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Clinical Radiology
The Royal College of Radiologists

Recommendations for cross-sectional imaging in cancer management, Second edition

Renal and adrenal tumours

Faculty of Clinical Radiology

Contents

Renal cell carcinoma

Clinical background

Renal cell carcinoma occurs in 16 out of 100,000 individuals, with a true increase in its incidence in recent decades.[1] It accounts for 80–90% of primary malignancies of the kidney in adults and the majority are clear cell carcinoma. Less common variants are papillary and chromophobe-type carcinomas which are less aggressive. Accurate assessment of venous invasion is essential for planning surgery as, if present, the upper extent of tumour thrombus within the inferior vena cava (IVC) is vital information. Metastases are a strong indicator of a poor prognosis, and common sites include the lungs, bones and adrenal glands. The para-aortic and paracaval nodes are the regional lymph nodes, and spread to these or beyond the perirenal fascia markedly reduces patients' survival. Over recent years, nephron-sparing surgery has been increasingly used for tumours less than 4 cm as this preserves renal function. Minimally invasive techniques including laparoscopic surgery and percutaneous ablation are further treatment options.

Who should be imaged?

All patients in whom renal cell carcinoma is suspected on imaging techniques should be imaged using CT. MRI is usually reserved for patients unable to undergo CT or to address particular questions regarding venous invasion.[2]

Staging objectives

- To assess the size of the tumour.
- To assess perinephric tumour invasion.
- To identify local and regional lymph node involvement.
- To detect spread into adjacent structures including the liver, spleen and muscles.
- To identify involvement of the ipsilateral and contralateral adrenal glands.
- To identify the presence and extent of venous invasion including the ipsilateral renal vein and inferior vena cava. Where caval extension is present, it is important to determine the upper level of the extent of the thrombus in relation to the hepatic veins.
- To identify tumours in the contralateral kidney.

In small tumours, additional objectives include assessing the feasibility of nephron-sparing surgery and therefore includes:

- An evaluation of the relationship of the tumour to the collecting system of the kidney and the kidney's arterial and venous supply
- Providing optimal images to aid local surgical removal; for example, multiplanar reformats for laparoscopic removal of small tumours.

Staging

CT

CT of the abdomen and chest is the investigation of choice to stage the primary tumour and to detect metastatic disease; the pelvis only needs to be included if there are symptoms referable to this, such as bone pain.

- Pre-contrast scans through the abdomen, in order to study contrast medium enhancement features for optimal characterisation of lesions. This is not required for staging renal tumours.
- 100–150 ml of intravenous iodinated contrast medium injected at 3–4 ml/sec.
- MDCT with acquisition in the cortico-medullary phase at 30 seconds performed through the abdomen only. (This is of particular importance if considering nephron-sparing surgery in order to optimally visualise the arterial anatomy.)
- For lesion characterisation (prior to definitive diagnosis), post-contrast MDCT should be performed at 80–100 seconds to provide a true nephrographic phase of enhancement.
- Delayed urographic phase images at 8–10 minutes are useful to outlining the pelvi-calyceal system especially in patients being considered for nephron-sparing surgery.

Protocol for imaging renal tumours

Sequence	Plane	Slice thickness	Field of view	Principle observations
T1W	Axial	6 ± 2 mm	Large	Primary tumour Venous invasion Lymph node involvement
T2W±	Axial	6 ± 2 mm	Large	
T1W + fat sat	Axial	6 ± 2 mm	Large	
T1W + fat sat (+C)	Axial	6 ± 2 mm	Large	
T1W	Sagittal/coronal	6 ± 2 mm	Large	Inferior vena cava and renal vein invasion

±Respiratory triggering

- Using MDCT, slice thickness will depend on scanner capability. In general, sections are acquired at 1.25–2.5 mm and reformatted at 5 mm for viewing.

Values of $CTDI_{vol}$ should normally be below the relevant national reference dose for the region of scan and patient group (see Appendix and section on Radiation protection for the patient in CT in Section 2).

MRI

MRI is used to solve problems; for example, to assess the extent of venal caval invasion.

Abdominal surface coil (torso) should be used whenever possible. Optional sequences include T1W with electrocardiographic (ECG) gating if supradiaphragmatic extension is suspected. Gradient-echo (GRE) T1W ± C as an option to fat sat T1 (above) to assess venous patency.

Suggested renal vein/caval protocol (additional).

3D fat-saturated GRE sequence.

At the onset of examination (0 seconds), 0.1 mmol/kg patient body weight gadolinium-containing contrast medium mixed with 20 ml saline injected at 4 ml/sec with 20 seconds data acquisition at 20, 50 and 80 seconds post-injection.

PET-CT

^{18}FDG PET-CT is not commonly used for primary renal tumour assessment as ^{18}FDG is excreted in the urine and therefore uptake by tumour may be masked. Furthermore, primary renal cell carcinoma displays wide-ranging uptake of ^{18}FDG from negative through to intense. ^{18}FDG PET-CT is of limited value in evaluating metastatic disease as up to 30% of metastases are not FDG-avid. It may be useful in individual patients in difficult management situations or when standard imaging is inconclusive.[3]

Follow-up

The frequency of follow-up depends on stage and histology at presentation at surgery. In principle, larger tumours with lymph node infiltration or venous tumour extension are reviewed more frequently. Data suggest that no follow-up is needed for T1 N0 M0 tumours. T2 and T3 tumours not receiving adjuvant therapy are scanned at 24 and 60 months or when symptomatic. Patients with T3a tumours are rescanned at three to six months following surgery, as a baseline for future follow-up.

CT is the optimal technique. Only post-contrast scans to include chest and abdomen are required, unless there is a specific indication to include the pelvis.

Tips

- Following nephrectomy, unopacified loops of small bowel lying in the renal resection bed can cause confusion and bowel opacification is advised.
- As 30% of recurrent disease occurs in the chest, follow-up should always include imaging of the chest.

Adrenocortical cancer

Clinical background

Adrenocortical carcinomas (ACC) are rare and only account for 0.05–0.2% of all cancers,[4] have a bimodal age distribution (before the age of five and in the 4–5th decades), and are more often 'functioning' in children, where the majority present with virilisation (40%) or in combination with Cushing's syndrome (50%).[4] Prognosis is very poor; even in those undergoing complete resection, 85% will recur.[4]

Who should be imaged?

All patients with a histologically diagnosed adrenocortical carcinoma should be staged.

Patients presenting with adrenal hyper function especially virilisation or Cushing's syndrome.

Staging objectives

- To determine the size of the ACC.
- To detect invasion of retroperitoneal fat around the adrenal and adjacent viscera.
- To identify venous invasion.
- To identify lymph node enlargement.
- To identify distant metastases.

Staging

CT

CT is the technique of choice.

- The abdomen and chest should be examined.
- Unenhanced scan through the abdomen.
- 100–150 ml of intravenous iodinated contrast medium injected at 3–4 ml/sec.
- MDCT from lung apices to iliac crest at 65 seconds.
- Reformatting images in sagittal and coronal planes allows optimal assessment of infiltration of adjacent viscera and aids surgical planning.
- Using MDCT, slice thickness will depend on scanner capability. In general, sections are acquired at 1.25–2.5 mm and reformatted at 5 mm for viewing.

Values of $CTDI_{vol}$ should normally be below the relevant national reference dose for the region of scan and patient group (see Appendix and section on Radiation protection for the patient in CT in Section 2).

Follow-up

- CT of the abdomen as a baseline following surgery and if relapse is suspected.

Tip

- MDCT-reformatted images provide a useful vascular map prior to surgical resection.

Evaluation of the incidental adrenal gland mass in patients with cancer

Staging objectives

To distinguish between adrenal adenomas and non-adenomatous masses in patients with cancer

CT

Adrenals

- Pre-contrast scan. Attenuation value <0 HU has 100% specificity for adenoma and <10 HU has a specificity of 98% for adenomas. Homogeneous mass <10 HU requires no further characterisation. Mass >10 HU requires CT washout or MRI as below.

CT washout

- Intravenous injection of 100 ml contrast medium at 3–4 ml/sec.
- Acquisition through the adrenals at 1 minute and 15 minutes.
- Using MDCT, slice thickness will depend on scanner capability. In general, sections are acquired at 1.25–2.5 mm and reformatted at 5 mm for viewing.
- Values of $CTDI_{vol}$ should normally be below the relevant national reference dose for the region of scan and patient group (see Appendix and section on Radiation protection for the patient in CT in Section 2).
- Measure attenuation value on all scans using the region of interest (ROI) to include three-quarters of the lesion. Contrast medium washout characteristics are only applicable to homogenous adrenal masses.
- Calculate contrast medium washout using the following formula:

$$\frac{A_I - A_D}{A_I - A_U} \times 100$$

where

A_D = attenuation value at 15 min

A_U = attenuation of unenhanced image

A_I = attenuation value at 1 min

A value of greater than 60% is 98% specific for an adrenal adenoma.

MRI

Adrenals

- Gradient echo T2W sequence to characterise adrenal mass – cystic v solid.
- Dual-echo chemical shift imaging (CSI).
- Calculate signal intensity loss by evaluating the Signal Intensity Index (SII).

$$\frac{\text{SI (in-phase)} - \text{SI (out-of-phase)}}{\text{SI (in-phase)}} \times 100$$

A value exceeding SI (in-phase) >11.2% is >95% specific for an adenoma.

PET-CT

^{18}FDG PET-CT is useful to differentiate benign from malignant adrenal lesions; adenomas do not demonstrate significant ^{18}FDG uptake whereas metastases usually demonstrate intense FDG uptake. The one caveat is that adrenal hyperplasia may show low- to moderate-grade ^{18}FDG uptake.

Adenomas may have FDG uptake but this should be less or equivalent to liver uptake. Metastases have FDG uptake greater than liver.

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