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Metastases to the kidney: a clinicopathological study of 43 cases with an emphasis on deceptive features

Angela J Wu, Rohit Mehra, Khaled Hafez, J Stuart Wolf Jr & Lakshmi P Kunju
Department of Pathology, University of Michigan, Ann Arbor, MI, USA

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Aims: To review our experience with metastases to the kidney in surgical pathology material.
Methods and results: The clinicopathological features of all metastases to the kidney in surgical pathology cases between May 1987 and May 2013 at our institution were reviewed. Autopsy cases were excluded. Forty-three cases (16 nephrectomies, 25 biopsies, and two fine needle aspirations) were included; the primary malignancy was diagnosed prior to/concurrently with the metastasis in nearly all cases. Common primary sites included the lung, breast, female genital tract, and head and neck; the majority were carcinomas. A primary renal tumour was suspected prior to the pathological diagnosis in 35% of cases. Unusual features included: common unilateral (77%) and unifocal (70%) involvement, lack of other distant organ metastases (37%), >10 years between primary and metastasis diagnoses (19%), lack of a discrete mass (5%), and renal vein extension (19% of resections). The most common dilemma was excluding urothelial or high-grade renal cell carcinoma; however, metastases from the thyroid commonly mimicked low-grade renal cell carcinomas.
Conclusions: In surgical pathology material, metastases to the kidney most commonly present as solitary unilateral masses, and in a substantial subset of cases mimic a primary renal tumour.

Keywords: metastases, metastasis, metastatic carcinoma, metastatic tumour, renal neoplasm, secondary neoplasms

Introduction

Metastases to the kidney are rare, and the literature on metastases is rather limited; the majority of the largest studies were performed in the 1950s and 1960s, and most included primarily autopsy cases.[1–4] In addition, many of these studies included not only discrete metastases to the kidney but also either lymphoma/leukaemia or tumours with contiguous spread ('direct extension') into the kidney. The literature on metastases to the kidney seen in surgical pathology material is even more limited, and is confined to either individual case reports or a few cases included in primarily autopsy series.[3,5–11] However, metastases to the kidney can pose a significant challenge to the surgical pathologist as they may mimic histologically both low-grade and high-grade primary renal neoplasms, and distinguishing a primary renal neoplasm from a metastasis is clinically highly significant. The advent of core biopsies in the primary evaluation of renal masses has also probably increased the number of sampled metastases, and adds the additional challenge that only limited histological material is available for evaluation. Given these challenges to the surgical pathologist, we reviewed our experience with tumours metastatic to the kidney, focusing only on those sampled in surgical pathology material and

Address for correspondence: A J Wu, Department of Pathology, University of Michigan, 1500 East Medical Center Drive 2G332 UH, Ann Arbor, MI 48109, USA. e-mail: angelawu@med.umich.edu

with an emphasis on deceptive clinical and histological features.

Materials and methods

CASE SELECTION

This was an institutional review board-sanctioned study. We performed a database search for all metastases to the kidney received at the University of Michigan from May 1987 to May 2013. Only primary hospital cases and cases in which the patient was transferring care to the University of Michigan were included; consultation cases and autopsy cases were excluded. Tumours that were thought to involve the kidney through contiguous/direct extension were excluded, and only tumours that primarily involved the renal parenchyma, as opposed to the perirenal adipose tissue or hilar structures, were included. We excluded cases of lymphoma/leukaemia. Only patients with a documented primary tumour and a final definitive diagnosis of a metastatic tumour were included; those cases in which a metastasis was suggested or included in a differential diagnosis, but for which a primary tumour was not ultimately discovered, were excluded.

METHODOLOGY

Any available clinical history, corresponding radiological reports, gross and surgical pathology reports and any available slides, including any immunostains, were reviewed by one of the authors (A.W.). Site of origin, histological subtype, pertinent radiological/gross features and histological features were documented.

Results

Forty-three cases were included, comprising 12 radical nephrectomies, four partial nephrectomies, 25 core biopsies, and two fine needle aspirations; these accounted for <1% of all resected/biopsied renal masses during this time period at our institution,. There was an equal gender ratio (male/female = 21:22), and the median age of the patients was 61 years (range 25–81 years).

SITE OF PRIMARY TUMOUR

Approximately half of our tumours were metastases from the lung, followed by metastases from the breast, female genital tract, and head and neck. The remaining cases included metastases from the colon, prostate, adrenal gland, skin, tibia, and testis (Figure 1). Carcinomas accounted for the majority of the metastases (86%), and comprised primarily adenocarcinomas. The carcinomas included metastases from the lung (11 adenocarcinomas; eight squamous cell carcinomas; and one small-cell carcinoma), breast (three invasive ductal carcinomas; two invasive lobular carcinomas; and one malignant adenomyoepithelioma), head and neck (two Hürthle cell thyroid carcinomas; one papillary thyroid carcinoma; and one carcinoma ex-pleomorphic adenoma from the salivary gland), female genital tract (two endometrioid adenocarcinomas from the uterus; and one adenoid cystic carcinoma from the vulva), colon (two adenocarcinomas), prostate (one adenocarcinoma), and adrenal gland (one adrenocortical carcinoma). Non-carcinomatous tumours accounted for 14% of the metastatic tumours, and included one leiomyosarcoma and one placental site trophoblastic tumour from the female genital tract, one leiomyosarcoma from the prostate gland, one melanoma from the skin, one osteosarcoma from the tibia, and one seminoma from the testis (Figure 1).

CLINICAL FEATURES

In the vast majority of cases, the primary tumour was diagnosed either prior to or concurrently with the metastasis; in one case, the diagnosis of the kidney metastasis preceded the diagnosis of the primary tumour. In this case, a renal cyst was excised and found to be diffusely infiltrated by lobular carcinoma of the breast. Of note, immediately preoperatively, the patient had been found to have a large breast mass; however, as the cyst was given a definitive diagnosis of metastatic breast carcinoma, the primary breast mass was never biopsied. The median time interval between the diagnosis of the primary tumour and the kidney metastasis was 3.1 years, but the range was broad (0–21.6 years); in a subset of the cases (19%) there was a >10-year interval between the diagnoses of the primary tumour and the kidney metastasis. In 37% of the cases, the kidney metastasis was the first site of a diagnosed distant metastasis for that patient.

In approximately half of the cases a metastasis was clinically suspected. However, in 35% of cases, a primary renal neoplasm was favoured clinically (Table 1).

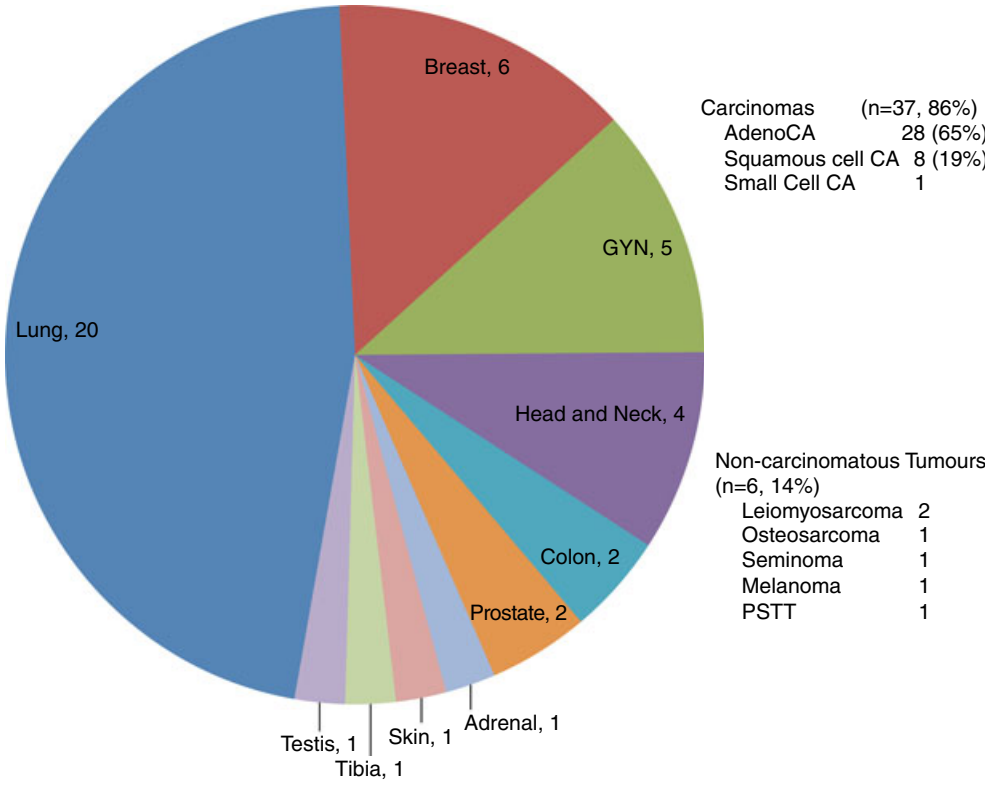

Figure 1. Distribution of primary sites and types of tumour. CA, carcinoma; GYN, female genital tract; PSTT, placental site trophoblastic tumour.

GROSS AND RADIOLOGICAL FEATURES

The vast majority (93%) of patients presented with a solid renal mass found on imaging. In one case (metastatic lobular carcinoma of the breast) the patient presented with a renal cyst. Two patients presented either with renal failure or elevated creatinine. One of these had a known history of metastatic breast carcinoma, and underwent a kidney core biopsy for renal failure; the biopsy revealed mammary ductal carcinoma diffusely infiltrating the renal parenchyma, and on subsequent imaging the patient had an abnormal-appearing kidney but no discrete mass. The other patient had a known diagnosis of metastatic prostate cancer, and underwent a renal core biopsy for elevated creatinine; the biopsy revealed metastatic prostatic adenocarcinoma, and subsequent imaging showed renal cysts but no discrete solid masses. Of the patients who presented with a renal mass, only a subset had multiple masses (30%) or bilateral masses (23%). These were primarily cortical, but involvement of the medulla was not uncommon (Table 2). Of those with unilateral masses there was an equal distribution between right-sided and left-sided tumours (right/left = 16:15).

HISTOLOGICAL FEATURES

Of the 16 resections, the majority of tumours (81%) extended beyond the kidney, with invasion of the perirenal fat and/or invasion of hilar fat/structures, or growth/extension into the renal vein, or both. Extension into the renal vein grossly and radiologically mimicked the renal vein growth commonly seen in high-stage renal cell carcinomas, and was observed in three cases: a Hürthle cell thyroid carcinoma, an osteosarcoma, and a leiomyosarcoma from the uterus. Two cases (endometrioid uterine adenocarcinoma and lung adenocarcinoma) extended beyond the kidney to involve adjacent organs (Table 3).

Based on morphological features, the metastatic tumours fell into three general groups: high-grade conventional adenocarcinomas, squamous cell carcinomas, and small-cell carcinomas; histologically well-differentiated carcinomas from the thyroid; and unusual carcinomas and non-carcinomatous tumours (Table 4).

HIGH-GRADE CARCINOMAS

This group (n = 32) of conventional adenocarcinomas, squamous cell carcinomas and small-cell carcinomas

Table 1. Clinical features of the 43 cases

Timing of diagnosis, no. (%)	
Primary tumour diagnosed first	38 (88)
Kidney metastasis diagnosed first	1 (2)
Diagnosed concurrently	4 (9)
Time interval between diagnosis of primary tumour and Kidney metastasis, median (range) (years)	3.1 (0–21.6)
>10-year interval between the diagnoses of primary tumour and kidney metastasis, no. (%)	8 (19)
No other known distant metastases at the time of kidney metastasis diagnosis, no. (%)	16 (37)
Clinical diagnosis, no. (%)	
Metastasis favoured	22 (51)
Primary renal neoplasm (RCC, UC, AML) favoured	15 (35)
Unknown	6 (14)

RCC, Renal cell carcinoma; UC, Urothelial carcinoma; AML, Angiomyolipoma.

Table 2. Gross and radiological features

Presentation, no. (%)	
Solid renal mass	40/43 (93)
Renal cyst	1/43 (2)
Renal failure/elevated creatinine in the absence of a discrete mass	2/43 (5)
Multiple tumours*, no. (%)	12/40 (30)
Bilateral tumours*, no. (%)	9/40 (23)
Location (n = 36)†, no. (%)	
Cortical	25/36 (69)
Medullary	4/36 (11)
Both	7/36 (19)
Size of largest nodule (n = 35)‡, median (range) (mm)	45 (10–105)

*n = 40: number of patients presenting with a renal mass.
†n = 36: tumour location not reported in four cases.
‡n = 35: largest nodule size not reported in five cases.

from the lung, breast, colon, prostate, female genital tract or adrenal gland were uniformly high-grade and infiltrative, and the primary histological differential diagnoses included either high-grade unclassified or collecting duct renal cell carcinomas or urothelial carcinomas with or without divergent differentiation. Of these, nine carcinomas were resected; they formed either rather discrete nodules or ill-defined, firm tumours (Figure 2A), often with associated necrosis. In addition, these carcinomas (even those that had grossly formed discrete nodules) had infiltrative borders, generally infiltrated in between glomeruli, and typically extended beyond the kidney to directly invade the perirenal/hilar adipose tissue and/or hilar structures, or into adjacent organs (Figure 2B, C). Desmoplastic stroma, an associated inflammatory reaction and angiolymphatic invasion (Figure 2D) were common.

The largest subgroup comprised high-grade adenocarcinomas, with appearances ranging from well-formed glands to more poorly differentiated areas, often within the same tumour (n = 21); these included 11 lung adenocarcinomas, three mammary ductal carcinomas, one malignant adenomyoepithelioma of the breast, two colonic adenocarcinomas, two endometrioid uterine carcinomas, one prostatic adenocarcinoma, and one poorly differentiated adrenocortical carcinoma. The main differential diagnoses for this subgroup included high-grade urothelial carcinoma with or without glandular differentiation, high-grade unclassified renal cell carcinoma, and collecting duct carcinoma (Figure 3A, B). One case (metastatic endometrioid adenocarcinoma) had, on core biopsy, focal micropapillary features, mimicking a high-grade urothelial carcinoma with micropapillary differentiation (Figure 3C). In three of these cases (two lung adenocarcinomas and one colonic adenocarcinoma), carcinoma secondarily colonized the pelvic urothelium, mimicking an *in-situ* urothelial component (Figure 3D).

The remainder of the cases (n = 11) generally mimicked either urothelial carcinomas with divergent differentiation or unusual primary kidney tumours. These included: eight squamous cell carcinomas from the lung, which mimicked urothelial carcinoma with squamous differentiation or primary squamous cell carcinoma (Figure 3E); two lobular carcinomas from the breast, one of which mimicked urothelial carcinoma with plasmacytoid/signet ring cell differentiation (Figure 3F), and one of which (owing to extensive infiltration of the adipose tissue) mimicked, on both imaging and core biopsy, an epithelioid angiomyolipoma (Figure 3G); and one small-cell carcinoma from the lung, which mimicked invasive urothelial carcinoma with small-cell differentiation or primary small-cell carcinoma (Figure 3H).

Table 3. Histological features in resected metastatic tumours (n = 16)

Extension beyond the kidney, no. (%)	13 (81)
Direct invasion of perirenal/hilar fat	8 (50)
Growth into renal vein/renal vein branches	2 (13)
Both perirenal/hilar fat invasion and growth into renal vein/renal vein branches	1 (6)
Adjacent organs	2 (13)
Small-vessel/lymphovascular invasion, no. (%)	10 (63)

Immunostains were obtained in 13 (41%) of these 32 cases, most commonly for TTF-1, ER, CK7, PAX-2 or PAX-8, and p63. Of the high-grade adenocarcinomas, these 13 cases included six of the 11 lung adenocarcinomas (for which some combination of TTF-1, CK7, CK20, p63, PAX-2 or PAX-8 staining was ordered); two of the three mammary ductal carcinomas (some combination of pancytokeratin, CK7, ER, PR, HER-2/*neu*, BRST-2 or HMB-45, the latter in the case mimicking angiomyolipoma); the high-grade adenomyoepithelioma from the breast (CK5/6, CK7, CK20, p63, smooth muscle actin and BRST-2); one of the two colorectal carcinomas (CK7 and CK20); and one of the two endometrioid adenocarcinomas (ER, PR, PAX-2 and c-kit). The two other cases with immunostains were from the non-adenocarcinoma subgroup: one of the eight squamous cell carcinomas of the lung (TTF-1, CK7, CK20, p63 and CDX-2); and the metastatic small-cell lung carcinoma (pancytokeratin and chromogranin A). Immunostains confirmed the diagnosis of a metastatic tumour in all cases.

HISTOLOGICALLY WELL-DIFFERENTIATED TUMOURS FROM THE THYROID

This group included two Hürthle cell carcinomas from the thyroid and one papillary thyroid carcinoma, all of which grossly and histologically mimicked well-differentiated renal cell carcinomas. Two of these tumours (one Hürthle cell carcinoma and the papillary thyroid carcinoma) were resected; they formed well-defined nodules with non-infiltrative borders, and had distinct capsules (Figure 4A). The resected Hürthle cell carcinoma grew into the segmental branches of the renal vein similar to renal cell carcinoma (Figure 4B); the papillary thyroid carcinoma was confined to the kidney. The two Hürthle cell carcinomas had relatively monotonous-appearing, low-grade nuclei and tubulopapillary architecture, primarily mimicking low-grade papillary renal cell carcinomas (Figure 4C). Immunostains showed that both tumours were TTF-1 positive. The papillary thyroid carcinoma mimicked the recently described thyroid-like follicular carcinoma of the kidney;[12] however, this tumour had large overlapping nuclei with prominent central nuclear clearing, similar to that seen in typical papillary thyroid carcinomas (Figure 4D). After immunostains had shown that the tumour was positive for TTF-1, thyroglobulin, CK7, and PAX-8, but negative for PAX-2, examination of the patient's records revealed that she had a remote history of a thyroid resection for malignancy.

UNUSUAL CARCINOMAS AND NON-CARCINOMATOUS TUMOURS

This group included any carcinomas or non-carcinomatous tumours (n = 8) that were highly unusual and histologically distinctive; recognition of these metastases was usually dependent on pattern recognition and knowledge of the patient's history. These included an adenoid cystic carcinoma from the vulva (Figure 5A), a seminoma from the testis (Figure 5B), a carcinoma ex-pleomorphic adenoma in a patient who had a pleomorphic adenoma of the salivary gland diagnosed 21 years previously (Figure 5C), a placental site trophoblastic tumour from the uterus, a melanoma from the skin, an epithelioid leiomyosarcoma from the prostate (Figure 5D), a leiomyosarcoma with

Table 4. Subtypes of metastatic tumour based on histological features

Histological groups	Likely primary sites	Differential diagnosis
High-grade conventional adenocarcinoma, squamous cell carcinoma, or small-cell carcinoma	Lung, breast, colon, female genital tract	Urothelial carcinoma with/without divergent differentiation; collecting duct/high-grade renal cell carcinoma
Histologically well-differentiated carcinomas	Thyroid	Low-grade renal cell carcinoma
Rare/unusual carcinomas, sarcomas, germ cell tumours	Salivary gland, female genital tract, testis, bone, skin	Extremely rare renal primaries or primary sarcomas

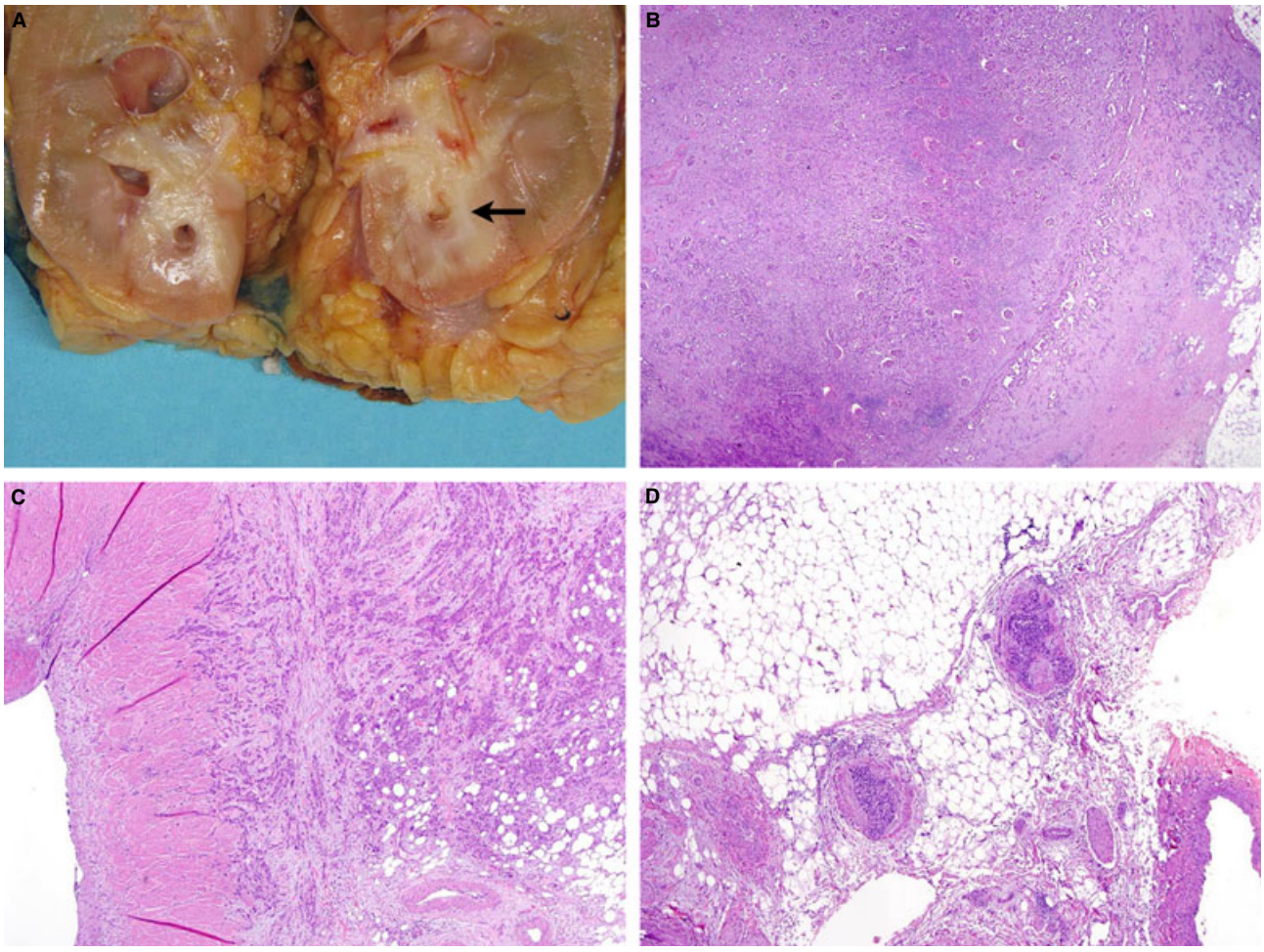

Figure 2. The largest subgroup of metastases to the kidney consisted of conventional high-grade adenocarcinomas, squamous cell carcinomas or small-cell carcinoma from sites such as the lung, breast, or colon. These formed either discrete nodules or ill-defined, firm tumours (**A**). They were infiltrative, grew between glomeruli, and commonly extended beyond the kidney to involve the perirenal fat (**B**). Desmoplastic stroma and infiltrative growth into hilar structures (**C**) and angiolymphatic invasion (**D**) were common. (**B**–**D**, haematoxylin and eosin).

epithelioid and spindled features from the uterus, and an osteosarcoma from the tibia. Five of these cases were resected; two extended beyond the kidney into either the hilar or perirenal adipose tissue (seminoma and carcinoma ex-pleomorphic adenoma); two grew into the renal vein or branches of the renal vein similarly to renal cell carcinoma (leiomyosarcoma from the uterus and osteosarcoma); and one was confined to the kidney (placental site trophoblastic tumour). The differential diagnosis depended on the histology of the tumour, but in this group included either unusual high-grade renal cell carcinomas or sarcomatoid carcinomas. Immunostains were necessary in only two cases: the carcinoma ex-pleomorphic adenoma was positive for myoepithelial markers (S100, SMA, calponin, and p63), and the seminoma was positive for PLAP and negative for pancytokeratin and CD30.

CONCURRENT TUMOURS

In one case the kidney was resected for a pT3 urothelial carcinoma and was found to have concurrent cortical metastases from a known lung adenocarcinoma (Figure 6A, B). These cortical nodules had been noted on imaging, and were considered to be suspicious for metastases. This patient also had a biopsy-proven clear cell renal cell carcinoma in the contralateral kidney. No other patients had concurrent tumours.

DISTRIBUTION OF CASES WITH UNUSUAL FEATURES

We attempted to correlate unusual clinical, radiological and/or histological features (including: no other

known history of malignancy; no other known distant metastases; >10 years between primary and metastatic tumour diagnoses; primary renal neoplasm clinically suspected; no solid mass; solitary unilateral mass; and growth into the renal vein similarly to high-grade renal cell carcinomas) with primary site. For the majority of these unusual features, there was no helpful association with a particular primary site (Table S1). All of the metastases from the head and neck presented as unilateral solitary masses, and in all of the metastases from the head and neck a primary renal neoplasm was clinically suspected prior to the biopsy/nephrectomy. The cases that had growth/extension into the renal vein were one relatively well-differentiated thyroid carcinoma and two sarcomas.

Discussion

Most of the literature on metastases to the kidney has relied heavily on autopsy cases. In one of the largest published abstracts of 443 secondary neoplasms of the kidney, only 18 of the cases were surgical cases.[3] The majority of reported metastases to the kidney in surgical pathology material have been limited to individual case reports.[5–8,10,11] However, basing our understanding of metastases to the kidney on autopsy studies is potentially limited by a selection bias in such cohorts; these cases already have disseminated end-stage disease. The more clinically relevant cohort of patients comprises those who undergo a surgical pathology workup, as these are the patients who will present a critical and often difficult diagnostic dilemma. To our knowledge, this is the largest cohort of consecutive patients with metastases to the kidney presenting in surgical pathology material published in the last 30 years.

Metastases to the kidney represented an extremely small proportion (<1%) of all resected/biopsied renal masses at our institution over a 26-year time period. As the popularity and ease of core biopsies of renal masses have increased, we might expect that the proportion of these patients with suspected metastases undergoing surgical pathology workup would have increased. In fact, the majority (58%) of our patients underwent core biopsy.

On the basis of prior autopsy studies, metastases to the kidney typically present as bilateral, multiple masses.[3,13] However, as would be expected, a significant subset of patients with metastases to the kidney who presented for surgical pathology workup had some unusual clinical or radiological features, as only those patients with some clinical or radiological doubt regarding the diagnosis of a metastatic tumour would be selected for a biopsy or resection. The majority presented with a solitary renal mass on imaging (70%), and with unilateral masses (77%). Although most presented as cortical masses, medullary masses or masses involving both the cortex and medulla were common. Other unusual but rare primary presentations included a renal cyst, and renal failure/elevated creatinine in the absence of a mass. For those patients for whom a clinical/radiological impression was reported, in a significant subset (40%) a primary renal neoplasm (not a metastasis) was suspected. Prior autopsy studies have also found that metastases to the kidney invariably occur in the setting of metastases to other distant organs;[3] however, in our study, a substantial proportion (37%) of patients had no other known metastases at the time of diagnosis of the kidney metastasis.

One helpful clinical feature that has held true in our cohort of patients is that the vast majority (88%) presented first with the primary tumour; in 9% ($n = 4$), the primary tumour and metastasis were diagnosed concurrently, and in only one patient was the metastasis diagnosed prior to the primary tumour. However, in a significant proportion (19%), there was a >10-year interval between the diagnoses of the primary tumour and the metastasis; in a few cases, there was a 15–22-year time interval between the two diagnoses. In many of these cases the diagnosis of the primary tumour was not provided to the surgical pathologist. In some the diagnosis of the primary tumour was so remote that it was not evident even to the clinician, and in one case the patient had been originally diagnosed mistakenly with a benign salivary gland tumour. This indicates that, in all of these patients, avoidance of a misdiagnosis of a primary renal tumour is possible, given the history of a primary tumour, but vigilance on the part of the surgical pathologist is necessary.

The types and histological features of the metastases were somewhat similar to those reported in prior studies; the lung was the most common primary site (47%) in our cohort, followed by the breast, female genital tract, and head and neck. These are all relatively common sites in other studies. In our study, we did not have any metastases from the upper gastrointestinal tract, pancreas, or contralateral kidney, which have been reported in other studies.[3,13] This may be attributable to normal variation in the distribution of metastases seen in different practices, or may be a reflection of the different cohort of patients studied (i.e. autopsy versus surgical pathology cases).

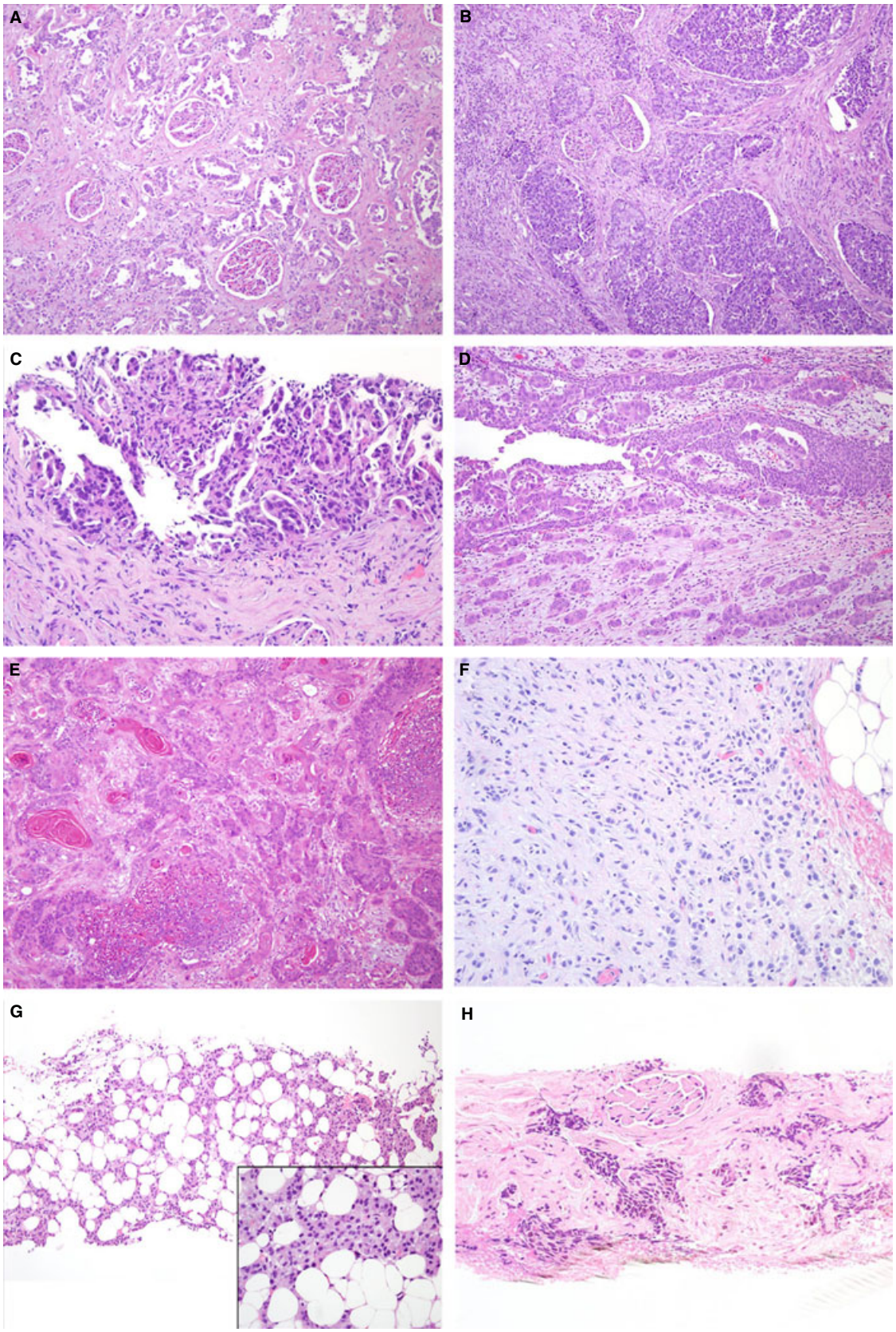
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Figure 3. Metastatic conventional adenocarcinomas showed appearances ranging from relatively well-formed glands to more poorly differentiated areas; these most commonly mimicked either urothelial carcinomas with or without glandular differentiation or collecting duct/high-grade renal cell carcinomas; for example, metastatic lung adenocarcinoma (**A**, **B**). A core biopsy of an endometrioid adenocarcinoma mimicked a urothelial carcinoma with micropapillary features (**C**). Another potentially deceptive histological feature was colonization of the pelvic urothelium that mimicked an *in-situ* urothelial component; for example, metastatic lung adenocarcinoma (**D**). Other high-grade metastatic carcinomas mimicked either urothelial carcinomas with divergent differentiation or primary carcinomas. These included: metastatic squamous cell carcinoma from the lung that mimicked either urothelial carcinoma with squamous differentiation or primary squamous cell carcinoma of the kidney (**E**); a metastatic lobular breast carcinoma that mimicked urothelial carcinoma with plasmacytoid/signet ring cell features (**F**); a metastatic lobular breast carcinoma that, on imaging and on a limited core biopsy, infiltrated the adipose tissue and mimicked an epithelioid angiomyolipoma (**G**); and a small-cell carcinoma from the lung that mimicked either urothelial carcinoma with small-cell differentiation or a primary small-cell carcinoma of the kidney (**H**). (**A**–**H**, haematoxylin and eosin).

Histologically, the vast majority of tumours were carcinomas; the majority of these were high-grade adenocarcinomas or squamous cell carcinomas that were prominently infiltrative, and mimicked urothelial carcinomas with or without divergent differentiation or high-grade unclassified/collecting duct renal cell carcinomas. One unusual differential diagnosis included a lobular carcinoma that mimicked an epithelioid angiomyolipoma, owing to its relatively low grade, monotonous appearance, extensive infiltration

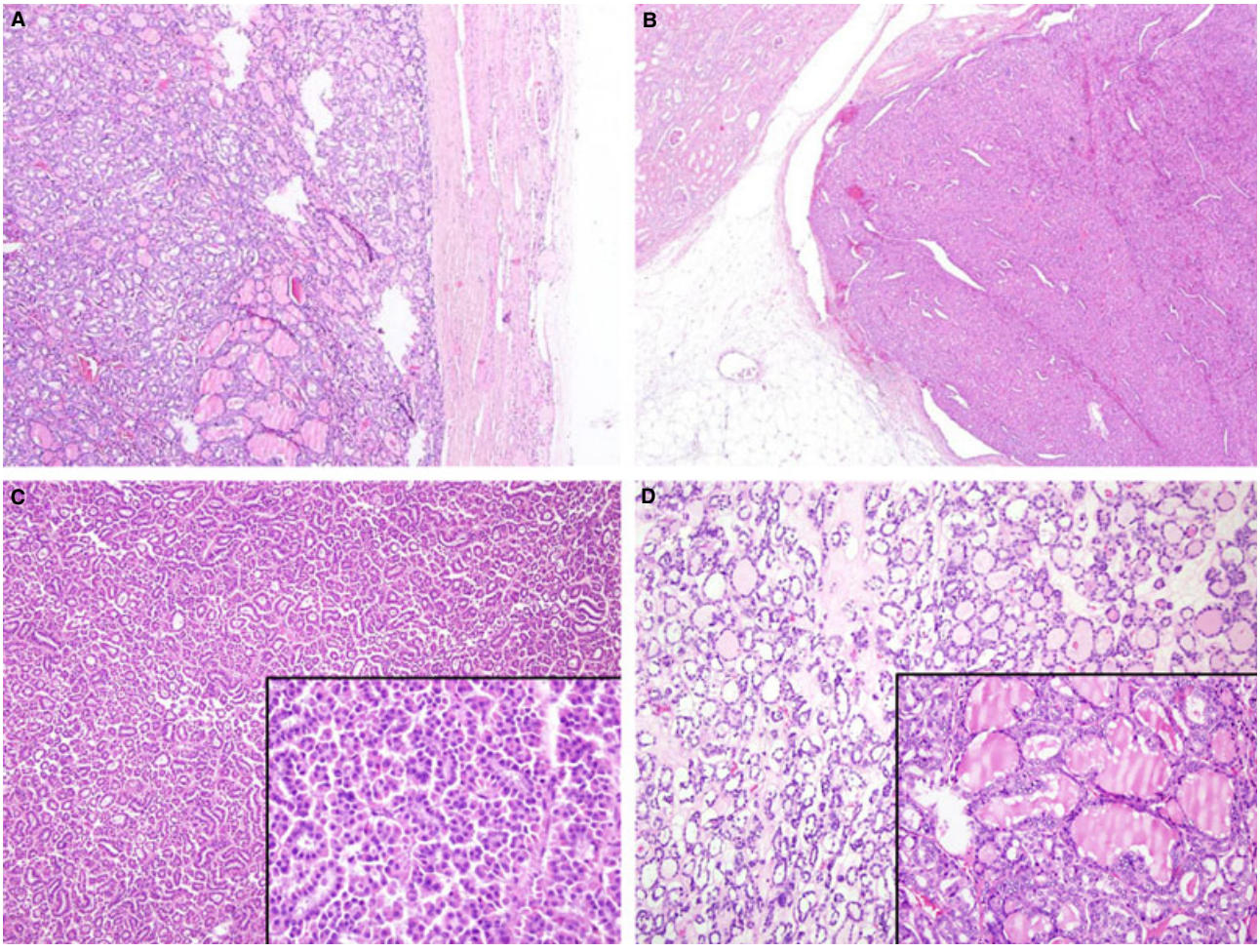

Figure 4. Metastatic papillary thyroid carcinoma and Hürthle cell carcinomas from the thyroid were relatively well circumscribed and often had a fibrous capsule, similar to low-grade renal cell carcinomas: (**A**) shows papillary thyroid carcinoma. One Hürthle cell carcinoma that was resected also grew into the renal vein (**B**), similar to renal cell carcinomas. Hürthle cell carcinomas had low-grade, monotonous nuclei and grew in tubules and pseudopapillae (**C**), mimicking low-grade papillary renal cell carcinoma. A metastatic papillary thyroid carcinoma mimicked a primary thyroid-like follicular carcinoma of the kidney at low power (**D**); however, it had the characteristic nuclear features of a papillary thyroid carcinoma (**D**, inset). (**A**–**D**, haematoxylin and eosin).

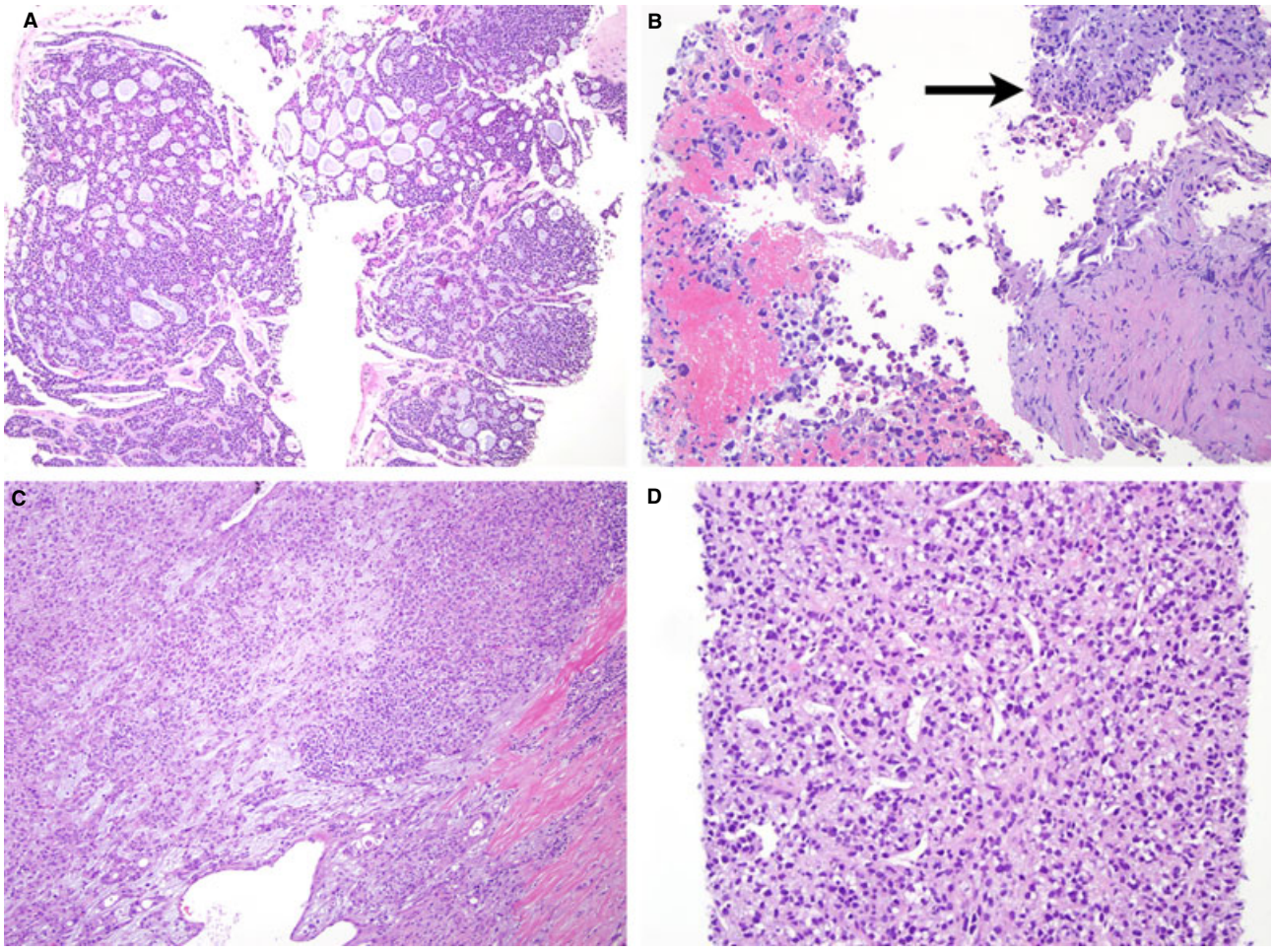

Figure 5. Unusual carcinomas and non-carcinomatous tumours included: a metastatic adenoid cystic carcinoma from the vulva (**A**); a metastatic seminoma from the testis (**B**), with characteristic associated granulomatous inflammation (arrow); a metastatic carcinoma ex-pleomorphic adenoma in a patient who had a remote diagnosis of a benign salivary gland tumour (**C**); and a metastatic epithelioid leiomyosarcoma from the prostate (**D**). (**A**–**D**, haematoxylin and eosin).

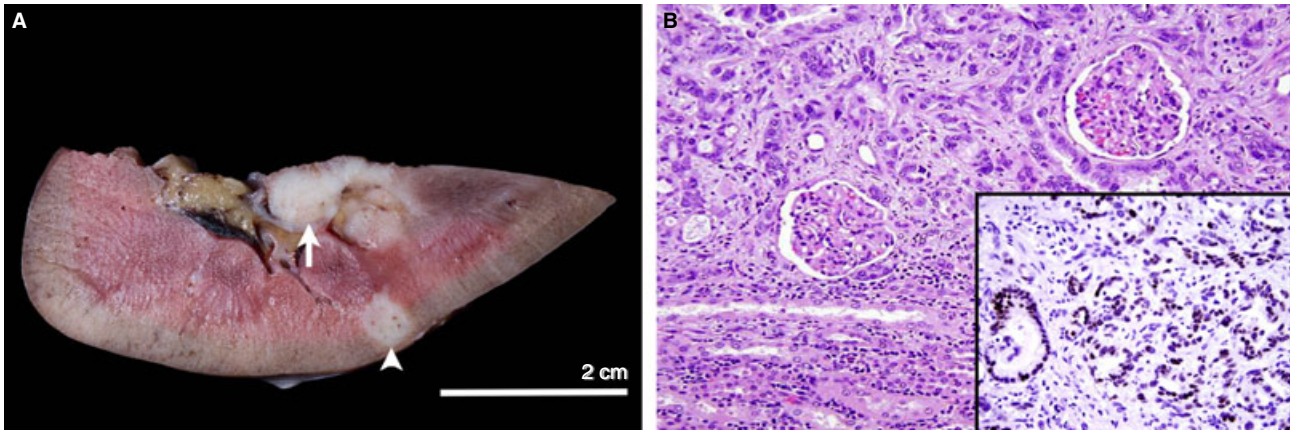

Figure 6. One patient had concurrent urothelial carcinoma of the renal pelvis (**A**, arrow) and metastatic lung adenocarcinoma (**A**, arrowhead). The metastatic carcinoma was composed of relatively well-formed, infiltrative glands (**B**) that were TTF-1 positive (**B**, inset). (**A**, **B**, haematoxylin and eosin; **B**, inset, TTF-1 immunostain).

into the perirenal fat, and the fact that it was a limited sample obtained via core biopsy. Three carcinomas from the thyroid were well-differentiated, and mimicked well-differentiated/low-grade renal cell carcinomas, either low-grade papillary renal cell carcinomas or primary thyroid follicular-like carcinomas. Finally, a small subset of unusual carcinomas and non-carcinomatous tumours were histologically distinct, and their diagnosis depended on both pattern recognition and knowledge of the patient's history. Other unusual but relatively rare histological features included colonization of the pelvic urothelium mimicking an *in-situ* component, and growth/extension into the renal vein or renal vein branches, similarly to primary renal cell carcinoma. Fortunately, and with the help of immunostains in a subset (42%) of cases, the correct diagnosis of a metastasis was reached in all cases.

Metastases to the kidney are rare, but can present a significant diagnostic challenge to the surgical pathologist. In this study of metastases to the kidney diagnosed by the use of surgical pathology material, we found that unusual clinical and radiological features were relatively common; fortunately, in the vast majority of our cases, a primary tumour had been diagnosed prior to the metastasis. Therefore, avoidance of misdiagnosis is possible, but is dependent on a high index of suspicion, diligent examination of patient records, comparison between the primary tumour and the metastatic tumour, and selected immunostains in a subset of cases.

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Conflict of interests

None of the authors have any conflicts of interest or funding disclosures.

Author contributions

Angela Wu primarily conceived the project, primarily collected and analysed the data, and was the primary author of the manuscript. Rohit Mehra and Priya Kunju helped to conceive the project and helped to edit and revise the final manuscript. Khaled Hafez and J. Stuart Wolf collected some of the data and helped to edit and revise the final manuscript.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Distribution of unusual clinical/histological features among different primary sites (no. of cases).