environment and they showed significant correlations [6,7]. However, emerging evidences indicate that these markers of renal tissue damage may not be sufficient to substitute for actual histological assessment of renal damage and correlations with clinical parameters as demonstrated by JL Taft et al. [8] and White and Bilous et al. [9] in separate studies. Secondly, evidences suggest that renal disease in type 2 diabetes may not only be a direct consequence of diabetic nephropathy. For instance, Sharma et al. [10] showed that among 2,642 native kidney biopsies, 37% of patients showed pure diabetic nephropathy, 36% showed a non-diabetic renal disease while there was a mixture of diabetic nephropathy and non-diabetic renal disease among 27% of the subjects.

There is generally paucity of data on the pattern of renal histopathological changes and its correlation with clinical parameters in our local practice. A previous study carried out about two decades ago found significant correlations between clinical parameters such as systolic and diastolic blood pressure, age at onset and duration of DM, and some specific renal histopathological changes [11]. Since then, little efforts have been made in that direction to corroborate these findings. This study was carried out in the hope that it may add to the pool of existing knowledge in a developing country using newer criteria.

2. METHODOLOGY

The study was a cross-sectional, descriptive study carried out at the Obafemi Awolowo University Teaching Hospitals Complex, Osun State, Southwest Nigeria. One hundred and eighty three consecutive type 2 diabetes mellitus patients diagnosed according to the World Health Organization criteria were recruited. Diabetic nephropathy was defined as persistent proteinuria of >300 mg/day in the presence of reduced glomerular filtration rate with or without microvascular complications of DM. Exclusion criteria were subjects who did not give informed consent, type 2 diabetes mellitus with duration less than 5 years, type 1 diabetes; type 2 diabetics with other causes of chronic kidney diseases such as bladder outlet obstruction, multicystic kidney diseases, autoimmune diseases, kidney stones, congenital anomalies etc; type 2 diabetics with congestive cardiac failure, primary or secondary metastases and pregnancy.

Their demographic, clinical parameters and laboratory findings were obtained and documented in a proforma. Their anthropometrics were measured and recorded. All the patients were examined for retinopathy by a Consultant Ophthalmologist using the *Wellch-Allyn* ophthalmoscope (*Welch-Allyn*, USA) after informed consent. The pupils were dilated with 2 drops of atropine eye medication and thereafter examined (one eye after the other) in a dimly-lit room with the eyes fixated on a still object. Their blood pressures were assessed in the supine and erect positions using the mercury sphygmomanometer (*Accoson,* Germany). Hypertension was defined as blood pressure >140/90 mmHg or regular use of antihypertensive medications [12]. Sensation to vibration, joint position and light touch were determined by standard clinical methods. Blood samples were collected and processed for fasting lipid profile, serum calcium, fasting blood glucose and 2-hours post-prandial blood glucose, and glycated haemoglobin. Early morning mid-stream urine samples were collected and tested for proteinuria and microbial cultures after each patient received verbal and written instructions on the collection method. Daily protein excretion was quantified by a 24- hour urine collection after detailed education. The estimated glomerular filtration rate (eGFR) of subjects was determined using the Chronic Kidney Disease-Epidemiology (CKD-EPI) calculator [13].

All subjects were weaned off anti-proteinuric drugs (Angiotensin Converting Enzyme-Inhibitors or Angiotensin Receptor Blockers) 96 hours before proteinuria testing. These were continued thereafter with other treatment regimen as appropriate.

Subjects with eGFR< 60 to ≥ 15 ml/minute with or without significant proteinuria on at least 2 occasions 3 to 6 months apart in the absence of urinary tract infection and haematuria were recruited for kidney biopsy. The haemogram and clotting profile of those scheduled for biopsy were pre-determined. Necessary standard precautions such as correction of anaemia, blood pressure and glucose control were ensured before biopsy.

Histology slides were read and interpreted by the authors in conjunction with a certified specialist renal histopathologist. The 2010 Renal Pathological Society (RPS) classification of Diabetic Nephropathy model was used to evaluate and score severity of renal changes [14]. The scoring systems derived for this study from the RPS classification model are shown in Tables 1-2.

Table 1. Scoring format for severity of glomerular lesion adapted for our study from Renal Pathological Society 2010 classification for Diabetic Nephropathy

Class	Description	Criteria	Score	Frequency	Percentage
I	Mild or non specific light microscopic changes (e.garterionephrosclerosis, ischemic type changes, or interstitial fibrosis) EM-proven GBM thickening	Biopsy does not meet any of the criteria in class II-IV GBM >395nm in female and >430nm in male individuals 9 years of age and older	1	9	(22.5%)
IIa	Mild mesangial expansion	Biopsy does not meet criteria for class III-IV Mild mesangial expansion in >25% of observed mesangium	2	15	(37.5%)
IIb	Severe mesangial expansion	Biopsy does not meet criteria for class IV. At least one convincing Kimmestiel Wilson lesion	3	1	(2.5%)
III	Nodular sclerosis	Global glomerular sclerosis in >50% of glomeruli. Lesions from classes I-III	4	4	(10%)
IV	Advanced diabetic glomerulosclerosis	Biopsy does not meet criteria for class III-IV Severe mesangial expansion in >25% of observed mesangium	5	11	(27.5%)

Table 2. Scoring format for severity of tubular and interstitial lesions adapted for our study from RPS 2010 classification for DN

Lesion	Criteria	Score	Frequency	Percentage
Interstitial fibrosis and tubular atrophy (IFTA)				
	No IFTA	0	15	(37.5%)
	<25% of area of involved interstitium and tubules	1	14	(35%)
	25-50% of area of involved interstitium and tubules	2	6	(15%)
	>50% of area of involved interstitium and tubules	3	5	(12.5%)
Interstitial inflammation				
	Absent	0	12	(30%)
	Infiltration in relation to IFTA	1	21	(52.5%)
	Infiltration in areas without IFTA	2	7	(15.5%)
Arteriolar hyalinosis				
	Absent	0	14	(35%)
	at least one area of arteriolar hyalinosis	1	8	(20%)
	more than one area of arteriolar hyalinosis	2	18	(45%)
Presence of large vessel arteriosclerosis				
	No intimal thickening	0	18	(45%)
	intimal thickening less than thickness of media	1	13	(32.5%)
	intimal thickening greater than thickness of media	2	9	(22.5%)

Ethical approval was obtained from the Ethics and Research Committee of Obafemi Awolowo University Teaching Hospital.

Statistical analysis was carried out using Statistical Package for Social Sciences 19. Descriptive variables such as age, gender, duration of DM, age at diagnosis, anthropometric measurements, biochemical parameters were presented as frequencies, percentage and mean (± standard deviation). Independent sample T test was used to determine significant differences between the mean (± standard deviation) of variables. Test of association between variables was by bivariate correlation and linear regression. The p value was regarded as significant at $p < 0.05$. The correlation coefficient was used to determine the direction and strength of associations.

3. RESULTS

Eighty eight (48.1%) subjects had clinical evidence of Diabetic Nephropathy out of a total of 183 consecutive type 2 diabetes mellitus patients who were screened. Forty seven (53.4%) were males with a male to female ratio of 1.2:1.

Out of the 88 subjects with clinical DN, only forty; 16(40%) males and 24(60%) females consented to kidney biopsy. Their age range was 44 to 68 years with a mean age (±SD) of 58.05 (±6.10) years. The mean age at diagnosis and duration of DM were 48.48 (±6.10) and 9.55 (±4.1) years respectively. Twenty eight (70%) had associated hypertension. The mean duration of hypertension was 7.71 (±5.24) years. The mean (±SD) systolic blood pressure was 142 (±24) mmHg and the mean (±SD) diastolic blood pressure was 84 (±13) mmHg. Forty five percent had clinical evidence diabetic retinopathy.

Table 3 is a summary of the clinical and laboratory parameters of the 40 subjects who consented to renal biopsy. The mean BMI (±SD) was 25.76 (±3.50) kg/m2. Their mean plasma triglyceride and HDL were 1.28 (±0.57) mmol/L and 1.47 (±0.56) mmol/L. Mean estimated GFR was 45.1 (±12) ml/min. The mean (±SD) glycated haemoglobin was 9.51 (±2.60)%. Thirty one (77.5%) had glycated haemoglobin level above

cut-off. The mean (±SD) corrected serum calcium was 2.34 (±0.23 mmol/L) and the mean (±SD) serum albumin was 35.18 (±4.19 g/L).

Table 4 shows the varieties of histological changes in the subjects. The severity of renal tissue damage involving the glomeruli and the interstitium according to the 2010 RPS classification are shown in Tables 1 and 2.

Figs. 1-3 are real-time histological slides of renal tissue tissues from some of our subjects in this study. They show varying histological changes.

Table 3. Clinical characteristics and laboratory parameters of type 2 diabetic nephropathy patients who underwent renal biopsy

Parameters	Mean ±SD	Male	Female	P value
		Mean±SD	Mean±SD	
Age (years)	58.05 (±6.10)	59.44 (±5.39)	57.1 (±6.48)	0.245
DM duration (years)	9.55 (±4.1)	10.25 (±3.49)	9.08 (±4.4)	0.386
e – GFR (ml/min)	45.1 (±12)	44.58 (±11.32)	45.4 (±12.9)	0.832
BMI (kg/m^2)	25.76 (±3.50)	24.66 (±2.60)	26.49 (± 3.87)	0.10
Waist-hip ratio	0.97 (±0.56)	0.97 (±0.40)	0.97 (±0. 65)	0.95
SBP (mmHg)	142 (±24)	148 (±19)	139 (±26)	0.29
DBP (mmHg)	84 (±13)	89 (±12)	81 (±14)	0.06
Glycated haemoglobin (%)	9.51 (±2.60)	9.58 (±2.60)	9.46 (±2.68)	0.89
Urinary Protein excretion (g/day)	0.88 (±1.2)	0.74 (±1.1)	0.97 (±2.68)	0.56
Urea (mmol/L)	5.78 (±3.55)	6.98 (±4.33)	5.28 (±3.27)	0.17
Creatinine (µmol/L)	126.2 (±46.87)	148.5 (±73.6)	121.75(±50.6)	0.18
Bicarbonate (mmol/L)	23.3 (±2.5)	22.9 (±2.57)	23.54 (±2.48)	0.46
PCV (%)	35.03 (±6.26)	37.3 (±6.6)	33.45 (±5.6)	0.05
TC (mmol/L)	5.11 (±1.11)	4.86 (±1.11)	5.26 (±1.09)	0.26
TG (mmol/L)	1.28 (±0.57)	1.32 (±0.67)	1.2 (±0.53)	0.56
HDL (mmol/L)	1.47 (±0.56)	1.41 (±0.62)	1.48 (±0.68)	0.70
LDL (mmol/L)	3.03 (±0.73)	2.79 (±0.70)	3.25 (±0.74)	0.06
Corrected calcium (mmol/L)	2.34 (±0.23)	2.23 (±0.22)	2.25 (±0.23)	0.92
Inorganic phosphate (mmol/L)	1.42 (±0.61)	1.34 (±0.49)	1.48 (±0.68)	0.50
Albumin (g/L)	35.18 (±4.19)	35.75 (±4.97)	34.7 (±3.65)	0.45
Total protein (g/L)	72.68 (±8.23)	72.9 (±8.72)	71.58 (±8.3)	0.62
Uric acid (mmol/L	0.34 (±0.09)	0.35 (±0.09)	0.33 (±0.88)	0.52

Table 4. Frequency of the types of histological lesions in type 2 DN using light microscopy

	Histology	Frequency (%)
GBM and mesangium	GBM thickening	39 (97.5%)
	Mesangial expansion	22 (55%)
Glomerular	Nodular glomerulosclerosis	6 (15%)
	Diffuse glomerulosclerosis	25 (62.5%)
Vascular	Arteriolar hyalinosis	27 (67.5%)
	Large vessel arteriosclerosis	25 (62.5%)
Tubulo-interstitial	Tubular atrophy	27 (67.5%)
	Tubular dilatation	18 (45%)
	Interstitial fibrosis	29 (72.5%)
	Interstitial inflammation	28 (70%)
Other findings	Capsular drop	3 (7.5%)
	Segmental sclerosis	16 (40%)
	Periglomerular fibrosis	22 (55%)
	Peritubular fibrosis	6 (15%)
	Tubular casts	8 (20%)
	Tubular membrane thickening	13 (32.5%)

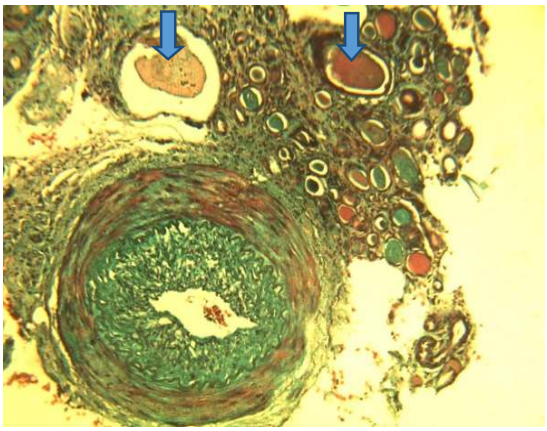

Fig. 1. Masson trichrome stain of renal tissue of one of the subjects showing massive thickening of tunica media in a large vessel
Note sclerosed glomeruli (blue arrows) and highly interspaced dilated tubules (in-between the glomeruli and thickened vessel)

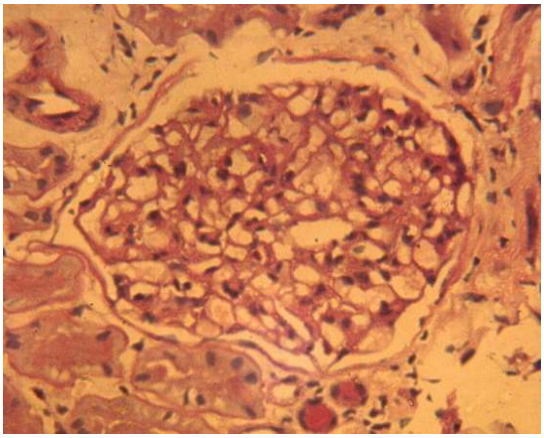

Fig. 2. Per-iodic Acid Schiff (PAS) stain showing widespread glomerular basement membrane thickening of renal tissue from one of thesubjects
Note also PAS stain of peritubular tissues indicating peritubular fibrosis

Table 5 summarizes the correlation between the clinical parameters, daily protein excretion, estimated glomerular filtration rate and renal histopathology. It shows a significant positive correlation between the systolic blood pressure and glomerular lesions (r= 0.48, p= 0.002); interstitial fibrosis and tubular atrophy (IFTA) (r= 0.602, p= 0.000); interstitial inflammation (r= 0.602, p= 0.000), arteriolar hyalinosis (r= 0.470, p= 0.003); large vessel arteriosclerosis (r= 0.429 p= 0.006) and diffuse glomerulosclerosis (r=0.373, p=0.018).

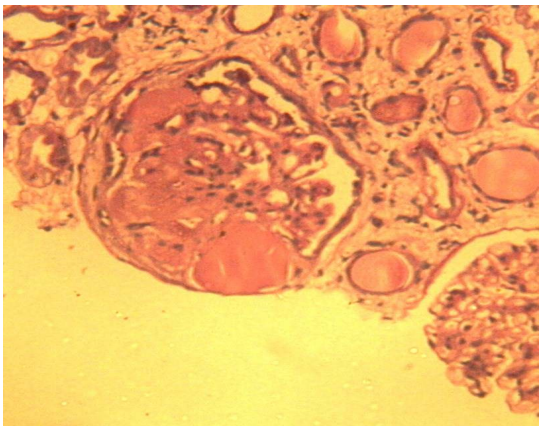

Fig. 3. Periodic Acid Schiff stain of a diabetic renal tissue showing nodular glomerulosclerosis with sparsed mesangial cells
Note adjacent dilated tubules filled in with homogenous PAS-staining collagen

There was a significant positive correlation between the diastolic blood pressure and glomerular lesions (r= 0.500, p=0.001); interstitial fibrosis and tubular atrophy (IFTA) (r= 0.479, p= 0.002); interstitial inflammation (r= 0.479, p= 0.001); arteriolar hyalinosis(r= 0.431, p= 0.006); large vessel arteriosclerosis (r= 0.424, p= 0.007); diffuse glomerulosclerosis (r= 0.372, p= 0.018) and nodular glomerulosclerosis. A similar pattern was found for Mean Arterial Blood Pressure (Table 5).

The daily protein excretion correlated significantly with glomerular lesions (r= 0.457, p= 0.003), interstitial fibrosis and tubular atrophy (IFTA) (r= 0.327, p= 0.047), interstitial inflammation (r = 0.320, p= 0.047), arteriolar hyalinosis (r= 0.483, p= 0.002), large vessel arteriosclerosis (r= 0.332, p= 0.039) and diffuse glomerulosclerosis (r= 0.407, p= 0.009).

There was a significant positive correlation between diabetic retinopathy and glomerular lesions (r= 0.406, p= 0.009) and, diabetic retinopathy and diffuse glomerulosclerosis (r= 0.547, p= 0.000).

There was no correlation between mesangial expansion and clinical parameters of diabetic nephropathy (p >0.05). There was no significant relationship between duration of DM and renal histology (Table 5).

4. DISCUSSION

In this study, out of the 183 type 2 diabetics screened, 88 (48.1%) fulfilled the inclusion

criteria for clinical diabetic nephropathy. This occurrence rate of diabetic nephropathy is higher than 40% reported at a sister institution about two decades ago [11]. Figures ranging between 6% and 46% have been reported in some other parts of Africa [15-17]. There were more males than females in this study in keeping with established facts [18]. The mean age of subjects was similar to figures from earlier studies [11,19-20]. The mean duration of DM also compared well with the studies by Alebiosu et al. and Bruno et al. [11,21]. There was a high prevalence of hypertension (70%) in our study. Bella *et al* found hypertension in 55% of diabetics with DN in Nigeria in 1988 while Ikem et al. [22] and Alebiosu et al. [11] reported a prevalence of 41.6% and 58% respectively about a decade ago [22-23]. Figures reported from other parts of Africa were as low as 46% in Kenya, and 24% in Ethiopia [15,17,24]. This relative increase in the prevalence of hypertension in our study tallies with the World Health Organization report that hypertension and concomitant diabetes are on the increase globally and, especially at a higher rate in developing countries [25].

The prevalence of diabetic retinopathy was 45%, a considerably low figure when viewed against the backdrop of higher results expected in patients with diabetic nephropathy. However, similar results have been found in other studies. For instance, Gall et al. and Roberto et al. reported prevalence rates of 45% and 58.5% respectively [26-27].

The commonest histological lesion was glomerular basement membrane (GBM) thickening in this study. GBM thickening has been regarded as a "pre-diabetic" lesion [28]. An association between GBM thickening and loss of kidney function has equally been demonstrated in type 2 diabetic patients [29].

Hyaline arteriosclerosis was found in more than two-thirds of renal tissues. The presence of efferent arteriolar hyalinosis distinguishes DN from hypertensive nephrosclerosis, another common cause of diffuse GBM thickening known to affect only the afferent arteriole [30].

Diffuse glomerulosclerosis was found in 62.5% of the biopsy specimen in this study compared to 15% with nodular glomerulosclerosis. This pattern is similar to results from earlier researchers [31-32]. Our study demonstrated few biopsies with nodular glomerulosclerosis. Such rarity of the Kimmelstiel-Wilson lesion was reported by Alebiosu *et al* who recorded the occurrence rate of 20% nodular sclerosis in 55 patients with biopsy-proven DN [11].

There is paucity of reports on the co-occurrence of nodular and diffuse glomerulosclerosis. Existing reports however indicate that it is more common for diffuse sclerosis to occur alone when compared to nodular sclerosis. Our study showed diffuse glomerulosclerosis occurring in the absence of nodular glomerulosclerosis among 32.7% of the renal tissues studied while co-occurrence of nodular and diffuse sclerosis was found in 12.5% of biopsy specimens. Only one biopsy report showed nodular glomerulosclerosis occurring in the absence of diffuse sclerosis. We found that the daily protein excretion correlated positively with severity of glomerular lesions, interstitial fibrosis and tubular atrophy (IFTA), interstitial inflammation, arteriolar hyalinosis, large vessel arteriosclerosis, diffuse glomerulosclerosis and nodular glomerulosclerosis. These findings are similar to the results of studies by Suzuki et al. and Okada et al. [33-34] and may have implications in the follow up of patients when using proteinuria as surrogate.

Gellman et al. [35] as far back as 1959 showed a correlation between hypertension, proteinuria and severity of diffuse glomerulosclerosis. Our study found an association between diffuse glomerulosclerosis and proteinuria greater than 3.5 g/day while this was not seen in those with nodular sclerosis. It has been suggested that diffuse glomerulosclerosis, and not the nodular lesion of Kimmelstiel and Wilson, is the cause of massive proteinuria and the nephrotic syndrome in diabetes [35-36].

The study also showed a significant positive correlation between the systolic blood pressure and glomerular lesions, interstitial fibrosis and tubular atrophy (IFTA), interstitial inflammation, arteriolar hyalinosis, large vessel arteriosclerosis and diffuse glomerulosclerosis. There was also no correlation with nodular glomerulosclerosis. These may be explained by the fact that in type 2 DM patients with nephropathy, the most common histological findings are a mixture of diabetic glomerulosclerosis, hypertensive nephrosclerosis and tubulointerstitial involvement— and not necessarily the classical Kimmelstiel-Wilson lesions [37]. These have clinical implications as hypertension portends a worsening of renal lesion and improved control may attenuate or retard progression as has been discussed.

Table 5. Association between renal histology and clinical features of study group

Severity of histology	Duration of diabetes		SBP		DPB		MABP		Diabetic retinopathy		Daily protein excretion		e-GFR	
	r	P value	r	P value	r	P value	r	P value	r	P value	r	P value	r	P value
Glomerular lesion	0.115	0.482	0.480	0.002*	0.500	0.001*	0.556	<0.001*	0.406	0.009*	0.457	0.003*	-0.198	0.22
IFTA	-0.057	0.730	0.602	<0.001*	0.479	0.002*	0.568	<0.001*	0.264	0.104	0.327	0.047*	-0.229	0.161
Intestitial inflammation	0.072	0.659	0.507	0.001*	0.479	0.001*	0.564	<0.001*	0.212	0.189	0.320	0.047*	-0.251	0.118
Arteriolar hyalinosis	0.004	0.978	0.470	0.003*	0.431	0.006*	0.492	0.001*	0.013	0.939	0.483	0.002*	-0.131	0.427
LVA	-0.142	0.388	0.429	0.006*	0.424	0.007*	0.452	0. 004	0.222	0.174	0.332	0.039*	-0.204	0.213
Mesangial expansion	0.127	0.434	-0.262	0.102	-0.269	0.093	-0.286	0.074	-0.144	0.376	-0.161	0.320	-0.025	0.876
Diffuse glomerulosclerosis	0.060	0.714	0.373	0.018*	0.372	0.018*	0.427	0.006*	0.547	<0.001*	0.407	0.009*	-0.121	0.456
Nodular sclerosis	0.230	0.153	0.197	0.223	0.333	0.036	0.316	0.047	0.285	0.075	0.134	0.411	0.055	0.737

The diastolic blood pressure showed a similar association to renal histology as in SBP in addition to nodular glomerulosclerosis as in earlier reported findings [11]. It should be noted that several other authors have reported similar relationships among type 1 DM patients in which interstitial expansion and percentage of global sclerosis directly correlated to proteinuria and hypertension [38-41].

Our study found a significant positive correlation between diabetic retinopathy and glomerular lesions. It also found a positive correlation between diabetic retinopathy and diffuse glomerulosclerosis, findings similar to the report of Klein et al. [42] among type 1 diabetics.

There was no significant relationship between duration of DM and renal histology similar to results by Christensen et al. [43] among type 2 diabetics with DN. This might be due to the difficulty in timing the onset of disease in type 2 DM unlike in type 1 DM.

There was no relationship between the severity of the renal tissue histology and glomerular filtration rate in this study unlike earlier reports [38-39]. This is probably because patients that were used in this study were restricted to GFR <60 to ≥15 ml/min and it has been shown that the percentage of sclerotic glomeruli correlates with the level of albuminuria and GFR in patients with diabetic nephropathy [43]. Our study showed only a correlation between diffuse glomerulosclerosis and daily protein excretion.

In sequential biopsy studies, both arteriolar hyalinosis lesionsand the number of sclerosed glomeruli progresses as the diabetic kidney disease advances [8]. Our study also demonstrated a positive correlation between arteriolar hyalinosis and percentage of diffuse glomerulosclerosis.

In this study, a positive correlation between the degree of interstitial fibrosis and both the systolic and diastolic blood pressure was found. There was also a weak correlation with the daily protein excretion. These findings corroborate earlier findings that treatment modalities that reduce blood pressure and proteinuria assist greatly in retarding progression of nephropathy [44-45].

5. LIMITATION

Our study was limited by the short period allowed for weaning subjects off Angiotensin Converting Enzyme-inhibitors (ACE-Is) and/or angiotensin Receptor Blockers (ARBs) as holding ACE-I for 96 hours may not fully uncover the subject's true capacity for proteinuria.

6. CONCLUSIONS

The prevalence of diabetic nephropathy among type 2 diabetics in Ile-Ife, south western Nigeria is high. Glomerular basement membrane thickening was the most prevalent renal histological changes. There was a positive correlation between blood pressure, urinary protein excretion, retinopathy and renal histology as these factors significantly predict severity of renal damage in diabetics. Efforts should be intensified on improved community awareness programmes and intensification of efforts aimed at screening of population at risk for prevention, early detection and retardation of progression of disease. The management of diabetes mellitus should be multidisciplinary once diagnosis is made especially in developing countries. An integral part of preventing diabetic nephropathy should be a 6-monthly to annual screening for Diabetic Nephropathy in the type 2 diabetic population.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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