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A PICTORIAL PRESENTATION OF CT KIDNEY LESIONS IN ADULTS, PARTICULARLY KIDNEY CANCER: PART 3

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ABSTRACT
There are many pathologies that affect the kidneys. The focus of this paper is computed tomography of kidney cancer. Other imaging modalities for kidney pathologies are briefly discussed. A few examples of benign tumours and masses are presented. The bulk of the paper is a pictorial presentation of kidney cancer and its spread to other organs and bones. A range of unenhanced and enhanced CT images are included for self-assessment.

Keywords: renal cell carcinoma, lymphadenopathy, oncocytoma, imaging modalities

LAY ABSTRACT
Imaging of the kidneys is done to find out whether a mass in a kidney may be a benign tumour, cyst or cancer. If it is a cancer then it is important to check whether there is spread to other organs. Examples of computed tomography (CT) are used to describe the different patterns of benign and cancer lesions.

7. VARIED APPEARANCES OF KIDNEY CANCER ON CT

When assessing CT images of the abdomen it is important to differentiate clinically insignificant renal cysts from solid renal masses. The latter may also be potentially malignant. On contrast-enhanced images it is necessary therefore to determine the HU values in a ROI. Enhancement values in a ROI that are more than 10-12 HU above that of pre-contrast measurements are considered significant.[36] Masses in the kidney visualised on contrast-enhanced CT scans do not contain functioning renal nephrons. Lesions show a varying degree of enhancement and can be hyper-vascular or hypodense. The majority of renal masses have lower attenuation than normal surrounding tissue in terms of homogeneity. The rich vascular supply of a RCC means there is significant enhancement. The margin of the lesion is usually well-defined because of a pseudo-capsule which is formed by compressed surrounding renal tissue and fibrotic reaction. RCC shows significant enhancement above pre-contrast measurements: typically over 100 HU in the corticomedullary phase (also called angionephrographic or late arterial phase) and 60 HU in the delayed phase.[36]

7.1 Small versus large tumours

Small tumours are usually homogeneous with a distinct mass-kidney interface.[37] Intra-luminal haemorrhage or necrosis in larger tumours tend to be more heterogeneous. The abnormal vessels in larger tumours cause a fairly rapid washout of contrast which results in rapid de-enhancement. Such a pattern is characteristic of RCC.[36] On average 31% of RCC show visible calcification in CT images.[37]

7.2 Chromophobe and papillary RCC

Chromophobe tumours account for <1% of RCC. They form in the cells of kidney tubules and show weak homogenous enhancement. On the other hand a papillary lesion, which accounts for 7 - 15% of RCC, exhibits a more gradual enhancement.[36]

7.3 Collecting duct cancer

This a rare tumour which has an infiltrative pattern with underlying normal renal tissue. The latter is used as a framework for invasive growth.[36]

7.4 Intrarenal transitional cell carcinoma

The pattern of this cancer, in terms of renal parenchyma, is a centrally located infiltrating mass which has invaded the renal sinus fat. It has poorly defined borders and its enhancement is lower than normal renal parenchyma.[36]

7.5 Metastases to the kidney

Metastases to the kidney are rare. Renal metastases (i.e., spread from elsewhere to the kidneys) can be easily diagnosed if many bilateral renal cortical lesions enhance less than normal surrounding kidney. Common primary sites of metastasis to the kidneys are from lung cancer, breast cancer, gastric cancer, and melanoma.[36]

7.6 Transitional cell carcinoma (TCC)

This carcinoma arises from the urothelium of the renal pelvis or calyces overlying the renal parenchyma.[38] A TCC on a pre-contrast scan is typically hy-

perdense (5-30 HU) to that of urine and renal parenchyma. An advanced TCC extends into the latter in an infiltrating pattern. The normal architecture is distorted but there is preservation of the reniform shape unlike in RCC.

7.7 Anatomic extent of tumour

An important prognosis factor is the extent of a renal tumour.[36]

- Tumour can be confined within the renal capsule.
- There can be peri-nephric spread. A pseudo-capsule suggests the tumour is confined to the affected kidney.
- Ipsi-lateral adrenal glands. The incidence of metastasis in low (4.3%) but evaluation of the adrenal glands is very important for surgical management.
- Venous spread of RCC is very common thus important to carefully evaluate the renal vein and IVC.
- Renal lymph node size is important. Nodal enlargement of > 1cm short axis diameter is important in terms of tumour spread via the lymphatic system.
- Local extension and distant metastases. It is important to evaluate focal change in attenuation within adjacent organs. This is because there is a possibility of direct infiltration if there is loss of tissue planes and irregular margins between the tumour and surrounding structures.

8. RENAL CYSTS AND RENAL MALIGNANCIES

A kidney may have a cyst and tumour but they may not be causally related.[37] A tumour may occur next to a solitary cyst. It may obstruct renal tubules which in turn causes dilation and cyst formation. The latter is sometimes referred to as 'sentinel' cysts.

9. LYMPHOMA

Renal lymphoma usually occurs when there is dissemination in a patient with the disease. Diagnosis is primarily made by CT as the patterns show single or multiple masses, diffuse renal infiltration, perirenal lymphoma, or from contiguous perirenal disease.[39] As the tumour enlarges in the kidney surrounding renal tissue is compressed and destroyed resulting in the formation of an expansile mass. The more common form is the growth of foci of lymphomatous tissue. This then results in multiple masses in both kidneys. If growth continues the parenchyma becomes replaced. At CT renal lymphoma may be mimicked by solid renal masses including RCC.[39] Figures 9a and b show a proven B-cell lymphoma. Figure 9c shows a perinephric lymphoma.

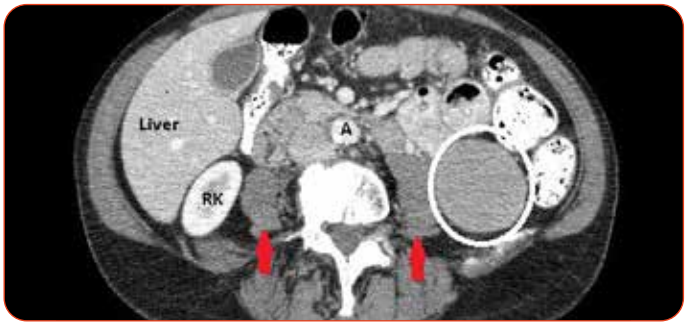

Figure 9a. Enhanced axial CT scan showing soft tissue mass in renal bed (white circle). Red arrows= psoas muscles . RK = kidney. A = aorta. Proven B-cell lymphoma (Courtesy of Professor D Kim University of Wisconsin).

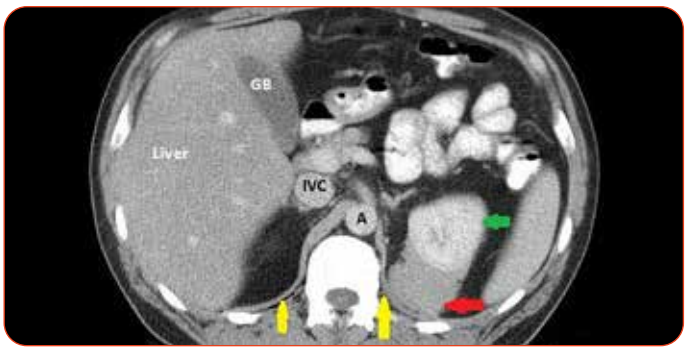

Figure 9c. Enhanced axial CT scan showing mass (red arrow) posterior to the left kidney (green arrow) in keeping with collection of perinephric lymphomatous tissue. Crus of diaphragm (yellow arrows). GB = gallbladder. IVC = inferior vena cava. A = aorta. (Courtesy of Professor D Kim University of Wisconsin).

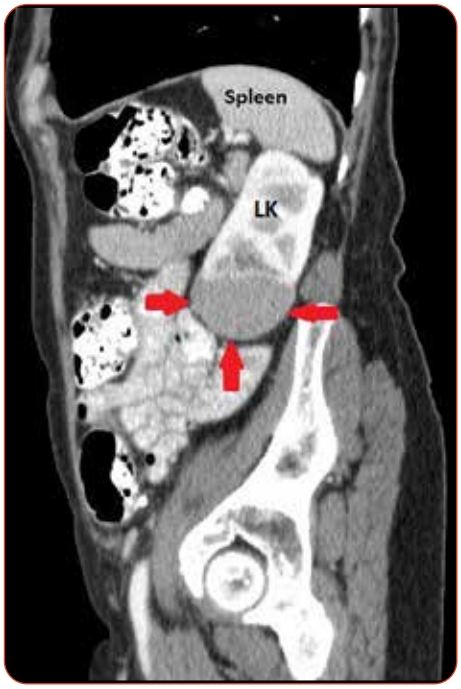

Figure 9b. Enhanced sagittal CT scan of the patient in Figure 9a showing well defined mass (red arrows) in relation to lower left kidney (LK) Lymphoma infiltrating the left kidney. Spleen is normal size. (Courtesy of Professor D Kim University of Wisconsin).

10. MULTIPHASE CT FOR EXAMINATION OF THE ABDOMEN FOR LESIONS IN THE KIDNEY AND SPREAD TO ADJACENT ORGANS

Multiphase CT improves the sensitivity of renal lesion detection. Four phase helical renal CT is the most widely used scanning protocol in many imaging departments for detecting and staging renal tumours.[36] Seth and Fishman[36] recommend an unenhanced phase for visualisation of fat and calcification and to assess degree of enhancement; corticomedullary phase to assess vascular enhancement of the kidneys and lesions, if present; nephrographic phase to assess size and shape of kidneys, and to assess small renal masses < 5cm; excretory phase. Hackworth et al[40] recommend the following for RCC detection.

- Unenhanced (noncontrast) phase
- Corticomedullary phase (also called angionephrographic or late arterial phase) obtained at 25 - 30 seconds. Longer delays (35 - 55 seconds) are often used
- Nephrographic (venous) obtained at 60 - 70 seconds but longer delays (90 - 120 seconds) are often used
- Excretory (delayed) phase obtained at 240 - 300 seconds.

Dose to a patient is high when the above multiphase CT technique is used.[40, 41] The findings of a study by Songib et al[41] was that dose to a patient can be reduced if the nephrographic phase is omitted. They reported that diagnostic quality was not compromised in a three-phase examination as small and large renal lesions were detected. They concluded that by omitting the nephrographic phase would result in a 22% reduction of ionising radiation dose to patients.

Protocol may vary from department to department based on the reason for a multiphase CT examination.[40, 41]

REFERENCES

See Part 5.