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Tubulocystic Renal Cell Carcinoma: A Scoping Review of Radiological, Clinicopathological, and Immunohistochemical Features

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Tubulocystic Renal Cell Carcinoma: A Scoping Review of Radiological, Clinicopathological, and Immunohistochemical Features

Running title: TCRCC: Radiologic and Clinicopathologic Review

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Abstract:
Introduction: Tubulocystic renal cell carcinoma (TC-RCC) is a rare and distinct subtype of renal cell carcinoma with characteristic histopathological and immunohistochemical features. Due to its rarity, limited data exist regarding its clinicopathological profile, biological behavior, and prognosis. This review aims to analyze reported TC-RCC cases to improve understanding of tumor characteristics, outcomes, and key diagnostic markers. **Methods:** Scoping review of 30 published TC-RCC cases was conducted. Data collected included tumor laterality, site, size, focality, stage, associated malignancies, local extension, metastatic spread, lymph node involvement, vascular invasion, and immunohistochemical findings relevant to diagnosis and prognosis**. Results:** TC-RCC demonstrated a left-sided predominance (63.3%) and was most often unifocal. The upper renal pole was the most commonly involved site (36.7%). Tumor size ranged from 0.8 to 37 cm. Concurrent malignancies were identified in 26.7% of cases, most frequently papillary renal cell carcinoma. Extra-renal extension and distant metastases occurred in 16.7% of cases, while lymphovascular invasion was uncommon. Immunohistochemistry showed frequent positivity for AMACR (66.7%), CD10 (46.7%), and Vimentin (43.3%). **Conclusion:** TC-RCC exhibits variable clinical behavior and a notable association with concurrent malignancies. Immunohistochemical markers, particularly AMACR and CD10, are diagnostically valuable. Further studies are needed to establish prognostic markers and standardized management strategies.

Key words:
TC-RCC, renal tumor, kidney cancer, RCC

1 Introduction:
Tubulocystic renal cell carcinoma (TC-RCC) is a rare and distinct subtype of renal cell carcinoma (RCC), first described in detail in the early 2000s and officially recognized in the 2016 World Health Organization (WHO) classification of renal tumors[1]. TC-RCC accounts for less than 1% of all renal cell carcinomas [2] and primarily

affects middle-aged and older adults with a strong male predominance (male-to-female ratio of approximately 7:1)[3, 4]. Most cases are detected incidentally during imaging for unrelated conditions, but some patients present with symptoms such as flank pain, hematuria, or an abdominal mass[5]. TC-RCC is generally associated with indolent behavior, isolated cases have exhibited aggressive features, including metastatic potential[6].

Radiologically, TC-RCC typically appears as a well-circumscribed, multilocular cystic mass with thick septa and occasional solid components. While these features are suggestive of malignancy, distinguishing TC-RCC from other cystic renal tumors, such as multilocular cystic RCC and papillary RCC, can be challenging[7]. TC-RCC is characterized by its unique microscopic structure of numerous tubules and cysts lined by a single layer of epithelial cells, often creating a spongy or “bubble-wrap” appearance[8]. Despite its distinct histological features, its pathogenesis, clinical behavior, and optimal management strategies remain poorly understood due to its rarity.

Preoperative diagnosis of TC-RCC remains challenging, particularly when the tumor presents as a purely cystic lesion, making it radiologically indistinguishable from benign renal cysts[9]. Grossly, TC-RCC typically manifests as a well-circumscribed, multicystic renal lesion with a characteristic "bubble-like" or "spongy" appearance[10]. Histologically, the defining features include variably sized tubules and cysts lined by a single layer of cuboidal to hobnail epithelial cells. These epithelial cells often exhibit enlarged nuclei with conspicuous nucleoli consistent with WHO/ISUP nucleolar grade 3[10]. On immunohistochemical analysis, TC-RCC demonstrates diffuse positivity for PAX8, alpha-methylacyl-CoA racemase (AMACR), and CD10, supporting its epithelial and renal origin. Notably, fumarate hydratase (FH) expression is typically preserved in TC-RCC, distinguishing it from FH-deficient RCC and reinforcing its recognition as a distinct pathological entity[10].

The last comprehensive review of TC-RCC was conducted in 2018, summarizing available radiological and pathological findings [11]. Since then, additional case reports and series have been published, contributing new insights into its clinical presentation, imaging characteristics, and management. However, given the rarity of TC-RCC, the current body of evidence remains limited and is predominantly derived from such small-scale studies, which may affect the robustness and generalizability of conclusions. Therefore, this scoping review aims to systematically synthesize the most recent literature, with a focus on case reports and series, to provide a clearer understanding of its epidemiology, diagnosis, treatment options, and prognosis. By mapping the existing evidence, this review seeks to offer a structured foundation for future research and support clinical decision-making in this rare entity.

2 Materials and Methods

2.1 Research strategy

The scoping review was conducted following the JBI (Joanna Briggs Institute) methodology for scoping reviews[12]. Two authors and collaboration with the institute’s librarian to optimize the search terms and ensure comprehensive coverage of the relevant literature. Then, the reference lists of all included sources were screened to identify additional relevant studies. Owing to the rarity of the diagnosis, all types of studies, including case reports, were considered to ensure comprehensive coverage of available data. The search terms used ware " Tubulocystic renal cell carcinoma "," Tubulocystic RCC” and “TC-RCC “ , with no time limits were set. The search was limited to articles published in or translated into English.

2.2 Eligibility and Study Selection

The inclusion criterion was studies reporting on TC-RCC cases. Reviews, non-original studies, and articles lacking sufficient radiological data on TC-RCC and duplicate publications were immediately excluded, and the remaining studies were selectively included and analyzed. Two authors independently reviewed the full texts of the articles and applied the inclusion criteria using EndNote© X9 software. Any disagreements were resolved through discussions with the senior author until consensus was achieved.

2.3 Data extraction

The following parameters were extracted: patient demographics, presentation, radiological findings, pathological and immunohistochemical diagnoses, management, and follow-up.

2.4 Outcomes
The primary objective of this scoping review was to evaluate the radiological characteristics of patients with TC-RCC. Additionally, we sought to analyze the histopathological and immunohistochemical features associated with TC-RCC.

3 Results:
3.0 Study Selection:
As outlined in the PRISMA flow chart **(Figure 1),** the search strategy identified 148 articles from PubMed/MEDLINE. Following a title and abstract screening, 104 articles were excluded. Of the remaining 44 articles, 4 were unobtainable, leaving 40 for full-text review. After thorough evaluation, 15 articles were excluded for reasons specified in the PRISMA flow chart. Ultimately, 25 articles fulfilled the selection criteria and were included in the final analysis.

3.1 Patient Characteristics:
Table 1 summarizes the characteristics and data from studies included in this analysis, encompassing 25 articles published between 2011 and 2024. Collectively, these articles reported on 30 cases with a mean patient age of 49.76 years. Approximately 77% of the cases were male. Tumor cases were identified incidentally in 40% of patients, while the remaining 60% presented with various symptoms, including flank pain, abdominal pain, prostatism, breathlessness, urinary urgency and frequency, abdominal swelling, and hematuria. In two referral cases, the chief complaints were not documented.

Among the 30 cases of TC-RCC included in this review, information on the surgical or diagnostic procedures was available for 26 cases, while there was no mention about the procedure performed in 4 cases (13.3%). Radical nephrectomy was the most frequently performed procedure, accounting for 18 cases (60%). Partial nephrectomy was conducted in 6 cases (20%), and minimally invasive diagnostic approaches, such as CT-guided biopsy or renal cyst marsupialization, and renal cyst deroofing were performed in 3 cases (10%). Among the radical nephrectomies, one case (3.3%) was associated with retroperitoneal lymph node dissection, and another was preceded by laparoscopic renal cyst marsupialization. Additionally, a single case (3.3%) involved bilateral laparoscopic radical nephrectomy

Seven patients had adjuvant pharmacological therapy, often involving dual-agent regimens. These included combinations such as sunitinib and everolimus, sorafenib alone, sunitinib and temsirolimus, gemcitabine and carboplatin, gemcitabine, cisplatin, and sunitinib, and other combinations involving agents like docetaxel, pazopanib, and nivolumab.

3.2 Tumor Characteristics
Tumor characteristics of the reported TC-RCC cases are summarized in Figure 2. Tumors most commonly involved the left kidney, with fewer cases affecting the right kidney and rare bilateral involvement. When intrarenal location was specified, the upper pole was the most frequently involved site, either alone or in combination with other renal regions. Tumor size varied widely, with lesions larger than 10 cm representing the most common size category, although size was unreported in a substantial proportion of cases. Half of the tumors were confined to the kidney, while others demonstrated extension into adjacent structures or had indeterminate extent due to limited reporting. Most tumors were unifocal or had indeterminate focality. Concurrent malignancies were identified in approximately one-quarter of cases, while the remainder represented pure TC-RCC.

3.2.0 Tumor Laterality
Among the 30 TC-RCC cases, tumor involvement was predominantly left-sided, occurring in 20 cases (66.7%). The right kidney was affected in 9 cases (30.0%), and bilateral involvement was observed in only 1 case (3.3%), suggesting that bilateral disease is uncommon.

3.2.1 Tumor Location within the Kidney
Tumor location within the kidney was specified in 17 cases. The upper pole was the most commonly involved region, reported in 11 cases (36.7%), either alone or in combination with other renal segments. The middle portion was involved in 8 cases (26.7%), and the lower pole in 6 cases (20.0%). Tumors involving all three renal

regions were identified in 5 cases (16.7%), while combined upper and middle pole involvement was reported in 2 cases (6.7%). Limited data were available regarding anterior/posterior or cortical/medullary localization, with posterior involvement mentioned in only 1 case (3.3%).

3.2.2 Tumor Size

Tumor size was reported in 21 cases (70.0%). Among these, tumors measuring ≤4 cm were identified in 6 cases (20.0%), those >4–≤7 cm in 3 cases (10.0%), >7–≤10 cm in 2 cases (6.7%), and >10 cm in 10 cases (33.3%). Tumor size was not documented in 9 cases (30.0%). The smallest reported tumor measured 0.8 cm, while the largest measured 37 cm. No tumors were reported to be exactly 10 cm in size.

3.2.3 Tumor Extent

Tumor extent was documented in all cases. Kidney-confined disease was present in 15 cases (50.0%). Extension beyond the kidney was observed in 5 cases (16.7%), involving structures such as the diaphragm, liver, renal sinus, pelvicalyceal system, or perinephric tissue. One case described extensive infiltration of the diaphragm and liver with compression of the inferior vena cava. Tumor extent could not be determined in 10 cases (33.3%) due to incomplete data.

3.2.4 Tumor Focality

Unifocal tumors were identified in 12 cases (40.0%), while multifocal disease was reported in 3 cases (10.0%). Tumor focality was indeterminate in 15 cases (50.0%), reflecting limited reporting. Among multifocal tumors, one case demonstrated multiple small foci (0.3–2.5 cm), and another reported two distinct tumor foci.

3.2.5 Concurrent Malignancies

Concurrent malignancies were identified in 8 cases (26.7%), while 22 cases (73.3%) represented pure TC-RCC. Papillary renal cell carcinoma (PRCC) was the most frequent coexisting malignancy, observed in 6 cases (20.0%). Poorly differentiated PRCC was reported in 2 cases (6.7%), including one with fumarate hydratase loss suggestive of hereditary leiomyomatosis and renal cell carcinoma syndrome. Rare cases included multiple synchronous renal tumors of different histologic subtypes, bladder carcinoma with lymph node metastasis, and poorly differentiated subepithelial foci.

3.2.6 Pathological TNM (pTNM) Classification

According to the AJCC 8th Edition[13], pT1 tumors were the most common stage, reported in 13 cases (43.3%), followed by pT2 tumors in 8 cases (26.7%) and pT3a tumors in 6 cases (20.0%). Tumor stage was undetermined in 5 cases (16.7%). Overall, early-stage disease (pT1–pT2a) accounted for 50.0% of cases, while advanced-stage tumors (pT2b–pT3a) accounted for 40.0%.

Node-negative disease (pN0) was confirmed in 5 cases (16.7%), while nodal status was unknown in the remaining cases; no nodal metastases were reported. Distant metastases (pM1) were identified in 3 cases (10.0%), while the majority of cases were non-metastatic or had unknown metastatic status.

3.2.7 Distant Metastasis

Information on distant metastasis was explicitly reported in 5 cases (16.7%). In most cases (70.0%), metastatic status was not mentioned, and indirect evidence suggestive of metastasis was noted in 4 cases (13.3%). Detailed metastatic findings are summarized in Table 2.

3.3 Radiological features:

Radiological findings across imaging modalities are summarized in **Figure 3** and **Table 3.** Among patients undergoing CT imaging, cystic masses with septations constituted the most common finding, followed by indeterminate lesions and cystic masses with solid components. MRI and ultrasound findings showed greater variability, with fewer cases available for evaluation and a wider distribution of cystic, solid, and mixed lesions.

3.3.0 CT scan

Among the 26 patients who underwent CT, the results included 1 cystic mass, 9 cystic masses with septae, 3 cystic masses with a solid component, 3 cystic masses with septae and a solid component, 3 cystic masses with septae

and solid nodules, 1 hemorrhagic cyst, 4 indeterminate findings, and 2 cases of solid masses while 4 cases had no clear CT scan finding discerption . Using the Bosniak classification[14], CT findings were categorized as Bosniak I in 1 case, Bosniak II in 2 cases, Bosniak III in 5 cases, Bosniak IV in 9 cases, indeterminate in 6 cases, and not available in 7 cases.

3.3.1 MRI scan

Of the 6 patients who underwent MRI, findings included 2 cystic masses with septae, 1 cystic mass with septae and a solid component, 1 cystic mass with septae and solid nodules, 1 cystic mass with a solid component, and 1 indeterminate case. Bosniak classifications for MRI identified Bosniak III in 1 case), Bosniak IV in 3 cases, and indeterminate in 1 case.

3.3.2 US scan

Ultrasound findings were reported in seven patients. Among these, two cases revealed a hyperechoic mass with a solid component, one case demonstrated a solid mass with simple cysts, one showed a heterogeneous mass, one was classified as indeterminate, one exhibited a heterogeneous mass with septations, and one presented as a hypoechoic cyst with septations and a solid component.

3.4 Histopathology

Table 4 describes the pathologic gross and microscopic features of TCRCC.

3.4.1 Gross Features

Gross pathological findings demonstrated marked heterogeneity, reflecting the variable presentation of tubulocystic renal cell carcinoma (TC-RCC). Mixed solid and cystic morphology was observed in 10 cases (33.3%). Predominantly cystic features, including spongy, circumscribed, multilocular/lobulated, and purely cystic patterns, were reported in 18 cases (60.0%). Within this group, spongy cystic tumors accounted for 6 cases (20.0%), circumscribed cystic lesions for 5 cases (16.7%), purely cystic tumors for 2 cases (6.7%), and multilocular/lobulated cystic tumors for 5 cases (16.7%).

Tumor circumscription was noted in 9 cases (30.0%), often accompanying cystic or hemorrhagic features, while encapsulation was specifically reported in 1 case (3.3%). Intralesional fluid characteristics included watery fluid (1 case, 3.3%), brownish fluid (1 case, 3.3%), serous fluid (2 cases, 6.7%), bloody fluid (2 cases, 6.7%), and gelatinous material (1 case, 3.3%). Tumor coloration varied and included grey (2 cases, 6.7%), gelatinous white-tan, tan-yellow, and brown-pink (each 1 case, 3.3%). Hemorrhage was documented in 3 cases (10.0%), ill-defined margins in 2 cases (6.7%), and necrosis in 1 case (3.3%). Gross descriptions were unavailable in 8 cases (26.7%).

3.4.2 Cellular Architecture

Tubulocystic architecture was the predominant growth pattern, identified in 16 cases (53.3%), frequently associated with papillation (5 cases, 16.7%) and rarely with necrosis (1 case, 3.3%). Circumscription was described in 6 cases (20.0%), commonly in combination with tubulocystic or papillary patterns. Encapsulation was rare (1 case, 3.3%).

Purely tubular architecture was reported in 3 cases (10.0%), while cysts-only architecture was observed in 4 cases (13.3%), including papillary features in 2 cases and poorly differentiated components in 1 case. Papillation was present in 6 cases (20.0%), usually alongside tubulocystic architecture. Poorly differentiated features were rare (1 case, 3.3%), characterized by cribriform growth and inclusion-like eosinophilic nucleoli. Architectural details were not reported in 6 cases (20.0%).

3.4.3 Cytological Features

Single-layer epithelial lining was the most common cytological feature, observed in 21 cases (70.0%). This included combinations of cuboidal, columnar, flat, and hobnail cells, most frequently cuboidal and hobnail cells. Cuboidal cells were identified in 17 cases (56.7%), hobnail cells in 17 cases (56.7%), and columnar cells in 7 cases (23.3%), typically in combination.

Multilayered epithelium was rare (1 case, 3.3%), and sarcomatoid differentiation was noted focally in 1 case (3.3%). Cytological features were not described in 6 cases (20.0%). Additional findings included intracytoplasmic vacuoles, focal calcifications, inflammatory cells, subepithelial poorly differentiated tumor cells, and PAS/alcian blue positivity, each reported infrequently.

3.4.4 Cytoplasmic and Nuclear Features

Eosinophilic cytoplasm was the most frequent cytoplasmic feature, present in 21 cases (70.0%), with abundant cytoplasm noted in 5 cases (16.7%). Clear cytoplasm was identified in 3 cases (10.0%), all coexisting with eosinophilic cytoplasm.

Nuclear grading revealed G2 nucleoli in 6 cases (20.0%) and G3 nucleoli in 9 cases (30.0%), with no higher grades observed. Oval nuclei and nuclear membrane irregularity were each reported in 4 cases (13.3%). Moderate pleomorphism and granular chromatin were observed in a minority of cases. Eosinophilic cytoplasm co-occurred with G2 or G3 nucleoli in over half of cases (52.4%). Cytoplasmic or nuclear details were not reported in 10 cases (33.3%).

3.4.5 Intervening Stroma

Fibrotic stroma was the most common stromal feature, reported in 13 cases (43.3%), occasionally accompanied by hyalinization or paucicellularity. Fibrovascular stroma was observed in 2 cases (6.7%), and edematous stroma in 1 case (3.3%). Stromal features were not described in 12 cases (40.0%).

3.5 Immunohistochemistry

The immunohistochemical staining profile of the included cases is summarized in **Figure 4** and **Table 5.**

3.5.1 Positive Stains

As shown in Figure 4A, AMACR was the most frequently positive marker, identified in 20 of 30 cases (66.7%), followed by CD10 (14 cases, 46.7%) and vimentin (13 cases, 43.3%). CK7 positivity was observed in 9 cases (30.0%), while PAX8 and pancytokeratin were positive in 7 (23.3%) and 6 cases (20.0%), respectively. HMWCK showed positivity in 5 cases (16.7%), and FH retention was noted in 4 cases (13.3%), whereas PAX2 expression was rare (1 case, 3.3%). Additional markers grouped under “Other” were positive in 8 cases (26.7%).

3.5.2 Negative Stains

Negative immunohistochemical findings are illustrated in Figure 4B, with CK7 being the most frequently negative marker (11 cases, 36.7%), followed by HMWCK (7 cases, 23.3%) and CD10 (6 cases, 20.0%). CK20 was negative in 5 cases (16.7%), while TFE-3 was negative in 4 cases (13.3%). Several additional markers, including CA-IX, estrogen receptor, progesterone receptor, p63, and c-kit, were each negative in 2 cases (6.7%), whereas EMA, S100, SMA, RCC, CK50, TFEb, and CD117 were infrequently negative (1 case each, 3.3%).

4 Discussion:

This scoping review comprehensively consolidated the most recent literature on tubulocystic renal cell carcinoma (TC-RCC), emphasizing case reports and case series to elucidate its epidemiological characteristics, radiological features, pathological features, therapeutic approaches, and prognostic outcomes. Through systematic synthesis of the available evidence, the review established a robust framework to guide future investigative efforts and support evidence-based clinical management of this uncommon renal neoplasm.

The biological behavior of TC-RCC is generally indolent, with most tumors being low-grade and confined to the kidney at diagnosis[15]. Nevertheless, cases with high-grade or poorly differentiated components have been reported, and these may exhibit more aggressive behavior, including metastasis. Given the rarity of TC-RCC and the limited number of reported cases, ongoing surveillance and further studies are necessary to fully understand its clinical course and optimal management strategies[15].

Lawrie et al. conducted a molecular genetic study on TC-RCC using targeted next-generation sequencing (NGS) to examine over 2,800 cancer-related mutation hotspots[16]. They identified 27 somatic mutations across 14 genes, with ABL1 and PDGFRA emerging as frequently mutated in TC-RCC. These two genes were altered in over 60% of

TC-RCC cases but in fewer than 5% of other renal tumors, emphasizing TC-RCC's unique genetic signature[16]. Notably, the ABL1 mutations were non-synonymous and clustered around the kinase domain, pointing to a possible role in disease development. Overall, the mutation landscape of TC-RCC was markedly different from other renal cancers, with ABL1 being the most commonly mutated gene in TC-RCC—yet rarely altered in CCRCC, PRCC, or ChRCC[16].

The primary treatment for TC-RCC is surgical resection, typically via partial or radical nephrectomy, depending on tumor size and location[4]. Since it is rare, no standardized guidelines exist for adjuvant therapies, and treatment decisions for advanced or metastatic disease remain case-dependent[9]. While systemic therapies such as tyrosine kinase inhibitors or immunotherapy have been used in advanced cases, their effectiveness specifically for TC-RCC has not been well established[15]. TC-RCC is generally considered an indolent tumor with a favorable prognosis[2]. Most patients remain disease-free following surgical resection, and the risk of recurrence is low[1]. However, there have been reports of aggressive cases with metastatic spread to lymph nodes, lungs, and bones, highlighting the need for long-term follow-up in all patients[17].

Grossly, TC-RCC typically appears as a complex cystic mass with a spongy cut surface, often identified in males in their seventh decade of life. Histologically, TC-RCC is characterized by variably dilated tubules lined by markedly atypical epithelial cells with eosinophilic cytoplasm and prominent nucleoli, corresponding to WHO/ISUP nucleolar grade 3, usually set within a fibrous stroma[9]. In some instances, areas of poor differentiation may be observed, marked by pleomorphic nuclei and prominent nucleoli, and these are associated with a more aggressive clinical course.

Immunohistochemically, TC-RCC tumor cells are typically reported in literature to be positive for cytokeratin, vimentin, and AMACR, while negative for CK7 and CD10, aiding in their distinction from other renal neoplasms[9]. In contrast, our observations revealed that alpha-methylacyl-CoA racemase (AMACR) and PAX8 were consistently expressed, whereas CK7 demonstrated variable expression, being positive in some cases and negative in others. CD10 was occasionally positive, while markers such as vimentin, epithelial membrane antigen (EMA), and CK19 showed heterogeneous staining patterns. Fumarate hydratase (FH) expression was generally preserved but could be lost in poorly differentiated areas, reflecting underlying tumor heterogeneity. Conversely, CK20 and p63 remained negative across all cases, supporting their role in differential diagnosis. Collectively, these findings highlight the diagnostic value of AMACR and PAX8, while underscoring the variability of CK7 expression in TC-RCC compared with prior literature.

Overall, the available evidence suggests relatively consistent clinicopathological features and generally indolent behavior, although variability in imaging findings, immunohistochemical expression, and clinical outcomes highlights ongoing uncertainty.

Clinical Implications:
From a clinical perspective, TC-RCC should be considered in the differential diagnosis of cystic renal masses, particularly when imaging demonstrates a multiloculated cystic lesion with septations and variable solid components. However, radiological findings are often non-specific, and definitive diagnosis typically relies on histopathological and immunohistochemical evaluation. Accurate distinction from other cystic renal neoplasms, including cystic clear cell RCC and multilocular cystic renal neoplasm of low malignant potential, is essential to guide appropriate management.
Given the generally indolent behavior reported in most cases, nephron-sparing approaches may be appropriate when feasible; however, due to limited and heterogeneous evidence, management decisions should be individualized. A multidisciplinary approach integrating radiological, pathological, and clinical findings is recommended to optimize diagnostic accuracy and treatment planning.

Limitations:
This review is limited by the nature of the available evidence, which is predominantly derived from case reports and small case series. This inherently reduces the robustness and generalizability of the findings, as such studies are subject to selection and reporting bias, inconsistent diagnostic criteria, variable follow-up, and heterogeneous

outcome reporting. Consequently, the conclusions of this review should be interpreted as primarily descriptive and hypothesis-generating rather than definitive.

In line with the methodology of scoping reviews, a formal critical appraisal of study quality was not performed; however, the included studies are of variable quality and are inherently prone to bias due to their design. Differences in reporting standards and clinical detail further contribute to heterogeneity and limit direct comparability across studies.

Additionally, publication bias may lead to overrepresentation of unusual or aggressive cases, which may not fully reflect the typical clinical course of tubulocystic renal cell carcinoma. While focusing on pure TC-RCC enhances diagnostic specificity, it may limit insights into overlapping or related renal neoplasms. Future multicenter studies, prospective data collection, and standardized reporting are needed to strengthen the evidence base and guide clinical decision-making.

5 Conclusion:

Tubulocystic renal cell carcinoma (TC-RCC) demonstrates a heterogeneous clinical profile, with presentations ranging from incidental findings to symptomatic lesions, and a notable proportion of patients exhibiting synchronous or metachronous malignancies. Despite the fact that the majority of TC-RCC cases are identified at an early stage with localized disease, there remains a subset that presents with advanced or poorly differentiated components, which may be associated with more aggressive clinical behavior and worse prognosis. These findings emphasize the importance of developing standardized diagnostic and management protocols. Identifying molecular signatures, predictive biomarkers, and radiological features will be essential for stratifying patients based on risk and guiding tailored therapeutic strategies to improve long-term outcomes in TC-RCC.

Statement of Ethics: In accordance with institutional and international guidelines, ethical approval was not required, and a formal waiver was obtained.

Conflict of Interest Statement: The authors declare no conflict of interest.

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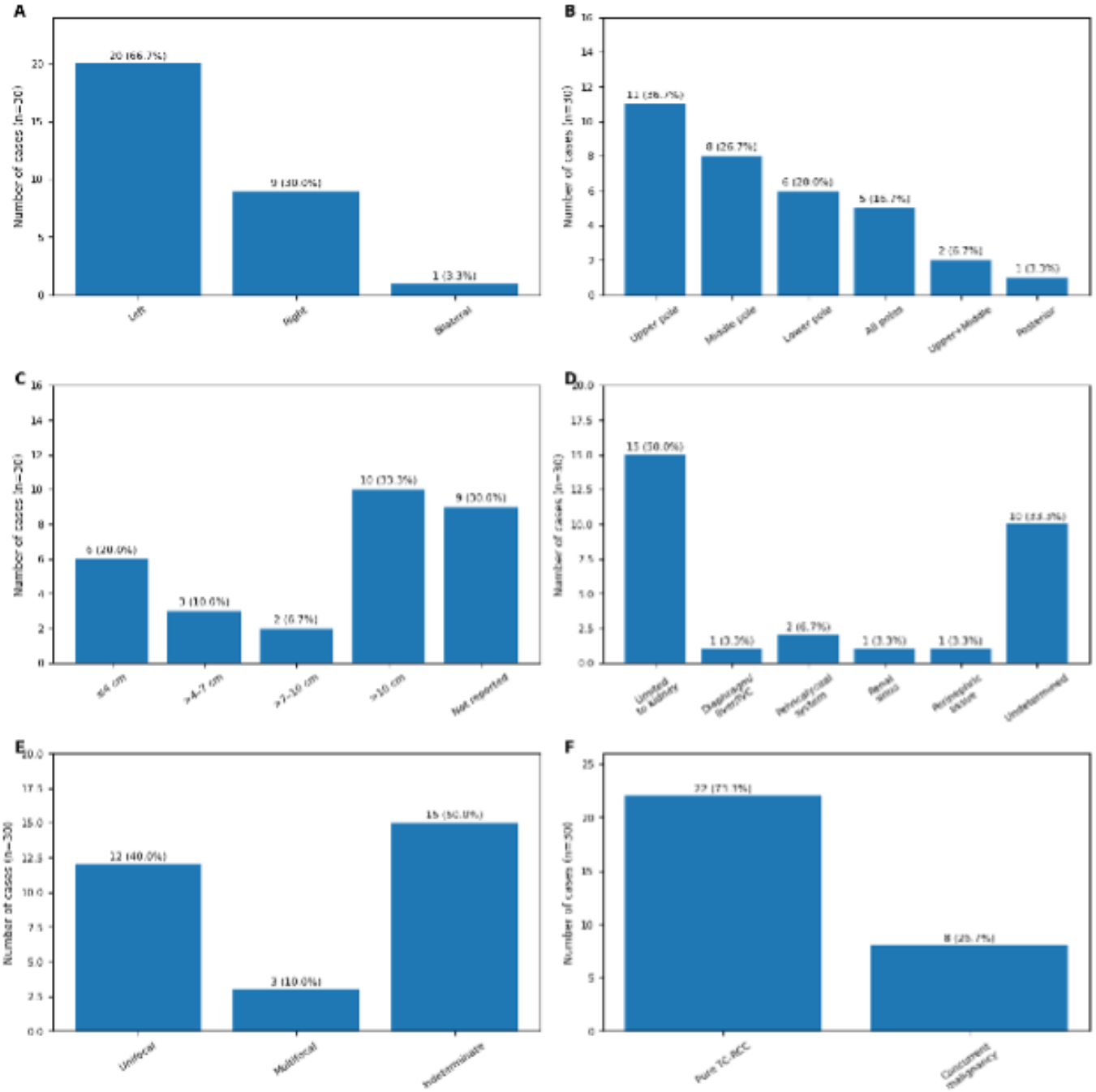
Figures and Figure legends:
Figure 1: PRISMA flowchart of included studies.

Figure 2: illustrates the tumor characteristics of TC-RCC cases (n = 30), including tumor laterality, intrarenal location, size, extent, focality, and the presence of concurrent malignancies. (A) Tumor laterality demonstrates a predominance of left-sided involvement. (B) Tumor location within the kidney is shown as reported in the literature and includes non-mutually exclusive categories due to combined anatomic descriptions in some cases. (C) Tumor size distribution includes cases with unreported measurements. (D) Tumor extent is categorized as limited to the kidney, extension beyond the kidney into adjacent structures, or undetermined. (E) Tumor focality is classified as unifocal, multifocal, or indeterminate. (F) Concurrent malignancies are shown in comparison with pure TC-RCC.

Figure 3. Distribution of radiological findings by imaging modality. The distribution of radiological findings identified on computed tomography (CT; n = 26), magnetic resonance imaging (MRI; n = 6), and ultrasound (US; n = 7). A unified color scheme is used across modalities to represent identical radiological categories. Percentages and absolute case numbers (n) are displayed within each pie segment. The accompanying legend reports the number of cases per category for each imaging modality. CT imaging most frequently demonstrated cystic masses with septations, whereas MRI and US findings were more heterogeneous, reflecting the limited number of cases assessed with these modalities.

Figure 4. Immunohistochemical staining profile of reported cases (n = 30).
(A) Distribution of positive immunohistochemical markers across cases. AMACR was the most frequently expressed marker, followed by CD10 and vimentin. (B) Distribution of negative immunohistochemical markers, with CK7 being the most commonly negative stain. Numbers above bars indicate the number of cases.



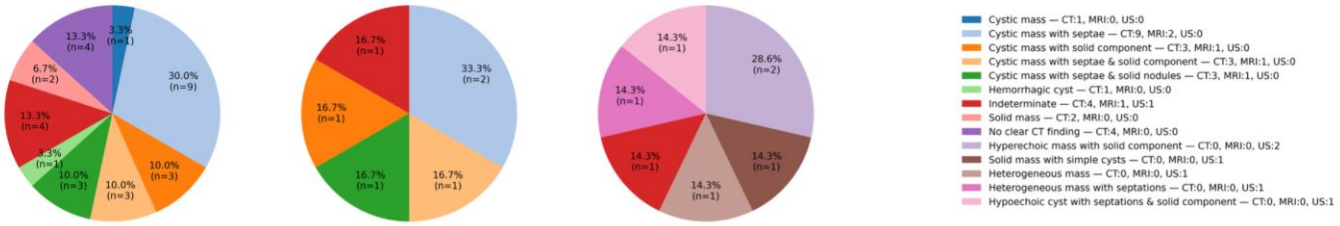


Figure A. Positive Immunohistochemical Stains (n = 30)

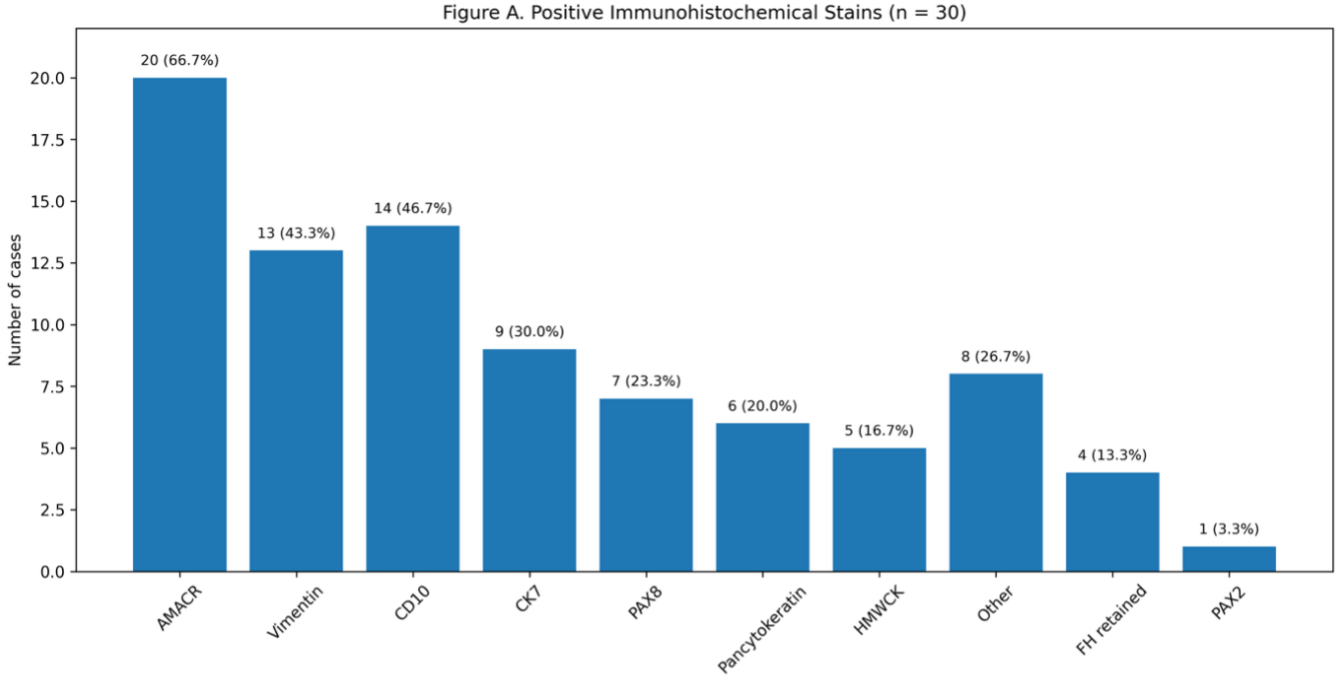
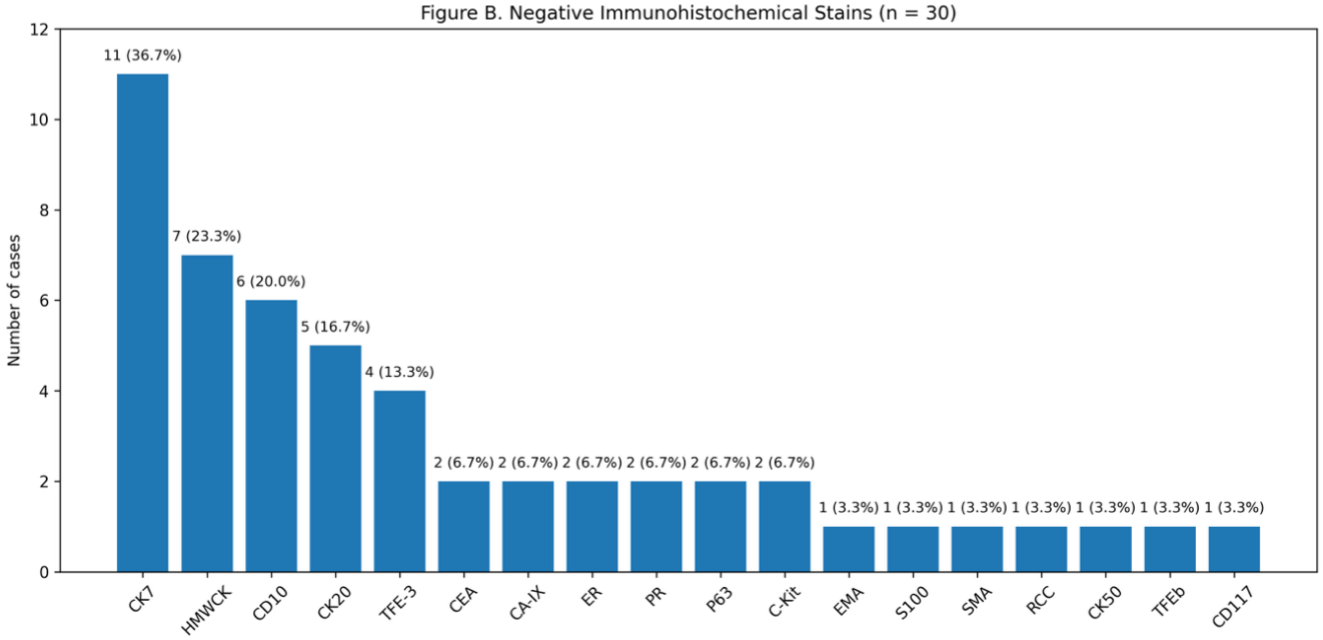
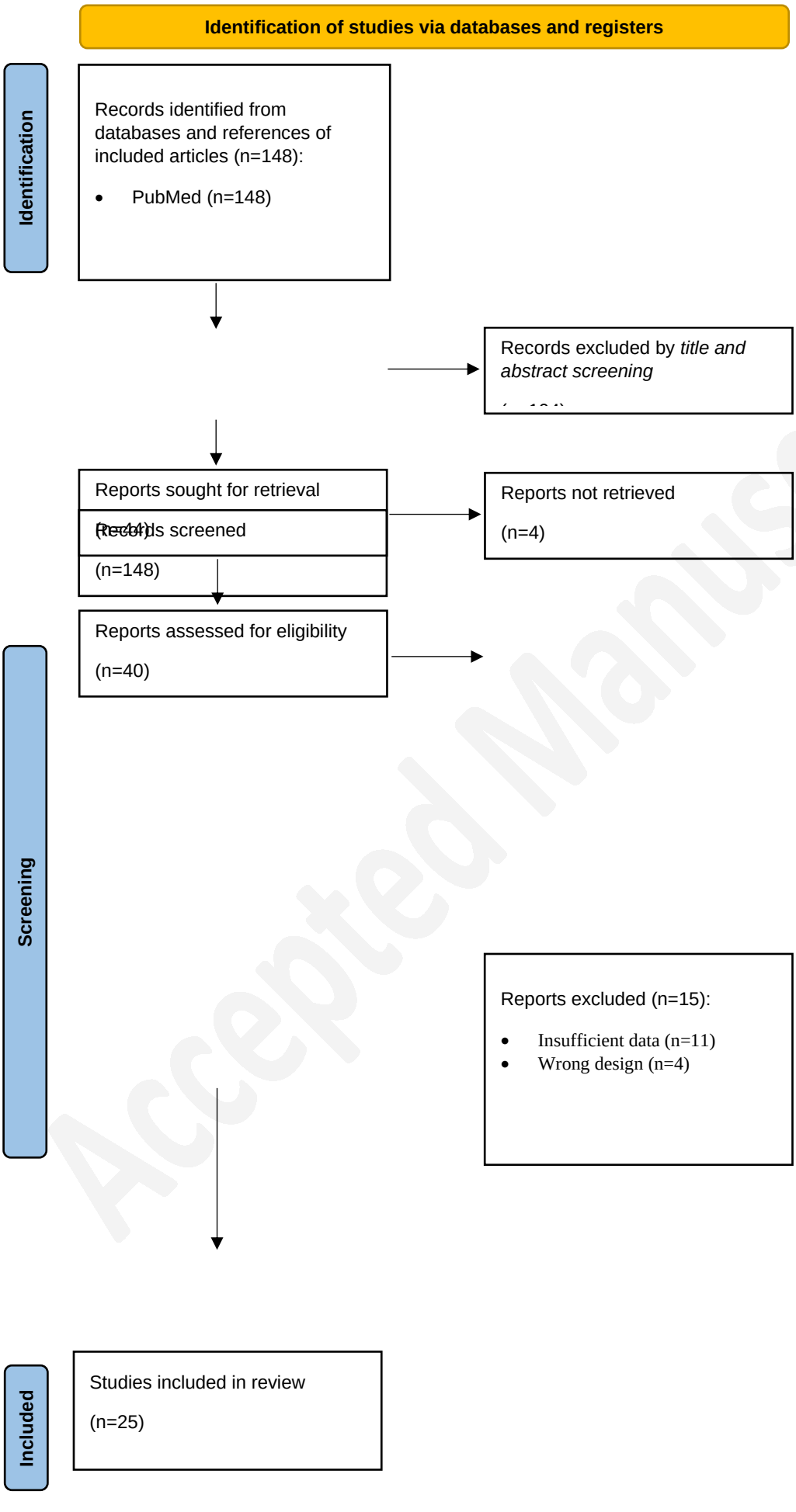


Figure B. Negative Immunohistochemical Stains (n = 30)





Author	Number of cases	Age	Gender	Presenting complaint	Treatment / Diagnostic modality	Additional pharmacological therapy
Bhullar et al. (2011)[8]	1	33	M	Flank pain	Radical nephrectomy	Sorafenib
Al-Jubouri et al. (2024) [3]	1	35	M	Abdominal pain	Partial nephrectomy	N/A
Gönül II et al. (2009)[13]	1	57	M	Incidental finding	Partial nephrectomy	Gemcitabine, Carboplatin
Salvatori et al. (2020)[14]	1	70	M	Incidental finding	CT guided biopsy	Pazopanib, Nivolumab
Brennan et al. (2010)[15]	1	72	M	Incidental finding	Radical nephrectomy	N/A
Ishibashi et al. (2014)[16]	1	35	F	Flank pain	Radical nephrectomy	N/A
Laddha et al. (2020)[2]	1	17	F	Incidental finding	Partial nephrectomy	N/A
Gizzi et al. (2015)[17]	1	15	M	Abdominal swelling	Radical nephrectomy	Gemcitabine, cisplatin, Sunitinib malate
Alfaseh et al. (2019)[18]	1	22	F	Flank pain with decreased appetite, nausea, progressive fatigue and unintentional weight loss	Radical nephrectomy	N/A
Jipp et al. (2015)[19]	1	52	M	Incidental finding	Radical nephrectomy	N/A
Ruch et al. (2020)[20]	1	65	M	Hematuria, lower limb swelling	Radical nephrectomy	N/A
McFadden et al. (2019)[21]	1	59	M	Incidental finding	Partial nephrectomy	N/A
Kakkar et al. (2015)[22]	1	65	M	Flank pain, flank swelling	Radical nephrectomy	N/A
Iakovleva et al. (2015)[23]	1	70	M	Flank pain, weight loss	Radical nephrectomy	N/A
Al-Hussain et al. (2020)[24]	1	45	M	Flank pain	Radical nephrectomy	N/A
O'Connor et al. (2021)[25]	1	90	F	Abdominal swelling	Radical nephrectomy	N/A
Choi et al. (2021)[9]	1	60	M	Incidental finding	Renal cyst marsupialization followed by Radical nephrectomy	Temsirolimus, Sunitinib
Deshmukh et al. (2011)[26]	1	18	F	Abdominal swelling	Radical nephrectomy with retroperitoneal lymphnode dissection	N/A

Sangle et al. (2013)[27]	1	45	F	Incidental finding	Radical nephrectomy	N/A
Banerjee et al. (2016)[4]	1	45	M	Flank pain, abdominal distention	Renal cyst deroofing and cyst wall biopsy	Sunitinib, Everolimus
Kong et al. (2013)[28]	1	62	M	Painless gross hematuria, neck and chest pain	Radical nephrectomy.	N/A
Maeda et al. (2016)[29]	1	46	M	Incidental finding	Radical nephrectomy	N/A
Khera et al. (2022)[30]	1	21	M	Flank pain, flank swelling, constipation, burning micturition	Radical nephrectomy	N/A
Xing et al. (2021)[1]	2	66	F	Incidental finding	Radical nephrectomy	N/A
		50	M	Incidental finding	Partial nephrectomy	N/A
Hora et al. (2011)[31]	5	44	M	Breathlessness, fluidothorax	Radical nephrectomy	Gemcitabine,cisplatin,docetaxeland sunitinib
		67	M	Incidental finding	N/A	N/A
		70	M	Incidental finding	N/A	N/A
		68	M	Incidental finding	N/A	N/A
		29	M	Flank pain	N/A	N/A

Table 1: Basic characteristics of cases included in the review , M: male , F: female , N/A : not available

Author	Tumor laterality	Tumor location	Tumor Size (cm)	Tumor Extent	Tumor Focality	pTNM CLASSIFICATION*	Distant metastasis	Distant metastasis area
Bhullar et al. (2011)[8]	Left Kidney	N/A	N/A	Limited to kidney	Unifocal	N/A	Yes	Multiple peritoneal and bony metastases
Al-Jubouri et al. (2024) [3]	Left Kidney	Lower pole	3	Limited to kidney	Unifocal	pT1a pNx pMx	No	N/A
Gönül II et al. (2009)[13]	Right Kidney	Middle pole	5.5	Limited to kidney	Unifocal	pT1a pN0 pM0	No	N/A
Salvatori et al. (2020)[14]	Left Kidney	N/A	1.5	N/A	Multifocal	N/A	No	N/A
Brennan et al. (2010)[15]	Left Kidney	Lower pole	1	Limited to kidney	Unifocal	N/A	No	N/A
Ishibashi et al. (2014)[16]	Left Kidney	Upper pole	12	N/A ;	N/A	pT2 pNx pMx	No	N/A
Laddha et al. (2020)[2]	Left Kidney	Upper pole	4.5	Limited to kidney	Unifocal	pT1b pNx pMx	No	N/A
Gizzi et al. (2015)[17]	Left Kidney	N/A	11	N/A	N/A	pT3a pN0 pMx	Yes	Pleural, liver me and peritoneal metastasis
Alfaseh et al. (2019)[18]	Right Kidney	Upper and Middle poles	12.5	Extends into right haemidiaphragm and liver and compressing the inferior vena cava	Unifocal	pT2b pNx pMx	No	N/A
Jipp et al. (2015)[19]	Left Kidney	Upper pole	0.8	Limited to kidney	Two focal identified	pT1a(m) pNx pMx	No	N/A
Ruch et al. (2020)[20]	Left Kidney	Upper pole	32.3	N/A	Unifocal	pT1a pNx pMx	No	N/A
McFadden et al. (2019)[21]	Right Kidney	N/A	2.0	Limited to kidney	N/A	pT1b pNx pMx	No	N/A

Kakkar et al. (2015)[22]	Left Kidney	Upper, middle, and lower poles	15	Extends into pelvicalyceal system	N/A	pT2b pNx pMx	No	N/A
Iakovleva et al. (2015)[23]	Left Kidney	Upper, middle, and lower poles	15.1	Limited to kidney	N/A	pT2b pN0 pM1	Yes	Vertebral metastasis
Al-Hussain et al. (2020)[24]	Left Kidney	N//A;	24	Limited to kidney	N/A	pT2b pNx pMx	No	N/A
O'Connor et al. (2021)[25]	Left Kidney	Upper, middle, and lower poles	18	Limited to kidney	N/A	pT2b pNx pMx	No	N/A
Choi et al. (2021)[9]	Left Kidney	Upper pole	N/A	N/A	Unifocal	pT1a pNx pMx	Yes	Retroperitoneal metastasis
Deshmukh et al. (2011)[26]	Right Kidney	Upper, middle, and lower poles	12	Extends into renal sinus	Unifocal	pT3a pN1 pMx	Yes	Paraaortic nodes metastases
Sangle et al. (2013)[27]	Right Kidney	N/A	4.5	Extends into perinephric tissue (beyond renal capsule)	N/A	pT3a pNx pMx	Yes	paraspinal tissue, peritoneal and adrenal gland metastasis
Banerjee et al. (2016)[4]	Left Kidney	N/A	N/A	N/A	N/A	N/A	Yes	peritoneal and omental metastasis
Kong et al. (2013)[28]	Bilateral	Upper, and middle poles	2.5	N/A	Multifocal	pT1 pNx pMx	No	N/A
Maeda et al. (2016)[29]	Left Kidney	Upper, middle, and lower poles	9.0	Limited to kidney	Multifocal	pT2a pNx pMx	No	N/A
Khera et al. (2022)[30]	Right Kidney	Upper, middle, and lower poles	37	Extends into pelvicalyceal system	Unifocal	pT3a Nx pMx	No	N/A
Xing et al. (2021)[1]	Left Kidney	N/A	8.5 cm	Limited to kidney	Unifocal	pT2a pNx pMx	No	N/A
	Left Kidney	N/A	N/A	Limited to kidney	Unifocal	N/A	No	N/A
	Right Kidney	N/A	N/A	N/A	N/A	pT1b pN0 pM1	Yes	Pleural metastasis

Hora et al. (2011)[31]	Right Kidney	N/A	N/A	N/A	N/A	pT3a pN0 pM0	No	N/A
	Right Kidney	N/A	N/A	N/A	N/A	pT1b pN0 pM0	No	N/A
	Left Kidney	N/A	N/A	N/A	N/A	pT1b pN0 pM0	No	N/A
	Right Kidney	N/A	N/A	N/A	N/A	pT1a pN0 pM1	Yes	Vertebral , sternal , mediastinal lymph nodes and ribs metastasis

Table 2: Tumor and oncological characteristics, * according to AJCC 8th Edition, N/A: not Available

Authors	CT scan Findings	Bosniak classification by CT	MRI scan Findings	Bosniak classification by MRI	US scan Findings
Bhullar et al. (2011)[8]	Cystic mass with solid component	IV	N/A	N/A	N/A
Al-Jubouri et al. (2024)[3]	Cystic mass	I	Cystic mass with solid component	IV	Hyperechoic mass with posterior enhancement
Gönül II et al. (2009)[13]	N/A	N/A	N/A	N/A	N/A
Salvatori et al. (2020)[14]	Cystic mass with septae	N/A	Cystic mass with septae	N/A	N/A
Brennan et al. (2010)[15]	N/A	N/A	Indeterminate	Indeterminate	solid mass and simple cysts
Ishibashi et al. (2014)[16]	Hemorrhagic cyst	Indeterminate	Cystic mass with septae	III	N/A
Laddha et al. (2020)[2]	Cystic mass with septae & solid component	IV	N/A	N/A	N/A
Gizzi et al. (2015)[17]	N/A	N/A	N/A	N/A	Heterogenous mass
Alfaseh et al. (2019)[18]	Cystic mass with solid component	IV	N/A	N/A	Hyperechoic mass with posterior enhancement with solid component
Jipp et al. (2015)[19]	Indeterminate	Indeterminate	N/A	N/A	Indeterminate
Ruch et al. (2020)[20]	Cystic mass with septae & solid component	IV	N/A	N/A	N/A
McFadden et al. (2019)[21]	Cystic mass with septae	III	N/A	N/A	N/A
Kakkar et al. (2015)[22]	Cystic mass with septae & solid component	IV	N/A	N/A	Heterogenous mass with septae
Iakovleva et al. (2015)[23]	Cystic mass with septae	Indeterminate	N/A	N/A	N/A
Al-Hussain et al. (2020)[24]	Cystic mass with septae	III	N/A	N/A	N/A
O'Connor et al. (2021)[25]	Cystic mass with solid component	IV	N/A	N/A	N/A
Choi et al. (2021)[9]	Cystic mass with septae	II	N/A	N/A	N/A
Deshmukh et al. (2011)[26]	Indeterminate	Indeterminate	N/A	N/A	N/A
Sangle et al. (2013)[27]	Indeterminate	Indeterminate	N/A	N/A	N/A
Banerjee et al. (2016)[4]	Cystic mass with septae	II	N/A	N/A	N/A
Kong et al. (2013)[28]	Cystic mass with septae & solid nodules	IV	N/A	N/A	N/A
Maeda et al. (2016)[29]	Cystic mass with septae & solid component	IV	Cystic mass with septae & solid component	IV	N/A
Khera et al. (2022)[30]	N/A	N/A	Cystic mass with septae & solid nodules	IV	Hypoechoic cyst wit septae and solid component
	Indeterminate	Indeterminate	N/A	N/A	N/A

Xing et al. (2021)[1]	Cystic mass with septae	III	N/A	N/A	N/A
Hora et al. (2011)[31]	Solid Mass	N/A	N/A	N/A	N/A
	Cystic mass with septae	III	N/A	N/A	N/A
	Cystic mass with septae	III	N/A	N/A	N/A
	Solid Mass, two parts	N/A	N/A	N/A	N/A
	Cystic mass with septae & solid component	IV	N/A	N/A	N/A

Table 3: Radiological findings of the cases included in the review , CT : computed tomography , MRI : magnetic resonance imaging , US : ultrasound , N/A : not available.

Author	Gross features identified	Cellular architecture	Cytological features	Nuclear features	Intervening stroma
Bhullar et al. (2011)[8]	Solid and cystic	Tubulocystic; papillation	Single layer; hobnail; sarcomatoid; focal sarcomatoid (percentage not specified)	G3; nucleoli conspicuous at 100× magnification; eosinophilic cytoplasm	Fibrotic; hyalinized
Al-Jubouri et al. (2024) [3]	Spongy; cystic; fluid watery	Circumscribed; tubulocystic	Single layer; cuboidal	G2; nucleoli conspicuous and visible at 400×, not prominent at 100×; nuclear membrane irregularity; large nuclei; eosinophilic cytoplasm	Fibrotic; paucicellular
Gönül II et al. (2009)[13]	Spongy; lesion color grey	Tubulocystic	Single layer; cuboidal; columnar; hobnail; few chronic inflammatory cells present in stroma; focal PAS and alcian blue (pH 2.5) positivity in cytoplasm and tubular lumina	N/A	Edematous
Salvatori et al. (2020)[14]	N/A	Tubules only	Single layer; cuboidal; hobnail	Eosinophilic cytoplasm; clear cytoplasm also noted	N/A
Brennan et al. (2010)[15]	Sheets	Tubules only	Epithelial	Moderately pleomorphic; eosinophilic cytoplasm	Fibrovascular
Ishibashi et al. (2014)[16]	Circumscribed; solid and cystic	Circumscribed; tubulocystic; papillation	Single layer; cuboidal; hobnail	N/A	N/A
Laddha et al. (2020)[2]	Circumscribed; cystic	Circumscribed; encapsulated; cysts only; focal solid area	Single layer; cuboidal; hobnail	Granular chromatin; G2; nucleoli conspicuous and visible at 400×, not prominent at 100×; oval-shaped nuclei; moderate cytoplasm	N/A
Gizzi et al. (2015)[17]	Cystic; spongy	Tubulocystic	Single layer; cuboidal; columnar; hobnail; focal calcifications	Eosinophilic cytoplasm	N/A
Alfaseh et al. (2019)[18]	Circumscribed; spongy; solid and cystic	N/A	N/A	N/A	N/A
Jipp et al. (2015)[19]	Solid and cystic; gelatinous white-tan lesion	Tubulocystic	Single layer; hobnail	Eosinophilic cytoplasm; abundant cytoplasm; prominent nucleoli	Fibrotic
Ruch et al. (2020)[20]	Circumscribed; encapsulated; cystic	Tubulocystic	Single layer; hobnail	G3; nucleoli conspicuous at 100×; eosinophilic cytoplasm; high N/C ratio	Paucicellular; fibrotic
McFadden et al. (2019)[21]	Circumscribed; cystic	Circumscribed; tubulocystic; papillation	Single layer; multilayered; hobnail; intracytoplasmic vacuoles focally present	Eosinophilic cytoplasm; variable oncocytic-like cytoplasm; G3; nucleoli conspicuous at 100×	Fibrotic
Kakkar et al. (2015)[22]	Cystic; lobulated; brownish fluid	Tubulocystic	Cuboidal; columnar; hobnail	Abundant eosinophilic cytoplasm; oval-shaped nuclei; granular chromatin; G3; nucleoli conspicuous at 100×; low N/C ratio	Fibrovascular; fibrotic; paucicellular
Iakovleva et al. (2015)[23]	Ill-defined; spongy; cystic	Cysts only	Single layer; cuboidal; hobnail	Cellular atypia	Fibrotic
Al-Hussain et al. (2020)[24]	Solid and cystic; circumscribed; watery fluid; multiple yellow-tan solid areas	Cysts only; papillation; papillary and poorly differentiated components; cribriform growth with focal papillary formation; inclusion-like eosinophilic nucleoli with perinuclear halo	Single layer	Eosinophilic cytoplasm; G3; nucleoli conspicuous at 100×	N/A
O'Connor et al. (2021)[25]	Circumscribed; cystic; necrosis; hemorrhage;	Tubulocystic	Cuboidal; single layer	G2; nucleoli conspicuous at 400×; eosinophilic cytoplasm;	Fibrotic

	extensive coagulative necrosis			focal metaplastic bone formation; oncocytic features	
Choi et al. (2021)[9]	Cystic	Tubulocystic	Single layer; flat; cuboidal; columnar; hobnail; poorly differentiated tumor cells in subepithelial area	Eosinophilic cytoplasm; moderately pleomorphic	Fibrotic; poorly differentiated tumor cells in subepithelial area
Deshmukh et al. (2011)[26]	N/A	Bluish mucoid secretions; tubulocystic	Single layer; flat; cuboidal; columnar; hobnail; focal cytoplasmic vacuolization	Eosinophilic cytoplasm; nuclear membrane irregularity; G2; nucleoli conspicuous at 400×	N/A
Sangle et al. (2013)[27]	Hemorrhage; solid and cystic	Cysts only	Single layer; cuboidal; hobnail	Nuclear membrane irregularity; G3; nucleoli conspicuous at 100×	Fibrotic; hyalinized
Banerjee et al. (2016)[4]	N/A	Tubules only	Cuboidal; hobnail	Eosinophilic cytoplasm; clear cytoplasm; prominent nucleoli	N/A
Kong et al. (2013)[28]	Spongy and cystic; grey, sharply demarcated lesion; serous fluid	Tubulocystic	Columnar; cuboidal; single layer; hobnail	Eosinophilic cytoplasm; abundant cytoplasm; oval-shaped nuclei; G2; nucleoli conspicuous at 400×	Fibrotic
Maeda et al. (2016)[29]	Spongy and cystic	Tubulocystic	Single layer	Eosinophilic cytoplasm	N/A
Khera et al. (2022)[30]	Solid and cystic; brown fleshy tumor; blood-filled fluid	Tubulocystic; papillation; necrosis; focal necrosis; calcification; focal ossification	Single layer; cuboidal; columnar; hobnail	Moderately pleomorphic; oval-shaped nuclei; G3; nucleoli conspicuous at 100×; eosinophilic, clear, and granular cytoplasm; abundant cytoplasm	Fibrotic
Xing et al. (2021)[1]	Cystic; blood-filled fluid	Tubulocystic	N/A	Prominent nucleoli; enlarged nuclei	N/A
	N/A	Tubulocystic	Single layer; epithelial	Eosinophilic cytoplasm; G3; nucleoli conspicuous at 100×	N/A
Hora et al. (2011)[31]	N/A	N/A	N/A	N/A	N/A

Table 4 : Pathological Gross and Microscopic Features. N/A Not Available

Authors	Positive IHC	Negative IHC
Bhullar et al. (2011)[8]	AMACR ;	N/A ;
Gönül II et al. (2009)[13]	CD10 ;Vimentin ;Strong positivity for CK19, EMA , RCC, CD15..... focally positive for ck 7 ;CK7;	N/A ;
Salvatori et al. (2020)[14]	PAX8 ;AMACR ;	HMWCK : Cytokeratin 34 beta E12;CK7;carbonic anhydrase-IX (CA-IX),;
Brennan et al. (2010)[15]	CK7;CD10 ;AMACR ;diffuse positivity ;	HMWCK : Cytokeratin 34 beta E12;CK20;
Ishibashi et al. (2014)[16]	strongly positive for E-cadherin;AMACR ;	HMWCK : Cytokeratin 34 beta E12;WT1;TFE-3;CD10 ;
Laddha et al. (2020)[2]	AMACR ;CD10 ;	CK7;N/A ;
Gizzi et al. (2015)[17]	Vimentin ;EMA;	CK7;TFE-3;CK50, CEA , TFEb;
Alfaseh et al. (2019)[18]	CD10 ;weakly positive for pancytokeratin and vimentin;Pancytokeratin;Vimentin ;	CK7;CK20;
Ruch et al. (2020)[20]	CD10 ;AMACR ;Vimentin ;CK7;focally for CK7 ;	EMA ;
McFadden et al. (2019)[21]	CK7;HMWCK : Cytokeratin 34 beta E12;Vimentin ;AMACR ;FH retained ;34-beta-E12, and ck7 focally positive , other demonstrates diffuse positivity . weakly positive for RCC;	S100 protein and c-kit;
Kakkar et al. (2015)[22]	Pancytokeratin;CD10 ;CK19;AMACR ;Vimentin ;	CK7;No reactivity for estrogen receptors, progesterone receptors or smooth muscle actin was noted in the stroma;
Iakovleva et al. (2015)[23]	AMACR ;Vimentin ;HMWCK : Cytokeratin 34 beta E12;PAX8 ;	N/A ;
Al-Hussain et al. (2020)[24]	Pancytokeratin;AMACR ;FH lost in poorly differentiated areas ;	CK7;TFE-3;CD10 ;CA-IX ;
Choi et al. (2021)[9]	Pancytokeratin;Vimentin ;AMACR ;	CK7;CD10 ;
Deshmukh et al. (2011)[26]	CD10 ;CK7;CK19, The staining was strongest in the areas with intracytoplasmic vacuolization. CK7 staining was absent in PRCC element consistent with its high-grade nature.;	HMWCK : Cytokeratin 34 beta E12;P63;
Sangle et al. (2013)[27]	AMACR ;Vimentin ;EMA ;	CK7;CD10 ;HMWCK : Cytokeratin 34 beta E12;RCC, C-Kit;
Banerjee et al. (2016)[4]	CK7;CK19;AMACR ;	CD10 ;
Kong et al. (2013)[28]	PAX2 ;Vimentin ;Pancytokeratin;AMACR ;CD10 ;CK7;HMWCK : Cytokeratin 34 beta E12;CK18\18. Focally strong immunoreactivity for CK7, EMA, Vimentin and 34BE12. The tubule-containing and cystic areas of the tumor demonstrated equal immunoreactivity for pan-cytokeratin, CK8/18 and AMACR. Immunoreactivity for 34BE12, CK7, CD10 and EMA was greater in the tubule-containing areas, relative to the cystic areas.;	CK20;p63;
Maeda et al. (2016)[29]	PAX8 ;AMACR ;	CK7;CD10 ;
Khera et al. (2022)[30]	PAX8 ;Vimentin ;AMACR ;	CK7;CD117, ER, P;
	AMACR ;PAX8 ;CK7;FH retained ;Focal CD10 positivity ;	N/A ;

Xing et al. (2021)[1]	CD10 ;PAX8 ;FH retained ;AMACR ;	CK7;

Table 5: Positive and negative immunohistochemistry stains.