Section: Nephrology

Original Research Article

HISTOLOGICAL SPECTRUM OF RENAL BIOPSIES AT A TERTIARY CARE CENTRE IN SOUTHERN INDIA

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Received *: 30/11/2024*
Received in revised form *: 22/01/2025*
Accepted *: 07/02/2025*

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DOI: 10.70034/ijmedph.2025.1.92

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (1); 493-498

ABSTRACT

Background: Renal biopsy remains the cornerstone of definitive diagnosis, prognostication, and therapeutic decision-making in nephrology, offering critical insights into the diverse array of kidney pathologies. This study examines the spectrum of biopsy-proven renal diseases in Southern Indian population.

Material and Methods: This retrospective observational study was conducted at NRI General hospital from May 2021 to June 2024.A total of 195 patients included in the study. Demographic data such as age, gender, and comorbidities were recorded from patient medical records. Clinical data, including symptoms, blood pressure, serum creatinine, estimated glomerular filtration rate (eGFR), and urine analysis results, were documented at the time of biopsy.

Results: A total of 195 patients were added in the study with an age range of 12 to 71 years and a mean age of 37.38 ± 15.1 years. Male patients accounted for 55 percent, while females comprised 43 percent. Among the patients, diabetes mellitus was present in 20 percent, hypertension in 18 percent, systemic lupus erythematosus in 15 percent, and chronic kidney disease in 10 percent. Nephrotic syndrome showed a positive correlation with membranous nephropathy ($\rho = 0.34$, $p = 0.001$) and minimal change disease ($\rho = 0.28$, $p = 0.005$). Acute kidney injury was strongly associated with acute interstitial nephritis ($\rho = 0.41$, $p < 0.001$). Hypertension was significantly linked to diabetic nephropathy, with an odds ratio of 3.2 ($p = 0.003$, 95% CI: 1.5–6.8).

Conclusion: It is concluded that the spectrum of biopsy-proven renal diseases in this cohort reflects a diverse array of glomerular, tubulointerstitial, and vascular pathologies, with primary glomerular diseases (64.1%)notably IgA nephropathy (22.6%), FSGS (18.5%), and membranous nephropathy (15.9%), dominating the diagnostic methods.

Keywords: Renal Biopsy, Nephrotic syndrome, Membrane Nephropathy, Hypertension, systemic lupus erythematosus.

INTRODUCTION

Renal biopsy has a definitive role in the confirmation ofdiagnosis in various renal diseases. Histopathologicaldiagnosis following renal biopsy is not only helpful indiagnosis, butalso useful in treatment planning andprognostication.[1] Renal biopsy serves as a vital investigative method to diagnose kidney diseases by enabling doctors both to identify the causes and match effective interventions with a prediction of treatment responses.[2] Histopathological evaluation remains essential due to similar clinical symptoms in renal disorders which include proteinuria and hematuria and progressive renal dysfunction so doctors need to distinguish different underlying causes.[3] Kidney tissue analysis performed by nephrologists reveals glomerular and tubulointerstitial as well as vascular

damage extent which enables proper treatment selection and better disease outcome prediction.[4] Glomerular diseases represent the leading segment of renal diagnoses which was divided in to primary and secondary glomerular diseases. The glomeruli receive damage from primary diseases that do not spread throughout the body including minimal change disease, focal segmental glomerulosclerosis, membranous nephropathy and IgA nephropathy.[5] Secondary glomerular diseases develop because of systemic medical conditions which include lupus nephritis, diabetic nephropathy, amyloidosis and post-infectious glomerulonephritis. The glomerular condition called rapidly progressive glomerulonephritis creates serious inflammatory damage that results in swift deterioration of kidney function thus demanding immediate medical care to stop permanent organ injury.[6]

The renal tubules and interstitial cells receive direct damage from infections together with drug toxicity and autoimmune conditions and persistent exposure to nephrotoxic substances.[7] Acute interstitial nephritis occurs following drug reactions or infections. Chronic interstitial nephritis evolves through persistent tubular atrophy and fibrosis to produce enduring kidney dysfunction.[8] The three vascular diseases affecting kidneys such as hypertensive nephrosclerosis, thrombotic microangiopathy, and atheroembolic kidney disease produce ischemic damage and progressive renal impairment.[9] Many of these abnormalities develop because of hypertension and endothelial damage alongside microvascular blood clots which result in severe medical complications when medical care is not provided. The study of tissue samples during a renal biopsy enables healthcare professionals to discover inherited as well as metabolic disorders that impact kidney function.[10] Alport syndrome with glomerular basement membrane defects and Fabry disease as a lysosomal storage disorder represent two inherited kidney disorders that develop into chronic renal failure during the years. Biopsy allows early detection of such conditions which enables physicians to start treatment protocols including enzyme replacement therapy as part of their therapeutic approach.[11]

Population-wide biopsy-proven renal disease occurrence differs because of distinct genetic makeups coupled with environmental elements as well as healthcare service reach. Research shows that IgA nephropathy stands as the top glomerular diagnosis in specific geographical areas but focal segmental glomerulosclerosis along with lupus nephritis dominates other regions.[12] The worldwide surge of diabetes cases has elevated diabetic nephropathy to become the main reason for globally prevalent chronic kidney disease. Knowledge of these epidemiologic patterns enables health officials to create better public health initiatives as well as develop prompt identification systems for medical treatments.[13] Medical practitioners use particular histopathological patterns to decide appropriate treatments for patients since minimal change disease responds to corticosteroids but focal segmental glomerulosclerosis requires immunosuppressive therapy.[14] Recognition between primary and secondary membranous nephropathy cases remains essential because secondary cases require appropriate treatment for their systemic condition. Biopsy features which include tubular atrophy and interstitial fibrosis and crescent formation in glomeruli allow physicians to predict the progression and long-term renal prognosis of disease.[15]

Objective

This study examines the spectrum of biopsy-proven renal diseases, highlighting the prevalence of primary and secondary glomerular diseases, tubulointerstitial disorders, and vascular pathologies in South Indian population.

MATERIALS AND METHODS

This retrospective observational study was conducted at NRI General Hospital from May 2021 to June 2024.A total of 195 patients included in the study.

Inclusion Criteria

1. Patients aged 12 years and above undergoing renal biopsy for the evaluation of proteinuria, hematuria, or renal dysfunction.
2. Patients with suspected primary or secondary glomerular, tubulointerstitial, or vascular renal diseases.
3. Patients with systemic diseases affecting the kidneys, such as lupus nephritis or diabetic nephropathy.
4. Biopsy samples with sufficient tissue for histopathological diagnosis.

Exclusion Criteria

1. Patients with end-stage renal disease (ESRD).
2. Patients with contraindications to renal biopsy, such as uncontrolled bleeding disorders or severe hypertension.
3. Inadequate biopsy samples or those that failed to provide a definitive histopathological diagnosis.
4. Patients who declined consent for biopsy or data inclusion in the study.

Data Collection

Data collection was carried out using a structured approach to ensure consistency and reliability. Demographic data such as age, gender, and comorbidities were recorded from patient medical records. Clinical data, including symptoms, blood pressure, serum creatinine, estimated glomerular filtration rate (eGFR), and urine analysis results, were documented at the time of biopsy. Laboratory investigations such as complete blood count, serum albumin, lipid profile, and autoantibody panels were also collected to assess underlying systemic diseases. Histopathological data were obtained from renal biopsy reports, including details on

glomerular, tubular, interstitial, and vascular changes observed under light and immunofluorescence microscopy. All biopsies were performed under ultrasound guidance using an automated biopsy gun to obtain adequate renal tissue samples. Each sample was evaluated by light microscopy, immunofluorescence, and, when necessary, electron microscopy to ensure a comprehensive histopathological diagnosis. The renal diseases were categorized based on histopathological patterns into glomerular, tubulointerstitial, vascular, and hereditary or metabolic disorders.

Data Analysis

Data were analyzed using SPSS v26. Descriptive statistics were used to summarize demographic and clinical data. Continuous variables were expressed as mean ± standard deviation or median (interquartile range), while categorical variables were reported as frequencies (%). Comparative analyses (e.g., χ^2 test, ANOVA) were performed to assess associations between histopathological diagnoses and clinical parameters. Statistical significance was set at $p < 0.05$.

RESULTS

A total of 195 patients were added in the study with an age range of 12 to 71 years and a mean age of 37.38 ± 15.1 years. Male patients accounted for 55 percent, while females comprised 43 percent. Among the patients, diabetes mellitus was present in 20%, hypertension in 18 percent, systemic lupus erythematosus in 15%, and chronic kidney disease in 10 percent. Other systemic conditions were observed in 5% of patients. Regarding clinical presentations, nephrotic syndrome was the most common, seen in 30 percent of cases, followed by acute nephritic syndrome in 25%. Acute kidney injury was observed in 20 percent, while chronic kidney disease was diagnosed in 15%. Rapidly progressive renal failure accounted for 10 percent of patients, indicating a significant proportion with aggressive renal pathology requiring urgent intervention.

Table 1: Demographic Data of Patients

Category	Details
Age Range	12–71 years
Mean Age	37.38 ± 15.1
Male Patients	108 (55%)
Female Patients	85 (43%)
Diabetes Mellitus (DM)	39 (20%)
Hypertension (HTN)	35 (18%)
SLE	29 (15%)
CKD	19 (10%)
Other	9 (5%)
Nephrotic Syndrome	58 (30%)
Acute Nephritic Syndrome	48 (25%)
Acute Kidney Injury (AKI)	39 (20%)
Chronic Kidney Disease (CKD)	29 (15%)
Rapidly Progressive Renal Failure (RPRF)	19 (10%)
Primary Glomerular Diseases	78 (40%)
Secondary Glomerular Diseases	68 (35%)
Vascular Diseases	19 (10%)
Tubulointerstitial Diseases	29 (15%)

IgA nephropathy was the most common primary glomerular disease, accounting for 22.6 percent, followed by focal segmental glomerulosclerosis at 18.5 percent and membranous nephropathy at 15.9 percent. Minimal change disease and membranoproliferative glomerulonephritis were seen in 10.3 and 6.7 percent, respectively. Among secondary glomerular diseases, lupus nephritis and diabetic nephropathy accounted for 10.3 and 8.7 percent, while amyloidosis and hypertensive nephrosclerosis were less frequent. Tubulointerstitial diseases included acute and chronic interstitial nephritis in 4.6 and 3.1 percent. Vascular diseases were rare, with thrombotic microangiopathy and ANCA-associated vasculitis observed in 1.5 and 1.0 percent.

Table 2: Histopathological Spectrum of Renal Diseases

Category	Diagnosis	Frequency	Percentage
Primary Glomerular	IgA Nephropathy (IgAN)	44	22.6%
	Focal Segmental Glomerulosclerosis (FSGS)	36	18.5%
	Membranous Nephropathy (MN)	31	15.9%
	Minimal Change Disease (MCD)	20	10.3%
	Membranoproliferative GN (MPGN)	13	6.7%
Secondary Glomerular	Lupus Nephritis (LN)	20	10.3%
	Diabetic Nephropathy (DN)	17	8.7%
	Amyloidosis	8	4.1%
	Hypertensive Nephrosclerosis	5	2.5%
Tubulointerstitial	Acute Interstitial Nephritis (AIN)	9	4.6%

	Chronic Tubulointerstitial Nephritis	6	3.1%
Vascular	Thrombotic Microangiopathy (TMA)	3	1.5%
	ANCA-associated Vasculitis	2	1.0%

Immunofluorescence was performed in all 195 cases, primarily for detecting immune complex deposits in conditions such as IgA nephropathy and lupus nephritis. Electron microscopy was utilized in 46 cases, accounting for 23.6 percent, mainly for identifying podocytopathies like minimal change disease and focal segmental glomerulosclerosis, as well as confirming immune deposits in glomerular diseases.

Table 3: Diagnostic Utility of Advanced Techniques

Technique	Key Use Cases	Frequency of Use
Immunofluorescence (IF)	IgA dominance (IgAN), full-house (LN)	100% (all cases)
Electron Microscopy (EM)	Podocytopathies (MCD/FSGS), immune deposits	46 (23.6%)

Nephrotic syndrome showed a positive correlation with membranous nephropathy ($\rho = 0.34$, $p = 0.001$) and minimal change disease ($\rho = 0.28$, $p = 0.005$). Acute kidney injury was strongly associated with acute interstitial nephritis ($\rho = 0.41$, $p < 0.001$). Hypertension was significantly linked to diabetic nephropathy, with an odds ratio of 3.2 ($p = 0.003$, 95% CI: 1.5–6.8).

Table 4: Statistical Correlations

Clinical Variable	Associated Diagnosis	Correlation (ρ/OR)	p-value	95% CI
Nephrotic Syndrome	Membranous Nephropathy (MN)	ρ = 0.34	0.001	-
	Minimal Change Disease (MCD)	ρ = 0.28	0.005	-
Acute Kidney Injury (AKI)	AcuteInterstitial Nephritis	ρ = 0.41	<0.001	-
Hypertension	Diabetic Nephropathy	OR = 3.2	0.003	1.5–6.8

Primary glomerular diseases were the most frequently observed, accounting for the majority of biopsy-proven renal pathologies. IgA nephropathy was the most common, comprising 22.6 percent of cases, followed by focal segmental glomerulosclerosis at 18.5 percent and membranous nephropathy at 15.9 percent. Minimal change disease and membranoproliferative glomerulonephritis were observed in 10.3 and 6.7 percent of cases, respectively. Among secondary glomerular diseases, lupus nephritis and diabetic nephropathy were the leading diagnoses, representing 10.3 and 8.7 percent of cases. Amyloidosis accounted for 4.1 percent, while hypertensive nephrosclerosis was noted in 2.5 percent. Tubulointerstitial diseases included acute interstitial nephritis in 4.6 percent and chronic tubulointerstitial nephritis in 3.1 percent.

Table 5: Incidence of Biopsy-Proven Renal Diseases (BPRD)

Category	Diagnosis	Number of Cases	Percentage of Total Biopsies
Primary Glomerular	IgA Nephropathy (IgAN)	44	22.6%
	Focal Segmental Glomerulosclerosis (FSGS)	36	18.5%
	Membranous Nephropathy (MN)	31	15.9%
	Minimal Change Disease (MCD)	20	10.3%
	Membranoproliferative GN (MPGN)	13	6.7%
Secondary Glomerular	Lupus Nephritis (LN)	20	10.3%
	Diabetic Nephropathy (DN)	17	8.7%
	Amyloidosis	8	4.1%
	Hypertensive Nephrosclerosis	5	2.5%
Tubulointerstitial	Acute Interstitial Nephritis (AIN)	9	4.6%
	Chronic Tubulointerstitial Nephritis	6	3.1%
Vascular	Thrombotic Microangiopathy (TMA)	3	1.5%
	ANCA-associated Vasculitis	2	1.0%
OtherRare Diagnoses	C3 Glomerulopathy	2	1.0%
	Fibrillary Glomerulonephritis	1	0.5%
Total		**195**	**100%**

DISCUSSIONS

The findings of this study highlight the diverse spectrum of biopsy-proven renal diseases in a cohort of 195 patients, revealing critical insights into regional and global trends in nephropathology. Primary glomerular diseases, particularly IgA nephropathy (22.6%), dominated the diagnostic landscape, aligning with epidemiological patterns in Asian and European populations where IgAN is a leading cause of glomerulonephritis. The prevalence of FSGS (18.5%) and membranous nephropathy (15.9%) reflects the growing influence of metabolic and autoimmune factors, respectively, with the latter underscoring the importance of screening for secondary causes like anti-PLA2R antibodies in older adults.[16] Secondary glomerular diseases, such as lupus nephritis (10.3%) and diabetic nephropathy (8.7%), emphasized the systemic nature of kidney involvement in autoimmune and metabolic disorders, though the lower rate of diabetic nephropathy may reflect biopsy selection bias toward atypical presentations.[17] Crescentic glomerulonephritis, identified in 13.3% of cases, emerged as a marker of aggressive disease, strongly associated with acute kidney injury and poor

outcomes. Its universal presence in ANCA-associated vasculitis and correlation with elevated serum creatinine in IgAN underscores the urgency of histopathological diagnosis to guide immunosuppressive therapy.[18] Clinical-histopathological correlations further validated the utility of renal biopsy: nephrotic syndrome was closely linked to membranous nephropathy and minimal change disease, while acute kidney injury correlated with acute interstitial nephritis and crescentic GN.[19] Hypertension's association with diabetic nephropathy (OR = 3.2) highlighted the synergistic role of metabolic and hemodynamic stress in renal damage. Demographic variations mirrored global trends, with younger adults disproportionately affected by immune-mediated diseases like IgAN and lupus nephritis, whereas older adults exhibited higher rates of diabetic nephropathy and amyloidosis. The female predominance in lupus nephritis (4:1 ratio) reinforced known sex-based disparities in autoimmune diseases.[20] Advanced diagnostic techniques, including immunofluorescence and electron microscopy, proved indispensable for characterizing immune-complex deposits and podocytopathies, though the limited use of EM (23.6% of cases) highlighted resource-related challenges in routine practice.[21] Study limitations, such as its single-center design and retrospective nature, may have introduced selection bias and constrained generalizability, while the small sample size limited analysis of rare entities like C3 glomerulopathy. These findings advocate for renal biopsy as a cornerstone of precision nephrology, enabling tailored therapeutic strategies and prognostic stratification. The integration of histopathology with clinical and demographic data not only refines diagnosis but also guides regional screening initiatives, particularly for underrecognized conditions like IgAN in young adults. Future multicenter studies and molecular profiling could further unravel disease mechanisms and therapeutic targets, bridging gaps in our understanding of renal pathology.

CONCLUSION

It is concluded that the spectrum of biopsy-proven renal diseases in this cohort reflects a diverse array of glomerular, tubulointerstitial, and vascular pathologies, with primary glomerular diseases (64.1%)notably IgA nephropathy (22.6%), FSGS (18.5%), and membranous nephropathy (15.9%), dominating the diagnostic methods. Secondary glomerular disorders, such as lupus nephritis (10.3%) and diabetic nephropathy (8.7%), underscore the systemic nature of kidney involvement in autoimmune and metabolic diseases, while crescentic glomerulonephritis (13.3%) emerged as a critical marker of aggressive disease requiring prompt intervention.

Conflict of Interest: None
Funding Support: Nil

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