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Research Article

Histopathological Spectrum of Lesions in Nephrectomy Specimens: A Two-Year Descriptive Study from a Tertiary Care Hospital

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Abstract

Background: Nephrectomy specimens show a wide range of lesions, and the pattern differs between regions. This study describes the histopathological lesions in nephrectomy specimens received at a tertiary care hospital and classifies the tumours using the 2022 World Health Organization (WHO) scheme.

Methods: This descriptive observational study was done in the department of pathology over a period of 2 years extending from June 2024 to May 2026. All nephrectomy specimens received during this period were included (n = 62). Specimens were fixed in 10% buffered formalin, and 3 to 4 micrometre sections were stained with haematoxylin and eosin. Age, sex, symptoms, imaging findings, type of nephrectomy, and laterality were recorded. Results are given as numbers and percentages.

Results: There were 41 men (66.1%) and 21 women (33.9%). The mean age was 50.66 years (standard deviation 18.46; range 4 to 86). Non-neoplastic lesions made up 53 specimens (85.5%) and neoplastic lesions 9 (14.5%). Chronic pyelonephritis was the commonest diagnosis (28; 45.2%), followed by acute on chronic pyelonephritis (11; 17.7%), xanthogranulomatous pyelonephritis (5; 8.1%), acute suppurative pyelonephritis (4; 6.5%), emphysematous pyelonephritis (3; 4.8%), and multicystic renal dysplasia (2; 3.2%). Among tumours, clear cell renal cell carcinoma was commonest (5), followed by invasive urothelial carcinoma (2), papillary renal cell carcinoma (1), and squamous cell carcinoma (1). Fever was the commonest symptom (43; 69.4%), then flank pain (32; 51.6%). Simple nephrectomy accounted for 57 specimens (91.9%), and 38 specimens (61.3%) were from the left side. All five clear cell carcinomas were stage pT3; three were ISUP grade 2 and two were grade 4.

Conclusion: Most nephrectomies were done for non-neoplastic disease, mainly chronic infection. Clinical and imaging diagnoses often differed from the final histology, so every nephrectomy specimen needs full histopathological examination.

Keywords: nephrectomy; histopathology; pyelonephritis; renal cell carcinoma; kidney

Introduction

The kidneys remove metabolic waste, balance fluid and electrolytes, help control blood pressure and acid-base status, and make erythropoietin. Throughout life they are exposed to infection, obstruction, stones, toxins, and vascular and metabolic injury. Kidney disease is a major public health problem. In 2017, an estimated 697.5 million people worldwide had chronic kidney disease of any stage, a prevalence of 9.1%, and 1.2 million people died from it.[1] Most of this burden is managed with

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medical treatment. A smaller group of patients reaches a point where the kidney is damaged beyond repair, or contains a tumour, and surgical removal becomes necessary.

Nephrectomy is a common operation in surgical practice. A simple nephrectomy removes the kidney alone. It is done for a kidney that no longer works after long-standing infection, obstruction, stone disease, or severe trauma. It is also done for severe one-sided parenchymal damage from reflux, nephrosclerosis, or congenital dysplasia, and for renovascular hypertension that cannot be corrected. A radical nephrectomy removes the kidney together with the surrounding fat and fascia. It is the standard operation for most renal cell carcinomas. A partial nephrectomy removes only the part of the kidney that holds the tumour.

Infection is an important cause of nephrectomy for benign disease. Xanthogranulomatous pyelonephritis is a destructive chronic infection that is often linked to obstructing stones. It forms a mass that can look like a tumour on imaging and at surgery. Escherichia coli and Proteus mirabilis were the organisms cultured most often.[2] Emphysematous pyelonephritis is a gas-forming, necrotising infection of the kidney. It is seen mostly in people with diabetes. Management has moved from early nephrectomy toward drainage and medical treatment. In a meta-analysis of 1146 patients, 82.5% were diabetic, and emergency nephrectomy was associated with higher mortality. Of the patients who had upfront emergency nephrectomy, 26% died.[3] Chronic pyelonephritis and multicystic renal dysplasia are other benign conditions that end in nephrectomy when the kidney has stopped functioning.

Chronic pyelonephritis follows repeated or poorly treated infection, often with reflux or obstruction. It scars the kidney, and the end result is a small organ that no longer works. Pyonephrosis is pus in an obstructed collecting system. It can lead quickly to sepsis and loss of kidney function. Multicystic renal dysplasia is a developmental condition in which the kidney is replaced by cysts of varying size. Drainage and medical treatment come first in most of these conditions. The kidney is removed when they fail, or when the kidney is beyond recovery.

Tumours are the second large group. Renal cell carcinoma is the commonest malignant tumour of the kidney. Its incidence has continued to rise, while mortality has levelled off. Rates vary with geography, sex, and age. Hypertension, obesity, and smoking are the best-established risk factors.[4] Tumours of the renal pelvis, such as urothelial carcinoma, and rarer tumours of childhood are also treated by nephrectomy.

The WHO classification of renal tumours was revised in 2022. The fifth edition lists tumours by site, category, family, and type. It adds molecularly defined entities, such as TFEB-altered, ALK-rearranged, and ELOC-mutated renal cell carcinoma, and a new morphologically defined entity, eosinophilic solid and cystic renal cell carcinoma. Some of these tumours need molecular tests for a firm diagnosis.[5] Pathologists therefore need to apply the current criteria when they classify a renal tumour.

We therefore reviewed all nephrectomy specimens received over two years in the department of pathology of a tertiary care teaching hospital. We describe the age and sex of the patients, their symptoms, the imaging findings, the type of nephrectomy, and the side operated on. We give the histopathological diagnosis for each specimen and classify the tumours according to the 2022 WHO scheme. We also describe the stage and nuclear grade of the clear cell renal cell carcinomas. The aim of this study was to document the histopathological spectrum of lesions in nephrectomy specimens received at our institutions and to compare it with other studies.

Materials and Methods

This descriptive, cross-sectional observational study was conducted in the Department of Pathology, Bharati Vidyapeeth (Deemed to be University) Medical College and Hospital, Sangli, a tertiary care teaching hospital in Maharashtra, India over a period of 2 years extending from June 2024 to May 2026. The sample size was calculated by power analysis for a single proportion using SPSS version 29. The expected proportion was 4%, based on departmental records of 445 nephrology cases. The calculation

used a null value of 15%, 80% power and a 5% level of significance. This gave a minimum sample size of 60, and 62 consecutive nephrectomy specimens were included. Clinical details were recorded for each case on a structured proforma. These were age, sex, presenting complaints, radiological findings, clinical diagnosis, gross findings, histopathological diagnosis and any special studies.

Nephrectomy specimens were fixed in 10% neutral buffered formalin. Each specimen was examined grossly, and representative sections were taken according to standard protocol. The tissue was processed routinely and embedded in paraffin. Sections 3–4 µm thick were cut and stained with hematoxylin and eosin (H&E). Special stains and immunohistochemistry were applied where needed for diagnosis. Slides were reviewed microscopically and lesions were classified as non-neoplastic or neoplastic. Neoplastic lesions were classified according to the WHO Classification of Urinary and Male Genital Tumours, 5th edition (2022). Renal cell carcinomas were graded using the WHO/ISUP nuclear grading system and staged using the pathological TNM (pTNM) system. Data was entered in Microsoft Excel and analysed using SPSS version 29. Categorical variables (sex, age group, lesion type, laterality) are given as frequencies and percentages. Continuous variables (age) are given as mean ± standard deviation and range. The findings were compared with those of previously published studies.

Inclusion criteria

- All nephrectomy specimens (simple, partial, radical, and nephroureterectomy) received in the Department of Pathology during the study period
- Specimens from patients of all ages and both sexes
- Specimens with adequate clinical details and properly labelled requisition forms
- Patients who gave written informed consent (or consent from a guardian for minors)

Exclusion criteria

- Specimens that were autolysed, poorly fixed or inadequate for histopathological assessment
- Specimens with incomplete or missing clinical or demographic records
- Renal biopsies (needle or wedge), which were not considered nephrectomy specimens
- Repeat or recurrent specimens from the same patient, so that each patient was counted once

Results

A total of 7050 specimens were received in the department during the study, and 62 of them (0.9%) were nephrectomy specimens.

Of the 62 patients, 41 (66.1%) were men and 21 (33.9%) were women, a ratio of 1.95:1. The mean age was 50.66 years (standard deviation 18.46; range 4 to 86). The largest group was older than 60 years (20 patients; 32.3%), followed by the 41 to 50 year group (13; 21.0%). Neoplastic lesions were seen only from the fifth decade onwards (Table 1).

Variable	Non-neoplastic n (%)	Neoplastic n (%)	Total n (%)
Gender			
Male	34 (54.8)	7 (11.3)	41 (66.1)
Female	19 (30.6)	2 (3.2)	21 (33.9)
Age group (years)			
0 to 10	3 (4.8)	-	3 (4.8)
11 to 20	2 (3.2)	-	2 (3.2)
21 to 30	2 (3.2)	-	2 (3.2)
31 to 40	10 (16.1)	-	10 (16.1)
41 to 50	11 (17.7)	2 (3.2)	13 (21.0)
51 to 60	10 (16.1)	2 (3.2)	12 (19.4)
Above 60	15 (24.2)	5 (8.1)	20 (32.3)
Total	**53 (85.5)**	**9 (14.5)**	**62 (100)**

Table 1: Age and gender distribution of the study population by type of lesion (n = 62). Mean age ± SD: 50.66 ± 18.46 years; range 4 to 86 years. Percentages are of the total 62.

Fever was the commonest symptom (43 patients; 69.4%), followed by flank pain (32; 51.6%), haematuria (25; 40.3%), and burning micturition (12; 19.4%). Fever was the commonest symptom in non-neoplastic lesions (38; 61.3%). Haematuria was the commonest symptom in neoplastic lesions (8; 12.9%). Bone pain, abdominal lump, and vomiting were recorded only in patients with neoplastic lesions (Table 2).

Symptom	Non-neoplastic n (%)	Neoplastic n (%)	Total n (%)
Fever	38 (61.3)	5 (8.1)	43 (69.4)
Flank pain	25 (40.3)	7 (11.3)	32 (51.6)
Haematuria	17 (27.4)	8 (12.9)	25 (40.3)
Burning micturition	10 (16.1)	2 (3.2)	12 (19.4)
Bone pain	-	6 (9.7)	6 (9.7)
Abdominal lump	-	2 (3.2)	2 (3.2)
Vomiting	-	2 (3.2)	2 (3.2)

Table 2: Presenting symptoms by type of lesion (n = 62). A patient could have more than one symptom. Percentages are of the total 62.

Non-functioning kidney was the commonest clinical diagnosis (12 patients; 19.4%). Emphysematous pyelonephritis and chronic pyelonephritis were each the clinical diagnosis in 11 patients (17.7%). Renal cell carcinoma, including clear cell carcinoma, was the clinical diagnosis in 6 patients (9.7%) (Table 3).

Clinical diagnosis	Non-neoplastic n (%)	Neoplastic n (%)	Total n (%)
Non-functioning kidney	11 (17.7)	1 (1.6)	12 (19.4)
Emphysematous pyelonephritis	11 (17.7)	-	11 (17.7)
Chronic pyelonephritis	11 (17.7)	-	11 (17.7)
Pyonephrosis	8 (12.9)	-	8 (12.9)
Xanthogranulomatous pyelonephritis	4 (6.5)	1 (1.6)	5 (8.1)
Renal abscess	3 (4.8)	-	3 (4.8)
Multicystic dysplastic kidney	2 (3.2)	-	2 (3.2)
Acute suppurative pyelonephritis	1 (1.6)	-	1 (1.6)
Renal haematoma	1 (1.6)	-	1 (1.6)
Phaeochromocytoma	1 (1.6)	-	1 (1.6)
Upper pole mass	-	1 (1.6)	1 (1.6)
Renal cell carcinoma	-	4 (6.5)	4 (6.5)
Clear cell renal cell carcinoma	-	2 (3.2)	2 (3.2)
Total	**53 (85.5)**	**9 (14.5)**	**62 (100)**

Table 3: Clinical diagnosis recorded before surgery, grouped by the final histological category (n = 62). Percentages are of the total 62.

Imaging reports were available for 53 of the 62 patients and were not available for 9. Computed tomography showed pyelonephritis in 27 of 53 patients (50.9%). A renal mass was reported in 8 patients (15.1%) on CT (6) or ultrasonography (2). Emphysematous pyelonephritis was reported on CT in 4 patients (7.5%) (Table 4).

Imaging finding	n	%
CT: pyelonephritis	27	50.9
CT: renal mass	6	11.3
CT: emphysematous pyelonephritis	4	7.5
Ultrasonography: hydronephrosis	3	5.7
CT: abscess	3	5.7
CT: calculi with pus	2	3.8
Ultrasonography: pyelonephritis	2	3.8
Ultrasonography: renal mass	2	3.8
CT: multicystic dysplastic kidney	2	3.8
CT: xanthogranulomatous pyelonephritis	2	3.8
Total	**53**	**100**

Table 4: Imaging findings in patients with an imaging report (n = 53). CT, computed tomography. Percentages are of 53.

Simple nephrectomy was the commonest procedure (57 specimens; 91.9%). Radical nephrectomy was done in 3 patients (4.8%), and partial and total nephrectomy in 1 patient each (1.6%). The left kidney was removed in 38 patients (61.3%) and the right in 24 (38.7%) (Table 5).

Variable	n	%
Type of nephrectomy		
Simple	57	91.9
Radical	3	4.8
Partial	1	1.6
Total	1	1.6
Side		
Left	38	61.3
Right	24	38.7
Total specimens	**62**	**100**

Table 5: Type of nephrectomy and side of the specimen (n = 62).

Non-neoplastic lesions made up 53 specimens (85.5%) and neoplastic lesions 9 (14.5%). Chronic pyelonephritis was the commonest non-neoplastic diagnosis (28; 45.2%), followed by acute on chronic pyelonephritis (11; 17.7%). Clear cell renal cell carcinoma was the commonest tumour (5; 8.1%). Renal cell carcinoma as a whole accounted for 6 specimens (9.7%). Men outnumbered women in both the non-neoplastic and neoplastic groups. Women outnumbered men only in emphysematous pyelonephritis (2 women and 1 man) (Table 6).

Histological diagnosis	Male n	Female n	Total n (%)
Non-neoplastic lesions	**34**	**19**	**53 (85.5)**
Chronic pyelonephritis	18	10	28 (45.2)
Acute on chronic pyelonephritis	6	5	11 (17.7)
Acute suppurative pyelonephritis	2	2	4 (6.5)
Xanthogranulomatous pyelonephritis	5	-	5 (8.1)
Emphysematous pyelonephritis	1	2	3 (4.8)
Multicystic renal dysplasia	2	-	2 (3.2)
Neoplastic lesions	**7**	**2**	**9 (14.5)**
Clear cell renal cell carcinoma	3	2	5 (8.1)
Papillary renal cell carcinoma	1	-	1 (1.6)
Invasive urothelial carcinoma	2	-	2 (3.2)
Squamous cell carcinoma	1	-	1 (1.6)
Total	**41**	**21**	**62 (100)**

Table 6: Histological diagnosis and gender distribution (n = 62). Percentages are of the total 62.

Chronic pyelonephritis was seen in every age group, with 6 patients in each of the 31 to 40, 41 to 50, and 51 to 60 year groups and 5 patients above 60 years. Clear cell renal cell carcinoma occurred from the fifth decade onwards and was commonest above 60 years (3 patients). Multicystic renal dysplasia was seen in the 0 to 10 and 31 to 40 year groups (Table 7).

Histological diagnosis	0-10	11-20	21-30	31-40	41-50	51-60	>60	Total
Age group (years), n	**3**	**2**	**2**	**10**	**13**	**12**	**20**	**62**
Non-neoplastic lesions								
Chronic pyelonephritis	2	2	1	6	6	6	5	28
Acute on chronic pyelonephritis	-	-	1	2	3	1	4	11
Acute suppurative pyelonephritis	-	-	-	1	1	1	1	4
Xanthogranulomatous pyelonephritis	-	-	-	-	1	1	3	5
Emphysematous pyelonephritis	-	-	-	-	-	1	2	3
Multicystic renal dysplasia	1	-	-	1	-	-	-	2
Neoplastic lesions								
Clear cell renal cell carcinoma	-	-	-	-	1	1	3	5
Papillary renal cell carcinoma	-	-	-	-	-	-	1	1
Invasive urothelial carcinoma	-	-	-	-	1	-	1	2
Squamous cell carcinoma	-	-	-	-	-	1	-	1

Table 7: Histological diagnosis by age group, number of specimens (n = 62).

All five clear cell renal cell carcinomas were stage pT3. All five showed capsular invasion and perinephric fat invasion. Renal vein invasion was seen in 3 (60%) and renal sinus invasion in 1 (20%). None invaded Gerota fascia. Three tumours (60%) were ISUP grade 2 and two (40%) were grade 4 (Table 8).

Feature	n	%
Capsular invasion	5	100
Perinephric fat invasion	5	100
Renal vein invasion	3	60
Renal sinus invasion	1	20
Invasion of Gerota fascia	0	0
Pathological stage pT3	5	100
ISUP nuclear grade 1	0	0
ISUP nuclear grade 2	3	60
ISUP nuclear grade 3	0	0
ISUP nuclear grade 4	2	40

Table 8: Histopathological features of clear cell renal cell carcinoma (n = 5). ISUP, International Society of Urological Pathology.

The gross and microscopic appearances of the main non-neoplastic lesions are shown in Figure 1, and those of the tumours in Figure 2.

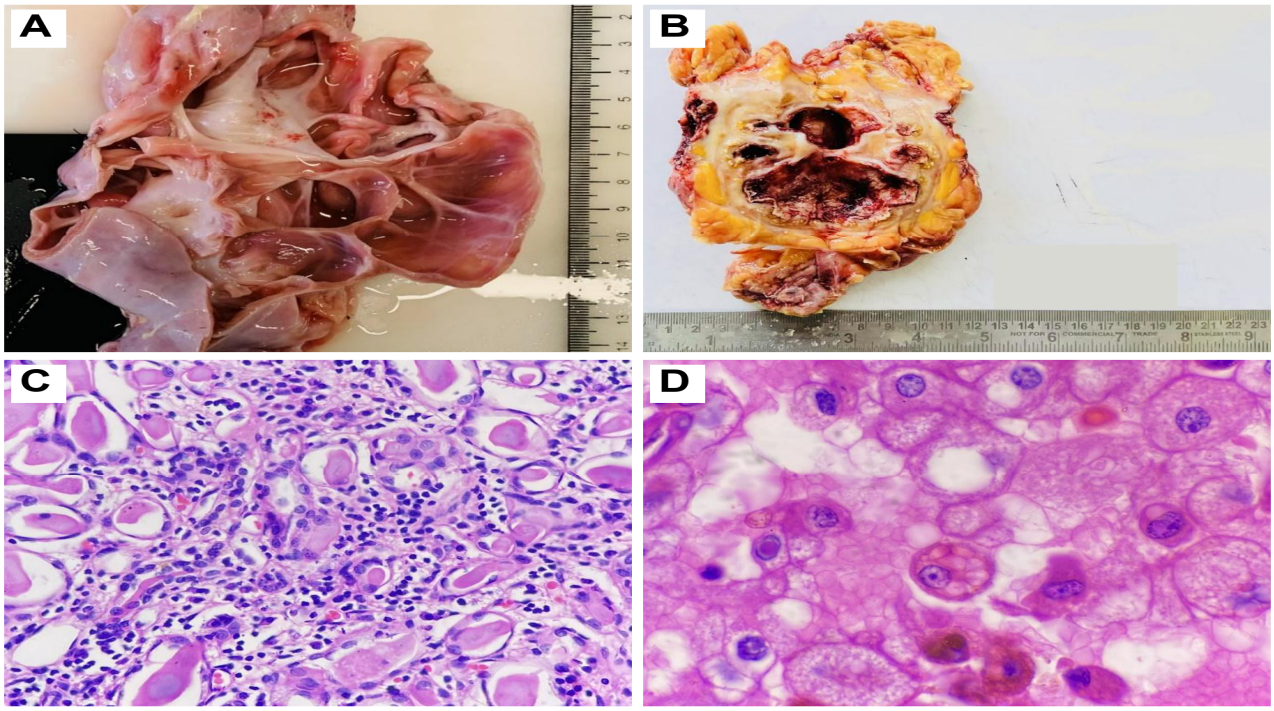


Figure 1: Non-neoplastic lesions. (A) Chronic pyelonephritis, cut section of the nephrectomy specimen with a thin cortical rim and a dilated pelvicalyceal system. (B) Xanthogranulomatous pyelonephritis, cut surface with a dilated pelvicalyceal system filled with yellowish dark brown material and thinning of the cortex. (C) Chronic pyelonephritis, atrophic and dilated tubules with thyroidisation (H&E, 40X). (D) Xanthogranulomatous pyelonephritis, sheets of foamy macrophages (H&E, 40X).

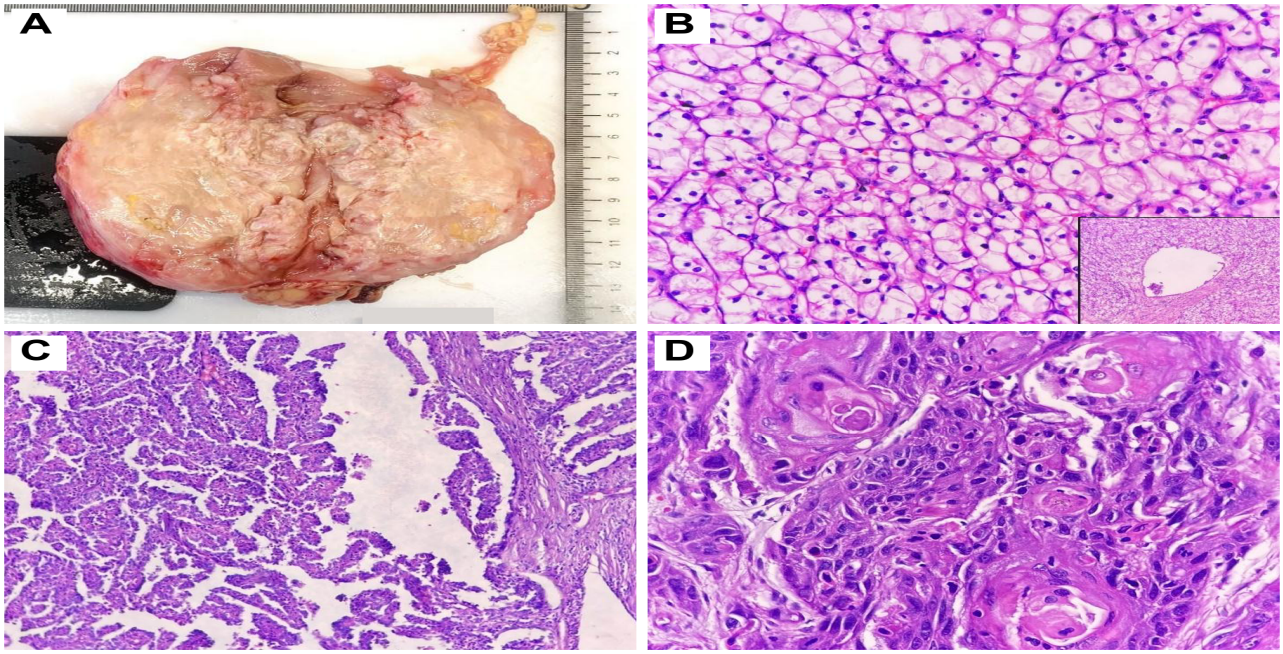


Figure 2: Neoplastic lesions. (A) Clear cell renal cell carcinoma, a yellowish grey-white tumour replacing most of the kidney. (B) Clear cell renal cell carcinoma, sheets of cells with optically clear cytoplasm; the inset shows tumour in a renal vein (H&E, 40X). (C) Papillary renal cell carcinoma, papillary architecture (H&E, 10X). (D) Squamous cell carcinoma with keratin pearls and individual cell keratinisation (H&E, 40X).

Discussion

This study reviewed 62 nephrectomy specimens received over two years. Non-neoplastic lesions made up 85.5% of the specimens, and chronic pyelonephritis was the commonest diagnosis. Renal cell carcinoma accounted for six of the nine tumours.

The mean age of our patients was 50.66 years, and 32.3% were older than 60 years. Ghalayini reported 423 nephrectomies from northern Jordan. Infection-related conditions led to 161 of the 298 operations for benign disease. Patients with benign disease had a mean age of 38.4 years and those with malignant tumours 46.7 years.[6] Our patients were older, but the predominance of infective disease is similar. Kumar et al. studied 60 patients with pyonephrosis. Their mean age was 54.62 years and 68.3% were men.[7] In our series 66.1% were men. Flank pain, with or without fever, was the commonest symptom in their patients (76.7%). In ours, fever was commonest (69.4%), and flank pain followed (51.6%). Mancini et al. note that men are diagnosed with kidney cancer more often than women.[8] Seven of our nine tumours, and three of the five clear cell carcinomas, were in men. These numbers are too small to draw a conclusion.

Our series differs from reports that start with tumour nephrectomies. Kläger et al. examined the non-tumour kidney in 206 tumour nephrectomies. Kidney disease was present in 39 (18.9%).[9] Sarsik et al. re-examined 403 nephrectomies done for primary renal tumours. They found non-tumoral changes in 23 specimens, with diabetic nephropathy in eight. The changes were seen in about 5% of clear cell carcinomas, chromophobe carcinomas, and oncocytomas, and at about twice that rate in papillary carcinomas.[10] Bijol et al. studied 110 tumour nephrectomies. More than 60% showed obvious abnormalities in the non-neoplastic parenchyma. Patients with severe changes had a rise in serum creatinine six months after radical nephrectomy ($P = 0.001$).[11] Henriksen et al. describe arterionephrosclerosis and diabetic nephropathy as the commonest non-neoplastic diseases in tumour nephrectomy specimens.[12] These cohorts began with tumours. Ours began with all nephrectomies, so non-neoplastic disease formed most of our material. We did not report changes in the non-tumour parenchyma of our nine tumour specimens. This should be added in future work, since such changes affect the outlook of the patient after surgery.

Chronic pyelonephritis was the commonest lesion in our series (45.2%), and a further 17.7% were acute on chronic pyelonephritis. Ademola et al. studied 43 patients with chronic pyelonephritis. Nephrectomy was done in 17 (39.5%), and the indication was a pus-filled, non-functioning kidney. Urinary tract obstruction (49%) and poorly treated urinary infection (35%) were the main risk factors.[13] Chronic pyelonephritis affected 18 men and 10 women in our series. We did not collect risk-factor data, so we cannot make a comparison with that series. Clinical and histological diagnoses did not always agree in our series. Chronic pyelonephritis was the clinical diagnosis in 11 patients, but 28 had it on histology. Emphysematous pyelonephritis was the clinical diagnosis in 11 patients (17.7%). It was confirmed on histology in 3 (4.8%) and reported on CT in 4 of the 53 patients with imaging. Ubee et al. describe the disease as a severe necrotising infection, with CT as the test that confirms gas in the kidney and surrounding tissue. Up to 95% of their reviewed cases had uncontrolled diabetes.[14] We did not record diabetes status.

Six of our nine tumours were renal cell carcinoma, and five of these were clear cell type. All five clear cell carcinomas were stage pT3, with capsular and perinephric fat invasion in every case. Three were ISUP grade 2 and two were grade 4. The WHO and ISUP grading system has been validated for clear cell and papillary carcinoma, and chromophobe carcinoma should not be graded.[15] With five cases, we cannot relate grade to stage or outcome. Follow-up data were not collected. Squamous cell carcinoma, invasive urothelial carcinoma, and papillary carcinoma were seen in one, two, and one patient, so no comparison can be made for them.

This study has limits. It is a single-centre series from one department. The sample was small, and the design was descriptive, so no tests of association were done. Imaging reports were missing for nine patients. Counts for individual lesions and tumours

are small, so the percentages should be read with care. The figures describe the specimens that reached the pathology laboratory. They are not population rates. The left kidney was removed more often than the right (61.3%). The studies cited here did not give laterality, so we offer no comparison. Even so, the series shows that infective kidney disease dominates nephrectomy specimens in this setting. It also shows that clinical and imaging diagnoses often did not match the final histology. These findings support histological examination of every nephrectomy specimen and close contact between surgeon, radiologist, and pathologist. For tumours, the report should state the type, grade, and stage, and describe the non-tumour kidney.

Conclusion

Most nephrectomies in this series were done for non-neoplastic disease, and chronic pyelonephritis was the commonest diagnosis. Chronic infection was the main reason for removing the kidney in this setting. Renal cell carcinoma, mainly clear cell type, was the commonest tumour, and all five clear cell tumours were stage pT3. The clinical and imaging diagnoses often differed from the final histology. Every nephrectomy specimen should therefore receive a full histopathological examination, and the report should give the tumour type, grade, and stage.

Declarations

Ethical Approval

The study protocol was approved by the Institutional Ethics Committee of the institute before commencement of the study.

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Conflict of Interest

The authors declare that they have no conflict of interest.

Informed Consent

Not Applicable

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to applicable institutional and ethical requirements.

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