

A Clinicopathological Study of 267 Patients with Diabetic Kidney Disease Based on the Renal Pathology Society – 2010 Classification System

Abstract

Introduction: Renal biopsy is primarily indicated in patients with diabetes mellitus (DM) with proteinuria, to diagnose non-diabetic renal disease (NDRD). However, Renal Pathology Society classification (RPSc) – 2010 has classified diabetic nephropathy (DN) into four classes of glomerular lesions with a separate scoring for tubulointerstitial and vascular lesions. Paucity of data from Indian subcontinent prompted us to plan this study to classify DN on biopsy as per the RPSc and correlate the clinical profile with histology. **Materials and Methods:** Patients with DM who underwent renal biopsy for various indications (between Aug 2013 and Nov 2015) were included in the study. DN on histology was classified according to RPSc. Histopathology lesions of DN were correlated with clinical and biochemical profiles. **Results:** Of the 267 patients studied, 252 (94.3%) were type 2 DM. NDRD alone was seen in 65 (24.34%), DN in 161 (60.3%), and NDRD with DN in 41 (15.3%). The most common indications for biopsy were rapidly progressive renal failure (76.7%) and nephrotic syndrome (16.4%). The most common glomerular class was class IV (43.5%), followed class III (41%), class II (13.3%), and class I (1.9%). The most common NDRD seen was acute interstitial nephritis (AIN) in 20.2% and is frequently associated with class III. Tubulointerstitial chronicity and not the arteriolar chronicity, was correlated with low estimated glomerular filtration rate (eGFR). **Conclusions:** Most patients with DN subjected to renal biopsy were in class IV, and AIN was the most common NDRD. Only tubulointerstitial chronicity correlated with low eGFR.

Keywords: AIN, biopsy, diabetic kidney disease, India, nondiabetic kidney disease, RPS classification

Introduction

Diabetic nephropathy (DN) is the leading cause of end-stage renal disease (ESRD) across the world. It refers to a characteristic set of structural and functional kidney abnormalities in patients with diabetes mellitus (DM). It is a secondary glomerulopathy, which occurs as part of multisystem disease. DN is broadly defined as a clinical syndrome characterized by persistent albuminuria (>300 mg/24 h or >300 mg/g creatinine), a relentless decline in glomerular filtration rate (GFR), and raised arterial blood pressure with enhanced cardiovascular morbidity and mortality. Renal biopsy may be indicated in diabetic patients with proteinuria to exclude non-diabetic renal disease (NDRD). Renal biopsy also aids in staging of renal lesions in DN, though just for diagnosis of DN, renal biopsy is rarely done. A uniform classification system for DN is developed by Renal Pathology

Society (RPS).^[1] DN is classified into four hierarchical classes of glomerular lesions with a separate scoring for tubule-interstitial and vascular lesions.^[1] Both glomerular and interstitial lesions contribute to the decline in renal function in diabetics and are independent factors in the progression of DN. Not many studies reporting renal biopsy findings in diabetics in the literature classified DN according to the latest 2010 Renal Pathology Society classification (RPSc) system. Very few studies correlated the clinical features with the pathologic glomerular class and tubulointerstitial and vascular severity score of DN as per the new classification system. We planned this study to classify DN on biopsy, in patients of diabetes who were subjected to renal biopsy, as per the RPSc system and correlated the clinical profile with histology.

Materials and Methods

All diabetic patients from August 2013 to November 2015, who underwent renal

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biopsy for various indications were included in the study. Those with inadequate biopsy sample for analysis were excluded from the study. Demographic, clinical, and biochemical profiles of patients were collected. Estimated GFR (eGFR) was calculated using the Modification of Diet in Renal Disease formula. The indications for renal biopsy included (1) persistent nephrotic range proteinuria (defined as proteinuria >3.5 g/day/1.73 m² or protein: creatinine ratio >3 g/g with edema, hypoalbuminemia, that is, serum albumin <3.5 g/dL) or (2) sudden onset overt proteinuria; or (3) hematuria with dysmorphic red blood cells (RBCs) in urine (defined as >5 RBCs/hpf on microscopic examination of urine); or (4) rapidly progressive renal failure (RPRF) (defined as renal failure over days/weeks, proteinuria, hematuria with RBC casts); or (5) suspicion of other nephropathies secondary to coexistent systemic diseases such as rheumatoid arthritis, hepatitis B, and hepatitis C infection.

Renal biopsy sample was examined both by light microscopic and immunofluorescence (IF) techniques. Sections for light microscopy were stained with hematoxylin and eosin, periodic acid Schiff, Masson's trichrome, and periodic acid methanamine silver stains. IF staining was done for IgG, IgA, IgM, C3C, C1q, κ , and λ . Renal biopsy sample was assessed by a single pathologist. No blinding was done. Electron microscopic examination was not done in any case.

DN on renal biopsy was classified according to the pathological classification by RPS by Tervaert *et al.*^[1] Class I DN was diagnosed based on membrane thickening in the absence of spikes, presence of arteriolar hyalinosis, and immunofluorescence picture. Negative IF ruled out glomerulonephritis. Pathologic lesions (both diabetic and nondiabetic) were correlated with clinical and biochemical profiles. For those patients detected with NDRD on biopsy, detailed workup was done for immunologic disorders, monoclonal gammopathies, etc. Acute interstitial nephritis (AIN) on biopsy was defined by the presence of inflammatory infiltrate in nonscarred areas composed of neutrophils, lymphocytes, monocytes, and eosinophils with tubular damage showing tubulitis and intraluminal neutrophils in viable tubules. This is differentiated from lymphomononuclear infiltrate surrounding fibrotic foci, atrophic tubules, and around glomerulosclerosis. Interstitial eosinophilic infiltrate in areas of interstitial fibrosis and tubular atrophy (IFTA) without findings of AIN is not considered as AIN.

Statistical analysis

Data were analyzed using SPSS version 20. Descriptive statistical analysis was done. The results on continuous measurements are presented as mean \pm standard deviation. The results on categorical measurements are presented as frequencies and percentages. Chi-square test has been used to find out the significance of study parameters

on a categorical scale between two groups. Analysis of variance has been used to find out the significance of study parameters on a continuous scale between more than two groups. Statistical significance was set at $P < 0.05$.

Results

A total of 267 diabetic patients who underwent renal biopsy for various indications, were included in this study. Three cases were excluded from the study due to inadequate biopsy sample. The indications for biopsy in excluded cases were nephrotic proteinuria in two and RPRF in one. Among the study population, 218 (81%) patients were male and 49 (19%) were female with a mean age of 51.53 ± 10.29 years. There were 15 (5.62%) patients with type 1 diabetes and 252 (94.38%) with type 2 diabetics. The various indications for biopsy are shown in Table 1. NDRD was more frequently seen in patients presenting with RPRF, nephritic syndrome, and glomerular hematuria. NDRD was diagnosed in 39% (71 of 182) of cases presenting with RPRF, 50% (17 of 34) of cases with nephritic syndrome, 31% (14 of 44) of cases with nephrotic syndrome, and 80% of those with glomerular hematuria.

Single kidney was found in four of our diabetic patients, and the indications for renal biopsy in them were RPRF in two, nephritic syndrome in one, and nephrotic syndrome in one case. Various systemic diseases detected in our diabetic patients were rheumatoid arthritis in 2 cases, chronic active hepatitis B infection in 3 cases, hepatitis C infection in 4 cases, pulmonary tuberculosis in 4 cases, colonic tuberculosis in 1 case, carcinoma tongue in 1 case, and stone disease in 3 cases. Eight (2.91%) patients developed severe abdominal pain after biopsy, and ultrasound abdomen showed renal hematoma. None of them had accelerated hypertension or worsening of renal function. None of them required blood transfusions. No other major complications occurred due to biopsy. Clinical profile of patients with DN, NDRD, and DN with coexistent NDRD on histology is shown in Table 2. Various histopathological lesions seen in renal biopsy are shown in Table 3.

Patients with DN on histology were classified according to Tervaert classification system into four classes of glomerular lesions. Among patients with DN, class I was seen in 4 (1.98%), class II was seen in 27 (13.36%),

Table 1: Indications for renal biopsy and the biopsy findings (%)

	NDRD (n=65)	DN (n=161)	DN with NDRD (n=41)
RPRF	48 (73.84)	111 (68.94)	23 (56.09)
Nephritic syndrome	8 (12.30)	17 (10.55)	9 (21.95)
Nephrotic syndrome	7 (10.76)	30 (18.63)	7 (17.07)
Glomerular hematuria	2 (3.07)	1 (0.62)	2 (4.87)
Non-resolving AKI	0	2 (1.24)	0

NDRD: Nondiabetic renal disease; DN: Diabetic nephropathy; RPRF: Rapidly progressive renal failure; AKI: Acute kidney injury

Table 2: Clinical profile of patients with NDRD, DN, and DN + NDRD

Variables	NDRD (n=65)	DN (n=161)	DN + NDRD (n=41)	P
Age (years)	49.43±11.87	52.32±9.54	51.73±10.17	0.1
Male (%)	43 (66)	141 (87)	34 (83)	0.0008
Duration of diabetes (years)	6.5±5.96	10.02±6.91	8.39±7.89	0.002
Diabetes duration (years)				
<5	35 (53.84)	46 (28.57)	20 (48.78)	0.0005
>5	30 (46.16)	115 (71.43)	21 (51.22)	
Diabetic retinopathy present	11 (16.92)	78 (48.44)	11 (26.82)	0.00001
Laser treatment Received	5 (7.69)	37 (22.98)	7 (17.07)	0.02
Hypertension Present	45 (69.23)	141 (87.57)	33 (80.48)	0.004
24-H urine protein (g/day)	1.55±1.99	2.91±2.39	2.52±2.9	0.02
eGFR (mL/min/1.73m ²)	25.4±28.81	29.9±19.07	21.92±15.45	0.00004
Hemoglobin (g/dL)	10.04±2.45	9.87±2.51	9.75±2.17	0.5
Albumin (g/dL)	3.27±0.79	3.09±0.79	3.02±0.81	0.9
HbA1C	7.6±2.06	7.66±2.26	8.31±2.01	0.5

Data are presented as mean±standard deviation and percentages. NDRD: Nondiabetic renal disease; DN: Diabetic nephropathy; DM: Diabetes mellitus; eGFR: Estimated glomerular filtration rate

Table 3: Nondiabetic renal lesions in diabetic patients

Nondiabetic renal lesion	NDRD alone (n=65)	DN + NDRD (n=41)
AIN	27	27
MN	9	0
DPGN	2	2
Crescentic glomerulonephritis	2	4
Hypertensive vascular changes	5	0
PIGN	2	2
FSGS	4	1
MPGN	2	1
Granulomatous AIN	3	1
Amyloidosis	1	1
Thrombotic microangiopathy	1	0
Acute tubular necrosis	4	0
CIN	2	0
Hyperoxalosis	0	1
IgA Nephropathy	1	1

NDRD: Nondiabetic renal disease; DN: Diabetic nephropathy; AIN: Acute interstitial nephritis; MN: Membranous nephropathy; DPGN: diffuse proliferative glomerulonephritis; PIGN: Postinfectious glomerulonephritis; FSGS: Focal segmental glomerulonephritis; MPGN: Membranoproliferative glomerulonephritis; CIN: Chronic interstitial nephritis; Data are presented as frequencies

class III was seen in 83 (41.08%), and class IV was seen in 88 (43.56%) cases with DN on histology. In those patients with NDRD in conjunction with DN on biopsy, the most common histologic class of DN was class III seen in 17 cases followed by class IV in 8 cases, class II in 9 cases, and class I in 7 cases. The average duration of diabetes in our cohort was 8.94 ± 7 years. The average duration of diabetes in patients with NDRD alone was 6.5 ± 5.96 years. In patients with DN alone on biopsy, the duration of diabetes was 10.02 ± 6.91 years. The duration of diabetes in patients with DN along with non-diabetic renal lesions on biopsy was 8.39 ± 7.89 years. The duration

of diabetes mellitus did not show statistical significance with class of DN. Diabetic retinopathy (DR) and its severity as well as hypertension did not show statistical significance with severity of glomerular class on histology. eGFR, proteinuria, and serum albumin showed statistical significance with the class of DN. Patients with class IV DN had lowest GFR compared with other classes. Patients with class III DN had significantly higher proteinuria and hypoalbuminemia compared with class IV and other classes [Table 4].

Interstitial lymphomononuclear infiltrate was a common finding on histopathology of DN and was seen in 108 of 161 patients with pure DN (67.08%) [Table 5]. Plasma cells were found in the infiltrate in 11 (6.83%) of them. Interstitial neutrophilic infiltrate was seen in 7 (4.34%) patients without any evidence of urinary tract infection. Of 161 patients with DN alone on renal biopsy, 126 had interstitial fibrosis. Severe interstitial fibrosis of >50% was seen in 66 patients. Interstitial eosinophilic infiltrates were seen in 18 (11.18%) patients with pure DN on histology. Nine of them had class IV DN. Interstitial lymphomononuclear and eosinophilic infiltrates are in areas of IFTA, and hence have been thought to be secondary to diabetes and not from primary acute or chronic interstitial nephritis; however, there is no way for the authors to be certain of the origin of this infiltrate. None of them had any obvious drug cause for AIN and did not meet pathological criteria for AIN as described above. Interstitial fibrosis and tubular atrophy showed statistically significant association with low GFR and anemia [Table 6]. Tubulointerstitial chronicity did not show statistical significance with duration of diabetes mellitus, presence of hypertension, or proteinuria [Table 6]. Arteriolar hyalinosis did not show statistical significance with eGFR, anemia, duration of diabetes mellitus, hypertension, and proteinuria [Table 7].

Table 4: Clinical profile of patients with DN on histology with different glomerular lesions

Variables	Class I (n=4)	Class II (n=27)	Class III (n=83)	Class IV (n=88)	P
Males	4 (100)	24 (88.88)	73 (87.95)	74 (84.09)	0.7
Age (years)	64.5±5.44	51.59±10.98	50.86±9.27	53.1±9.36	0.4
Duration of diabetes	7.5±6.13	6.33±5.85	9.62±6.97	10.89±7.46	0.5
Duration of diabetes (years)					
<5	2 (50)	15 (55.55)	22 (26.50)	27 (30.68)	0.03
>5	2 (50)	12 (44.45)	61 (73.5)	61 (69.4)	
Diabetic retinopathy present	0 (0)	9 (33.33)	40 (48.19)	40 (45.45)	0.1
Laser Received	0 (0)	3 (11.11)	19 (22.89)	22 (25)	0.3
Hypertension present	3 (75)	23 (85.18)	69 (83.13)	79 (89.77)	0.5
eGFR (mL/min/1.73 m ²)	26.25±15.28	20.44±14.69	28.01±21.52	16.39±10.96	0.000001
24-H urine protein excretion (g/day)	1.03±0.9	1.61±1.35	3.23±2.84	2.85±2.37	0.0002
Serum albumin (g/dL)	3.52±0.57	3.38±0.97	2.9±0.75	3.13±0.75	0.02
HbA1C	10±2.83	8.21±2.92	8.05±2.28	7.36±1.86	0.02
Hemoglobin (g/dL)	11.92±3.02	9.73±2.38	9.87±2.61	9.87±2.04	0.1

DN: Diabetic nephropathy; eGFR: Estimated glomerular filtration rate, Data are presented as mean±standard deviation and percentages

Table 5: Tubule-interstitial and vascular lesions in patients with different glomerular classes

	Class I (n=2)	Class II (n=20)	Class III (n=66)	Class IV (n=73)
IFTA				
0	2	2	12	8
1	0	4	6	5
2	0	8	24	20
>50%	0	6	24	40
Interstitial infiltrates				
0	2	6	13	10
1	0	4	10	10
2	0	10	43	53
Arteriolar hyalinosis				
0	1	2	10	0
1	0	2	6	7
2	1	16	50	66

Data are presented as frequencies; IFTA: Interstitial fibrosis and tubular atrophy

Discussion

In this study, we evaluated the relationship between renal histologic findings and clinical features in a large cohort of diabetic patients subjected to renal biopsy. This is the first largest study from a tertiary care center in south India. Renal pathologic changes in patients with diabetes are not always attributable to DN. The pathology of DN involves all components of renal cortex, including glomeruli, tubulointerstitium, and blood vessels. Glomerular lesions are the most characteristic feature of DN. Not many studies reporting renal biopsy findings in diabetics in the literature classified DN according to the latest 2010 RPSc classification system. Very few studies correlated the clinical features with the pathologic class and score of DN as per the new classification system.

The reported incidence of NDRD ranges from 23% to 54% in proteinuric diabetic patients.^[2,3] The incidence of NDRD in our study was 30%. Meta-analyses report an incidence of 26.7% of NDRD in Asian patients.^[4] The variation in incidence could be due to selection bias in indications for biopsy.

The most common non-diabetic renal lesion found in our study was AIN. The most common possible etiology for AIN in our group was drug-induced due to antibiotics (Cephalosporins) and proton pump inhibitors (Pantoprazole). The commonest non-diabetic renal lesions reported were different in different studies in the literature. Prakash *et al.* reported that idiopathic MN was the most common NDRD lesion in diabetics.^[2] But the sample size of the study was only 31 with isolated DN in 12, pure NDRD in 13, and mixed lesions in 6 cases. Four of the patients had MN.^[2] Wilfred *et al.* reported chronic interstitial nephritis as the most common NDRD followed by AIN in their group of 63 diabetic patients with NDRD.^[5] Soni *et al.* reported AIN as the most common NDRD in their large cohort of 160 diabetic patients.^[3] The next most common NDRD were postinfectious glomerulonephritis, MN, and FSGS. Others reported FSGS as the most common NDRD in diabetics.^[6] The most common glomerular class of DN among patients with coexistent NDRD in our study group is class III. Sahay *et al.* reported that the most common class of DN in their group was class IV followed by class III.^[7] The discrepancy could be due to bias in the selection of patients for biopsy.

Schwartz *et al.* noted a significant difference in the duration of diabetes between patients with Kimmelstiel–Wilson lesions and mesangial lesions.^[8] One study from south India reported that there is no statistically significant correlation between duration of diabetes mellitus and class of DN.^[7] In our study, the mean duration of diabetes mellitus in DN classes I, II, III, and IV was 7.5, 6.33, 9.62,

Table 6: Tubule-interstitial chronicity compared with clinical variables

Variables	Minimal IFTA (<25%) n=24	Severe IFTA (>50%) n=70	P
Age (years)	52.54±11.45	52.57±8.70	0.09
Duration of diabetes (years)	10.35±6.96	11.56±7.63	0.5
Hypertension	20 (83.33%)	63 (90%)	0.3
eGFR (mL/min/1.73 m ²)	34.29±28.47	15.45±12.21	0.00002
Creatinine (mg/dL)	3.37±2.49	5.3±2.66	0.002
24-H urine protein (g/day)	2.17±2.88	2.84±2.53	0.4
Serum albumin (g/dL)	3±0.85	2.95±0.69	0.2
Hemoglobin (g/dL)	10.3±2.34	9.46±1.67	0.03

Data are presented as mean±standard deviation and percentages. IFTA: Interstitial fibrosis and tubular atrophy; eGFR: Estimated glomerular filtration rate

Table 7: Severity of arteriolar hyalinosis compared with clinical variables

Variables	No arteriolar hyalinosis (n=13)	Severe arteriolar hyalinosis (n=133)	P
Age (years)	47.92±12.71	52.82±9.01	0.07
Duration of diabetes (years)	6.62±5.73	10.58±7.15	0.05
Hypertension	10 (76.9)	121 (90.9)	0.1
eGFR (mL/min/1.73 m ²)	30.15±18.63	20.71±16.18	0.4
Creatinine (mg/dL)	3.41±2.16	4.71±2.84	0.2
24-H urine protein (g/day)	1.97±1.52	2.95±2.46	0.05
Serum albumin (g/dL)	3.09±0.76	3.03±0.92	0.4
Hemoglobin (g/dL)	10.66±2.5	9.72±2.47	0.9

eGFR: Estimated glomerular filtration rate. Data are presented as mean±standard deviation and percentages

and 10.89 years, respectively. There was a statistically significant correlation between duration of diabetes mellitus and class of DN.

In our study, significantly higher number of patients with DN alone on biopsy had DR compared with patients with NDRD. Also, significantly higher number of patients with DN had severe DR and underwent laser treatment compared with patients with NDRD. Other studies in literature show that the presence or absence of DR poorly correlated with DN. In a study by Prakash *et al.*, 50% of the proteinuric diabetic patients with typical DN on biopsy did not have DR.^[9] In a study by Sahay *et al.*, of 86 cases of DN, 48 (55.8%) had DR and 38 (44.18%) had normal fundus.^[7] However, the numbers in these studies were smaller compared with our study. In a study by Harada *et al.*, patients with DN had higher rate of DR than those with NDRD (18 vs. 3). Also, patients with DR showed more severe renal histology than those without.^[10] However, in our study, among patients with DN, DR did not correlate with progressively worse glomerular class of DN.

The tubule-interstitial changes in DN include thickening of tubular basement membrane, tubular atrophy, and interstitial fibrosis. This is often associated with interstitial infiltrates predominantly lymphomononuclear. Tubulointerstitial infiltrate in areas of IFTA is a common superimposed pathologic finding reported in patients with DN.

AIN is reported to be the most common nondiabetic pathology in type 2 diabetics. Typical inflammatory infiltrates of AIN include both lymphocytes and

monocyte/macrophages. The presence of neutrophils/plasma cells points to an infectious etiology. Interstitial eosinophilic aggregate is defined as presence of >5 eosinophils per high-power field. The presence of interstitial eosinophilic aggregates is the hallmark of drug-induced tubule-interstitial nephritis. This finding can be seen in other conditions including autoimmune diseases, tubule-interstitial nephritis with uveitis, eosinophilic polyangiitis, and parasitic infections. Eosinophils may be detected among the inflammatory cells in the interstitial infiltrate of DN. However, the presence of interstitial eosinophilic aggregates is often interpreted as allergic drug reaction as diabetic patients commonly take multiple medications.

Dai *et al.* reported that interstitial eosinophilic aggregates are more prevalent in DN compared with other glomerulonephritis with a prevalence rate of 41% compared with 7%–26% seen in IgA nephropathy, MN, FSGS, and membranoproliferative glomerulonephritis.^[11] Also, the greater the interstitial eosinophilic aggregates, the more the interstitial fibrosis and tubular atrophy. The study suggests that interstitial eosinophilic aggregates are prevalent in DN and are not diagnostic of allergic-type interstitial nephritis.^[11] In our study, the prevalence of interstitial eosinophilic infiltrates is much less, seen in only 11.8% of patients with pure DN on histology.

Studies argue that progressive renal dysfunction in diabetes is primarily consequent to interstitial rather than glomerular lesions.^[12,13] Other studies contradict it. Other studies state that IFTA may be a stronger predictor of progression from established renal insufficiency to terminal uremia.^[14]

DN is associated with interstitial macrophage infiltrate, but their contribution to disease progression is unclear. Recent experimental evidence links the progression of DN to intrarenal inflammation and leucocyte cell infiltrate. Tubulointerstitial lymphomononuclear infiltrate was seen in 65.98% of patients with pure DN on biopsy. There is no correlation between the presence of tubule-interstitial infiltrate and glomerular class of DN.

The severity of tubule-interstitial score correlated with lower GFR and anemia. Patients with severe IFTA had statistically significant anemia and low eGFR compared with patients with minimal IFTA. Vascular hyalinosis did not correlate with GFR and serum creatinine. An *et al.* showed that interstitial fibrosis and tubular atrophy significantly correlated with renal outcome in type 2 diabetics in addition to glomerular class.^[15]

The recorded complication rate following renal biopsy was low. No major complications occurred and none required blood transfusions. Symptomatic hematoma occurred in eight (2.9%) of our patients. The reported incidence of renal hematoma is 2.1%.^[16] With the advent of new biopsy techniques, percutaneous renal biopsy has become a safe procedure with minimal risk of serious complications.

NDRD was more frequently seen in patients presenting with RPRF, nephritic syndrome, and glomerular hematuria. In our study, the most common glomerular class with coexistent NDRD was class III and without NDRD was class IV. Our study shows finding NDRD on biopsy was higher in cases with shorter diabetes duration (especially less than 5 years), absent retinopathy, less severe retinopathy, absence of hypertension, and less severe proteinuria with worse eGFR. Cases with above findings need to be considered for biopsy so as not to miss NDRD.

The main limitation of our study is its cross-sectional study design and it failed to see the progression to ESRD and death in the cohort.

Conclusion

In our study, the most common class of DN was class IV followed by class III, and in those with coexistent NDRD class III is most commonly detected on biopsy. Duration of diabetes, presence of DR and its severity, and hypertension did not show statistical significance with the glomerular class of DN. Patients with class IV DN had worse GFR compared with other classes. Patients with class III DN had significantly higher proteinuria and hypoalbuminemia compared with class IV and other classes. Lower eGFR and anemia showed significant correlation with severe tubule-interstitial chronicity. The most common NDRD in diabetic patients was AIN.

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Conflicts of interest

There are no conflicts of interest.

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