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Morphological Spectrum of Renal Pathology in Autopsy Kidneys: A Retrospective Cross-sectional Study

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Abstract:

Background

Renal lesions are frequently encountered during autopsy examinations and may remain clinically silent during life. Histopathological evaluation of autopsy kidneys provides valuable insights into the spectrum of renal diseases and their association with systemic disorders. The present study aimed to evaluate the gamut of renal lesions identified in autopsy kidneys over a five-year period.

Methods

This retrospective cross-sectional study was conducted in the Department of Pathology of a tertiary care teaching hospital over five years. A total of 167 autopsy cases with adequately preserved kidneys were included. Gross and microscopic examinations of renal tissue were performed using routine hematoxylin and eosin staining along with special stains wherever required. Histopathological lesions were categorized into glomerular, tubular, interstitial, vascular, infective, and neoplastic lesions. Data were analyzed using SPSS version 25.0, and associations were assessed using Chi-square test with $p<0.05$ considered statistically significant.

Results

The mean age of the study population was 46.8 ± 15.7 years, with male predominance (67.1%). Hypertension (34.7%) and diabetes mellitus (24.6%) were the most common comorbidities. Grossly, congested kidneys (42.5%) were the predominant finding. Histopathologically, acute tubular necrosis was the most common lesion (32.3%), followed by benign nephrosclerosis (25.7%), diabetic nephropathy (17.4%), and chronic pyelonephritis (14.4%). Significant associations were observed between nephrosclerosis and hypertension, and between diabetic nephropathy and diabetes mellitus ($p<0.001$). Clinically silent renal lesions were identified in 37.1% of autopsies.

Conclusion

Autopsy kidneys demonstrate a broad spectrum of renal lesions, many of which remain undiagnosed during life. Acute tubular necrosis, nephrosclerosis, and diabetic nephropathy were the predominant histopathological findings. Autopsy-based renal histopathology remains an important tool for identifying occult renal disease, understanding clinicopathological correlations, and assessing the burden of nephropathies in the population.

Keywords:

Autopsy; Renal lesions; Acute tubular necrosis; Histopathology; Kidney pathology

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Introduction

The kidneys play a pivotal role in maintaining homeostasis through regulation of fluid and electrolyte balance, acid–base equilibrium, blood pressure control, and excretion of metabolic waste products [1]. Owing to their high vascularity and complex functional architecture, kidneys are susceptible to a wide range of pathological insults, including infectious, inflammatory, vascular, metabolic, toxic, and neoplastic disorders [2]. Renal diseases constitute a significant public health concern worldwide, with chronic kidney disease (CKD) affecting approximately 8–16% of the global population and contributing substantially to morbidity, mortality, and healthcare expenditure [3,4]. In addition to CKD, acute kidney injury (AKI), glomerular diseases, tubulointerstitial disorders, and vascular nephropathies remain important causes of adverse clinical outcomes.

Despite advances in diagnostic imaging, laboratory investigations, and renal biopsy techniques, a considerable proportion of renal lesions remain clinically unrecognized during life [5]. Many kidney diseases are asymptomatic in their early stages and may not produce significant functional impairment until extensive structural damage has occurred [6]. Consequently, a substantial number of renal pathologies are discovered incidentally during postmortem examination. Autopsy therefore continues to serve as an invaluable tool for identifying occult diseases, establishing clinicopathological correlations, assessing diagnostic accuracy, and enhancing understanding of disease epidemiology [6].

Histopathological examination of autopsy kidneys offers a unique opportunity to evaluate the entire spectrum of renal lesions irrespective of their contribution to the cause of death [7]. Unlike renal biopsies, which are generally performed in selected clinical settings and often sample only a limited portion of renal tissue, autopsy studies permit comprehensive assessment of both gross and microscopic renal changes [8]. Such examinations can reveal a wide variety of lesions involving the glomeruli, tubules, interstitium, vasculature, and collecting system, many of which may have remained undiagnosed during life [7,8].

Literature have demonstrated a broad range of renal pathologies, including acute tubular necrosis, chronic pyelonephritis, glomerulonephritis, diabetic nephropathy, nephrosclerosis, tubulointerstitial nephritis, cystic diseases, and renal neoplasms [9,10]. Reported frequencies of renal lesions in autopsy series vary considerably, ranging from approximately 14% to over 40%, depending on the study population and diagnostic criteria employed [9,10]. It has been also highlighted the occurrence of clinically silent nephropathies that were unrelated to the immediate cause of death but reflected underlying chronic disease processes [10].

The increasing prevalence of diabetes mellitus, hypertension, obesity, sepsis, and other systemic disorders has further amplified the burden of renal pathology. Histomorphological evaluation of autopsy kidneys can therefore provide valuable insights into disease trends, regional patterns of renal involvement, and the hidden burden of kidney disease within the community. Moreover, identification of unsuspected hereditary, inflammatory, or neoplastic lesions may have implications for surviving family members and future preventive strategies [11,12]. In this context, the present study aimed undertaken to evaluate the histopathological spectrum of renal lesions encountered in autopsy specimens over a five-year period.

Material and methods

Study Design and Setting

This retrospective cross-sectional autopsy-based study was conducted in the Department of Forensic

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Medicine in collaboration with the Department of Pathology of a tertiary care teaching hospital over a period of five years from January 2019 to December 2023.

Study Population and Sample Size

The study included all autopsy cases in which both kidneys were adequately preserved and available for histopathological examination. Cases with advanced autolysis, severely damaged renal tissue, decomposed bodies, or incomplete clinical and autopsy records were excluded from the study. A total of 167 autopsy kidneys from 167 deceased individuals fulfilling the inclusion criteria were analyzed during the study period. Demographic details including age and sex, along with relevant clinical history, cause of death, comorbid conditions such as diabetes mellitus, hypertension, chronic kidney disease, septicemia, poisoning, and other systemic illnesses were obtained from hospital records, requisition forms, and postmortem reports wherever available.

Specimen Collection and Gross Examination

During autopsy, both kidneys were removed en bloc after standard dissection procedures. The kidneys were examined for external appearance, size, weight, capsular surface, consistency, cortical thickness, corticomedullary differentiation, and presence of any focal lesions, cysts, scars, infarcts, hemorrhage, hydronephrosis, calculi, or tumors. Measurements of the kidneys were recorded in centimeters, and representative gross findings were documented. Serial coronal sections were taken to assess the pelvicalyceal system and parenchymal architecture. Grossly abnormal areas, whenever present, were sampled extensively for histopathological evaluation.

Histopathological Processing and Microscopic Examination

Representative tissue sections were obtained from the cortex, medulla, pelvicalyceal region, and any grossly identifiable lesion. The tissue samples were fixed in 10% neutral buffered formalin for 24–48 hours, followed by routine paraffin processing. Sections of approximately 3–5 µm thickness were prepared using a rotary microtome and stained routinely with hematoxylin and eosin (H&E). Special stains such as Periodic Acid–Schiff (PAS), Masson's trichrome, Congo red, and Jones methenamine silver stain were employed in selected cases wherever required for better characterization of glomerular, tubular, interstitial, vascular, or amyloid-related lesions.

Microscopic examination was carried out independently by experienced histopathologists using standard light microscopy. Renal lesions were categorized into glomerular, tubular, interstitial, vascular, congenital, cystic, infectious, and neoplastic lesions based on established histopathological criteria. Glomerular changes such as glomerulosclerosis, glomerulonephritis, diabetic nephropathy, and amyloidosis were carefully assessed. Tubular lesions including acute tubular necrosis, tubular degeneration, and casts were documented. Interstitial inflammation, fibrosis, pyelonephritis, vascular nephrosclerosis, arteriosclerosis, and other pathological alterations were also recorded systematically. In cases showing multiple coexisting lesions, all significant histopathological findings were documented.

Data Collection and Statistical Analysis

Data obtained from autopsy records, gross examination findings, and histopathological reports were entered into Microsoft Excel spreadsheets and analyzed using Statistical Package for the Social Sciences (SPSS) software version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistical analysis was performed for demographic, clinical, gross, and microscopic renal findings. Continuous variables such as age were expressed as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. Associations between major renal lesions and variables such as age group, sex, comorbidities, and cause of death were analyzed using Chi-square test

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or Fisher's exact test wherever appropriate. Statistical significance was considered at a p-value of <0.05.

Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee. Since the study was based on archived autopsy specimens and retrospective review of records, waiver of informed consent was obtained from the ethics committee. Confidentiality of patient identity and medicolegal information was strictly maintained throughout the study in accordance with institutional and ethical guidelines.

Results

The present study included 167 autopsy cases with a mean age of 46.8 ± 15.7 years. The majority of cases belonged to the 41–60 years age group (40.7%), followed by 21–40 years (31.1%), while individuals aged less than 20 years constituted only 6.6% of the study population. Male predominance was observed with 112 cases (67.1%), whereas females accounted for 32.9% of cases. Most autopsies were medicolegal in nature (76.6%), while hospital or clinical autopsies constituted 23.4%. Among the associated comorbidities, hypertension was the most common condition identified in 34.7% of cases, followed by chronic alcohol use (29.3%) and diabetes mellitus (24.6%). Septicemia was present in 16.8% of cases, whereas chronic kidney disease and tuberculosis were noted in 9.6% and 7.2% of cases respectively. Cardiovascular causes were the leading immediate cause of death (23.4%), followed by poisoning (19.2%), trauma/RTA (17.4%), and infectious diseases (15.6%) (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics of the Study Population (n=167).

Variable	Frequency/Mean ± SD	%
Age Group (years)		
<20	**11**	**6.6**
21–40	**52**	**31.1**
41–60	**68**	**40.7**
>60	**36**	**21.6**
Age (years)	**46.8 ± 15.7**	
Gender		
Male	**112**	**67.1**
Female	**55**	**32.9**
Type of Autopsy		
Medicolegal	**128**	**76.6**
Hospital/Clinical	**39**	**23.4**
Associated Comorbidities		
Hypertension	**58**	**34.7**
Diabetes mellitus	**41**	**24.6**
Chronic alcohol use	**49**	**29.3**
Chronic kidney disease	**16**	**9.6**
Septicemia	**28**	**16.8**
Tuberculosis	**12**	**7.2**

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No known comorbidity	**61**	**36.5**
Immediate Cause of Death		
Cardiovascular causes	**39**	**23.4**
Poisoning	**32**	**19.2**
Trauma/RTA	**29**	**17.4**
Infectious diseases	**26**	**15.6**
Respiratory causes	**18**	**10.8**
Hepatic failure	**11**	**6.6**
Others	12	7.2

RTA – Road Traffic Accident.

Gross examination revealed congested kidneys as the most frequent finding, observed in 42.5% of cases. Pale swollen kidneys were identified in 19.8% of autopsies, while reduced corticomedullary differentiation and granular contracted kidneys were noted in 22.8% and 15.6% respectively. Renal cortical scarring was seen in 11.4% of cases, suggestive of chronic renal damage. Pyelonephritic changes were present in 9.6% of kidneys, whereas renal cysts, hydronephrosis, and infarcts were identified in 8.4%, 4.8%, and 4.2% of cases respectively. Nearly one-third of the kidneys (29.3%) appeared grossly unremarkable despite microscopic abnormalities in several of these cases (Table 2 and Figure 1).

Table 2. Distribution of Gross Renal Findings on Autopsy (n=167).

Gross Renal Findings	Frequency	%
Congested kidneys	**71**	**42.5**
Reduced corticomedullary differentiation	**38**	**22.8**
Granular contracted kidneys	**26**	**15.6**
Renal cortical scarring	**19**	**11.4**
Hydronephrosis	**8**	**4.8**
Renal cysts	**14**	**8.4**
Infarcts	**7**	**4.2**
Pyelonephritic changes	**16**	**9.6**
Pale swollen kidneys	**33**	**19.8**
Grossly normal kidneys	**49**	**29.3**

Gross renal findings were assessed during postmortem examination; multiple findings were present in certain cases.

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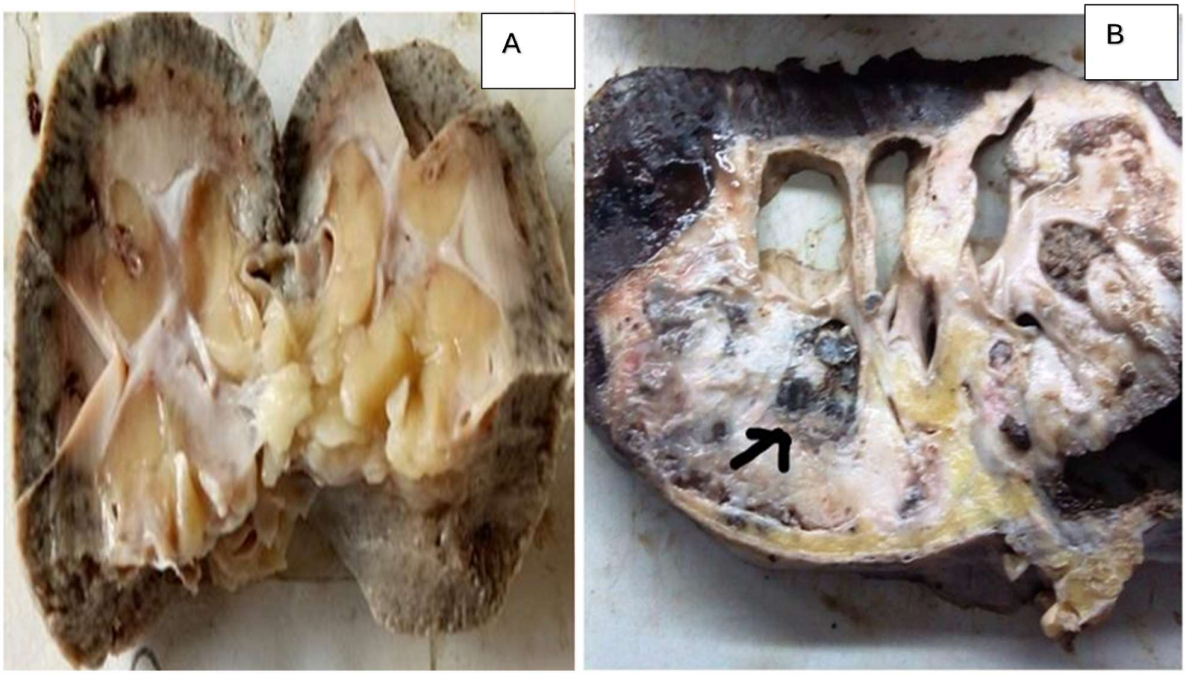

Figure 1. Representative gross renal lesions observed at autopsy. (A) Gross specimen showing nephrolithiasis with pyonephrosis and marked dilatation of the pelvicalyceal system. (B) Cut surface of kidney showing cortical scarring and pelvicalyceal dilatation consistent with chronic pyelonephritis.

Microscopic examination demonstrated a broad spectrum of renal lesions. Acute tubular necrosis (ATN) was the most common histopathological finding, detected in 32.3% of cases. Benign nephrosclerosis was identified in 25.7% of autopsies, while diabetic nephropathy and chronic pyelonephritis were observed in 17.4% and 14.4% respectively. Glomerulosclerosis was present in 13.2% of cases, and chronic interstitial nephritis was seen in 10.8%. Less common lesions included acute interstitial nephritis (6.6%), acute pyelonephritis (5.4%), renal infarction (4.2%), and amyloidosis (3.6%). Diffuse proliferative glomerulonephritis and membranous glomerulopathy were identified in 3.0% and 2.4% of cases respectively. Rare lesions included tuberculous granulomatous involvement, polycystic kidney disease, and renal cell carcinoma. Histologically unremarkable kidneys were observed in 21.6% of cases (Table 3 and Figure 2).

Table 3. Histopathological Spectrum of Renal Lesions Identified on Microscopy (n=167).

Histopathological Lesion	Frequency	%
Acute tubular necrosis (ATN)	**54**	**32.3**
Benign nephrosclerosis	**43**	**25.7**
Diabetic nephropathy	**29**	**17.4**
Chronic pyelonephritis	**24**	**14.4**
Glomerulosclerosis	**22**	**13.2**
Acute interstitial nephritis	**11**	**6.6**
Acute pyelonephritis	**9**	**5.4**
Chronic interstitial nephritis	**18**	**10.8**

ISSN : (Online): 3008-038X
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Amyloidosis	**6**	**3.6**
Membranous glomerulopathy	**4**	**2.4**
Diffuse proliferative glomerulonephritis	**5**	**3**
Tuberculous granulomatous lesion	**4**	**2.4**
Renal infarction	**7**	**4.2**
Polycystic kidney disease	**3**	**1.8**
Renal cell carcinoma	**2**	**1.2**
Histologically unremarkable kidneys	**36**	**21.6**

ATN – Acute tubular necrosis. Multiple histopathological lesions were observed in some kidneys.

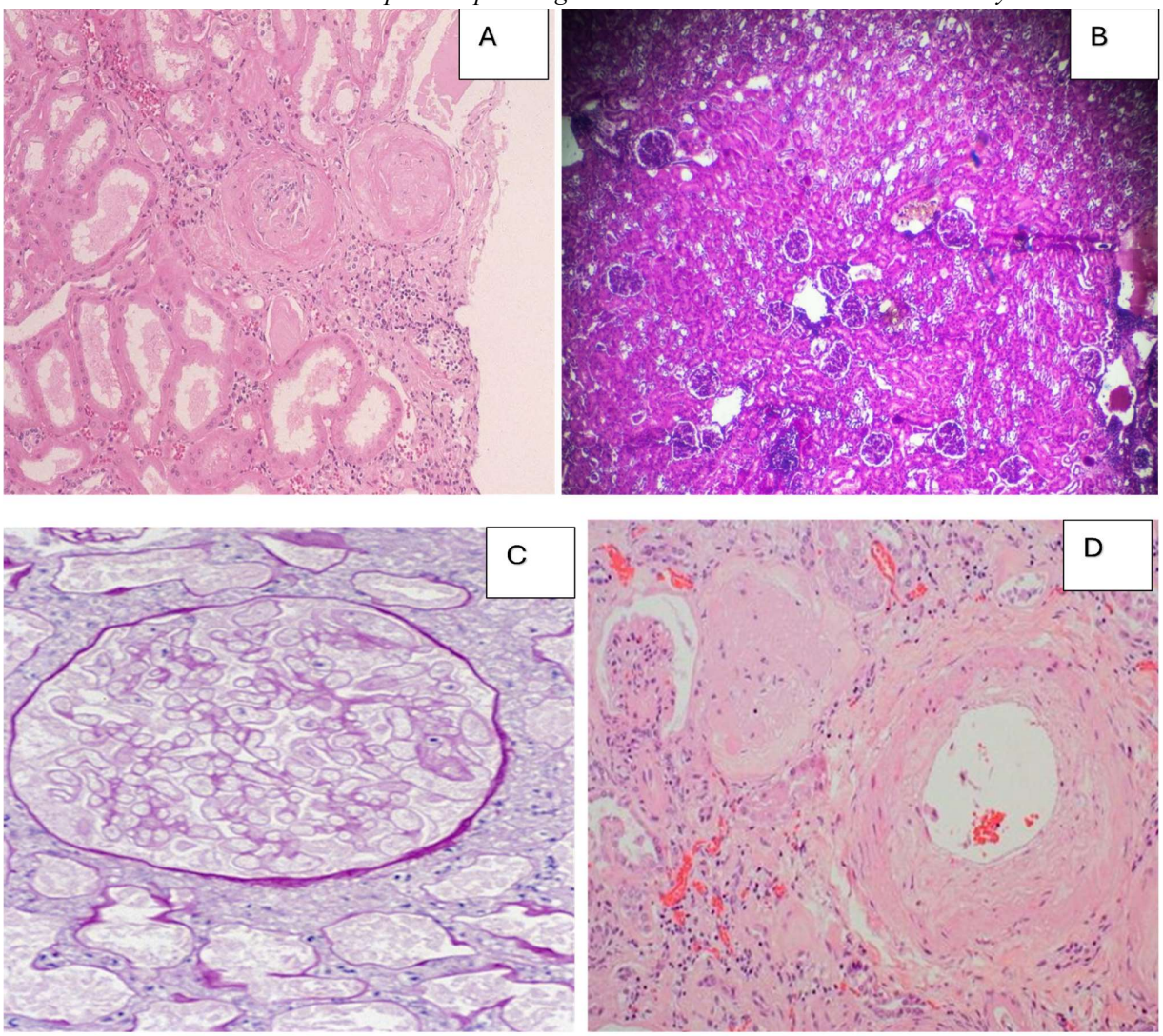

Figure 2. Histopathological features of tubulointerstitial and vascular renal lesions. (A) Chronic pyelonephritis showing tubular thyroidization and chronic inflammatory infiltrate (H&E, ×100). (B) Chronic interstitial nephritis with tubular atrophy and interstitial fibrosis (H&E, ×100). (C) Chronic tubulointerstitial nephritis showing tubular dilatation and fibrosis (H&E, ×200). (D) Benign nephrosclerosis demonstrating hyaline arteriolosclerosis and vascular wall thickening (H&E, ×200).

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Autopsy examination revealed a considerable burden of clinically unsuspected renal pathology. Overall, incidental renal lesions were identified in 37.1% of cases. Undiagnosed nephrosclerosis was the most common silent lesion, detected in 12.6% of autopsies, followed by early diabetic nephropathy (7.8%), chronic pyelonephritis (6.0%), and glomerulosclerosis (5.4%). Less frequent occult lesions included amyloidosis (2.4%), renal tuberculosis (1.8%), and occult renal neoplasms (1.2%). These findings emphasize the importance of autopsy-based histopathological evaluation in uncovering subclinical renal diseases that remain undetected during life (Table 4 and Figure 3).

Table 4. Frequency of Clinically Silent Renal Lesions Detected Only at Autopsy.

Silent Renal Lesions	Frequency	%
Undiagnosed nephrosclerosis	**21**	**12.6**
Early diabetic nephropathy	**13**	**7.8**
Chronic pyelonephritis	**10**	**6**
Glomerulosclerosis	**9**	**5.4**
Amyloidosis	**4**	**2.4**
Renal tuberculosis	**3**	**1.8**
Occult renal neoplasm	**2**	**1.2**
Any incidental renal pathology	**62**	**37.1**

Clinically silent lesions refer to renal pathologies not diagnosed or suspected during life and identified incidentally during autopsy examination.

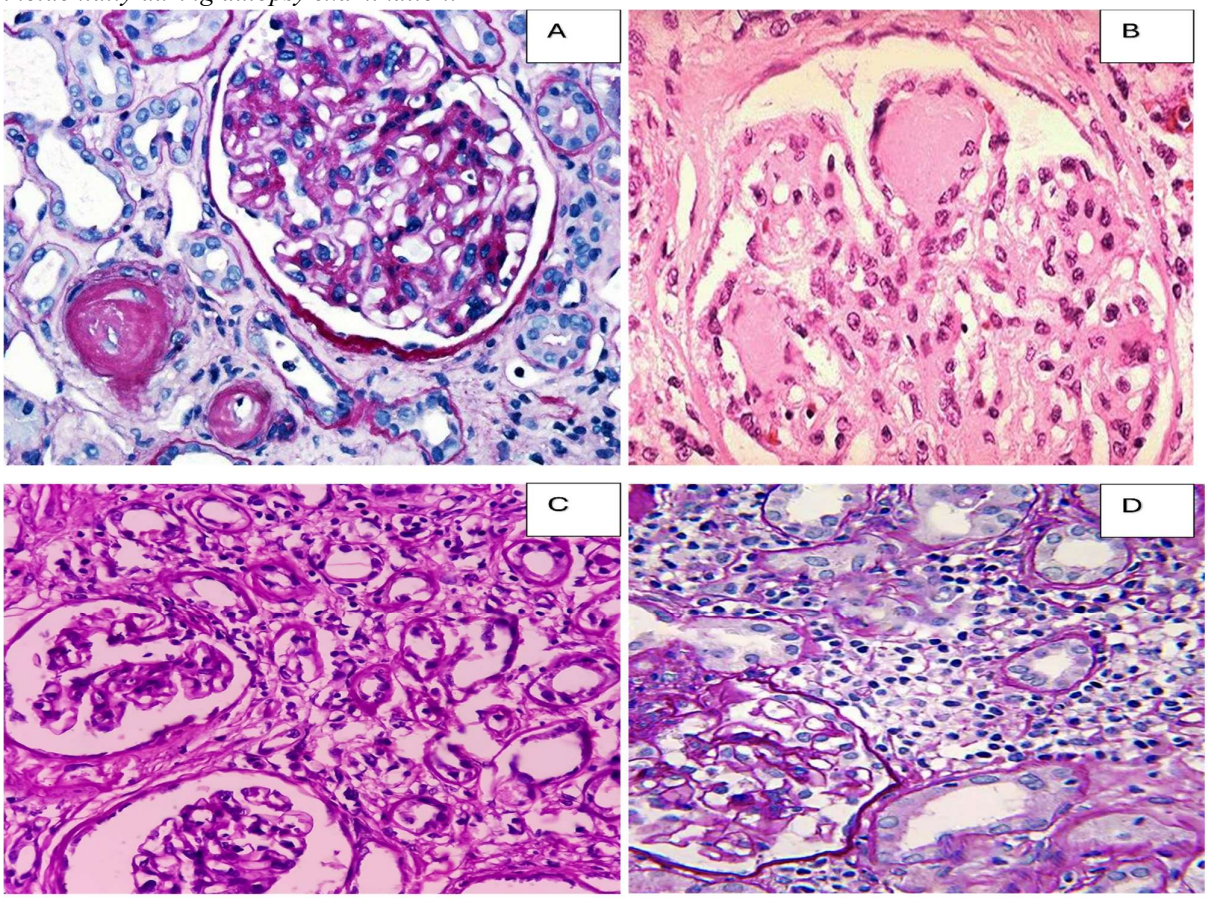

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Figure 3. Histopathological features of glomerular lesions. (A) Diabetic nephropathy showing mesangial expansion and glomerular basement membrane thickening (PAS, ×400). (B) Nodular glomerulosclerosis consistent with diabetic nephropathy (PAS, ×400). (C) Glomerulosclerosis showing increased mesangial matrix and partial obliteration of capillary loops (PAS, ×400). (D) Diabetic nephropathy with associated chronic inflammatory changes and tubular involvement (PAS, ×400).

A statistically significant association was observed between age group and major renal lesions (p=0.003). ATN was more common among individuals younger than 40 years (44.4%), whereas nephrosclerosis and diabetic nephropathy showed higher frequencies among elderly individuals aged above 60 years, accounting for 41.7% and 30.6% respectively. Hypertension demonstrated a strong association with nephrosclerosis (50.0%) and diabetic nephropathy (22.4%), with statistically significant differences compared to non-hypertensive individuals (p<0.001). Similarly, diabetic nephropathy was significantly more frequent among known diabetic patients (58.5%) compared to non-diabetics (4.0%) (p<0.001). These findings highlight the contribution of chronic systemic diseases to renal histopathological alterations (Table 5).

Table 5. Association of Major Renal Lesions with Age Group and Comorbidities.

Variable	ATN	Nephrosclerosis	Diabetic Nephropathy	p-value
	Frequency (%)			
Age Group				
<40 years (n=63)	**28 (44.4)**	**6 (9.5)**	**3 (4.8)**	**0.003**
41–60 years (n=68)	**18 (26.5)**	**22 (32.4)**	**15 (22.1)**	
>60 years (n=36)	**8 (22.2)**	**15 (41.7)**	**11 (30.6)**	
Hypertension				
Present (n=58)	**14 (24.1)**	**29 (50.0)**	**13 (22.4)**	**<0.001**
Absent (n=109)	**40 (36.7)**	**14 (12.8)**	**16 (14.7)**	
Diabetes Mellitus				
Present (n=41)	**11 (26.8)**	**14 (34.1)**	**24 (58.5)**	**<0.001**
Absent (n=126)	**43 (34.1)**	**29 (23.0)**	**5 (4.0)**	

ATN – Acute tubular necrosis.

A significant association was identified between cause of death and predominant renal lesions (p=0.001). ATN was most frequently observed among cases with septicemia/infections (57.7%) and poisoning (50.0%), indicating acute renal injury secondary to systemic insult. Chronic renal lesions were predominantly associated with cardiovascular causes, where 46.2% of cases demonstrated chronic nephropathic changes. Infective renal lesions were most common among septicemic and infectious disease-related deaths (30.8%). Trauma-related deaths showed comparatively fewer chronic and infective renal lesions, reflecting the acute nature of mortality in such cases (Table 6).

Table 6. Correlation Between Cause of Death and Predominant Renal Lesions.

Cause of Death	ATN	Chronic Renal Lesions	Infective Renal Lesions	p-value
	Frequency (%)			

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Septicemia/Infections (n=26)	**15 (57.7)**	**4 (15.4)**	**8 (30.8)**	**0.001**
Cardiovascular causes (n=39)	**9 (23.1)**	**18 (46.2)**	**3 (7.7)**	
Poisoning (n=32)	**16 (50.0)**	**5 (15.6)**	**2 (6.3)**	
Trauma/RTA (n=29)	**8 (27.6)**	**4 (13.8)**	**1 (3.4)**	
Respiratory diseases (n=18)	**4 (22.2)**	**6 (33.3)**	**2 (11.1)**	
Others (n=23)	**2 (8.7)**	**6 (26.1)**	**3 (13.0)**	

ATN – Acute tubular necrosis. Infective renal lesions included pyelonephritis and tuberculous lesions.

Comparison of renal lesions according to sex revealed that most histopathological abnormalities were more frequent among males. Acute tubular necrosis was observed in 34.8% of males compared to 27.3% of females. Benign nephrosclerosis and chronic interstitial nephritis were also more common in males. Conversely, chronic pyelonephritis and diabetic nephropathy showed relatively higher frequencies among females. However, none of the observed sex-wise differences demonstrated statistical significance, with all p-values exceeding 0.05. This suggests that although certain lesions appeared numerically more common in one sex, gender did not significantly influence the overall distribution of renal pathology in the study population (Table 7).

Table 7. Distribution of Renal Lesions According to Sex.

Renal Lesion	**Male (n=112)**	**Female (n=55)**	**p-value**
	Frequency (%)		
Acute tubular necrosis	**39 (34.8%)**	**15 (27.3%)**	**0.318**
Benign nephrosclerosis	**32 (28.6%)**	**11 (20.0%)**	**0.236**
Diabetic nephropathy	**18 (16.1%)**	**11 (20.0%)**	**0.529**
Chronic pyelonephritis	**13 (11.6%)**	**11 (20.0%)**	**0.142**
Chronic interstitial nephritis	**14 (12.5%)**	**4 (7.3%)**	**0.312**
Glomerulosclerosis	**16 (14.3%)**	**6 (10.9%)**	**0.548**

Discussion

The present five-year autopsy-based cross-sectional study demonstrated a wide spectrum of renal lesions, highlighting the substantial burden of both clinically evident and silent renal pathology. The majority of cases belonged to the 41–60 years age group (40.7%) with a mean age of 46.8 ± 15.7 years, and males constituted 67.1% of the study population. Similar male predominance and middle-aged distribution have been reported in previous Indian autopsy studies by Kumar et al., Desai et al., and Kaur et al., likely reflecting greater exposure to cardiovascular risk factors, alcohol consumption, trauma, and occupational stress among males [13,14,15].

Hypertension (34.7%) and diabetes mellitus (24.6%) were the most common associated comorbidities in the present study. These findings are consistent with the increasing prevalence of non-communicable diseases in India and their well-established role in chronic renal injury [16,17]. Hypertension causes progressive vascular narrowing and ischemic glomerular damage, while chronic hyperglycemia in diabetes leads to mesangial expansion and glomerulosclerosis [16]. Similar observations have been documented by Kakadiya et al., and Sandhu et al., who identified hypertensive and diabetic renal changes as major contributors to nephropathology in autopsy kidneys [18,19].

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Grossly, congested kidneys were the most frequent finding (42.5%), followed by reduced corticomedullary differentiation (22.8%) and pale swollen kidneys (19.8%). Congestion is commonly associated with terminal circulatory failure, septicemia, and cardiorespiratory compromise. Pale swollen kidneys usually indicate acute tubular injury due to ischemic or toxic insults. Granular contracted kidneys observed in 15.6% of cases reflected chronic hypertensive and ischemic renal damage. Similar gross findings have been reported in autopsy studies by Mulay et al., and Yadav et al., [20,21].

Histopathologically, acute tubular necrosis (ATN) was the most common lesion, identified in 32.3% of cases. Comparable frequencies ranging from 25–40% have been reported in earlier autopsy studies by Matkowski et al., and Sahoo et al., [22,23]. The high prevalence of ATN in the present study may be attributed to the large number of septicemic, poisoning, cardiovascular, and trauma-related deaths. Ischemia and toxic injury result in tubular epithelial cell necrosis through ATP depletion, oxidative stress, and inflammatory mediator release [23]. ATN was particularly common among younger individuals and in poisoning-related deaths, supporting the role of acute systemic insults in precipitating renal tubular injury [22].

Benign nephrosclerosis was the second most common lesion (25.7%) and showed significant association with hypertension and older age ($p<0.001$). Similar findings have been described in studies by Kakadiya et al., and Shah et al., where chronic vascular changes were strongly linked to longstanding hypertension [18, 24,25]. Diabetic nephropathy was identified in 17.4% of cases and demonstrated a highly significant association with known diabetes mellitus (58.5%, $p<0.001$). Persistent hyperglycemia induces basement membrane thickening, mesangial sclerosis, and podocyte injury, eventually resulting in diabetic glomerulosclerosis [25].

Chronic pyelonephritis (14.4%) and chronic interstitial nephritis (10.8%) were also frequently observed. These lesions are commonly associated with recurrent urinary tract infections, obstructive uropathy, and chronic inflammatory insults. The relatively higher frequency of chronic pyelonephritis among females is biologically plausible due to increased susceptibility to ascending urinary infections [17,18]. Rare lesions such as amyloidosis, tuberculous granulomatous lesions, polycystic kidney disease, and renal cell carcinoma further emphasized the broad histopathological spectrum encountered during autopsy examination [20,21].

An important finding of the present study was the high prevalence of clinically silent renal lesions, which were detected incidentally in 37.1% of cases. Undiagnosed nephrosclerosis and early diabetic nephropathy constituted the major occult lesions. Similar observations have been reported in autopsy studies by Thakur et al., and Patil et al., suggesting that a considerable proportion of renal disease remains asymptomatic and undiagnosed during life [26,27]. Limited screening, nonspecific symptoms, and lack of routine renal evaluation may contribute to underdiagnosis [27].

The study also demonstrated significant correlation between cause of death and renal pathology ($p=0.001$). ATN and infective lesions were predominantly associated with septicemia and poisoning, whereas chronic renal lesions were more frequent among cardiovascular deaths [28]. These findings highlight the close relationship between systemic diseases and renal injury, as kidneys are particularly vulnerable to hypoperfusion, toxins, inflammatory mediators, and metabolic disturbances [28,29].

Limitations

The present study was limited by its retrospective, single-center autopsy-based design, which may restrict generalizability to the broader population. Clinical correlation was incomplete in certain cases due to limited premortem investigations and unavailable medical records. Advanced ancillary techniques such as immunofluorescence and electron

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microscopy were not performed, potentially limiting detailed characterization of some glomerular lesions. Additionally, autolytic changes in a few specimens may have affected microscopic interpretation.

Conclusion

The present autopsy-based study demonstrated a wide spectrum of renal lesions ranging from acute tubular injury to chronic vascular, glomerular, interstitial, infective, and neoplastic pathologies. Acute tubular necrosis, benign nephrosclerosis, and diabetic nephropathy emerged as the most common lesions, reflecting the significant impact of systemic diseases such as hypertension, diabetes mellitus, septicemia, and poisoning on renal morphology. A considerable proportion of clinically silent renal lesions were identified only at autopsy, emphasizing the hidden burden of renal disease in the population. The study highlights the continuing importance of autopsy histopathology in detecting occult nephropathies, understanding disease patterns, and providing valuable clinicopathological insights for improving preventive and therapeutic strategies.

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