Histomorphological Characterization and the Role of Special Stains and Immunohistochemistry in Adult and Elderly Renal Pathology

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Abstract

Background: Renal diseases in adults and the elderly encompass diverse inflammatory, degenerative, and neoplastic processes that may be clinically silent until advanced. Histopathology, augmented by special stains and immunohistochemistry (IHC), is crucial for accurate diagnosis and patient management. This study retrospectively and prospectively analyzed 50 adult and elderly nephrectomy and autopsy kidney specimens to characterize the histomorphological spectrum and assess the role of special stains and IHC.

Methods: Fifty consecutive cases (≥18 years) undergoing renal resection or autopsy over 18 months were examined. Formalin-fixed paraffin-embedded tissues were processed by routine hematoxylin-eosin staining. Selected cases underwent additional special stains (Periodic Acid–Schiff [PAS], reticulin, Masson's trichrome, Congo red) as indicated by morphology. Renal neoplasms were further evaluated by IHC using panels of markers (including CK7, CD117, PAX8, AMACR, CD10, vimentin, HMB45, Melan-A, SMA, CK5/6, p63, GATA3, uroplakin). Demographic, clinical, and pathological data were tabulated.

Results: Patients were predominantly middle-aged to elderly (76% ≥41 years, peak 51–60 years) with a male predominance (58%). Most specimens derived from surgical nephrectomies (80%) with equal left/right involvement. Common presentations were flank pain (34%), hematuria (26%), and palpable mass (16%). Preoperative diagnoses included suspected renal cell carcinoma (38%), renal failure (24%), and pelviureteric obstruction (18%). Histologically, chronic pyelonephritis (12/50, 24%) and chronic glomerulonephritis (5/50, 10%) were the leading inflammatory lesions. Non-inflammatory, non-neoplastic changes comprised 30% (15/50) of cases, led by hypertensive nephropathy (5/50, 10%). Benign tumors accounted for 16% (8/50) – chiefly oncocytomas (5/50, 10%) and angiomyolipomas (3/50, 6%) – while malignant neoplasms comprised 20% (10/50), including clear-cell renal cell carcinoma (4/50, 8%), papillary RCC (1/50, 2%), chromophobe

RCC (2/50, 4%), squamous cell carcinoma (2/50, 4%), and invasive urothelial carcinoma (1/50, 2%). Special stains were applied in 32 cases: PAS in 66% (21/32), reticulin and Masson's trichrome in 16% each (5/32), and Congo red in 2% (1/32) to highlight basement membranes, fibrous stroma, and amyloid respectively[1]. IHC profiles confirmed tumor subtypes: all oncocytomas showed CD117 and CK7 positivity, angiomyolipomas were HMB-45/Melan-A/SMA-positive, clear-cell RCCs coexpressed CD10, PAX8, and vimentin, papillary RCCs were positive for CK7, PAX8, and AMACR, chromophobe RCCs expressed CK7, CD117, PAX8, and squamous carcinomas were positive for CK7, CK5/6, p63, and PanCK. Urothelial carcinoma expressed CK7, GATA3, and uroplakin[2].

Conclusion: Adult renal pathology in this cohort showed a broad histological spectrum, with chronic inflammatory and hypertensive/diabetic changes being common in non-neoplastic disease, and clear-cell RCC predominating among neoplasms. Standard histology combined with targeted special stains and immunohistochemistry proved essential for accurate diagnosis and subtyping. These findings are consistent with other tertiary-care series[3][4], underscoring the value of comprehensive morphological evaluation in kidney lesions.

Introduction

The kidneys are complex retroperitoneal organs responsible for waste excretion, fluid-electrolyte and acid-base balance, and hormone production (erythropoietin, renin, active vitamin D). Because of their large functional reserve, many renal disorders progress insidiously until advanced stages. As such, histopathological examination of renal tissue is often required to establish definitive diagnoses[5]. Adult and elderly patients may develop renal lesions from diverse etiologies – hypertensive or diabetic nephropathy, chronic infections (e.g., pyelonephritis), congenital anomalies, and neoplasms (benign and malignant) – each with distinct microscopic features. In particular, inflammatory and neoplastic diseases are common in this demographic. Accurate subclassification of renal neoplasms (e.g. clear-cell vs. papillary vs. chromophobe RCC) is critical for prognosis and therapy, often requiring immunohistochemical (IHC) markers[6][7]. Moreover, special stains such as Periodic Acid–Schiff (PAS), reticulin, trichrome, and Congo red enhance detection of basement membrane changes, fibrosis, and amyloid, respectively[1]. Previous studies of nephrectomy specimens from tertiary centers have reported that chronic pyelonephritis and clear-cell renal cell carcinoma predominate among non-neoplastic and neoplastic lesions, respectively[3][4]. This study reviews 50 cases from a tertiary hospital's pathology archives to characterize adult/elderly renal pathology in our population, and to illustrate the complementary roles of special stains and IHC in diagnosis.

Materials and Methods

This descriptive study included 50 consecutive adult (≥18 years) and elderly patients undergoing nephrectomy or autopsy over an 18-month period at a tertiary care hospital (Department of Pathology, MP Shah Government Medical College). Ethical clearance was obtained. Inclusion criteria were any nephrectomy specimen (benign or malignant) or autopsy kidney from patients ≥18 years; excluded were pediatric cases (<18 years) and autolyzed tissue. Specimens were fixed in 10% neutral buffered formalin and processed by routine tissue processing. Blocks were sectioned at 3 µm. All slides were stained with hematoxylin and eosin (H&E). Special histochemical stains were applied on selected cases based on morphological suspicion: PAS for basement membranes and mesangial matrix, reticulin for fibrous framework, Masson's trichrome for collagen/fibrosis, and Congo red for amyloid. Immunohistochemistry was performed on representative sections of all renal neoplasms, using an automated immunostainer. Panels of antibodies included cytokeratin 7 (CK7), CD117 (c-Kit), PAX8, AMACR, CD10, vimentin, HMB-45, Melan-A, smooth muscle actin (SMA), CK5/6, p63, GATA3, and uroplakin, among others. Antigen retrieval and detection were done per standard protocols. Microscopic features were recorded, and renal lesions were categorized as inflammatory, non-inflammatory non-neoplastic (degenerative), benign neoplastic, or malignant neoplastic. Clinical data (age, sex, presentation, provisional diagnosis) were obtained from records. Data were tabulated and expressed as frequencies and percentages.

Results

The cohort's age ranged from 18 to 80 years, with a mean of approximately 53 years. Only 4% (2/50) were ≤40 years, whereas the largest group (38%) was 51–60 years; 28% were 41–50, 24% were 61–70, and 6% were 71–80. Males predominated (58%, 29/50). Specimens were largely from surgical nephrectomies (80%, 40/50), with the remainder (20%, 10/50) from autopsies. Left and right kidneys were nearly equally represented (52% vs. 44%), with two cases (4%) of perinephric cysts.

Presenting features varied: flank pain was most common (34%, 17/50), followed by gross hematuria (26%, 13/50) and a palpable renal mass (16%, 8/50). Urinary symptoms (burning micturition, proteinuria) occurred in fewer cases. Preoperative clinical diagnoses included suspected renal cell carcinoma in 38% (19/50), renal failure in 24% (12/50), and pelvi-ureteric junction obstruction in 18% (9/50); end-stage renal disease and simple renal cysts accounted for the rest.

Table 1. Age distribution of cases (n=50)

Age group (years)	Number	Percentage
≤40	2	4%
41–50	14	28%
51–60	19	38%
61–70	12	24%
71–80	3	6%

Histopathological diagnoses showed a broad spectrum (Table 1). Inflammatory nephropathies were noted in 34% (17/50) of cases: chronic pyelonephritis (12/50, 24%) and chronic glomerulonephritis (5/50, 10%). Non-inflammatory, non-neoplastic lesions comprised 30% (15/50), led by hypertensive nephrosclerosis (5/50, 10%), diabetic nephropathy (3/50, 6%), localized amyloidosis (1/50, 2%), simple renal cysts (2/50, 4%), and acute tubular necrosis (4/50, 8%). Benign neoplasms accounted for 16% (8/50): renal oncocytoma (5/50, 10%) and angiomyolipoma (3/50, 6%). Malignant tumors comprised 20% (10/50): clear-cell renal cell carcinoma (4/50, 8%), papillary RCC (1/50, 2%), chromophobe RCC (2/50, 4%), well-differentiated squamous cell carcinoma of the kidney (2/50, 4%), and invasive urothelial carcinoma (1/50, 2%).

In total, inflammatory lesions (34%) slightly outnumbered neoplastic lesions (36% combined benign and malignant), with degenerative changes representing a substantial 30%. Chronic pyelonephritis dominated the inflammatory group. Among tumors, clear-cell RCC was the most common subtype. Table 1 summarizes the categorical breakdown. These proportions align with prior reports (e.g. chronic pyelonephritis was the commonest non-neoplastic lesion in 60% of such cases in Narang et al.5, and clear-cell RCC constituted 36.8% of renal neoplasms in their series[4]).

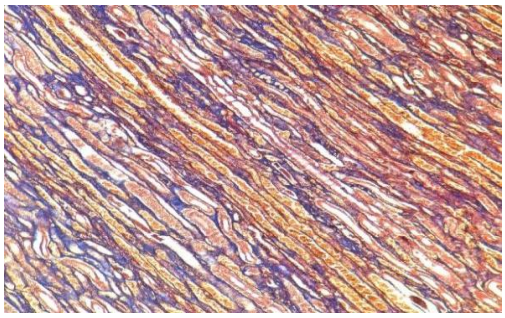
Table 2. Histopathological spectrum of renal lesions

Category	Diagnosis	Number (%)
Inflammatory	Chronic pyelonephritis	12 (24%)
Inflammatory	Chronic glomerulonephritis	5 (10%)
Non-neoplastic	Hypertensive nephrosclerosis	5 (10%)
Non-neoplastic	Diabetic nephropathy	3 (6%)
Benign tumor	Oncocytoma	5 (10%)
Benign tumor	Angiomyolipoma	3 (6%)
Malignant	Clear-cell RCC	4 (8%)
Malignant	Papillary RCC	1 (2%)
Malignant	Chromophobe RCC	2 (4%)
Malignant	Others	3 (6%)

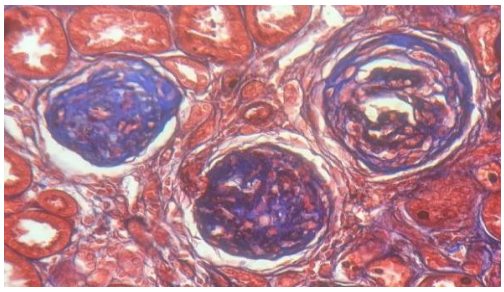
Special stains: Adjunctive staining was indicated in 32 cases. PAS was used most frequently (66%, 21/32 cases), highlighting glomerular basement membranes and pathological mesangial matrix expansion. Reticulin and Masson's trichrome were each employed in 16% (5/32) to evaluate fibrous frameworks and interstitial collagen. Congo red was applied in a single case (2%) with suspected amyloidosis[1]. The staining outcomes aided diagnosis in several cases (e.g., PAS accentuated glomerulonephritic lesions; trichrome delineated fibrosis).

Table 3. Use of special stains (n=32)

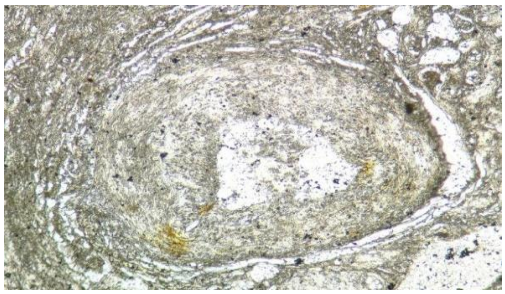
Stain	Cases	Purpose
PAS	21 (66%)	Basement membrane, mesangial matrix
Reticulin	5 (16%)	Architectural framework
Masson trichrome	5 (16%)	Fibrosis/collagen
Congo red	1 (2%)	Amyloid



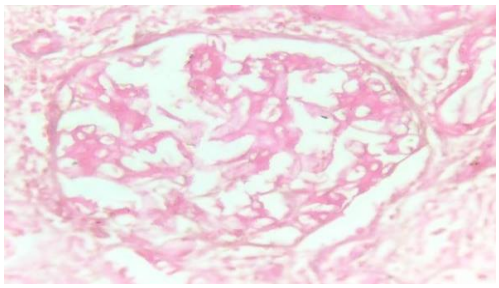
Masson trichrome Stain showing interstitial fibrosis (10x)



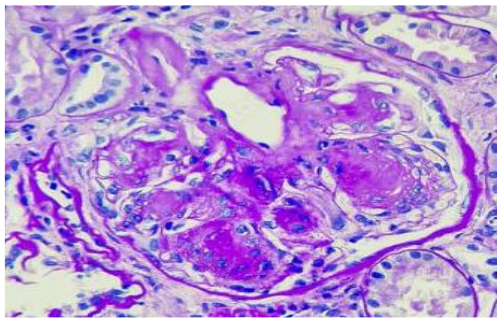
Masson trichrome stain showing college deposition in blue in Glomerulosclerosis (40x)



Reticulin stain showing kidney vessel with intima and media thickening (10x)



Congo red stain showing Amyloid deposition (40x)



PAS stain showing kimmelstiel wilson nodules consistent with diabetic nephropathy

Immunohistochemistry: All 18 neoplastic lesions (benign and malignant) were studied by IHC. Distinct immunoprofiles confirmed tumor subtypes. All oncocytomas (n=5) were strongly positive for CD117 and CK7 (100% each)[7]. Angiomyolipomas (n=3) showed robust HMB-45, Melan-A, and SMA positivity. Among carcinomas, all clear-cell RCCs (n=4) were diffusely positive for CD10, PAX8, and vimentin (100% each)[7]. The single papillary RCC expressed CK7, PAX8, AMACR, and CD117. Both chromophobe RCCs were positive for CK7, CD117, and PAX8 but lacked vimentin/AMACR expression. The two squamous cell

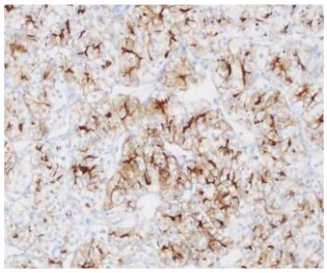
carcinomas showed positivity for CK7, CK5/6, p63, and pan-cytokeratin. The urothelial carcinoma was CK7+, GATA3+, and uroplakin+ (consistent with urothelial origin). These immunoprofiles are consistent with established diagnostic panels for renal tumors (e.g. oncocytoma: CD117+/CK7+, clear-cell RCC: CD10+/vimentin+, papillary RCC: CK7+/AMACR+).

Table 4. Immunohistochemistry profile of major tumors

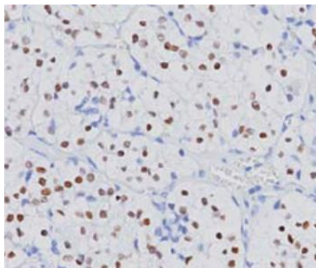
Tumor	Key markers
Oncocytoma	CD117+, CK7+
Angiomyolipoma	HMB45+, Melan-A+, SMA+
Clear-cell RCC	CD10+, PAX8+, Vimentin+
Papillary RCC	CK7+, AMACR+, PAX8+
Chromophobe RCC	CK7+, CD117+, PAX8+
Urothelial carcinoma	CK7+, GATA3+, Uroplakin+

Clear renal cell carcinoma

IHC Vimentin Positive

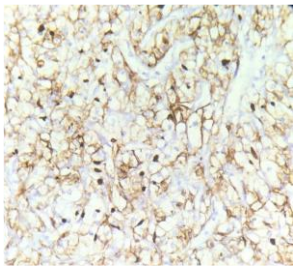


IHC Pax 8 Positive



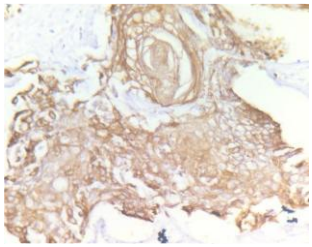
Chromophobe renal cell carcinoma

IHC CK 7 Positive



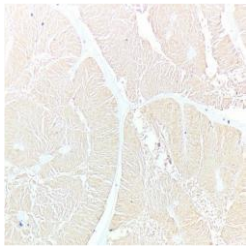
Squamous cell carcinoma

IHC PAN CK Positive



Invasive Urothelial carcinoma

IHC CK 7 Positive



IHC GATA 3 Positive

Figure 1. Distribution of renal lesion categories

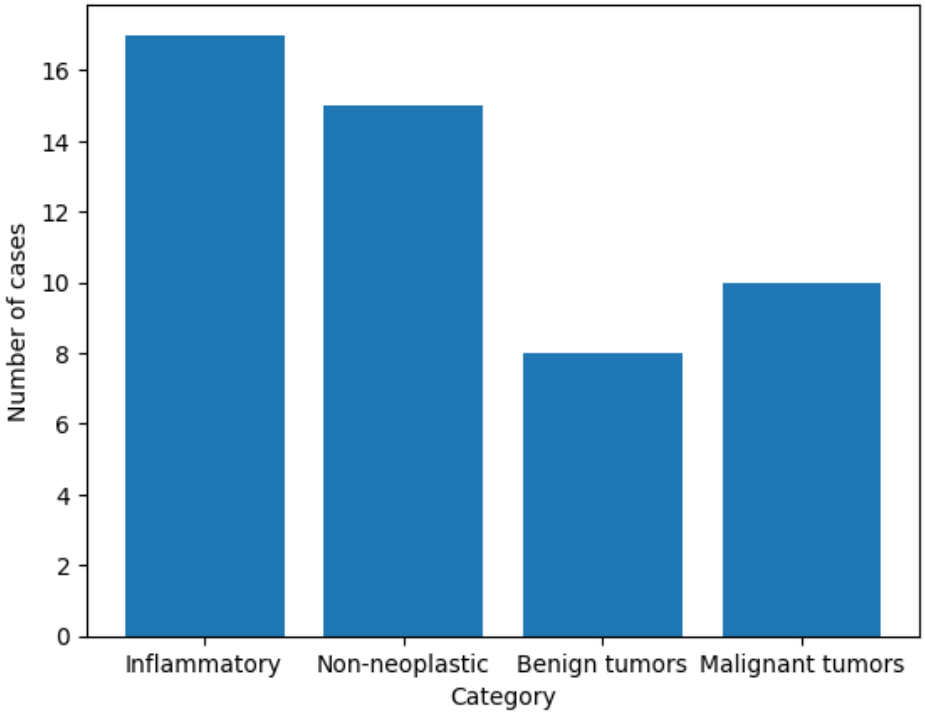
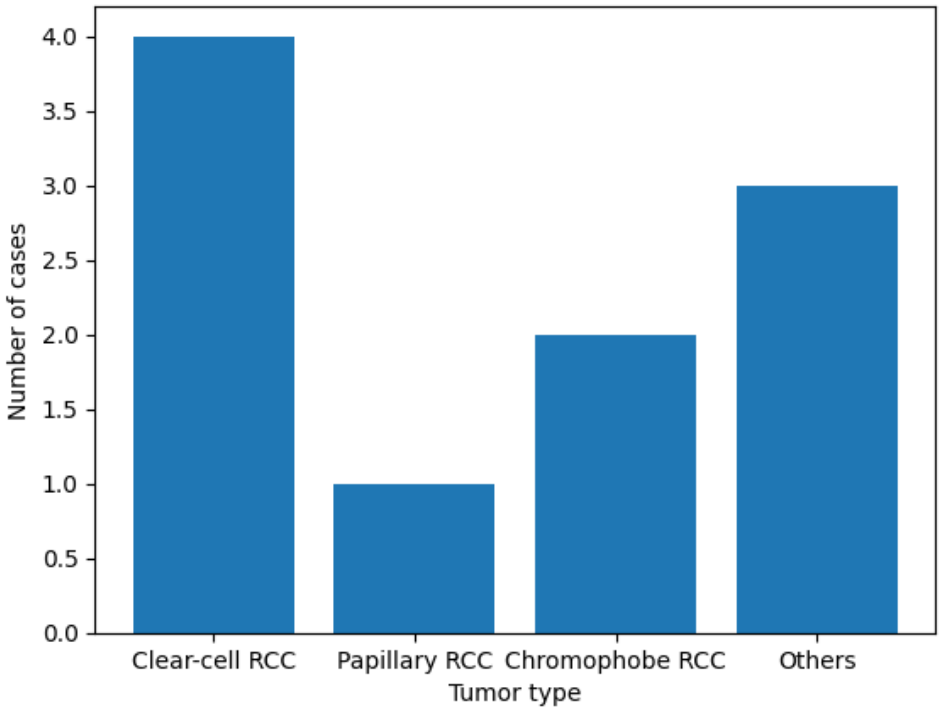


Figure 2. Distribution of malignant renal tumors



Conditions of the Kidney - Gross and Cut Surface Findings

Nature	Histopathologic type	Gross Findings	Cut Surface Findings
Inflammatory	Chronic pyelonephritis	Irregularly scarred kidneys. pale cortex	Depressed cortical scars, dilated calyces
	Chronic glomerulonephritis	Small, symmetrically shrunken kidney; finely granular surface	Diffuse granular cortex; loss of corticomedullary distinction
Non neoplastic non inflammatory	Hypertensive nephropathy	Small kidneys; finely granular surface; cortical thinning	Narrow cortex; sclerosed glomeruli; vascular thickening
	Diabetic nephropathy	Enlarged kidney	Pale, thickened cortex; granular texture
	Amyloid kidney	Enlarged, pale, firm, waxy surface	Homogeneous pale cortex, glistening waxy appearance
	Benign simple cyst	Simple, thin walled cyst; surface bulging	Clear fluid filled cavity
	Acute tubular necrosis	Normal to mildly enlarged	Cortex appears pale and swollen; medulla congested

Neoplastic			
Benign	Oncocytoma	Well circumscribed, Mahogany brown tumor, often with central scar	Homogeneous brown; central stellate scar; no necrosis or haemorrhage
	Angiomyolipoma	Well-defined mass; yellow to grey; may bulge from capsule	Mixture of fat (yellow), smooth muscle (tan-pink), and vessels; soft consistency
Malignant	Clear cell Renal cell carcinoma	Solitary, well circumscribed mass, often at the renal poles	Golden-yellow, soft, haemorrhagic and necrotic areas; cystic change may be seen
	Papillary Renal cell carcinoma	Well circumscribed, Encapsulated tumor; often bilateral or multifocal	Tan to brown; friable; may show haemorrhage, necrosis, and papillary architecture
	Chromophobe Renal cell carcinoma	Solid, homogeneous, well-defined mass	Pale beige or light brown; firm and fleshy; usually no haemorrhage or necrosis
	Well diff. squamous cell carcinoma	Irregular, infiltrative mass involving renal pelvis	Grey- white, firm, gritty cut surface
	Invasive urothelial carcinoma	Mass within renal pelvis or calyces; infiltrative	White-gray, firm, papillary or nodular; often Obstructs pelvicalyceal system

Discussion

This analysis of 50 adult and elderly renal specimens highlights the varied pathology encountered in a tertiary-care setting. The demographic and clinical patterns mirror those in the literature: a slight male predominance and peak incidence in the fifth and sixth decades are typical of adult renal disease series[3]. The preponderance of surgical cases (80%) reflects tertiary referral bias for operable lesions, whereas 20% autopsy cases provided insight into conditions that may have evaded clinical detection. Notably, chronic pyelonephritis was the leading non-neoplastic lesion (24% of all cases), consistent with similar studies in India reporting chronic pyelonephritis as the most common cause of non-functioning kidney[3]. This likely reflects a combination of long-standing obstructive or diabetic conditions in this population.

The tumor spectrum also aligns with prior work. Clear-cell RCC was the single most frequent malignancy, as seen by others[4]. The proportion of neoplastic cases (36%) was somewhat lower than in larger nephrectomy series (often >50%), likely due to inclusion of autopsy kidneys and a broad definition of renal pathology beyond neoplasms. The benign tumors (oncocytoma and angiomyolipoma) comprised 16%, slightly higher than some series, possibly due to referral patterns or incidental findings.

Special histochemical stains proved valuable. PAS was the most common stain used, underscoring its role in highlighting basement membranes and periodic-acid Schiff–positive deposits (e.g. mesangial sclerosis). Masson's trichrome and reticulin aided assessment of interstitial fibrosis and architectural integrity in a subset of cases. Congo red was appropriately reserved for a suspected amyloid case. These findings demonstrate that routine H&E is often sufficient, but special stains can unmask subtle changes (e.g., early fibrosis, Bowman's capsule thickening) that inform diagnosis[1].

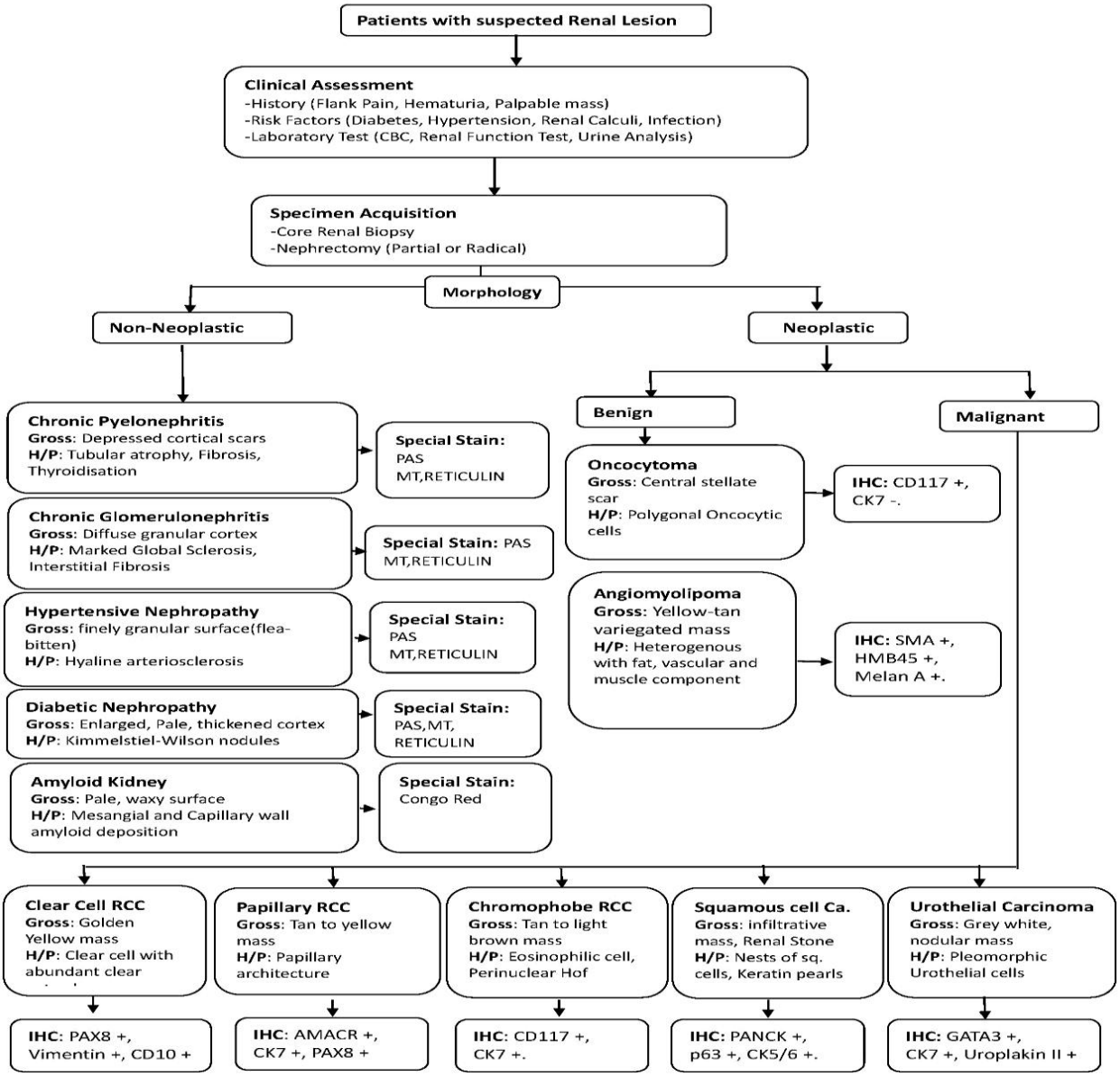
Immunohistochemistry substantially aided neoplasm classification. The distinct marker profiles we observed are in accordance with published immunoprofiles for renal tumors[7]. For example, the classic combination of CD117 and CK7 positivity in oncocytomas contrasts with the CD10/vimentin profile of clear-cell RCC. Papillary RCC's AMACR and CK7 positivity further confirm its lineage. CK7 and p63 expression in squamous cell carcinoma confirmed its differentiation. Such panels improve diagnostic confidence, especially in unusual or poorly differentiated tumors. The use of IHC is now standard in renal tumor workup to ensure correct subtyping (as recommended by uropathology guidelines), which has prognostic and therapeutic implications[7].

The inclusion of autopsy specimens also proved instructive. In 20% of cases, incidental or unrecognized renal pathology was documented. This echoes prior reports that a significant proportion of adult autopsies reveal renal diseases (e.g., diabetic nephropathy, glomerulonephritides, amyloidosis) that were clinically under-appreciated[8]. Such findings support advocating routine renal review at autopsy and may have public health implications.

A limitation of this study is the modest sample size (50 cases) from a single center, which may limit generalizability. Nonetheless, the demographic and histological trends correspond well with larger series[3][4]. Future studies with more cases and the addition of electron microscopy or molecular markers could yield further insights.

Conclusion

In summary, adult and elderly renal pathology encompasses a heterogeneous mix of inflammatory, degenerative, and neoplastic lesions. Chronic pyelonephritis and hypertensive nephrosclerosis were frequent non-neoplastic findings, while clear-cell RCC was the predominant malignancy. Standard H&E histology, supplemented by targeted special stains and immunohistochemical panels, provided definitive diagnoses and accurate tumor subtyping. These methods together enhance diagnostic accuracy and aid clinical management. Our findings, in line with other tertiary center reports[3][4], underline the importance of comprehensive morphologic and immunophenotypic evaluation in renal pathology.



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