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Histopathological Spectrum of Renal Biopsies in Patients Presenting with Nephrotic Syndrome: A Clinicopathological Study

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ABSTRACT

Background: Nephrotic syndrome (NS) is a common clinical condition characterized by heavy proteinuria, hypoalbuminemia, edema, and hyperlipidemia. The underlying renal pathology varies considerably among different populations, making renal biopsy essential for accurate diagnosis, treatment planning, and prognostication. This study aimed to evaluate the histopathological spectrum of renal biopsies in patients presenting with nephrotic syndrome and to analyze their clinicopathological characteristics.

Methods: A hospital-based observational study was conducted in the Department of Pathology of a tertiary care center over a period of one year. Fifty patients clinically diagnosed with nephrotic syndrome who underwent adequate renal biopsy were included. Clinical, laboratory, and histopathological data were collected and analyzed. Renal biopsy specimens were evaluated using routine histopathological techniques and immunofluorescence whenever available.

Results: Among the 50 patients studied, the majority belonged to the 18–40 years age group (40.0%), with a male predominance (62.0%). Generalized edema was present in all patients, while facial puffiness and hypertension were observed in 82.0% and 46.0% of cases, respectively. The mean serum albumin level was 2.31 ± 0.52 g/dL, and the mean 24-hour urinary protein excretion was 5.92 ± 2.11 g/day. Focal segmental glomerulosclerosis (FSGS) was the most common histopathological diagnosis (28.0%), followed by minimal change disease (20.0%) and membranous nephropathy (18.0%). Minimal change disease predominated in younger patients, whereas membranous nephropathy and diabetic nephropathy were more frequent in older age groups. Most primary glomerular diseases showed male predominance, while lupus nephritis was more common among females.

Conclusion: Focal segmental glomerulosclerosis was the predominant histopathological lesion among patients presenting with nephrotic syndrome, followed by minimal change disease and membranous nephropathy. Significant age- and gender-related variations were observed in the distribution of glomerular diseases. Renal biopsy remains indispensable for establishing an accurate diagnosis, facilitating clinicopathological correlation, guiding appropriate therapy, and improving patient outcomes. These findings contribute valuable regional data regarding the evolving epidemiology of nephrotic syndrome.

Keywords: Nephrotic syndrome; Renal biopsy; Focal segmental glomerulosclerosis; Minimal change disease; Clinicopathological correlation.

INTRODUCTION

Nephrotic syndrome (NS) is a common clinical entity characterized by massive proteinuria (>3.5 g/day), hypoalbuminemia, generalized edema, and hyperlipidemia. It represents a significant cause of morbidity across all age groups and results from a wide spectrum of glomerular diseases that disrupt the integrity of the glomerular filtration barrier. The incidence and prevalence of nephrotic syndrome vary globally, with differences observed according to age, ethnicity, geographic region, and underlying etiological factors. Renal diseases causing nephrotic syndrome may be primary (idiopathic) or secondary

to systemic disorders such as diabetes mellitus, systemic lupus erythematosus, amyloidosis, infections, and malignancies.[1,2]

The clinical manifestations of nephrotic syndrome are often nonspecific and do not reliably predict the underlying renal pathology. Histopathological examination of renal biopsy specimens remains the gold standard for establishing a definitive diagnosis, guiding therapeutic decisions, and determining prognosis. Light microscopy, immunofluorescence microscopy, and electron microscopy provide complementary information regarding the pattern and extent of glomerular injury, thereby facilitating accurate classification of renal diseases.[3,4]

The histopathological spectrum of nephrotic syndrome has undergone significant changes over recent decades. Earlier studies identified minimal change disease (MCD) as the predominant lesion, particularly among children; however, recent reports indicate a rising prevalence of focal segmental glomerulosclerosis (FSGS), membranous nephropathy (MN), and IgA nephropathy in many populations. These changing trends may reflect environmental influences, improved diagnostic capabilities, demographic transitions, and increasing prevalence of metabolic disorders.[5,6]

Several studies from different regions of India have demonstrated considerable geographical variation in the prevalence of glomerular diseases presenting as nephrotic syndrome. While minimal change disease remains common in pediatric populations, focal segmental glomerulosclerosis and membranous nephropathy are increasingly recognized among adults. Such regional differences underscore the importance of local clinicopathological data to improve diagnostic accuracy and optimize management strategies.[7,8]

Clinicopathological correlation of renal biopsy findings is essential for understanding disease patterns, assessing demographic and clinical associations, and evaluating outcomes. Identification of prevalent histopathological lesions in a particular population can assist clinicians in formulating differential diagnoses and selecting appropriate therapeutic interventions. Furthermore, knowledge of regional disease patterns contributes to epidemiological surveillance and healthcare planning.[9]

Therefore, the present study was undertaken to evaluate the histopathological spectrum of renal biopsies in patients presenting with nephrotic syndrome and to analyze their clinicopathological characteristics in a tertiary care center. The findings are expected to provide valuable insights into the distribution of glomerular diseases and their clinical correlations within the study population.

MATERIALS AND METHODS

Study design and setting: This was a hospital-based observational study conducted in the Department of Pathology at a tertiary care centre in Chhattisgarh, India, for a period of one year. Fifty patients clinically diagnosed as nephrotic syndrome and advised renal biopsy for diagnostic evaluation were included in the study.

Inclusion criteria: Patients of all age groups presenting with nephrotic syndrome who underwent renal biopsy and whose biopsy material was adequate for histopathological evaluation were included.

Exclusion criteria: Patients with inadequate renal biopsy tissue, autolysed samples, incomplete clinical data, bleeding diathesis, solitary kidney, uncontrolled hypertension, or those unwilling to give consent were excluded from the study.

Data collection: Clinical details including age, sex, duration of illness, presenting complaints, edema, blood pressure, history of diabetes mellitus, hypertension, systemic lupus erythematosus, infection, drug intake, and relevant past history were recorded. Laboratory parameters such as serum creatinine, blood urea, serum albumin, serum cholesterol, urine routine microscopy, 24-hour urinary protein or spot urine protein-creatinine ratio were collected from case records.

Renal biopsy procedure and processing: Renal biopsy was performed under ultrasound guidance using an automated biopsy needle after obtaining written informed consent. The biopsy specimen was immediately examined for adequacy. Tissue for light microscopy was fixed in 10% neutral buffered formalin and tissue for immunofluorescence was place in Michel's fixative then processed routinely for paraffin embedding.

Sections of 3–4 μm thickness were stained with hematoxylin and eosin, periodic acid–Schiff, Masson's trichrome, and Jones methenamine silver stains wherever required. Immunofluorescence study was performed when available using antibodies against IgG, IgA, IgM, C3, C1q, kappa, and lambda light chains.

Histopathological evaluation: All renal biopsy slides were examined by pathologists. The number of glomeruli, glomerular cellularity, basement membrane changes, sclerosis, crescents, mesangial expansion, tubular atrophy, interstitial inflammation, interstitial fibrosis, and vascular changes were evaluated. The biopsies were classified into various histopathological categories such as minimal change disease, focal segmental glomerulosclerosis, membranous

nephropathy, membranoproliferative glomerulonephritis, IgA nephropathy, lupus nephritis, diabetic nephropathy, amyloidosis, and other lesions.

Statistical analysis; Data were entered in Microsoft Excel and analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequency and percentage. Clinicopathological correlation was assessed by comparing histopathological diagnosis with age, sex, clinical presentation, proteinuria, serum creatinine, and other laboratory parameters. A p-value of <0.05 was considered statistically significant.

RESULTS

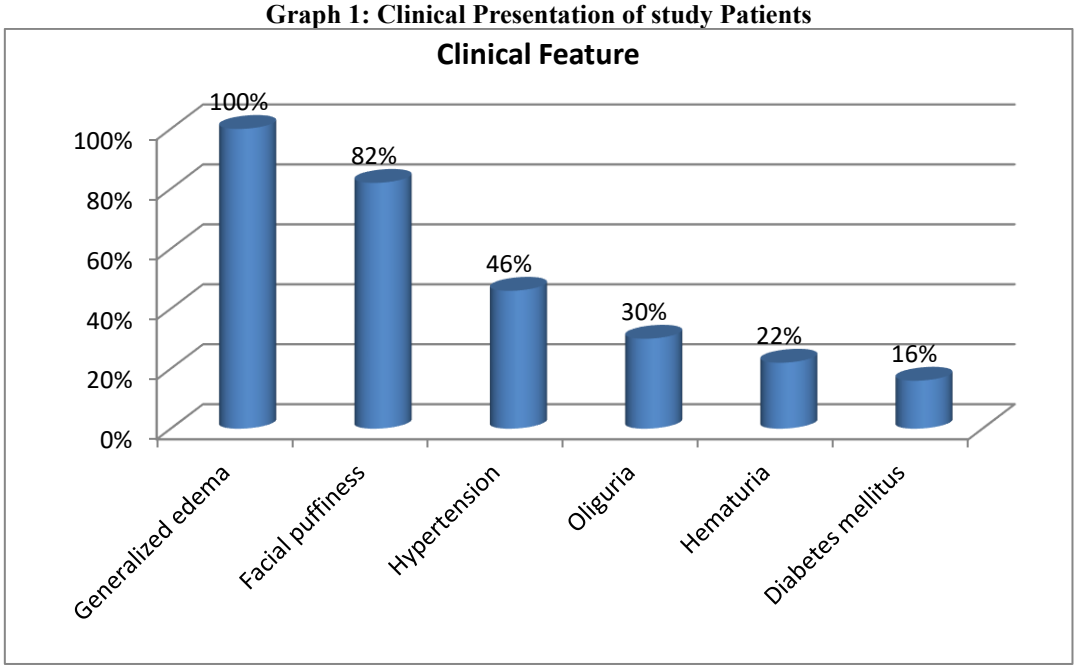
Among 50 nephrotic syndrome patients undergoing renal biopsy, the majority of patients belonged to the 18–40 years age group (40.0%) with mean age was approximately 39 years. Males predominated, accounting for 62.0% of cases.

Table 1: Age and Gender Distribution of Patients (n=50)

Variable	Number (n)	Percentage (%)
Age Group (years)		
<18	8	16.0
18–40	20	40.0
41–60	15	30.0
>60	7	14.0
Gender		
Male	31	62.0
Female	19	38.0

Generalized edema was observed in all patients, while facial puffiness and hypertension were present in 82.0% and 46.0% of patients, respectively

Graph 1: Clinical Presentation of study Patients



Patients demonstrated severe proteinuria with marked hypoalbuminemia and hypercholesterolemia, consistent with nephrotic syndrome.

Table 2: Laboratory Profile among study subjects

Parameter	Mean ± SD
Serum Creatinine (mg/dL)	1.78 ± 0.96
Blood Urea (mg/dL)	48.6 ± 16.2
Serum Albumin (g/dL)	2.31 ± 0.52
Serum Cholesterol (mg/dL)	312.4 ± 74.8
24-hour Urinary Protein (g/day)	5.92 ± 2.11

FSGS was the most common histopathological diagnosis (28.0%), followed by minimal change disease (20.0%) and membranous nephropathy (18.0%).

Table 3: Histopathological Spectrum of Renal Biopsies

Histopathological Diagnosis	Number (n)	Percentage (%)
FSGS	14	28.0
Minimal Change Disease	10	20.0
Membranous Nephropathy	9	18.0
IgA Nephropathy	5	10.0
Lupus Nephritis	4	8.0
Diabetic Nephropathy	3	6.0
MPGN	3	6.0
Amyloidosis	2	4.0

Minimal change disease predominated among younger patients, whereas membranous nephropathy and diabetic nephropathy were more common in older age groups. There was a statistically significant association between age group and histopathological diagnosis (**p = 0.0023**). This indicates that the distribution of renal biopsy diagnoses varied significantly across different age groups.

Table 4: Histopathological Diagnosis According to Age Group

Diagnosis	<18 yrs	18–40 yrs	41–60 yrs	>60 yrs
MCD	6	3	1	0
FSGS	2	8	3	1
MN	0	3	4	2
IgA Nephropathy	0	3	2	0
Lupus Nephritis	0	3	1	0
Diabetic Nephropathy	0	0	2	1
MPGN	0	0	2	1

Diagnosis	<18 yrs	18–40 yrs	41–60 yrs	>60 yrs
Amyloidosis	0	0	0	2

Most glomerular diseases showed a male predominance, whereas lupus nephritis was more frequent among females, but there was no statistically significant association between gender and histopathological diagnosis (p = 0.872).

Table 5: Histopathological Diagnosis According to Gender

Diagnosis	Male n (%)	Female n (%)
FSGS	10 (71.4)	4 (28.6)
MCD	6 (60.0)	4 (40.0)
MN	6 (66.7)	3 (33.3)
IgA Nephropathy	3 (60.0)	2 (40.0)
Lupus Nephritis	1 (25.0)	3 (75.0)
Diabetic Nephropathy	2 (66.7)	1 (33.3)
MPGN	2 (66.7)	1 (33.3)
Amyloidosis	1 (50.0)	1 (50.0)

DISCUSSION

Renal biopsy remains the cornerstone for establishing the precise diagnosis in patients presenting with nephrotic syndrome, particularly in adults where clinical manifestations often overlap among different glomerular diseases. In the present study, the majority of patients belonged to the 18–40 years age group, with a male predominance (62%). Similar demographic trends have been reported by Korbet et al., who observed that nephrotic syndrome in adults is more frequently encountered in middle-aged males, reflecting the higher prevalence of primary glomerular diseases in this population [10].

Generalized edema was the most common clinical manifestation, present in all patients, followed by facial puffiness and hypertension. These findings are consistent with the classical clinical presentation of nephrotic syndrome described by Hull and Goldsmith, who reported edema and hypoalbuminemia as the most frequent presenting features resulting from severe urinary protein loss [11]. The laboratory profile in our study demonstrated marked proteinuria, hypoalbuminemia, and hypercholesterolemia, which are characteristic biochemical hallmarks of nephrotic syndrome and correlate with the severity of glomerular injury [12].

The most important finding of the present study was that focal segmental glomerulosclerosis (FSGS) constituted the most common histopathological diagnosis (28%), followed by minimal change disease (20%) and membranous nephropathy (18%). This pattern supports the global trend of increasing FSGS prevalence reported by De Vriese et al., who identified FSGS as one of the leading causes of adult nephrotic syndrome worldwide [13] Similarly, Swaminathan et al. observed FSGS as the predominant biopsy diagnosis among adult nephrotic syndrome patients in a multicenter Indian cohort [14] Minimal change disease was predominantly observed in younger patients, particularly those below 18 years of age. This finding is in agreement with the observations of Vivarelli et al., who reported MCD as the principal cause of childhood nephrotic syndrome and a frequent diagnosis in young adults presenting with nephrotic-range proteinuria [15] In contrast, membranous nephropathy and diabetic nephropathy were more prevalent in older age groups, reflecting age-related changes in disease epidemiology and increasing prevalence of metabolic disorders. Similar age-related distributions have been reported by Ronco and Beck in studies of primary membranous nephropathy [16]

IgA nephropathy accounted for 10% of cases in the present series. Although IgA nephropathy commonly presents with hematuria rather than nephrotic syndrome, nephrotic-range proteinuria can occur in advanced disease. Trimarchi et al. reported comparable frequencies among biopsy-proven glomerular diseases in Asian populations [17] Lupus nephritis constituted 8% of cases and demonstrated a marked female predominance, consistent with the known epidemiology of systemic lupus erythematosus and its renal manifestations [18]

The gender distribution observed in this study revealed male predominance in most primary glomerular diseases, whereas lupus nephritis was more frequent among females. Similar observations were reported by Almaani et al., who noted a strong female predominance among patients with lupus nephritis due to the underlying sex predilection of autoimmune disorders [19]

CONCLUSION

The present study demonstrates that focal segmental glomerulosclerosis (FSGS) is the most common histopathological lesion among patients presenting with nephrotic syndrome, followed by minimal change disease and membranous nephropathy. Significant variations in the distribution of glomerular diseases were observed across different age groups and genders, with minimal change disease predominating in younger patients and membranous nephropathy and diabetic nephropathy occurring more frequently in older individuals. The findings highlight the changing epidemiological pattern of nephrotic syndrome and underscore the indispensable role of renal biopsy in establishing an accurate diagnosis, facilitating clinicopathological correlation, guiding appropriate therapy, and predicting prognosis. Regional histopathological data such as these are valuable for optimizing patient management and improving nephrology care in the local population.

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