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Original article

Clinicopathological spectrum of biopsy-proven renal diseases in a tertiary hospital

Hesham Mohamed El-Sayed[1], Heba Wahid El Said[1], Manal Ibrahim Salman[2], Maha Abdel Moneim Behairy[1], Mohamed Sary Gharib[1], and Al Shaimaa Ebrahem Ahmed[1]

[1]Internal Medicine and Nephrology Department, Faculty of Medicine, Ain Shams University, Cairo, Egypt
[2]Pathology Department, Faculty of Medicine, Ain Shams University, Cairo, Egypt

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Abstract

Background: Renal disorders require a renal biopsy for accurate diagnosis, effective treatment planning, and assessing the extent of active and chronic histologic changes.

Objective: To evaluate the spectrum of renal diseases diagnosed by renal biopsy and its clinical correlation.

Methodology: This was a four-year retrospective study carried out from January 2019 to December 2022 at Ain Shams University Hospitals. Patients' demographic data and clinical presentations were extracted from available data sheets. All specimens were examined using light and electron microscopy and stained with immunofluorescence or immunohistochemical techniques. The results were organized according to the most recent classification system.

Results: A total of 1851 renal biopsy specimens were studied (52.4 % males), with a mean patient age of 38.43±14.83 years. 346 patients (18.7 %) presented nephrotic syndrome, and 322 patients (17.4 %) had lupus nephritis as a secondary complication. The majority of patients with glomerulonephritis had hypertensive nephrosclerosis; 694 patients (37.5 %) had membranous glomerulonephritis. 124 patients (6.7 %) were diagnosed with IgA nephropathy. Most of them presented with asymptomatic hematuria. 52 patients (2.8 %) were diagnosed with thrombotic microangio-

Keywords: Renal biopsy, Hypertension, Glomerulonephritis, nephrotic, nephritic.

Correspondence: Al Shaimaa Ebrahem Ahmed, Ain Shams University, Abbassyia, 11566, Cairo, Egypt. E-mail: elshaimaa92@gmail.com

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pathy, all of them presented with acute kidney injury. 35 patients (1.9 %) were diagnosed with tubulointerstitial diseases; however, it was associated with other renal pathology diagnoses.
Conclusion: The most frequently observed diagnosis was hypertensive nephrosclerosis, with lupus nephritis being the most prevalent form of secondary glomerulonephritis. Membranous glomerulonephritis was the most common kind of primary glomerulonephritis.

Espectro clinicopatológico de enfermedades renales confirmadas por biopsia en un hospital terciario

Resumen

Contexto: los trastornos renales requieren una biopsia renal para un diagnóstico preciso, una planificación efectiva del tratamiento y la evaluación del grado de cambios histológicos activos y crónicos.
Objetivo: evaluar el espectro de enfermedades renales diagnosticadas mediante biopsia renal y su correlación clínica.
Metodología: se realizó un estudio retrospectivo de cuatro años, desde enero de 2019 hasta diciembre de 2022, en los Hospitales de la Universidad de Ain Shams. Se recopilaron los datos demográficos de los pacientes y sus manifestaciones clínicas a partir de las hojas de datos disponibles. Todas las muestras fueron examinadas mediante microscopía óptica y electrónica, y teñidas con inmunofluorescencia o inmunohistoquímica. Los resultados fueron organizados de acuerdo con el sistema de clasificación más reciente.
Resultados: se estudiaron un total de 1851 muestras de biopsia renal (52.4 % hombres), con una edad media de 38.43±14.83 años. 346 pacientes (18.7 %) presentaron síndrome nefrótico y 322 pacientes (17.4 %) tenían nefritis lúpica como complicación secundaria. La mayoría de los pacientes con glomerulonefritis presentaban nefroesclerosis hipertensiva; 694 pacientes (37.5 %) fueron diagnosticados con glomerulonefritis membranosa. 124 pacientes (6.7 %) fueron diagnosticados con nefropatía por IgA, la mayoría con hematuria asintomática. 52 pacientes (2.8 %) fueron diagnosticados con microangiopatía trombótica, todos ellos con insuficiencia renal aguda. 35 pacientes (1.9 %) fueron diagnosticados con enfermedades túbulo-intersticiales; sin embargo, estas se asociaban con otros diagnósticos de patología renal.
Conclusión: el diagnóstico más frecuente fue la nefroesclerosis hipertensiva, mientras que la nefritis lúpica fue la forma más prevalente de glomerulonefritis secundaria. La glomerulonefritis membranosa fue el tipo más común de glomerulonefritis primaria.

Palabras clave: biopsia renal, hipertensión, glomerulonefritis, nefrótico, nefrítico.

Introduction

A kidney biopsy is a crucial diagnostic technique for the precise identification of renal diseases. It not only aids in diagnosis but is also indispensable for making informed treatment decisions and determining the extent of active and chronic histological alterations. The degree of these changes plays a key role in determining the prognosis and the probability of treatment response. Furthermore, a kidney biopsy can evaluate genetic disorders [1].

Glomerular ultrastructural abnormalities, such as deposits, podocyte damage, or basement membrane modifications, are often diffuse in distribution. Consequently, in certain instances, an electron microscopy diagnosis may be possible with as little as a fraction of a single glomerulus [2].

Glomerulopathies exhibit different levels of occurrence in various regions worldwide. In Asia and some European countries, IgA nephropathy (IgAN) stands out as the most common primary glomerulopathy, whereas in Brazil and the United States focal segmental glomerulosclerosis (FSGS) takes the lead. In Africa, a comprehensive analysis of glomerulonephritis epidemiology revealed a higher prevalence of FSGS and minimal change disease (MCD). Secondary glomerulopathies are associated with a heightened presence of lupus nephritis (LN), diabetic kidney disease (DKD), and pauci-immune systemic vasculitis, with noticeable shifts in the prevalence rates of these conditions over the last twenty years [3].

Variations associated with ethnic background have been observed, such as a higher occurrence of IgA nephropathy (IgAN) in Asian communities, a greater prevalence of focal segmental glomerulosclerosis among individuals of African heritage, and a higher incidence of membranous nephropathy (MN) in Caucasian populations. Moreover, there is a notable difference in the distribution of histological types based on age [4].

The current research assessed the range of kidney disorders diagnosed by renal biopsy at Ain Shams University Hospitals, studied the clinical correlation of renal biopsies, and established a foundation for additional hypothesis-driven research in Ain Shams University Hospitals, which is considered one of the referral centers in Egypt for renal pathology evaluation by light (LM) and electron microscopy (EM).

Methodology

Study population

This was a four-year retrospective single-center study conducted at tertiary referral hospitals. A total of 1851 renal biopsies were reviewed from the Histopathology and Electron Microscopy (EM) laboratories of Ain Shams University Hospitals, covering the period from January 1, 2019, to December 31, 2022.

All native renal biopsy data of patients >18 years old were included, and renal biopsies of patients <18 years old, with incomplete general data, with insufficient renal tissue, and from transplanted kidneys were excluded.

Study procedure

Clinical data were collected retrospectively from the available extracted sheets focused on the patients age and sex. Age was classified into young adults (18-39 years old), middle-aged adults (40-59 years old), and older adults ($\geq$ 60 years old). Additional data included clinical presentations at the time of biopsy, detailed history of the presence of infections, systemic diseases, comorbidities, or medications at the time of renal biopsy, *e.g.*, systemic lupus erythematosus, and relevant laboratory tests at the time of biopsy.

All biopsy specimens were routinely processed. Formalin-fixed, paraffin-embedded tissue sections (4-5u) were prepared and stained with H&E, PAS, and Masson Trichrome and examined under the light microscope. Other prepared slides were stained for IgG, IgM, IgA, and C3 using either immunofluorescence or immunohistochemical staining. The specimen was routinely processed and embedded in resin blocks. Semithin sections (1 micrometer) and ultrathin sections (70 nm) were prepared for examination by transmission electron microscopy at 80 KV, obtaining electron micrographs by an embedded digital camera. At least two histopathologists verified the specimen's reports. The results of the histopathology analysis were categorized using a more modern approach [5].

Statistical analysis

Statistical analysis was done by SPSS v26 (IBM Inc., Chicago, IL, USA). Quantitative variables were presented as mean and standard deviation (SD). Quantitative non-parametric data was presented as median and interquartile range (IQR). Qualitative variables were presented as frequency and percentage (%).

Results

This study reviewed 1851 renal biopsy specimens (52.4 % males and 47.6 % females) with a mean age of 38.43 ± 14.83 years, classified into 3 age groups: 57.1 % were young adults (18-39 years old), 32.4 % were middle-aged adults (40-59 years old), and 10.5 % were older adults ($\geq$ 60 years old).

Data about systemic diseases among the study population revealed that 71.9 % of the study population were hypertensive, 8.6 % were diabetic, 16.5 % had systemic lupus, 0.9 % had rheumatological diseases, 0.9 % had hematological malignancies, 0.5 % had hepatic diseases, and 4.1 % had other types of systemic diseases.

Hypertensive nephrosclerosis was the most common diagnosis observed in 346 patients (18.7 %) and was associated with secondary focal segmental glomerulosclerosis. This was followed by lupus nephritis in 322 patients (17.4 %), membranous glomerulonephritis (GN) in 233 patients (12.6 %), and FSGS in 224 patients (12.1 %), as shown in Figure 1.

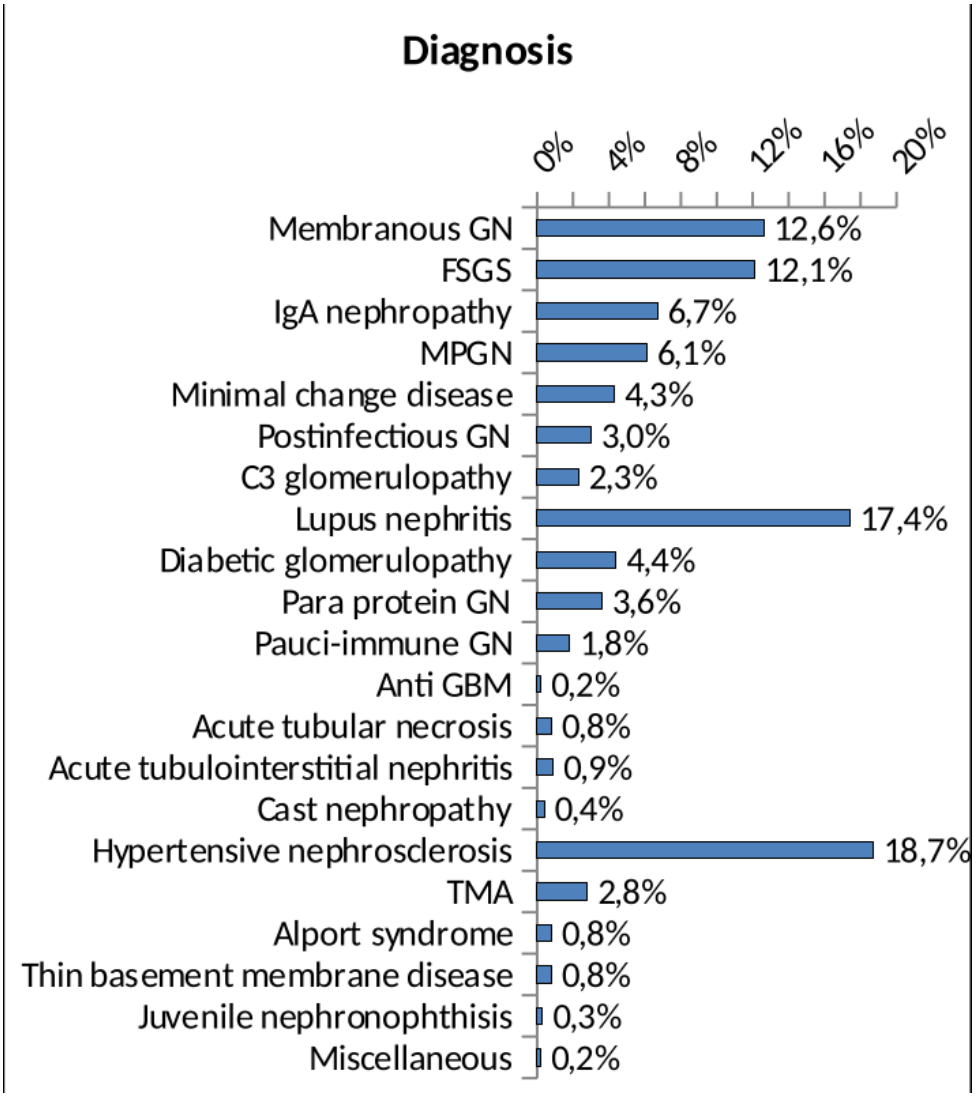

Figure 1. Percentage of the distribution of the cases studied according to renal pathology diagnosis

Source: Own elaboration.

However, primary glomerulonephritis was the most prevalent renal disease, diagnosed in 872 patients (47.1 %) of the study population, followed by secondary glomerulonephritis in 508 patients (27.5 %) and vascular diseases in 398 patients (21.5 %). Additionally, 35 patients (1.9 %) were diagnosed with tubulointerstitial diseases, although these were associated with other renal pathology diagnoses, as shown in Table 1.

Table 1. Distribution of the cases studied according to renal pathology diagnosis (n = 1851)

Diagnosis	No (%)
Primary GN (PGN)	**872(47.1%)**
Membranous GN	233(12.6%)
FSGS	224(12.1%)
IgA nephropathy	124(6.7%)
MPGN	113(6.1%)
Minimal change disease	80(4.3%)
Postinfectious GN	55(3.0%)
C3 glomerulopathy	43(2.3%)
Secondary GN (SGN)	**508(27.5%)**
Lupus nephritis	322(17.4%)
Diabetic glomerulopathy	81(4.4%)
Para-protein GN	68(3.6%)
Pauci-immune GN	34(1.8%)
Anti-GBM	3(0.2%)
Tubulointerstitial disease (TID)	**35(1.9%)**
Acute tubular necrosis	14(0.8%)
Acute tubulointerstitial nephritis	13(0.7%)
Cast nephropathy	8(0.4%)
Vascular disease	398(21.5%)
Hypertensive nephrosclerosis	346(18.7%)
TMA	52(2.8%)
Hereditary and congenital renal disease	**34(1.8%)**
Alport syndrome	15(0.8%)
Thin basement membrane disease	14(0.8%)
Juvenile nephronophthisis	5(0.3%)
Miscellaneous	**4(0.2%)**

Note. PGN: Primary GN; SGN: Secondary GN; TID: Tubulointerstitial disease; GN: glomerulonephritis; FSGS: focal segmental glomerulosclerosis, and TMA: thrombotic microangiopathy.
Source: Own elaboration.

Nephrotic syndrome was the most common clinical presentation, observed in 694 patients (37.4%) of the study population. It was predominantly associated with membranous GN in 210 patients (30.3%), followed by FSGS in 180 patients (25.9%) and minimal change disease in 79 patients (11.4%). In contrast, 286 patients (15.5%) of the study population presented

with nephritic syndrome, most of whom were diagnosed with lupus nephritis (181 patients, 63.3 %), followed by MPGN in 43 patients (15 %), as shown in Table 2.

Acute kidney injury was the second most common clinical presentation among the study population in 353 patients (19.1 %). The majority were diagnosed with hypertensive nephrosclerosis (98 patients, 27.8 %), followed by thrombotic microangiopathy (TMA) in 51 patients (14.4 %). Additionally, 337 patients (18.2 %) presented with chronic kidney disease, most of whom were diagnosed with hypertensive nephrosclerosis (211 patients, 62.6 %), followed by lupus nephritis in 44 patients (13.1 %) and diabetic nephropathy in 31 patients (9.2 %) as shown in Table 2.

Fewer patients were presented with rapidly progressive glomerulonephritis (RPGN) (112 patients, 6.1 %), most of whom were diagnosed with membranoproliferative glomerulonephritis (MPGN) (33 patients, 29.5 %), followed by post-infectious GN in 32 patients (28.6 %), while asymptomatic hematuria was the least common presentation, observed in 69 patients (3.7 %), most of them diagnosed as IgA nephropathy (48 patients, 69.6 %), as shown in Table 2.

Regarding glomerular diseases, hypertensive nephrosclerosis –which presented with secondary focal segmental glomerulosclerosis– was the most prevalent diagnosis in 346 patients (18.7 %). The majority of these patients belonged to the middle age group (162 patients, 27 %) with a mean age of 44.2 ± 13.4 years. Most cases presented with chronic kidney disease (211 patients, 62.2 %). Laboratory data revealed that the median creatinine level was 4.2 mg/dl, the mean albumin level was 2.89 ± 0.27 mg/dl, and the mean protein/ creatinine ratio was 3.82 ± 1.91 mg/g.

Lupus nephritis was the most frequent secondary glomerulonephritis, observed in 322 patients (17.4 %), most of them were from the young age group (260 patients, 24.6 %) with a mean of age of 30.17 ± 10.55 years. In addition, they were mostly presented with nephritic syndrome (181 patients, 63.3 %). Their laboratory data revealed that mean albumin level was 2.71 ± 0.32 mg/dl, and the mean protein/creatinine ratio was 4.75 ± 2.03 mg/g. Class IV was dominant among lupus nephritis patients in 133 patients (41.3 %), followed by class III in 74 patients (23 %), with a median of activity and chronicity index of 10/24 and 4/12, respectively.

Membranous GN was the predominant primary glomerulonephritis in 233 patients (12.6 %), most of them were from the middle age group (104 patients, 17.1 %) with a mean age of 42.55 ± 13.97 years; finally, they mostly presented with nephrotic syndrome (210 patients, 30.3 %).

Table 2. Relation between Presentation at the time of biopsy and renal pathology diagnosis

Diagnosis	Presentation at the time of biopsy											
	Nephrotic syndrome		Nephritic syndrome		AKI		CKD		RPGN		Asymptomatic hematuria	
	No. = 694		No. = 286		No. = 353		No. = 337		No. = 112		No. = 69	
Primary GN (PGN)	**524**	**75.60 %**	**96**	**33.40 %**	**84**	**23.70 %**	**39**	**11.60 %**	**81**	**72.40 %**	**48**	**69.60 %**
Membranous GN	210	30.30 %	4	1.40 %	18	5.10 %	1	0.30 %	0	0.00 %	0	0.00 %
FSGS	180	25.90 %	3	1.00 %	27	7.60 %	14	4.20 %	0	0.00 %	0	0.00 %
IgA nephropathy	24	3.50 %	17	5.90 %	15	4.20 %	17	5.00 %	3	2.70 %	48	69.60 %
MPGN	15	2.20 %	43	15.00 %	17	4.80 %	5	1.50 %	33	29.50 %	0	0.00 %
Minimal change disease	79	11.40 %	1	0.30 %	0	0.00 %	0	0.00 %	0	0.00 %	0	0.00 %
Postinfectious GN	5	0.70 %	16	5.60 %	2	0.60 %	0	0.00 %	32	28.60 %	0	0.00 %
C3 glomerulopathy	11	1.60 %	12	4.20 %	5	1.40 %	2	0.60 %	13	11.60 %	0	0.00 %
Secondary GN (SGN)	**134**	**19.30 %**	**183**	**64.00 %**	**79**	**22.30 %**	**78**	**23.20 %**	**31**	**27.70 %**	**0**	**0.00 %**
Lupus nephritis	66	9.50 %	181	63.30 %	30	8.50 %	44	13.10 %	1	0.90 %	0	0.00 %
Diabetic glomerulopathy	16	2.30 %	0	0.00 %	34	9.60 %	31	9.20 %	0	0.00 %	0	0.00 %
Para protein GN	52	7.50 %	0	0.00 %	11	3.10 %	2	0.60 %	0	0.00 %	0	0.00 %
Pauci immune GN	0	0.00 %	2	0.70 %	4	1.10 %	1	0.30 %	27	24.10 %	0	0.00 %
Anti-GBM	0	0.00 %	0	0.00 %	0	0.00 %	0	0.00 %	3	2.70 %	0	0.00 %
Tubulointerstitial disease (TID)	**1**	**0.10 %**	**0**	**0.00 %**	**35**	**10.00 %**	**2**	**0.60 %**	**0**	**0.00 %**	**0**	**0.00 %**
Acute tubular necrosis	0	0.00 %	0	0.00 %	14	4.00 %	0	0.00 %	0	0.00 %	0	0.00 %
Acute tubulointerstitial nephritis	1	0.10 %	0	0.00 %	13	3.70 %	2	0.60 %	0	0.00 %	0	0.00 %
Cast nephropathy	0	0.00 %	0	0.00 %	8	2.30 %	0	0.00 %	0	0.00 %	0	0.00 %
Vascular disease	**31**	**4.50 %**	**6**	**2.10 %**	**149**	**42.20 %**	**212**	**62.90 %**	**0**	**0.00 %**	**0**	**0.00 %**
Hypertensive nephrosclerosis	31	4.50 %	6	2.10 %	98	27.80 %	211	62.60 %	0	0.00 %	0	0.00 %
TMA	0	0.00 %	0	0.00 %	51	14.40 %	1	0.30 %	0	0.00 %	0	0.00 %

Hereditary &congenital renal disease	**0**	**0.00 %**	**1**	**0.30 %**	**6**	**1.60 %**	**6**	**1.80 %**	**0**	**0.00 %**	**21**	**30.40 %**
Alport syndrome	0	0.00 %	1	0.30 %	3	0.80 %	4	1.20 %	0	0.00 %	7	10.10 %
Thin basement membrane nephropathy	0	0.00 %	0	0.00 %	0	0.00 %	0	0.00 %	0	0.00 %	14	20.30 %
Juvenile nephronophthisis	0	0.00 %	0	0.00 %	3	0.80 %	2	0.60 %	0	0.00 %	0	0.00 %
Miscellaneous	**4**	**0.50 %**	**0**	**0.00 %**	**0**	**0.00 %**	**0**	**0.00 %**	**0**	**0.00 %**	**0**	**0.00 %**

Note. PGN: Primary GN; FSGS: focal segmental glomerulosclerosis; SGN: Secondary GN; TID: Tubulointerstitial disease, and TMA: thrombotic microangiopathy.

Source: Own elaboration.

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Their laboratory data revealed that the median creatinine level was 1.3 mg/dl, mean albumin level was 2.33 ± 0.36 mg/dl, and the mean protein/creatinine ratio was 7.92 ± 2.47 mg/g.

Primary FSGS was the second most prevalent primary glomerulonephritis, diagnosed in 224 patients (12.1 %). The majority were in the young age group (169 patients, 16 %) with a mean age of 31.86 ± 10.46 years. Most patients presented with nephrotic syndrome (180 patients, 25.9 %). Their laboratory data revealed that the median creatinine level was 1.5 mg/dl, the mean albumin level was 2.44 ± 0.37 mg/dl, and the mean protein/creatinine ratio was 7.04 ± 2.26 mg/g.

A total of 124 patients (6.7 %) of the study population were diagnosed with IgA nephropathy, most of them in the young age group (91 patients, 8.6 %) with a mean age of 38.74 ± 14.87 years. A majority of them presented with asymptomatic hematuria, observed in 48 patients (69.6 %). Their laboratory data revealed that the median creatinine level was 2.9 mg/dl, the mean albumin level was 2.62 ± 0.41mg/dl, and the mean protein/creatinine ratio was 5.74 ± 2.83 mg/g.

Among patients in the 18-39 years age group, lupus nephritis was the most prevalent diagnosis (260 patients, 24.6 %), followed by FSGS in 169 patients (16 %) and hypertensive nephrosclerosis in 134 patients (12.7 %). In the middle age group (40-59 years old), hypertensive nephrosclerosis was the most frequent, present in 162 patients (27 %), followed by membranous GN in 104 patients (17.4 %) and lupus nephritis in 62 patients (10.4 %). Finally, among the patients in the old age group (≥ 60 years old), hypertensive nephrosclerosis was the most prevalent, observed in 50 patients (25.6 %), followed by diabetic nephropathy in 33 patients (16.9 %), and membranous GN in 23 patients (11.8 %), as shown in Table 3.

Table 3. Relation between renal pathology diagnosis and age groups

Diagnosis	**Age groups**		
	(18 – 39)	**(40 -59)**	**≥ 60**
	No. = 1057	**No. = 599**	**No. = 195**
Primary GN (PGN)			
Membranous GN	106 (10.0 %)	104 (17.4 %)	23 (11.8 %)
FSGS	169 (16.0 %)	53 (8.8 %)	2 (1.0 %)
IgA nephropathy	91 (8.6 %)	27 (4.5 %)	6 (3.1 %)
MPGN	56 (5.3 %)	36 (6.0 %)	21 (10.8 %)
Minimal change disease	59 (5.6 %)	14 (2.3 %)	7 (3.6 %)

Postinfectious GN	32 (3.0 %)	16 (2.7 %)	7 (3.6 %)
C3 glomerulopathy	18 (1.7 %)	18 (3.0 %)	7 (3.6 %)
Secondary GN (SGN)			
Lupus nephritis	260 (24.6 %)	62 (10.4 %)	0 (0.0 %)
Diabetic glomerulopathy	17 (1.6 %)	31 (5.2 %)	33 (16.9 %)
Para-protein GN	16 (1.5 %)	33 (5.5 %)	16 (8.2 %)
Pauci-immune GN	15 (1.4 %)	13 (2.2 %)	6 (3.1 %)
Anti-GBM	0 (0.0 %)	3 (0.5 %)	0 (0.0 %)
Tubulointerstitial disease (TID)			
Acute tubular necrosis	7 (0.7 %)	7 (1.2 %)	0 (0.0 %)
Acute tubulointerstitial nephritis	9 (0.9 %)	3 (0.5 %)	4 (2.1 %)
Cast nephropathy	0 (0.0 %)	5 (0.8 %)	3 (1.5 %)
Vascular disease			
Hypertensive nephrosclerosis	134 (12.7 %)	162 (27.0 %)	50 (25.6 %)
TMA	31 (2.9 %)	11 (1.8 %)	10 (5.1 %)
Hereditary and congenital renal disease			
Alport syndrome	15 (1.4 %)	0 (0.0 %)	0 (0.0 %)
Thin basement membrane nephropathy	13 (1.2 %)	1 (0.2 %)	0 (0.0 %)
Juvenile nephronophthisis	5 (0.5 %)	0 (0.0 %)	0 (0.0 %)
Miscellaneous	4 (0.4 %)	0 (0.0 %)	0 (0.0 %)

Note. PGN: Primary GN; FSGS: focal segmental glomerulosclerosis; SGN: Secondary GN; TID: Tubulointerstitial disease, and TMA: thrombotic microangiopathy.
Source: Own elaboration.

Discussion

In this study, we retrospectively analyzed renal biopsies from 1851 patients with an average age of 38.43 ± 14.83 years. The cohort comprised 52.4 % males and 47.6 % females, covering January 2019 to December 2022.

Several studies have reported varying gender distributions in renal biopsy cases. Hu *et al.* [6] and Manjunath *et al.* [7] observed a male predominance, with males constituting 55.1 % and 61.5 % of cases, respectively. In contrast, Thomé *et al.* [8] and Mahajan *et al.* [9] found a slight female predominance, reporting 52.9 % and 51.1 % female cases, respectively.

In the current study, hypertensive nephrosclerosis emerged as the most prevalent renal diagnosis, affecting 18.7 % of patients. Lupus nephritis was the second most prevalent (17.4 %), followed by membranous glomerulonephritis (12.6 %) and primary focal segmental glomerulosclerosis (FSGS) (12.1 %). Notably, membranous glomerulonephritis was the most frequent primary glomerulonephritis, while lupus nephritis was the predominant form of secondary glomerulonephritis.

Nephrotic syndrome was the most common clinical presentation (Figure 2), observed in 37.5 % of patients. Within this group, membranous glomerulonephritis was the most frequent renal pathology (30.3 %), with a mean age of 42.55 ± 13.97 years, followed by FSGS (25.9 %), with a mean age of 31.86 ± 10.46 years.

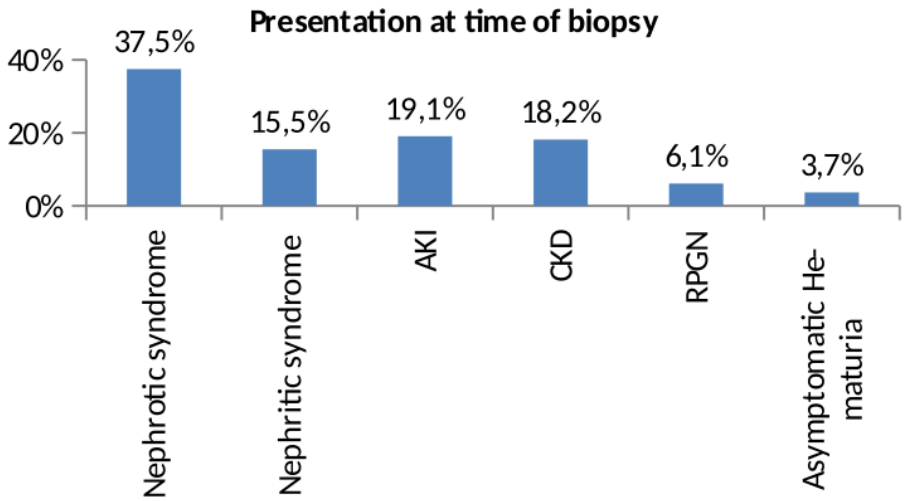

Figure 2. Distribution of the cases studied according to the clinical presentation at the time of biopsy (n = 1851)

Source: Own elaboration.

These findings align with several studies, including Hu *et al.* [6, 10], Manjunath *et al.* [7], Thomé *et al.* [8], Mahajan *et al.* [9], Muthukuda *et al.* [11], and Dhanapalan *et al.* [12], which also reported nephrotic syndrome as the most common clinical presentation at the time of biopsy.

Hu *et al.* [6] found membranous glomerulonephritis to be the most common primary glomerulonephritis (24.96 %), with a peak distribution in the 40-59 age group (48.9 %). Nephrotic syndrome was the predominant clinical presentation in patients with membranous glomerulonephritis (79.2 %).

However, some studies reported different findings. Thomé *et al.* [8] found FSGS and IgA nephropathy to be the most common primary glomerulonephritis (37.3 % and 24.4 %, respectively). Bobart *et al.* [13] reported FSGS and diabetic kidney disease as the most common diagnoses (15 % each). Moreover, Nili *et al.* [14] observed minimal change disease as the most frequent renal pathology diagnosis (17.9 %), followed by FSGS (15.9 %).

In our investigation, 286 patients (15.5 %) of the study cohort exhibited nephritic syndrome. The most prevalent renal pathology diagnosis among these patients was lupus nephritis, affecting 181 individuals (63.3 %) with a mean age of 30.17 ± 10.55 years. Within this group, lupus nephritis class IV predominated, occurring in 133 patients (41.3 %), with median activity and chronicity indices of 10/24 and 4/12, respectively.

These findings align with two retrospective studies conducted by Hu *et al.* (2020) and Thomé *et al.* (2021) [6, 8], which examined the spectrum of biopsy-proven renal diseases in central China and southern Brazil, respectively. Both investigations identified lupus nephritis as the most common secondary glomerulonephritis (7.55 % and 41.1 %, respectively). Additionally, these studies reported nephritic syndrome as the primary clinical presentation in lupus nephritis cases, with class IV being the most frequent manifestation among lupus nephritis patients (36.89 % and 31.7 %, based on the ISN/RPS classification).

Conversely, a prospective observational cohort study by El-Hameed *et al.* [15], focusing on the role of kidney biopsy in diagnosing various kidney disease patterns in a single center, yielded different results. In their study of 56 patients, lupus nephritis cases accounted for 19.6 % of the total. The clinical presentations varied, with 7.1 % of cases exhibiting sub-nephrotic range proteinuria, 7.1 % displaying sub-nephrotic range proteinuria with renal impairment, and 5.3 % presenting with nephrotic range proteinuria accompanied by renal impairment. Classes III & V were more prevalent, representing 27.2 % of total lupus nephritis cases based on the ISN/RPS classification.

Our research revealed that asymptomatic hematuria was the clinical presentation at the time of biopsy for 69 patients (3.7 %) within the study population. Most of these cases (48 patients, 69.6 %) were diagnosed with IgA nephropathy, with a mean age of 38.74 ± 14.87 years.

Lim's [16] comprehensive review of previous publications on the frequencies of biopsy-proven renal diseases reported in China, Japan, and South Korea demonstrated that IgA nephropathy was the most common primary glomerular disease. At the same time, lupus nephritis was the most prevalent secondary glomerulopathy. Furthermore, minimal change

disease was most frequently diagnosed in patients undergoing biopsy due to nephrotic syndrome.

In contrast to our findings, Thomé *et al.'s* [8] retrospective study of 1051 cases in a tertiary hospital in southern Brazil reported that nephritic syndrome was more closely associated with IgA nephropathy (38.4 %). Isolated hematuria was uncommon and primarily identified in patients with IgA nephropathy (1.4 %). The predominant clinical presentation in IgA nephropathy patients was proteinuria with hematuria (30.1 %).

This study identified acute kidney injury (AKI) in 353 patients (19.1 %) of the study population. Hypertensive nephrosclerosis was the most common diagnosis (98 patients, 27.8 %), followed by thrombotic microangiopathy (TMA) (51 patients, 14.4 %). TMA cases were associated with various underlying etiologies, including lupus nephritis, drug-induced causes, malignant hypertension, infections, pregnancy complications, and some cases of unknown origin.

These findings align with Hamza & Shaker's [17] research on native renal TMA in an Egyptian population, which found TMA in 3.9 % of 3256 renal biopsies, with AKI being the most common presentation (64.5 %). Similarly, a Japanese study by Katsuno *et al.* [18] reported TMA in 0.39 % of 38,495 patients registered in the Japan Renal Biopsy Registry over a 10-year period.

However, a study by AbdElHady *et al.* [19] in the Alexandria area found TMA to be more prevalent than hypertensive nephrosclerosis among patients with vascular diseases.

Chronic kidney disease (CKD) was observed in 337 patients (18.2 %) of the study population, with hypertensive nephrosclerosis being the most frequent diagnosis (211 patients, 62.6 %), followed by lupus nephritis (44 patients, 13.1 %) and diabetic nephropathy (31 patients, 9.2 %).

Although renal biopsy is not routinely performed for diabetic nephropathy, it may be indicated when other nephropathies are suspected in diabetic patients. In this study, diabetic nephropathy presented as AKI in 34 patients (9.6 %), CKD in 31 patients (9.2 %), and nephrotic syndrome in 16 patients (2.3 %), with a peak distribution in the $\geq$60 years age group (33 patients, 16.9 %).

These findings differ from a study by Hu *et al.* [6] in central China, which reported diabetic nephropathy in 2.7 % of 34,630 cases, with a peak distribution in the 40-59 years age group

(62.9 %) and nephrotic syndrome as the most common presentation (59.8 %).

Tubulointerstitial diseases were diagnosed in 35 patients (1.9 %) of the study population, although they were commonly associated with other renal pathology diagnoses. Chronic tubulointerstitial nephritis was observed in 1127 patients (60.9 %), while acute tubulointerstitial nephritis was found in 649 patients (35.1 %).

Hypertensive nephrosclerosis was diagnosed in 18.7 % of patients, with a mean age of 44.2 ± 13.4 years. Renal biopsies in these cases revealed secondary focal global glomerulosclerosis and focal segmental glomerulosclerosis associated with vascular changes. The most common clinical presentations were chronic kidney disease (61 %) and acute kidney injury (28.3 %).

The prevalence of hypertensive kidney disease (HKD) in biopsy registries varies significantly across different healthcare systems and ethnic groups. In European countries such as the United Kingdom, Finland, and Austria, hypertension is reported as the apparent cause of end-stage renal disease (ESRD) in 5-10 % of cases [10]. Kidney biopsy-based studies indicate that arterionephrosclerosis is a predominant microscopic finding that ranges from 0.7 % in Polish to 3.4 % in Czech cohorts. Among elderly patients, the prevalence of arterionephrosclerosis as a dominant/isolated pathology varies from 1.53 % in Chinese cohorts to 7.1 % in cohorts from the United States [20].

The study population was classified into three age groups according to the WHO classification. In the 18-39 years group, lupus nephritis was the most common diagnosis (260 patients, 24.6 %), followed by focal segmental glomerulosclerosis (FSGS) (169 patients, 16 %). In the 40-59 years group, hypertensive nephrosclerosis was the most frequent diagnosis (162 patients, 27 %), followed by membranous glomerulonephritis (GN) (104 patients, 17.4 %). In the $\geq$60 years group, hypertensive nephrosclerosis was the most common diagnosis (50 patients, 25.6 %), followed by diabetic nephropathy (33 patients, 16.9 %).

These findings contrast with a study by Mahajan *et al.* [9] in eastern India, which reported lupus nephritis as the most common diagnosis (17.0 %) in the 18-59-year-old group and membranous GN (18.8 %) in the $\geq$ 60-year-old group.

The spectrum of renal diseases in the Egyptian population may change over time. Earlier studies by Barsoum & Francis [21], as well as Ibrahim & Fayed [22] at Cairo University, found FSGS to be the most frequent cause of glomerulonephritis, followed by proliferative GN and mesangial proliferative GN. The histopathological and clinical data collected over four years

from the renal registry at the referral center –comprising the pathology and EM lab in Ain Shams University Hospital– provided us with prevalence and trends in the diagnosis of renal diseases in Egypt as a pilot study. This study's comprehensive data should serve as a basis for future studies on different renal diseases.

Our study faced several limitations. Data collection was particularly challenging and time-consuming due to the reliance on paper-based records. Additionally, there was no standardization in data recording methods, which impeded the consistency and accuracy of data collection and analysis. As a result, many cases were excluded from the study due to incomplete or non-standardized data.

Conclusions

In our study, the most common renal pathology diagnosis was hypertensive nephrosclerosis (18.7 %). Among studied renal biopsies, membranous GN was the most common primary glomerulonephritis (12.6 %). Lupus nephritis was the most common secondary glomerulonephritis (17.4 %), with class IV being dominant among cases of lupus nephritis (41.3 %).

Authors contribution

Study concept and design: Hesham Mohamed El-Sayed and Heba Wahid El Said; analysis and interpretation of data: Manal Ibrahim Salman and Maha Abdel Moneim Behairy; drafting of the manuscript: Mohamed Sary Gharib; critical revision of the manuscript for important intellectual content: Al Shaimaa Ebrahem Ahmed, and Hesham Mohamed El-Sayed; statistical analysis: Manal Ibrahim Salman.

Conflicts of interest

The authors have no conflict of interest.

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